Motivation and Achievement in Problem-Based Learning: The Role of Interest, Tutors, and Self-Directed Study

Lisette Wijnia

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The Role of Interest, Tutors, and Self-Directed Study

Motivatie en prestatie in probleemgestuurd onderwijs:

De rol van interesse, tutoren en zelfgestuurd leren

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VOORWOORD

Toen ik mij in de zomer van 2006 aan het oriënteren was op een onderzoeksstage voor mijn masterthesis sprongen verschillende onderwerpen er voor mij uit. Eén van de onderzoeksstages betrof een onderzoek naar probleemgestuurd onderwijs (PGO) bij Sofie Loyens. Een ander thema dat mij aansprak betrof het onderzoeksproject "Een bijbaantje of studeren" bij Eva Derous. Uiteindelijk is het een onderzoeksstage bij Sofie over motivatie in PGO met Eva als tweede begeleider geworden. Deze onderzoeksstage was heel leerzaam en leuk, daarom was ik blij dat ik in mei 2009 de kans kreeg om als promovendus te beginnen aan een promotieonderzoek over PGO bij Henk Schmidt, Sofie Loyens en Eva Derous. Voor u ligt het resultaat van dit promotietraject. Graag wil ik in dit voorwoord een aantal mensen bedanken voor alle steun, feedback en hulp die ik in de afgelopen jaren heb mogen ontvangen.

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Lisette
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Chapter 1

Motivation and achievement in problem-based learning: An introduction

INTRODUCTION

Student-centered learning methods are becoming more and more popular in education (Baeten, Kyndt, Struyven, & Dochy, 2010; Loyens & Rikers, 2011). These methods were developed as a reaction to teacher-centered learning, which focuses on the transmission of knowledge and meaning from the teacher to students. In contrast, in student-centered learning students have an active role and make use of classroom practices such as observations, generating questions, discussion, and self-study. These active learning methods are believed to promote deeper understanding of the subject matter and facilitate transfer of knowledge to other domains or to work (e.g., Baeten et al., 2010).

Problem-based learning (PBL) is an example of a student-centered learning environment. It was first developed in the mid-sixties of the last century in medical education with the aim to bridge the gap between what was learned in school and relevance for future professional practice. In PBL, small groups of students work together on meaningful problems under the guidance of a tutor (Barrows, 1996). A PBL cycle generally consists of three phases (Barrows, 1996; Schmidt, Van der Molen, Te Winkel, & Wijnen, 2009): an initial problem discussion, a self-study phase, and a reporting phase. During the initial discussion, the problem description is presented to students before they receive any other curriculum input and usually describes a phenomenon that can be observed in daily life (Schmidt 1983b; Schmidt & Moust, 2000). A problem could, for example, be a case description of a patient for whom students need to come up with a diagnosis and a subsequent treatment. Students read and discuss the problem by use of prior knowledge and common sense and eventually formulate learning issues for further self-study, which are questions that guide their self-study activities (e.g., "What is diabetes?"). Afterward, an individually-conducted, self-study period takes place. During this phase students select and study their own literature resources to answer the learning issues. After this self-study period (i.e., usually two to three days), students meet again in their tutorial groups to discuss their findings.

In addition to the goal of demonstrating the relevance of the to-be-learned subject matter by providing a meaningful and realistic context, PBL was designed with five other goals in mind (Barrows, 1986; Hmelo-Silver, 2004; Norman & Schmidt, 1992). PBL intends to help students develop (1) a flexible and extensive knowledge base, (2) effective collaboration skills, and (3) problem-solving or clinical reasoning skills. In addition, PBL aims to (4) promote students' intrinsic motivation, and (5) help them to become autonomous, self-directed learners. The current dissertation relates to the fourth and fifth goal and aims to gain a deeper understanding in the role of PBL in helping students to become autonomous, self-directed and intrinsically motivated learners and how this affects subsequent achievement. Before discussing the research aims of this dissertation, we first give an overview of motivation in education.

MOTIVATION IN EDUCATION

Motivation is an extensively researched and complex subject (Murphy & Alexander, 2000; Pintrich, 2003b; Pintrich & Schunk, 2002). Although many different conceptualizations of motivation exist, it can generally be defined as "the process whereby goal-directed activity is instigated and sustained" (Pintrich & Schunk, 2002, p. 5). Students' motivation in education is often driven by two questions: "Can I do this task?" and "Why am I doing this task?" (Pintrich, 2003a). These questions are a key element within the theoretical framework of this dissertation, namely self-determination theory (SDT), and correspond to two sets of beliefs students can have: beliefs about their ability to perform study-related activities and beliefs about the importance, interest, and utility of these activities. Figure 1.1 presents an overview of these motivational beliefs.

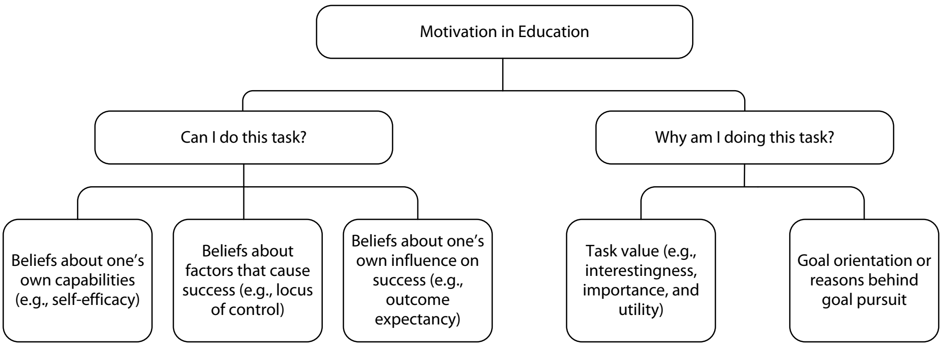

Figure 1.1. Overview of motivational beliefs in education (e.g., Pintrich, 2003a; Skinner, 1996).

Can I Do this Task?

Students' control beliefs can give an answer to the question: "Can I do this task?" (Pintrich, 2003a). Perceived control constructs can be classified in three groups based on the relationship between the student who exerts control, the pathway through which it is exerted, and the desired (or undesired) learning outcomes (Skinner, 1996; see Figure 1.1). The first group of perceived control constructs concerns students' beliefs about their *personal capabilities or skills*, such as self-efficacy beliefs and perceived competence (Skinner, 1996). Self-efficacy beliefs concern students' beliefs about their performance capabilities in school in general or for a specific subject (Bandura, 1997). Self-efficacy beliefs have been positively associated with adaptive study behaviors and actual achievements in the classroom (Pintrich, 2003a).

The second group of constructs refers to students' beliefs about the *factors that influence success in school*, such as ability, effort, others, or chance (Skinner, 1996). Within these constructs an internal locus of control or student-related causes are contrasted with an external locus of control or non-student-related causes. Examples of internal causes can refer to specific behaviors (e.g., effort) or attributes (e.g., ability) of the student. In contrast, external causes are beyond the students' control and can be divided in those that emanate from others (e.g., task difficulty) or factors outside of human control (e.g., chance). In general it is believed that perceptions of internal control are more beneficial for learning than perceptions of external control (Pintrich, 2003a).

The final group of perceived control constructs refers to beliefs about one's own influence on success. It concerns the extent to which an agent can intentionally attain desired outcomes or prevent undesirable outcomes (Skinner, 1996). Examples of these beliefs are outcome expectations or competence expectancy in which students perceive a linkage between their doing and the outcome (Bandura, 1997; Pintrich, 2003a). Skinner, Wellborn, and Connell (1990) have demonstrated that children's expectations about whether one can influence success and failure in school promoted or undermined active engagement in class and subsequent achievements. In short, students' control beliefs about their own capabilities, about what factors influence learning outcomes, and about whether they can influence success of failure experiences affect study-related behaviors, such as the amount of effort one puts forth, and achievement (e.g., Pintrich, 2003a; Skinner, 1996).

Why Am I Doing this Task?

Students' goals and perceived task value can answer the question "Why am I doing this task?" Goal pursuit is an important component in many motivational theories and models. These theories are not only focused on the specific target one is trying to attain or the general content of a goal, but also on the goal orientation and value of goal pursuit (Pintrich, 2003a; see Figure 1.1). *Goal orientation* refers to a general disposition towards developing ability (i.e., learning/mastery goal orientation) versus demonstrating ability (i.e., performance goal orientation) during goal pursuit (e.g., Dweck & Leggett, 1988). *Task value* often refers to the interestingness, importance, and utility of a task (Eccles, 1983; Eccles & Wigfield, 2002; Wigfield & Eccles, 2000).

With respect to the *interestingness* of tasks, a distinction is often made between individual, situational, and topic interest (e.g., Hidi, 2006; Krapp, 2002; Renninger, 2000; Schraw & Lehman, 2001). Individual interest concerns a general liking or positive attitude toward a task that is relatively stable and enduring, whereas situational interest is triggered by aspects of the environment, such as novelty, and is therefore more short term and context specific. The third form of interest, topic interest is an anticipatory response to a topic or task that is influenced by both individual and situational interest (Ainley, Hidi, & Berndorff, 2002; Hidi, 2006; Mason, Gava, & Boldrin, 2008). Topic interest can be described as an expectation of interest that is elicited by a word or a paragraph when a specific topic or task is first introduced. High interestingness of the task is associated with better learning outcomes.

The *importance* component of task value refers to students' perceptions of personal salience of the task (Eccles, 1983; Wigfield & Eccles, 2000). For example, a task can be important for a students' personal development or for his or her future life goals regardless of the interestingness of the task. Importance of a task is related to students' choice for and persistence in a task (e.g., Deci & Ryan, 2000; Pintrich, 2003a). Finally, *utility* value refers to students' instrumental motivation (e.g., Eccles, 1983). It concerns their beliefs about the degree to which a task is useful or instrumental for attaining immediate or future plans or goals, such as doing well in college or finding a future job.

Self-Determination Theory

According to SDT, all humans have three innate, basic needs: the need for autonomy, competence, and relatedness (Deci & Ryan, 1985, 2000; R. M. Ryan & Deci, 2000a, 2000b). Students' experience of fulfilment of these basic needs can answer the question "Can I do this task?" In a learning context, autonomy refers to students' need to feel internal control of their own learning process, which aligns with the construct of locus of control. The need for competence entails the need to feel self-efficacious or able to handle study-related activities. Finally, relatedness refers to the level of belongingness with others, such as peers and teachers. The social context of a learning environment can thwart or support students' basic needs. The extent to which learning environments can fulfil students' basic needs affects their motivation.

SDT distinguishes various types of motivation, based on students' reasons for performing study-related activities. Deci and Ryan have proposed a self-determination continuum, ranging from amotivation to intrinsic motivation (see Figure 1.2). With this continuum Deci and Ryan shift the focus away from the traditional distinction between intrinsic and extrinsic motivation toward a differentiation between autonomous and controlled motivation. In contrast to classical views on extrinsic motivation, in SDT it is argued that extrinsic motives for studying are not necessarily harmful for learning outcomes as long as students experience a sense of autonomy or self-determination during studying. Table 1.1 presents an overview of SDT constructs and how they relate to constructs from other theories as presented in Figure 1.1.

Table 1.1
Overview of Self-Determination Theory and Related Constructs

Theory	Construct				
Self-determination theory	Amotivation	External motivation	Introjected motivation	Identified motivation	Intrinsic motivation
Locus of control	Lack of control	External	Somewhat external	Somewhat internal	Internal
Task value	Not valuable	Instrumental motivation		Importance	Interest
Goal orientation		Performance goal		Mastery goal	

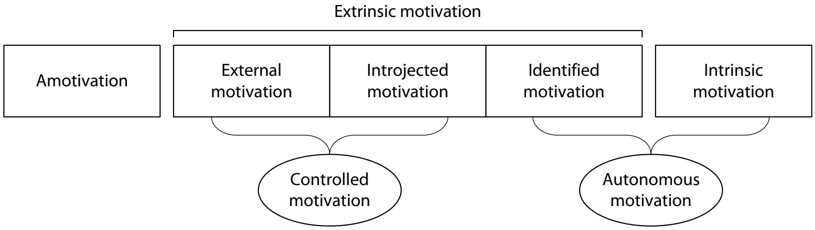

Figure 1.2. Self-determination continuum (e.g., Deci & Ryan, 2000, R. M. Ryan & Deci, 2000a, 2000b).

Students with autonomous motivation are regulated by choice and volition. Autonomously motivated students study in a self-empowered or self-directed manner. Intrinsic motivation is the highest level of autonomous motivation. Students with intrinsic motivation study because studying in itself is enjoyable or interesting. However, also more identified forms of extrinsic motivation are considered to be autonomous as can be seen in Figure 1.2. These students will have an extrinsic reason for studying, but that reason is integrated with their own intrinsic goals and needs. For example, a psychology student may voluntarily choose to invest effort in a statistics course, even if he or she does not find this enjoyable, because this course will help him or her achieve an important life goal: becoming a psychologist. In other words, tasks that are perceived as interesting or important can elicit autonomous motivation. In terms of goal orientations, it is assumed that autonomous motivation has close links with mastery goal orientation (e.g., Assor, Vansteenkiste, & Kaplan, 2009).

Controlled motivation, on the other hand, is regulated by an internal or an external pressure. Students with introjected motivation are regulated by internal pressures such as shame or guilt. Students with external motivation are regulated by external contingencies, such as demands of others, threat of punishment, or extrinsic rewards. The concept of introjected motivation closely aligns with having a performance goal orientation (Assor et al., 2009; Deci & Ryan, 2000), whereas the concept of extrinsic motivation is assumed to have positive associations with instrumental motivation/high utility value (Noels, Pelletier, Clément, & Vallerand, 2003). As can be seen in Figure 1.2, in addition to autonomous and controlled motivation, amotivation is distinguished. Amotivation is characterized by the relative absence of motivation (Deci & Ryan, 2000; R. M. Ryan & Deci, 2000a, 2000b). It is a state in which students lack an intention to act and a sense of personal causation. Amotivation can occur when the task or activity is not valued, when students do not feel competent to do a task, or when they believe acting will not lead to a desired outcome.

Motivation and Student Outcomes

Although different motivational theories and models exist, all theories are concerned with predicting student outcomes, such as students' involvement or engagement in tasks, persistence, actual performance, and affect (e.g., Deci & Ryan, 2000; Pintrich, 2003a; Pintrich &

Schunk, 2002). For example, SDT-based research has demonstrated that autonomous motivation has been associated with more favorable cognitive, affective, and behavioral outcomes relative to controlled motivation and amotivation (Deci & Ryan, 2000, 2008a; R. M. Ryan & Deci, 2000b; Vansteenkiste, Lens, & Deci, 2006). To gain a more complete thorough understanding of motivational processes in PBL, we also focused on learning outcome measures such as engagement and persistence, experience of positive and negative affect, test performance, and successful completion of the bachelor's program.

EFFECTIVENESS OF PBL FOR MOTIVATION

As mentioned above, PBL intends to help students to become intrinsically motivated, autonomous learners (Norman & Schmidt, 1992; Schmidt et al., 2009). Several studies have investigated the overall effectiveness of PBL for students' motivation. Most of these studies have focused on the effect on students' control beliefs, whereas fewer studies have focused on the effectiveness of PBL for students' interest or intrinsic motivation.

The Effectiveness of PBL for Students' Control Beliefs

With respect to the effectiveness of PBL for students' control beliefs, most studies have focused on the effect of PBL on students' beliefs about their personal capabilities or skills, such as self-efficacy beliefs. PBL intervention studies, in which PBL was often only implemented for a short time period and only for one of the subjects in a larger educational program, have generally found that students' beliefs about their own capabilities can increase after participating in a PBL course. For example, Pedersen (2003) found that a computer-enhanced PBL environment about the solar system increased children's perception of their own capability to make judgments about what to do. Similar results were found for PBL interventions on school children's self-efficacy beliefs in PBL science classes (Brown, Lawless, & Boyer, 2013; Liu, Hsieh, Cho, & Schallert, 2006). Moreover, Dunlap (2005) found significant increases in undergraduate students' self-efficacy beliefs during a 16-week PBL capstone course in software engineering.

Nevertheless, Papinczak, Young, Groves, and Haynes (2008) found that PBL students' self-efficacy beliefs significantly decreased during a 6-7 months postgraduate medical education course. In addition, cross-sectional studies that compare lecture-based (LB) students with PBL students have found mixed results in terms of students' beliefs about their own capabilities. Hwang and Kim (2006) found that PBL students' level of confidence in their ability to learn was higher when compared to LB students in an Adult Health Nursing course. However, other studies found no differences for students' self-efficacy beliefs (Galand, Raucent, & Frenay, 2010; Sungur & Tekkaya, 2006). Finally, a study by Loyens, Rikers, and Schmidt (2009) indicated that students in a LB course agreed less on self-perceived ability to learn the subject matter throughout the years, while the scores on this construct remained at the same level for students enrolled in a PBL curriculum. Their study concerned a cross-sectional study that both examined the effects of study year (i.e., first-, second-, and third-year students) and learning environment (i.e., PBL and LB).

Two studies have investigated the effect of PBL on students' beliefs about the factors that influence success in school, such as ability, effort, others, or chance. For instance, L. Martin, West, and Bill (2008) investigated the impact of a 12-week PBL intervention on students' locus of control. Their results indicated that scores on pretest and posttest measures did not significantly change over the course of the program. Similarly, Sungur and Tekkaya (2006) did not find an effect on students' perceived internal control of learning when comparing an experimental PBL group to a teacher-centered control group.

In short, studies with a pretest and posttest design have usually found positive effects of PBL in terms of students' beliefs in their own capabilities, whereas cross-sectional studies have found mixed results. Moreover, the studies that investigated the effect of PBL on internal control beliefs, have not found increases over time or differences between PBL and teacher-centered groups.

The Effectiveness of PBL for Students' Interest and Intrinsic Motivation

Several studies have examined the effect of PBL on students' motivation for studying. For example, Loyens et al. (2009) examined the effect of the learning environment on students' motivation to learn and found that PBL students scored lower than LB students. Because motivation was measured in a one-dimensional way and the scale included both items reflecting intrinsic and extrinsic motivation it is difficult to determine which aspects of motivation were affected.

Other studies that have focused on the effects of the learning environment on students' perceptions of task value, have generally found positive effects of PBL. For example, Sungur and Tekkaya (2006) found that students in an experimental PBL group scored higher on task value (i.e., interest, importance, and utility) than students in the teacher-centered group. Also, Hwang and Kim (2006) demonstrated that PBL students reported higher enjoyment and interest than the LB group, whereas no differences were found for importance or relevance. However, two studies that examined the effect of a PBL intervention on children's future interest in science education found mixed results. Brown et al. (2013) found that students' interest in future educational experiences increased during the course of the program, whereas Liu et al. (2006) found no differences between pre- and posttest measures of interest in science.

Other studies have examined the effect of PBL on students' goal orientation. PBL intervention studies have found positive effects on students' intrinsic goal orientation. For example, Pedersen (2003) found an increase in students' intrinsic goal orientation. Specifically, children reported a higher preference for challenging assignments, more interest, and a preference for figuring out problems on their own instead of asking for teacher guidance after the PBL intervention. Similarly, Sunger and Tekkaya (2006) found higher scores on intrinsic goal orientation for students in the PBL group when compared to the LB group, whereas no differences were found on extrinsic goal orientation. Nevertheless, Galand et al. (2010) did not find differences in students' mastery and performance goal orientation between a PBL and a LB cohort.

Finally, L. Martin et al. (2008) examined the effects of a 12-week PBL intervention in sports science on students' self-determined motivation. The intervention had a positive effect on students' intrinsic motivation, whereas no differences were found for identified, introjected, external, and amotivation. In sum, studies that examined relatively short-term PBL interventions demonstrated that PBL can indeed positively affect students' interest or intrinsic motivation (e.g., L. Martin et al., 2008; Pedersen, 2003), whereas it remains to be seen if similar effects are achieved in existing PBL curricula in higher education (e.g., Galand et al., 2010).

Research Aim I: Examining Differences in Motivation and Self-Regulated Learning between PBL and LB Students

To summarize the above, some prior studies suggest that a PBL environment can enhance students' control beliefs and intrinsic motivation. The most positive effects have been found for intervention studies in which PBL was often only implemented for a short time period and only for one of the subjects (e.g., science education; Pedersen, 2003; Sungur & Tekkaya, 2006). In contrast, existing PBL curricula in higher education have not always found results in favor of PBL (e.g., Galand et al., 2010; Loyens et al., 2009; Papinczak et al., 2008). In Study 1 of Chapter 2, we therefore investigated potential differences in autonomous/controlled motivation and competence beliefs between students enrolled in an existing PBL versus LB environment. In this PBL environment, PBL is implemented in the whole program instead of just one of the courses.

In addition to motivational beliefs, students' self-regulated learning (SRL) skills are measured. In PBL, knowledge is achieved through self-directed learning (SDL). SDL is a multifaceted construct that includes students' autonomy and SRL (Candy, 1991; Loyens, Magda, & Rikers, 2008). SDL requires students to take more initiative in and control over their learning processes, SRL skills such as management of study time and the learning environment, and the use of cognitive strategies, such as rehearsal and elaboration are therefore essential skills for effective self-directed study (e.g., Loyens et al., 2008).

MOTIVATIONAL ASPECTS OF PBL

Besides examining the overall effectiveness of PBL for students' motivation, it is even more important to examine if and how certain aspects of PBL can affect students' motivation and achievement. PBL is often believed to enhance students' motivation for two main reasons: the use of problems as start of the learning process and the student-centered nature of the learning environment that stresses the role of students' autonomy. This is investigated in Chapters 3 to 5.

Problems as a Trigger for Students' Interest

Problems are an important element in PBL. They are designed to be meaningful and challenging (e.g., Barrows, 1996). As problems form the starting point of the learning process, they are discussed with limited prior knowledge. Therefore, students cannot explain the problem completely during the initial discussion and will experience a knowledge or information gap. According to Schmidt (1983a) this incongruence between prior knowledge and the knowledge that is needed to explain the problem will increase students' intrinsic motivation. The results of two experimental studies by Schmidt (1983a) demonstrated that students who participated in a problem analysis of a problem on osmoses reported higher interest in the topic.

When students experience an information gap between what one knows and what one wishes to know their curiosity can be sparked (Loewenstein, 1994). This can result in focused attention and willingness to learn, because people are naturally inclined to engage in activities that interest them and that can help them master the environment (e.g., Deci & Ryan, 2000). Especially situational interest will be sparked by this knowledge gap (Schmidt, Rotgans, & Yew, 2011). As mentioned above, situational interest is triggered by environmental features, such as novelty (e.g., Hidi, 2006). Research investigating the development of interest during a PBL cycle indeed demonstrates that interest increased after the problem was presented and decreased afterward when students gained more knowledge about the problem (Rotgans & Schmidt, 2011b; 2014). Moreover, Rotgans and Schmidt (2014) found support for a knowledge-deprivation account of situational interest, by demonstrating that the lack of prior knowledge to understand a problem and the awareness that students lack knowledge can increase situational interest.

Although consideration of situational interest is important, students do not come to a course as blank slates and individual differences among students might influence the interestingness of problems. For example, Noordzij and Wijnia (2014) indicated that the quality of the problem - and in specific the interestingness of a problem - only increased autonomous motivation for students with a learning goal orientation, but not for students with a performance goal orientation. Likewise, at the beginning of a course students can have specific expectations about the content of the course that can affect their learning (Ainley et al., 2002). Therefore, it is also important to examine the role of students' topic interest as measured before the problem is presented or the course has started. Chapter 3 reports results on this issue.

Student-Centered Learning and Autonomy Support

In addition to the problem and problem analysis, the student-centered nature of the learning environment might also enhance students' autonomous motivation and learning skills. Student-centered learning environments are sometimes considered to be autonomy supportive (e.g., Black & Deci, 2000). A learning environment or teacher can provide autonomy support by offering students a certain degree of choice in learning materials; by showing respect; by understanding students' perspective and feelings concerning learning materials, by communicating why (uninteresting) study activities are relevant for students' goals; and by using non-controlling language (e.g., Black & Deci, 2000; Katz & Assor, 2007). In contrast, controlling learning environments ignore the students' perspective; rely on external contingencies, such as rewards, deadlines, or punishment; or pressure students to behave or think in a certain way (Soenens & Vansteenkiste, 2010). Several autonomy-supportive elements are present in PBL environments such as the guiding role of tutors and the emphasis on students' autonomy through self-directed study. Nevertheless, empirical evidence to support the claim that PBL learning environments are perceived as autonomy supportive is lacking.

Autonomy-supportive tutors

First, teachers or tutors in PBL curricula have a mere guiding, facilitating role instead of a directive one, leaving ample room for students' autonomy (e.g., Barrows, 1996; Schmidt et al., 2009). Research has shown that tutor behaviors such as cognitive congruence can influence students' situational interest (Rotgans & Schmidt, 2011a). Tutors are believed to be cognitively congruent when they have the ability to express themselves using the students' language and concepts and to understand the problems students encounter with the subject matter (Schmidt & Moust, 1995). In addition, qualitative studies have suggested that too dominant and too directive tutors are perceived to have a negative effect on students' commitment and learning (Hendry, Ryan, & Harris, 2003).

These studies illustrate that tutor behaviors can indeed influence students' interest and motivation. However, knowledge about the effects of autonomy-supportive and controlling tutoring on motivation and subsequent performance in PBL is lacking. Investigating effects of autonomy-supportive and controlling teaching in PBL is important because most studies investigating instructional styles have been conducted in teacher-centered environments (e.g., Jang, Reeve, & Deci, 2010; Vansteenkiste et al., 2012). It is unclear whether similar effects on motivation and learning outcomes will be found in student-centered learning environments.

Motivational effects of self-directed study

In student-centered learning environments students are offered autonomy and responsibility over their own learning process through self-directed learning. For example, in PBL environments students are often asked to select and study their own literature resources in order to answer the learning issues. Students are therefore often offered a certain degree of choice in learning materials. A meta-analysis on the effect of choice has indicated that choice can positively affect perceived competence, intrinsic motivation, and performance (Patall, Cooper, & Robinson, 2008). This might imply that having a choice in learning materials can also be beneficial in PBL environments.

Nevertheless, some researchers have expressed concerns about the autonomy and responsibility students are offered in PBL and have described it as unstructured, chaotic, and stressful (Duke, Forbes, Hunter, & Prosser, 1998; Sierens, Soenens, Vansteenkiste, Goossens, & Dochy, 2006). Kirschner, Sweller, and Clark (2006) described PBL as a minimally guided instructional approach. They argued that PBL would be less effective and efficient for learning than direct instruction, such as worked examples that show students the step-by-step procedure for solving the problem (Cooper & Sweller, 1987; Sweller & Cooper, 1985). Therefore, it is interesting to examine the effectiveness of the self-directed study phase in PBL for students' motivation and achievement.

Research Aim II: Stimulating Motivation and Achievement in PBL

A second objective of the current dissertation is to identify important factors that can enhance motivation in PBL. This goal was first addressed in a qualitative focus group study (Study 2 of Chapter 2). Focus groups are discussion groups around one central question (Kitzinger, 1995). In the focus group study we aimed to identify specific PBL aspects that can motivate or demotivate students. In addition, partially based on the results of the focus group study, we examined the role of students' initial interest in a topic, tutors' instructional styles, and the self-study phase for students' motivation and achievement in Chapters 3 to 5.

In the experimental study and the field study presented in Chapter 3, we investigated the effects of students' topic interest about a problem or course and the role of tutor-provided autonomy support or controlling teaching on students' motivation and subsequent learning outcomes, such as performance or participation during group discussions, persistence, and test performance. In Study 1 tutor instructions were manipulated to be autonomy supportive or controlling; topic interest was measured before students received the problem. A subsequent field study was conducted to cross-validate the results of Study 1. As it would be unethical to manipulate tutor instructions in a real PBL setting, two questionnaires were used to measure students' perceptions of tutor-provided autonomy support and controlling teaching.

In Chapters 4 and 5 the self-study phase in PBL is investigated. Inspired by the debate concerning the effectiveness of PBL and other constructivist methods (e.g., Kirschner et al., 2006; Tobias & Duffy, 2009), the experimental study presented in Chapter 4 examined the role of direct instruction during the self-study phase of PBL. Specifically, it was investigated whether providing students with an integrated model answer to the learning issues, in which information of several literature resources was integrated, would be more effective and efficient than letting students construct their own answers as is the case during a conventional PBL self-study phase in which students select and integrate information from a restricted set of relevant literature resources, and study those with the aim of finding an answer to the learning issues. The integrated model answer constitutes an adequate "solution" or answer based on those same literature resources, comparable to the type of answer tutors in PBL receive to prepare themselves for group meetings.

In the experimental study presented Chapter 5, we were interested in the role of student-selected literature resources during self-study in PBL. Research has indicated that both instructors and students in PBL sometimes report frustration or uncertainties with respect to students' responsibility during the PBL process (Dahlgren & Dahlgren, 2002; Miflin, Campbell, & Price, 1999, 2000; Moust, Van Berkel, & Schmidt, 2005). To cope with these frustrations, in several PBL environments students no longer self-select their own literature resources, but instead read mandatory, instructor-selected literature resources. In an experimental study, we therefore investigated the effect of student-selected versus instructor-selected resources on motivation and performance in PBL.

PREDICTORS OF ACADEMIC ACHIEVEMENT IN PBL

As mentioned earlier in this introduction, all motivational theories aim to predict students' learning outcomes. Student-centered, active learning environments, such as PBL usually have lower dropout rates (Braxton, Milem, & Sullivan, 2000; Schmidt et al., 2010; Van den Berg & Hofman, 2005). Nevertheless, graduation rates of students enrolled in the three-year psychology bachelor's program at Erasmus University Rotterdam have shown that on average one-third of the students leave the program without a degree (De Koning & Loyens, 2011). This graduation rate is in line with the average graduation rates reported in other institutes of higher education (Organisation for Economic Co-Operation and Development, 2013) and suggest there is room for improvement in terms of student retention. Preventing attrition and study delays are important, because they are time consuming and costly from both a student and institutional perspective.

De Koning, Loyens, Rikers, Smeets, and Van der Molen (2012) investigated the association of several student characteristics with achievement in a PBL bachelor's program. They examined the predictive value of demographic characteristics, prior educational attainments (e.g., in secondary school), intelligence (i.e., verbal intelligence, numerical intelligence, and special intelligence), Big Five personality factors, and tutor ratings of observed learning activities in meetings. Tutor ratings of observed learning activities are ratings of students' preparation, participation, and fulfillment of roles such as chairing a meeting (Loyens, Rikers, & Schmidt, 2007a) and can be considered a form of engagement. Results demonstrated that tutor ratings of observed learning activities/engagement, prior educational achievements, conscientiousness, and verbal ability were consistent predictors of academic achievement (De Koning et al., 2012). Loyens et al. (2007a) also identified tutor ratings as one of the best predictors of achievement and dropout in PBL.

Nevertheless, less is known about the predictive value of students' motivation early in the year for students' subsequent achievement. In addition, if tutor ratings of engagement in class are predictive of achievement in PBL, can tutors then also predict which students will be successful during the bachelor's program? Therefore, in the current dissertation, we examined the predictive value of student motivation (Chapter 6) and the usefulness of tutor judgments (Chapters 7 and 8) in predicting academic success.

Research Aim III: Predicting Academic Success and Failure in PBL

The role of motivation for students' achievement is examined in Chapter 6. Specifically, the relationships among motivation, affect, tutor ratings of engagement, and academic achievement during the first year of college in a PBL bachelor's program are investigated. Three alternative models were tested to examine the direct versus indirect effects of motivation on academic achievement through affect and tutor ratings of engagement.

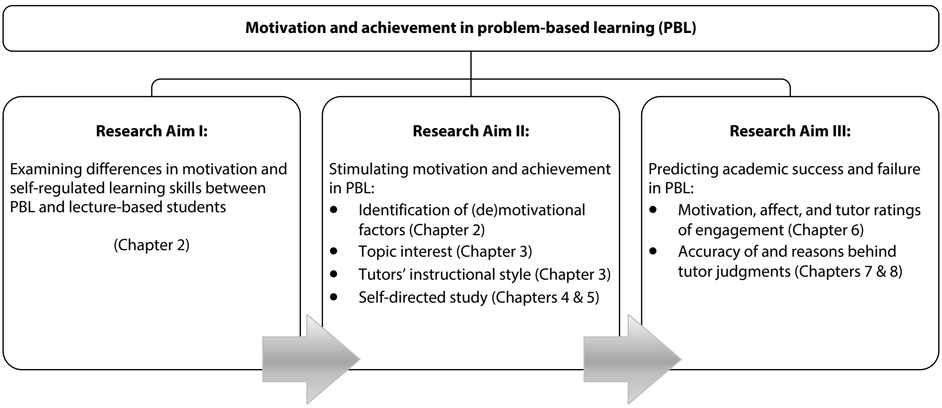

Figure 1.3. Overview of this dissertation.

Chapters 7 and 8 focused on the value of tutor ratings in predicting attrition or successful completion. In the study described in Chapter 7, tutors are asked to judge the chance that each student in their tutorial group would successfully complete the first year and the three-year bachelor's program. In addition, it was investigated whether tutor judgments are predictive of academic achievement above and beyond the influence of prior educational attainments, which have been found to be a consistent predictor of academic achievement (e.g., Central Bureau for Statistics, 2009; De Koning et al., 2012).

Finally, in Chapter 8, reasons behind tutor judgments were examined. Earlier research has indicated that teacher judgments often not only reflect students' actual ability, but are also influenced by other student characteristics such as motivation or engagement (Kaiser, Retelsdorf, Südkamp, & Möller, 2013). Therefore, in Chapter 8 it was investigated which student characteristics (e.g., ability or intelligence, motivation, personality, and engagement during meetings) tutors consider important for academic achievement and influence their judgments. The three research aims of this dissertation are summarized in Figure 1.3.

Chapter 2

Investigating effects of problem-based versus lecture-based learning environments on student motivation

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The data presented in Chapter 2 were collected by the first author during an internship under the supervision of Sofie Loyens in partial fulfillment of the requirements for the degree of Master of Science at Erasmus University Rotterdam.

The data presented in this chapter were also presented at the conference of the American Educational Research Association (AERA), Denver, Colorado, May 2010; the 4th interactional conference on Self-Determination Theory, Ghent, Belgium, May 2010; and the ICO Toogdag, Amsterdam, The Netherlands, November 2010.

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ABSTRACT

This study examines the effects of two learning environments (i.e., problem-based learning [PBL] versus lecture-based [LB] environments) on undergraduates' study motivation. Survey results demonstrated that PBL students scored higher on competence but did not differ from LB students on autonomous motivation. Analyses of focus groups further indicated that active learning aspects, such as collaboration are perceived as motivating. However, controlling elements (i.e., mandatory presence) and uncertainty (i.e., in selecting the correct and sufficient literature) were described as detrimental for students' motivation. In conclusion, PBL does not always seem to lead to higher intrinsic motivation. It is therefore crucial to build in the right amount of structure in learning environments and balance controlling elements versus autonomy, even in learning environments that are intended to be motivating for students.

INTRODUCTION

It is generally agreed that motivation is beneficial for learning and achievement: Motivated students invest more time in their courses (Pintrich, 2003a; Pintrich & Schunk, 2002) and are more likely to complete their study programs, whereas unmotivated students are more prone to drop out (e.g., Vallerand & Bissonnette, 1992). The social context of a learning environment can influence the motivation students experience (Black & Deci, 2000). For instance, the way instructions are framed, can influence students' subsequent learning process and performance (Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004). Differences in learning environments can therefore influence students' motivation and self-regulated learning (SRL). The present study aims to investigate the differential effects of a problem-based learning (PBL) environment versus a more conventional lecture-based (LB) environment on students' motivation and SRL.

PBL environments differ from LB environments by the type of support and study activities that are provided. Although there is considerable variation between PBL curricula, all PBL environments share six core characteristics (Barrows, 1996; Hmelo-Silver, 2004; Schmidt et al., 2009). First, PBL is a student-centered learning environment. Students work together in small groups (2) under the guidance of a tutor (3). A problem is used as the starting point of the learning process, to activate prior knowledge (4). In addition, a large amount of time is spent on self-study (5) and only a few complementary lectures are available (6). The PBL method differs from teacher-centered, LB environments in which courses are taught to much larger batches of students with less room for student activity (Kember, 2009; Lammers & Murphy, 2002).

In a recent meta-analysis by Schmidt et al. (2009), a PBL curriculum in medical education was found to be effective for student learning. For instance, it was found that PBL students and graduates had better interpersonal skills and practical medical skills compared to students from more conventional medical curricula. In addition, dropout was lower in the PBL curriculum and students completed their study programs faster than the traditional medical students. Moreover, students rated the quality of the PBL curriculum higher than the other medical curricula, indicating that students were generally more satisfied with the quality of the curriculum.

One of the goals of PBL is to enhance students' intrinsic motivation to study (Hmelo-Silver, 2004; Norman & Schmidt, 1992). Hmelo-Silver (2004) concluded in this respect that few studies directly examined intrinsic motivation in PBL. Most research focused on students' satisfaction or confidence. Several studies have been conducted since, that indicate that PBL can influence intrinsic motivation.

For instance, the quality of a problem can influence motivation (Noordzij & Te Lindert, 2010). Specifically, the interest level of problems in PBL was positively associated with intrinsic motivation. Moreover, several studies demonstrate that quasi-experimental manipulations and PBL interventions can increase students' motivation. For instance, Pedersen (2003) found that 6th grade students' intrinsic motivation significantly increased after working 13 weeks with the computer-based PBL program Alien Rescue. Similar increases were found for self-efficacy (i.e., students' beliefs about their ability to perform [future] study tasks) when this program was used in another sample of students (Liu et al., 2006). Also, other PBL interventions have shown positive effects on student motivation. L. Martin et al. (2008) demonstrated that a 12-week PBL intervention increased students' intrinsic motivation. However, no significant differences were found for extrinsic motivation and self-esteem. Moreover, a study by Dunlap (2005) found significant increases in self-efficacy after a 16-week PBL program in computer engineering. In a quasi-experimental study Sungur and Tekkaya (2006) compared an experimental PBL group with a conventional control group and found that the PBL group scored significantly higher on intrinsic goal orientation and task value compared to the control group. Also, the quasi-experimental study by Hwang and Kim (2006) demonstrated that PBL students had a higher motivation to learn than the control group. However, this study did not specify what form of motivation (e.g., intrinsic or extrinsic motivation) was measured. Finally, in a qualitative study by C. B. White (2008), PBL medical students described the transition to a PBL medical curriculum as difficult. Nevertheless, after a while, they felt more comfortable with the responsibility and autonomy PBL offered them. PBL students described the transition from the classroom to clerkships as more effective than students educated in a conventional medical curriculum. These studies suggest that a PBL environment can enhance students' intrinsic motivation.

A limitation of these studies on motivation in PBL is that the studies were not conducted in existing PBL curricula. PBL was often only implemented for a short time period and only for one of the subjects (e.g., science education). Therefore, this study investigates students enrolled in an existing PBL curriculum, in which PBL is implemented in the whole program, and contrasted with an existing LB curriculum. This design is beneficial in terms of the ecological validity. In addition, previous studies that examined PBL interventions could not shed light on the question which specific PBL elements can foster students' motivation.

An important motivational framework in educational science is the self-determination theory (SDT), which differentiates between autonomous and controlled reasons for performing study activities (Deci & Ryan, 2000, 2008a, 2008b; Guay, Ratelle, & Chanal, 2008; Pintrich, 2003b; R. M. Ryan & Deci, 2000a, 2000b). Autonomous behavior is regulated by choice and volition, which is reflected in a full endorsement and willingness to engage in an activity (e.g., intrinsic interest, personal commitment to study). As a result, behavior will be more self-determined with intrinsic motivation being the highest level of autonomous, self-determined behavior. However, also more integrated and identified forms of extrinsic motivation are considered to be autonomous. These students will have extrinsic but integrated reasons for studying that are in line with their own goals, interests, and needs. For example, a medical student may voluntarily choose to put forth effort in his or her studies, because it helps to achieve an important life goal, such as becoming a good doctor. Controlled behavior, on the other hand, is regulated by some internal pressure (e.g., guilt, shame) or external pressure (e.g., demands of others). As a result, study behavior will be more controlled in nature, with external regulation being the highest level of controlled motivation. In short, autonomous motivation consists of intrinsic motivation and identified or integrated forms of extrinsic motivation (Deci & Ryan, 2000; R. M. Ryan & Deci, 2000a, 2000b). Controlled motivation consists of extrinsic motivation types that focus on receiving rewards, avoiding punishment, or satisfying others, such as parents or teachers.

Besides autonomy, students' perceived competence can facilitate intrinsic motivation (Deci & Ryan, 2000; R. M. Ryan & Deci, 2000a, 2000b). Competence refers to students' feelings of competence to study for a particular course. According to R. W. White (1959), competence can be described as effectively interacting with the environment. Perceived competence has positive effects on intrinsic motivation (Deci & Ryan, 2000). For instance, Mac Iver, Stipek, and Daniels (1991) tested the hypothetical model that a change in self-concept of ability was positively related to effort and intrinsic value. The results indicated that an increase in perception of ability or competence led to greater enjoyment of the subject matter, and not the other way around. These results demonstrate that perceptions of competence are an important influence on students' intrinsic motivation.

Two concepts that closely relate to autonomous/controlled motivation and perceived competence are mastery versus performance goal orientations. Whereas the relative amount of autonomous/controlled motivation determines why students are motivated, students' goal orientations determine what they want to achieve (Deci & Ryan, 2000). For instance, students with mastery goals are focused on mastering, learning, and understanding a specific task (Elliot & McGregor, 2001). This concept corresponds well with the concept of autonomous motivation, because mastery goals are pursued for autonomous reasons (Deci & Ryan, 2000). On the other hand, students with performance goals want to demonstrate competence or get approval of others and are therefore pursued for relatively controlled reasons (Deci & Ryan, 2000; Elliot & McGregor, 2001).

Research further demonstrated that autonomous versus controlled motivation, as well as mastery versus performance goal orientation are associated with different outcomes. In general, autonomous motivation and mastery goals lead to greater psychological well-being, better performances, and long-term persistence than controlled motivation and performance goal orientation (Ames, 1992; Deci & Ryan, 2000, 2008a, 2008b; Derous & Ryan, 2008).

We expect that the specific design of PBL environments can stimulate autonomous motivation, mastery goal orientation, and feelings of competence. We propose that PBL requires students to make decisions, thus enhancing choice and in turn, intrinsic motivation. In addition, the use of challenging problems and activation of prior knowledge could positively influence perceptions of competence and competence can subsequently influence autonomous/intrinsic motivation (Mac Iver et al., 1991). This is supported by prior studies were PBL led to increases in self-efficacy (i.e., future beliefs about competence) and intrinsic motivation (Dunlap, 2005; Liu et al., 2006; L. Martin et al., 2008; Sungur & Tekkaya, 2006). Although LB environments can include autonomy-supportive and competence enhancing elements (Vansteenkiste, Simons, Lens, Sheldon, et al., 2004; Vansteenkiste, Simons, Lens, & Soenens, 2004), these environments are not specifically designed to enhance student motivation. While for PBL environments, one of its goals is to intrinsically motivate students (e.g., Hmelo-Silver, 2004). To justify our hypotheses, motivational aspects of student-centered learning environments, such as PBL, are further discussed below.

MOTIVATIONAL ASPECTS OF LEARNING ENVIRONMENTS

PBL has several aspects that can enhance student motivation: autonomy-supportive teachers, meaningful and challenging tasks, positive feedback, collaboration, and scaffolding (Ames, 1992; Blumenfeld, 1992; Deci & Ryan, 2000; Pintrich, 2003b; Pintrich & Schunk, 2002; R. M. Ryan & Deci, 2000b).

Autonomy-Supportive Teachers

Many aspects influence whether a learning environment is seen as autonomy supportive or controlling, but among the most important aspects is students' perception of their teacher (Deci & Ryan, 2008a). Specifically, teachers can achieve autonomy support by taking the perspective of their students, offering opportunities of choice, being receptive to students' questions and ideas, and making learning relevant (Assor, Kaplan, & Roth, 2002; Black & Deci, 2000; Katz & Assor, 2007; Reeve & Halusic, 2009). Also, the type of language a teacher uses can influence the amount of autonomy students experience (Vansteenkiste, Simons, Lens, Sheldon, et al., 2004; Vansteenkiste, Simons, Lens, & Soenens, 2004). Experimental studies showed that controlling instructions, such as "you must" or "you have to," negatively affected deep learning, study performance, and study persistence, whereas teaching instructions like "you can" or "you might" had positive effects on learning and retention. Students in autonomy-supportive contexts also evaluated study activities as more fun and useful.

Black and Deci (2000) argued that student-centered learning environments could be considered autonomy supportive. In both types of environments educators guide and encourage students to perform learning tasks in their own way. As mentioned, a core characteristic of PBL is student-centered learning by offering students more responsibility in selecting literature resources (Barrows, 1996; Schmidt et al., 2009). Tutors facilitate instead of direct students' learning process. To prevent overwhelming students with responsibility and uncertainty, tutor scaffolding is more present in the early stages of the study program (Schmidt, Loyens, Van Gog, & Paas, 2007; Schmidt et al., 2009). Building further on these findings, we expect PBL to be autonomy supportive.

Meaningful and Challenging Tasks

The design of meaningful tasks and study activities can increase intrinsic motivation (Ames, 1992; Blumenfeld, 1992; Eccles, 1983; Eccles & Wigfield, 2002; Katz & Assor, 2007; Pintrich & Schunk, 2002; Wigfield & Eccles, 2000). Meaningfulness can be promoted by making tasks personally relevant for students (Assor et al., 2002). The problems used in PBL often describe a phenomenon that can be observed in daily life; students could therefore perceive the problem/learning task as meaningful (Schmidt & Moust, 2000). Meaningful tasks are associated with increased student interest and better learning (Pintrich & Schunk, 2002).

Also, challenging tasks can positively enhance motivation. Challenging learning materials can be achieved through the use of complex, ill-structured problems (B.Y. White & Frederiksen, 1998). These problems do not necessarily have one single solution and usually have multiple ways to achieve a solution or understanding of its underlying mechanisms (Loyens, Rikers, & Schmidt, 2007b; Mayer & Wittrock, 2006; Zimmerman & Campillo, 2003). Discussing these problems helps students to develop understanding of the subject matter at hand and competence in the problem discussion process. In the PBL environment under study, educators provide complex, ill-structured problems that activate students' prior knowledge and motivate to deeper learning and insights into real-life problems (Barrows, 1996; Schmidt & Moust, 2000). Noordzij and Te Lindert (2010) demonstrated that the interest level of the problem was positively related to intrinsic motivation.

In addition, activation of prior knowledge can positively influence students' feelings of competence and interest (Deci & Ryan, 2000; Pintrich, 2003b; Schraw & Lehman, 2001). For example, Araz and Sungur (2007) found that PBL students with a higher level of prior knowledge had a higher intrinsic goal orientation. Hence, from these assumptions it is expected that PBL environments have a positive influence on students' autonomous motivation and perceived competence.

Positive Feedback

Evaluation of study performance can have detrimental effects on students' motivation when it is perceived as pressuring or controlling (Ames, 1992; Blumenfeld, 1992; Deci & Ryan, 2000, 2008a; Pintrich, 2003b; R. M. Ryan & Deci, 2000b). However, research also indicated that when students are given positive feedback and the opportunity to improve themselves, positive effects on perceived competence can be established (Deci & Ryan, 2000; R. M. Ryan & Deci, 2000b). In addition, positive feedback can also positively influence intrinsic and autonomous motivation, except when feedback is given in a controlling manner (Deci, Koestner, & Ryan, 2001). Therefore, evaluation should focus on individual improvement that also takes students' effort into account (Pintrich, 2003b). In the PBL curriculum under study some evaluations are formative (i.e., with no course credit associated with it) and can provide students with positive feedback without consequences.

Collaboration

Relatedness to significant others might also influence student motivation (Deci & Ryan, 2000; Furrer & Skinner, 2003; Wentzel, 1999, 2000). Most research on relatedness focuses on the influence of parents and teachers, but it is equally important to consider the influence of peers on students' engagement, motivation, and academic achievement (A. M. Ryan, 2000). Cooperative or collaborative learning could help students to feel more connected to peers, and as a result positively influence motivation, effort, and persistence (Deci & Ryan, 2000; Pintrich, 2003b; Reeve & Halusic, 2009; R. M. Ryan & Deci, 2000b; Wentzel, 1999, 2000). Cooperative learning has more effect on student learning when groups work toward a common goal and when there is individual accountability (Slavin, 1996). When students work together on a goal and value success of the group, they will help and encourage each other. Also, when groups are acknowledged or rewarded based on the individual learning of their members, students need to stimulate and help each other. If a student wants to perform well, he or she has to motivate and help the other students of the group to achieve the group's goal. This example demonstrates that connectedness to peers and collaboration can contribute to learning and study motivation.

Student-centered environments, such as PBL, explicitly stress collaboration by discussing real-life problems in small groups (max. 12 students; Barrows, 1996; Schmidt & Moust, 2000). Therefore, it can be expected that PBL fosters autonomous learning, study motivation, and hence, positive study outcomes.

Scaffolding

Some researchers argue that the greater responsibility PBL students experience could distract and confuse them and lead to more stress and anxiety (Berkson, 1993; Duke et al., 1998). In addition, PBL could sometimes be viewed as an unsystematic procedure that could negatively influence self-efficacy and intrinsic motivation (Zimmerman & Campillo, 2003). In this case, students may be more likely to attribute failure to a lack of ability instead of the procedure. However, we would like to point out that PBL should not be considered as an unguided or minimally guided instructional approach when the right amount of scaffolding is provided (Schmidt et al., 2007). Tutors in the PBL curriculum under study are trained to scaffold the group discussion for instance, by preventing that students spend too much time on irrelevant information. To guide students and to prevent them from stress and anxiety, scaffolding and well-trained tutors need to be provided (Schmidt et al., 2009).

Self-Regulated Learning

In addition to motivation, self-regulated learning (SRL) is included as an outcome variable in this study. SRL refers to thoughts, feelings, and actions of students that are planned and adapted to achieve their own goals (Zimmerman & Campillo, 2003). It includes processes, such as metacognition, management of study time and the learning environment, and the use of cognitive strategies, such as rehearsal and elaboration (Pintrich, 1999). Because knowledge is achieved through self-directed learning in PBL, SRL is an important characteristic of PBL (Barrows, 1996; Hmelo-Silver, 2004). SDL places responsibility on students to define their own learning task and requires effective planning and time management (Blumberg, 2000). It also includes critical evaluation of both selected literature resources and students' own study skills. SRL is a part of SDL, but SDL is a much broader concept since it implies more student initiative and more control over students' learning processes. Therefore, these concepts cannot be used interchangeably (see for a detailed discussion Loyens et al., 2008). Recently, a study of Downing, Kwong, Chan, Lam, and Downing (2009) showed that PBL students showed a larger improvement in SRL skills than non-PBL students at the end of the academic year. Building further on the arguments mentioned above, we expect that students report more SRL in PBL environments compared to LB environments.

HYPOTHESES

Until now, research on the relation between PBL environments and students' motivation were interventional and quasi-experimental in nature. PBL environments have several characteristics that may positively affect students' motivation and SRL, such as the guiding role of a tutor, the use of meaningful problems, the positive feedback system, and collaboration (Ames, 1992; Assor et al., 2002; Black & Deci, 2000; Blumenfeld, 1992; Deci & Ryan, 2000; Pintrich, 2003b; Pintrich & Schunk, 2002; R. M. Ryan & Deci, 2000b). However, PBL could also be stressful for students if the procedure is insufficiently structured so that students experience too much responsibility or attribute failure to a lack of ability (Duke et al., 1998; Zimmerman & Campillo, 2003). Nevertheless, we expect that PBL students in well-organized educational environments will maintain higher scores on motivational constructs that measure autonomous motivation (such as autonomous regulation and mastery goals) and competence but lower scores on controlled motivation as compared to students in LB environments (Hypothesis 1). In addition, it is expected that PBL students will score higher on SRL constructs than LB students (Hypothesis 2).

To investigate these hypotheses, two studies were conducted. In a survey study (Study 1), students in a PBL environment were compared to conventional LB students on motivation and SRL. Study 2 was a focus group study that investigated specific PBL aspects that can motivate students to a further extent. Focus groups were used because they are particularly useful in generating different opinions and experiences of students in order to investigate the survey results more in depth (Kitzinger, 1995).

STUDY 1

Method

Participants

Participants were undergraduates in psychology that were either enrolled in a PBL environment ($n = 117$) or a LB environment ($n = 126$). In the PBL group, 27 participants were male and 90 were female. The mean age of this group was 21.29 ($SD = 3.28$). In the LB group, 38 participants were male and 88 female. The mean age of this group was 19.12 ($SD = 1.40$). The great majority of students (88.90%) had a similar level of prior secondary education. With respect to age, PBL students were significantly older than the LB students, $t(241) = 6.80$, $p < .001$. In the analyses we therefore controlled for the influencing effects of age by including it as a covariate. However, further analyses showed there were no significant interactions between age and learning environment on the dependent variables. Therefore, the assumption of homogeneity of regression was met (Tabachnick & Fidell, 2007).

Learning environments

In the PBL environment, students worked in small groups with a maximum of 12 students on meaningful problems and met twice a week (Barrows, 1996). Groups were guided by a tutor. First, students were presented with the problem (Loyens, Rikers, & Schmidt, 2006; Schmidt & Moust, 2000). A problem is usually a description of an event or phenomenon that can be observed in daily life. After students read the problem, they start discussing and analyzing the problem, using their prior knowledge and common sense. To scaffold students during the problem discussion, students followed the seven steps of the "Seven Jump method", which enables students to tackle problems in the two tutorial group meetings that are held each week (Schmidt & Moust, 2000). During the first tutorial group meeting, students perform the first five steps: (Step 1) clarification of unknown concepts, (Step 2) formulation of a problem definition, (Step 3) brainstorming on the problem, (Step 4) problem analysis, and (Step 5) formulation of learning issues for further self-directed study. After the first meeting, students use these learning issues to select and study relevant literature resources (Step 6). Finally, after 2 days of self-directed study, students share their findings in the next tutorial meeting (Step 7).

The PBL curriculum entails eight 5-week periods, each 5-week period deals with a specific psychology subdiscipline, for instance social psychology, educational psychology, or clinical psychology. Therefore, courses are offered in a successive way. Thirty hours are reserved for self-study. In addition to the two compulsory tutorial meetings (6-hr), an optional lecture is given once a week (2-hr), and a compulsory 3-hr practical session (Schmidt et al., 2009). In the PBL curriculum under study, two types of tests are used: course tests and progress tests. A course test is given at the end of each of the eight 5-week periods and is formative in nature (i.e., no course credits are associated with it). Questions cover the specific content of that course (e.g., social psychology or educational psychology). The goal of the course test is to inform students about their performance on that course (Van Berkel, 1990). Students can use this information to improve their performance on the progress tests (McHarg et al., 2005).

The progress test consists of 190 true or false questions that cover the complete knowledge domain of the first two study years of the psychology program and emphasizes the importance of long-term knowledge. This test is administered three times a year and a great deal of course credits are associated with it. The scoring of this test is norm-referenced: The cut-off between passing and failure is based on the scores of all students in the one cohort they belong to (McHarg et al., 2005). The goal of the test is twofold. First, the test is used to check whether students learned a sufficient amount of knowledge in comparison with the other students in their cohort (Van Berkel, 1990). The second goal is to prevent massed practice before an exam, because the test focuses on long-term knowledge students cannot specifically prepare themselves for this type of test (McHarg et al., 2005). Preparation occurs through continuously studying during each 5-week period, instead of cramming for an exam. The progress test therefore takes into account study effort during the whole academic year.

The conventional, LB curriculum consisted of two semesters, of 13 weeks each with lectures and some obligatory practical sessions. During these 13 weeks students follow courses in many different psychology subdisciplines, such as social psychology, educational psychology, and clinical psychology. Therefore, courses are given in a parallel instead of a successive way. The 13 weeks of lectures are followed by 3 weeks of self-study in which no lectures are given and students need to prepare for their examinations. After these study weeks, exams are administered (i.e., in January and June, respectively). Students take the exams of all courses they followed during that semester.

Measures

Existing scales were used to measure motivational and self-regulated learning constructs and only minor (i.e., necessary) changes were made to adapt the existing questionnaires to a PBL environment. For example, in the survey version that was administered in the PBL environment, the word "tutorial group" was used instead of "lecture" (as used in the version administered in the LB environment). Demographic questions about age, gender, and study year were included. Overall, Cronbach's alphas were adequate (see Tables 2.1 and 2.2).

Table 2.1

Correlations and Cronbach's Alphas for Motivation Subscales

Variable	*M*	*SD*	1	2	3	4	5	6	7
1. Autonomous regulation	5.26	0.88	*.74*						
2. Controlled regulation	3.70	0.95	.52**	*.77*					
3. Perceived competence	5.38	0.99	.29**	.02	*.92*				
4. Competence expectancy	3.35	0.75	.29**	.14*	.52**	*.87*			
5. Mastery goal orientation	3.51	0.56	.43**	.37**	.03	.14*	*.64*		
6. Performance goal orientation	3.10	0.71	.21**	.49**	.20**	.35**	.36**	*.81*	
7. Instrumental motivation	3.75	0.75	.12	.22**	−.05	.02	.24**	.25**	*.68*

Note. Cronbach's alphas are included on the diagonal. Autonomous regulation, controlled regulation, and perceived competence were measured on a 7-point Likert scale. Competence expectancy, mastery goal orientation, performance goal orientation, and instrumental motivation were measured on a 5-point Likert scale.
* $p < .05$, ** $p < .01$.

Table 2.2

Correlations and Cronbach's Alphas for LASSI Subscales

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
1. Attitude	31.72	3.92	*.67*									
2. Anxiety	25.79	6.53	.39**	*.87*								
3. Motivation	26.41	5.14	.45**	.20**	*.76*							
4. Information processing	28.58	4.37	.17**	.02	.07	*.81*						
5. Selecting main ideas	17.92	3.40	.44**	.49**	.29**	.33**	*.77*					
6. Test strategies	27.98	5.04	.56**	.63**	.38**	.10	.63**	*.77*				
7. Self-testing	24.64	4.15	.19**	−.08	.42**	.43**	.25**	.06	*.64*			
8. Concentration	25.27	5.90	.48**	.43**	.64**	.13*	.47**	.55**	.28**	*.84*		
9. Time management	22.97	6.39	.43**	.27**	.67**	.10	.35**	.43**	.31**	.66**	*.86*	
10. Study aids	25.01	4.14	.11	−.20**	.31**	.29**	.08	−.05	.49**	.19**	.30**	*.52*

Note. Cronbach's alphas are included on the diagonal.
* $p < .05$,** $p < .01$.

Autonomous/controlled motivation. Autonomous and controlled motivation were measured with the Learning Self-Regulation Questionnaire (SRQ-L) from Black and Deci (2000). The SRQ-L measures students' perceived control. The questionnaire consists of two subscales: autonomous regulation ($k = 5$) and controlled regulation ($k = 7$). A 7-point Likert scale ranging from 1 (*not at all true*) to 7 (*very true*) was used. As mentioned in the introduction, autonomous regulation consists of intrinsic motivation and identified or integrated forms of extrinsic motivation (Deci & Ryan, 2000; R. M. Ryan & Deci, 2000a, 2000b). Controlled regulation consists of extrinsic motivation types that focus on receiving rewards, avoiding punishment, or satisfying others such as parents or teachers.

Perceived competence. Perceived competence was measured with the Perceived Competence Scale (PCS), a four-item questionnaire adapted from Williams and Deci (1996). Items were measured on a 7-point Likert scale ranging from 1 (*not at all true*) to 7 (*very true*). In addition, competence expectancy was measured on a 5-point Likert scale ranging from 1 (*not at all true*) to 5 (*very true*) using two items (Vanheste, Lens, & Vandenberghe, 2001).

Achievement goal orientation. To measure students' achievement goals, we used an adapted version of the Achievement Goal Questionnaire (AGQ) of Elliot and McGregor (2001; see Vanheste et al., 2001). This 12-item questionnaire contains two subscales: mastery goal orientation ($k=6$) and performance goal orientation ($k=6$). Items were measured on a 5-point Likert-type scale ranging from 1 (*not at all true*) to 5 (*very true*).

Instrumental motivation. Finally, based on Noels et al. (2003), a three-item questionnaire was used to measure instrumental motivation (e. g., "When I get bad study results [for instance, when I fail or have to repeat an academic year], this has negative consequences for my further plans and goals [for instance, not being able to go on holiday or find a job"].) These items reflect to what degree students perceive their study tasks as useful or instrumental for attaining a practical goal, such as a future job (Noels et al., 2003). Noels et al. (2003) previously showed positive relations with the SDT concept of extrinsic regulation. Extrinsic regulation is a form of controlled motivation (Deci & Ryan, 2000; R. M. Ryan & Deci, 2000a, 2000b). Because instrumental motivation is focused on attaining external outcomes, it is considered a form of controlled motivation and is therefore included in this study. A 5- point Likert scale is used, ranging from 1 (*not at all true*) to 5 (*very true*).

Self-regulated learning. To measure SRL, we administered the Learning and Study Strategy Inventory (LASSI; Weinstein, 1987). For this study, an adapted version was used (Lacante & Lens, 2005). This questionnaire consists of 77 items divided over 10 scales measuring: study attitude, test anxiety, study motivation, information processing, selecting main ideas, test strategies, self-testing, concentration, time management, and study aids (Weinstein, 1987; Weinstein & Palmer, 2002). Items were measured on a 5-point Likert scale ranging from 1 (*not at all typical*) to 5 (*very much typical*). For each subscale a higher score indicates a better response. For instance, a higher score on the subscale anxiety suggests that a student experiences less anxiety, whereas a low score on the subscale anxiety indicates this student has more concerns about failing and being incompetent.

Procedure

Participants took part on a voluntary basis. The questionnaires were combined in a web-based questionnaire, consisting of 110 items. Filling out the questionnaire did not take more than 60 minutes. Participants received 1-hr of research credits for participation in this study. The survey was administered from April through June in the 2006-2007 academic year.

Analyses

Psychometric characteristics of the questionnaires were analyzed by means of a reliability analysis. Differences between learning environments were analyzed using a structural equation modeling (SEM) approach with Amos 16.0 (Arbuckle, 2007). SEM was used instead of a multivariate analysis of variance (MANOVA) for two reasons. First, SEM was used to correct for possible measurement error. Each questionnaire measures an observed motivational construct that represents a latent construct (Hancock, 2003). It is likely that each construct does not exactly measure the latent construct, but also contains some measurement error. When a MANOVA is used the multivariate construct still contains this measurement error. However, when using SEM, measurement error is estimated and included in the analysis. Error terms represent unique variance, the variance of indicators (i.e., motivational constructs) that is not explained by the latent factor and consists of random (e.g., unreliability) and systematic error (e.g., type of measurement method; Kline, 2005). Second, we used SEM because we were more interested in the separate motivational constructs than the composite of motivational constructs (i.e., multivariate construct; Hancock, 2003).

The Comparative Fit Index (CFI; Bentler, 1990) and the Tucker-Lewis Index (TLI; Tucker & Lewis, 1973) were used as incremental fit indices. Values greater than .90 were considered as a good fit (Kline, 2005). For absolute fit indices chi-square and the root-mean-square error of approximation were used (RMSEA; Steiger, 1990). A small χ^2 value, in relation to the degrees of freedom, indicates a good fit between the hypothesized model and the observed data (Byrne, 2001). A RMSEA value below .08 is considered a reasonable fit (Kline, 2005).

The first step in SEM was to test the fit of the hypothesized model in two independent samples (i.e., PBL and LB). This model was derived from research literature on motivation (e.g., Deci & Ryan, 2000; Pintrich, 2003b). In a second step, we tested for measurement invariance. By doing so, we checked whether the observed constructs in both samples were measuring the same latent constructs (Cheung & Rensvold, 1999). To conclude measurement invariance, we examined whether the difference in χ^2 between the hypothesized model and the constrained model was nonsignificant. A non-significant difference in χ^2 indicated that the same latent constructs appear in both samples. Therefore, latent mean differences could be computed.

The influence of possible covariates such as age and gender were controlled for because prior research has shown that these variables can influence motivation and self-regulated learning (e.g., Bråten & Olaussen, 1998; A. J. Martin, 2004; Pintrich, 2003b; Pintrich & Schunk, 2002).

Results

Preliminary analyses

Tables 2.1 and 2.2 present Cronbach's alphas and correlations among study variables. Because Study Aids had a low reliability this scale was dropped from further analyses.

Hypothesis testing

Figure 2.1 illustrates the hypothesized motivation model. Gender and age were included as covariates. The subscales instrumental motivation, controlled regulation, and performance goal orientation were assumed to load on the latent construct controlled motivation. We assumed the scale competence expectancy could also load high on the construct controlled motivation, because the items of this scale focus on students' achievement/grade expectancy (i.e., a focus on getting good results is a controlled reason for studying; Deci & Ryan, 2000). The construct competence consists of the scales competence expectancy and perceived competence. Also, we assumed that both achievement goals were related to competence, because competence beliefs are believed to be the core of achievement goals (Elliot & McGregor, 2001). The subscales mastery goal orientation and autonomous regulation were hypothesized to be significantly related to the latent construct autonomous motivation. The error terms of autonomous regulation and controlled regulation were assumed to be related, because of the significant correlation between these two subscales (see Table 2.1).

The structure of the hypothesized model depicted in Figure 2.1 was tested separately for the PBL and LB student groups. Analysis of the hypothesized model for the PBL population in-

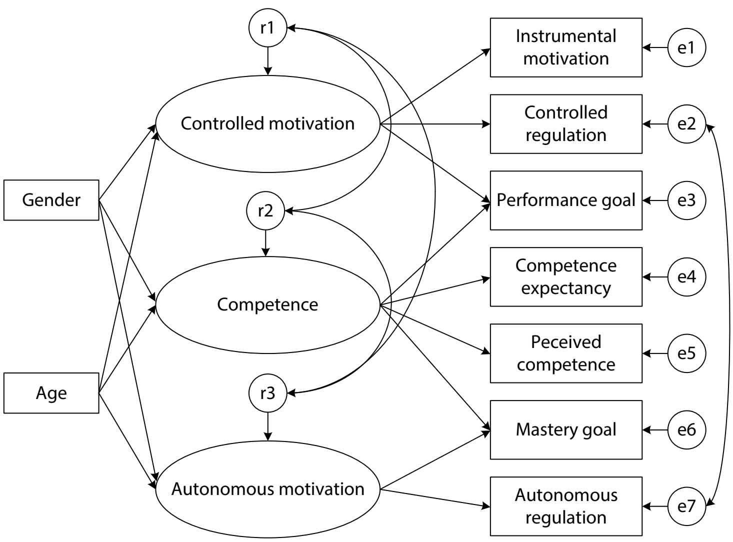

Figure 2.1. Hypothesized model.

2

dicated that the model did not fit the data very well $\chi^2(16, N = 117) = 46.41$, $p < .001$; CFI = .87; TLI = .71; and RMSEA = .13. However, the hypothesized model did fit well to the data of the LB student group, $\chi^2(16, N = 126) = 19.85$, $p = .23$; CFI = .98; TLI = .96; and RMSEA < .04.

Secondly, we examined the measurement invariance across student groups for both learning environments. Factorial structure of the hypothesized model across both student groups, resulted in a CFI of .92, a TLI of .83, and a RMSEA = .07, indicating a reasonable fit. The χ^2 analysis resulted in a less adequate fit $\chi^2(32, N = 243) = 66.27$, $p < .001$. However, the ratio of χ^2 divided by the degrees of freedom was less than three. Also, the constrained model, a model in which all factor loadings, variances, and covariances were fixed equal across groups, resulted in a fairly accurate fit, $\chi^2(49, N = 243) = 91.45$, $p < .001$; CFI = .90; TLI = .86; and RMSEA = .06. The χ^2 value of the constrained model was compared to the baseline χ^2 value of 66.27 of the unconstrained model to examine the invariance of the model (see Table 2.3).

The nonsignificant difference between the χ^2 values of the constrained and unconstrained model shows the factor loadings, variances, and covariances were invariant across the PBL and LB student groups. This suggests that the relationships between the measured motivational constructs and the latent motivation factors were equal for both groups. Therefore, latent means could be estimated and compared to test Hypothesis 1 (see Table 2.4).

In SEM latent means can only be estimated for one of the groups. We chose to estimate latent means for the PBL group. A positive mean implies that the PBL group scored higher. In contrast, a negative mean indicates the LB group scored higher. Significant differences were found on the latent motivation factor competence. This result implies that the PBL group scored significantly higher on competence in comparison to the LB students. No significant differences were found on the latent constructs autonomous motivation and controlled motivation. Therefore, Hypothesis 1 was partially supported.

Table 2.3

Goodness-of-Fit Statistics for Tests of Invariance for the Motivation Model

Model description	χ^2	df	$\Delta \chi^2$	Δ df	Statistical significance
Hypothesized model	66.27	32	-	-	-
Constrained model	91.45	49	25.18	17	NS

Note. $\Delta \chi^2$ = the difference in χ^2 values between the models; Δ df = the difference in degrees of freedom between both models; NS = non-significant at the .05 level.

Table 2.4

Latent Mean Differences between PBL and LB Students on Motivation

	Estimate	*SE*	*p*
Controlled motivation	–0.001	0.04	.99
Perceived competence	0.32	0.08	< .001
Autonomous motivation	0.09	0.12	.49

Note. Latent means were estimated for the PBL group.

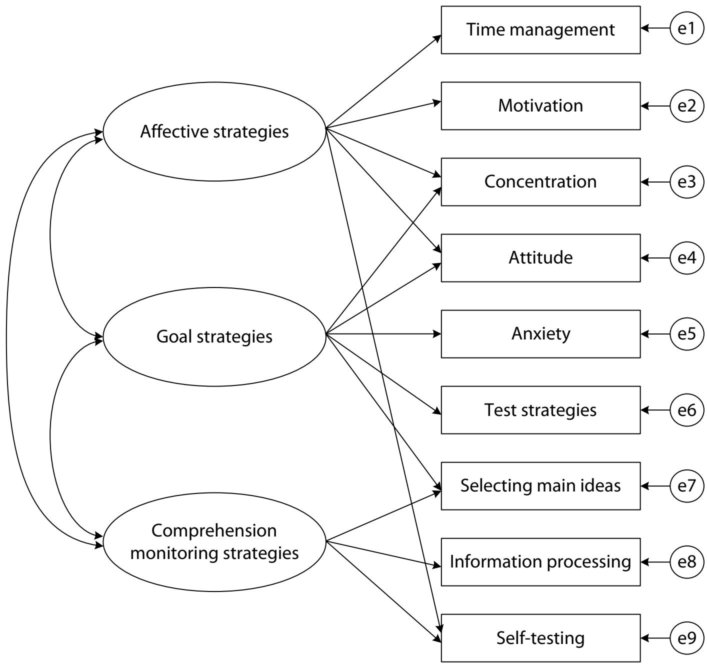

Figure 2.2. Hypothesized LASSI model, based on Cano (2006). Each subscale is associated with an error term. Double arrows indicate covariance among latent constructs.

To test Hypothesis 2 on SRL, the hypothesized model of the Learning and Study Strategy Inventory (LASSI; Weinstein, 1987) was tested for both student groups. As depicted in Figure 2.2, the LASSI is assumed to consist of three latent factors: affective strategies, goal structures, and comprehension monitoring strategies (Cano, 2006). The construct affective strategies consists of subscales that focus on working with effort. The construct goal strategies consists of subscales concerned with strategies for coping with examinations and anxiety, whereas the construct comprehension monitoring strategies is assumed to measure self-regulated learning and control strategies. Because analyses showed that the covariates gender and age did not influence the results, these covariates were dropped from further analyses.

Analysis of the hypothesized model for the PBL group resulted in a CFI of .97, a TLI of .94, and a RMSEA of .08. These results indicate that the model had a good fit. The χ^2 analysis resulted in a less adequate fit $\chi^2(20, N = 117) = 34.40$, $p = .02$. The hypothesized model for the LB student group had a good fit as well, $\chi^2(20, N = 126) = 38.80$, $p < .01$; CFI = .96; TLI = .93; and RMSEA = .09.

The structure of the model across both student groups resulted in a CFI of .96, a TLI of .94, and a RMSEA of .06, indicating a good fit. The χ^2 analysis gave the following results: $\chi^2(40, N = 243) = 73.20$, $p = .001$. As noted in Table 2.5, the models were invariant across both groups. Therefore, latent means could be estimated and compared (see Table 2.5).

Table 2.5

Goodness-of-Fit Statistics for Tests of Invariance for the LASSI Model

Model description	χ^2	df	$\Delta\chi^2$	Δ df	Statistical significance
Hypothesized model	73.20	40	-	-	-
Constrained model	98.39	56	25.20	16	NS

Note. $\Delta\chi^2$ = the difference in χ^2 values between the models; Δ df = the difference in degrees of freedom between both models.

Table 2.6

Latent Mean Differences between PBL and LB Students on Self-Regulated Learning

	Estimate	*SE*	*P*
Affective Strategies	0.91	0.25	< .001
Goal Strategies	0.94	0.33	< .01
Comprehension Monitoring Strategies	–0.61	0.35	.08

Note. Latent means were estimated for the PBL group.

Significant differences between PBL and LB students were found on the latent factors affective strategies and goal strategies, partially supporting Hypothesis 2 (see Table 2.6). These results indicate that students from a PBL environment seem to work with more effort in their courses and used strategies to deal with examinations and anxiety more effectively. However, no difference was found on comprehension monitoring strategies, which includes SRL and control strategies.

STUDY 2

As explained, some of Study 1's survey results ran counter to the hypothesized relations. For instance, PBL students did not differ on autonomous motivation and SRL when compared to LB students. To investigate these results to a further extent, a focus group study was conducted as a qualitative follow-up (Kitzinger, 1995).

Method

Participants

Two tutorial groups participated as focus groups, to elaborate on the survey results and to determine which aspects of a student-centered PBL environment were perceived as (de) motivating. The first focus group consisted of seven first-year psychology PBL students (three males, four females). The second group consisted of seven second-year students (one male, six females). Some of the participants of the first- and second-year focus group had also participated in Study 1.

Procedure

Focus groups were held at the end of the group meetings and lasted 45 minutes. One of the authors was the interviewer in both focus groups and hence, both groups had the same interviewer. The following question was asked: "Which aspects of PBL do you find motivating and which ones not?" Students were instructed to answer the question freely and could mention both negative and positive aspects of PBL. Based on the defining characteristics of PBL and the motivational literature it was determined that the following aspects of PBL should be covered in the discussions: the guiding role of tutors, the use of problems, the evaluation system that uses both course tests and progress tests, collaboration, and self-directed study. As mentioned earlier, these aspects were hypothesized to contribute to study motivation. When these topics were not naturally discussed in the focus group, the facilitator asked students their opinion about those issues. Both focus groups were audio taped.

Analysis

Focus group data were analyzed in line with Barbour (2001) and Kitzinger (1995). Audio tapes were transcribed. Statements were grouped in the following five categories: autonomy-supportive teachers, meaningful and challenging tasks, feedback, collaboration, and self-regulated learning. These categories were based on the motivation literature. The statements were coded by two independent subject matter experts (SMEs; Barbour, 2001). Overall, good agreement was found among SMEs ($\kappa = .77$). Where differences occurred, consensus was reached through discussion. Statements that could not be categorized within these clusters were sorted into a rest category.

Results

Analyses of both focus group data revealed that certain PBL aspects were perceived as motivating. However, students also perceived certain aspects as detrimental for motivation. Generally, students agreed that collaborative learning in group meetings is more motivating than lectures. They perceived lectures as too passive and group meetings gave them the opportunity to be actively engaged.

Autonomy-supportive teachers

First-year students indicated that the guiding role of a tutor was useful, but not particularly motivating. However, most students in the second-year focus group mentioned that enthusiastic and expert tutors are motivating. For instance, when tutors share their own experience with the subject matter, this is perceived as motivating. Most students also mentioned tutors should stimulate them and pay close attention to group discussions. When tutors asked questions about a part of the problem they had already discussed and closed, it was perceived as detrimental for motivation. Second-year students found it demotivating when tutors did not help them clarify some misconceptions and uncertainties encountered during group meetings. For example, when tutors said that students should clarify these uncertainties for themselves after the group meeting by reading more literature or ask the course coordinator for further explanation, this was perceived as demotivating. Students agreed that these tutors gave them an unsatisfied feeling about what they had learned in that group meeting.

Meaningful and challenging tasks

Students mentioned that they generally liked the way subject matter is introduced to them (i.e., by a problem). They reported that it stimulates them to search for explanations for the problem and master the subject matter to be studied. Students emphasized the importance of problem quality in terms of adequately introducing and covering the study topics. Especially a large discrepancy between the content of a problem and the literature to be studied was perceived as detrimental for their study motivation. According to these students, it is most motivating when problems cover all relevant study issues, so that they can be used as reference points. Moreover, problems are particularly perceived as motivating when they elicit a lot of discussion. Some students also mentioned problems were perceived as more meaningful and interesting when they describe phenomena or events they can experience in daily life.

The second-year students considered the procedure to tackle problems, the so-called "Seven Jump", as too directive. The Seven Jump consists of seven steps intended to guide students through the problem discussion. These steps could be divided into three separate phases: initial group discussion, self-study time, and sharing of the findings in the next tutorial meeting (see Schmidt & Moust, 2000). Especially, a too strict differentiation between the brainstorming (Step 3) and problem analysis steps (Step 4) was perceived as demotivating. Students perceived the procedure as useful in the first study year, but plead for more flexible scaffolding in the following years.

Feedback

Many students perceived the assessment system used in PBL as demotivating. As described earlier, the PBL curriculum under study uses two types of tests: course tests and progress tests. Students perceived progress tests as detrimental for motivation, because many course credits are associated with it, whereas no course credit are associated with the course tests. As mentioned, the cut-off between passing and failing is norm-referenced. Therefore, a proportion of students will always fail the test. A few students do not prepare themselves for the course tests (and fail), but do study for the progress test, and only pass the progress test. Students perceived this as hindering the PBL process, because these students do not actively contribute to the discussions during a course, but do manage to pass their first or second year. On the other hand, second-year students did appreciate the emphasis on long-term knowledge.

Collaboration

All students perceived collaborative learning, especially the interaction with fellow students, as motivating. Social interaction and sociability are perceived as very important and motivating. Students also experienced more "pressure" to study, because of social control and shared responsibility: They do not want to look bad in the eyes of the others. Students indicated they find it important that everyone prepares for the group meetings, because collaboration can be detrimental for motivation when students are unprepared and sponge off others. In addition, when some students only read their notes aloud without really explaining it, it was perceived as demotivating. Several first-year students also characterized the problem descriptions as sometimes being too straightforward and not eliciting sufficient group discussion. Other students disagreed and said the discussion did motivate them, because every student gave his or her thoughts on and explanations for the problem.

Self-regulated learning

In PBL, the initial discussion of problems results in the formulation of learning issues for further self-directed study (Loyens et al., 2006; Schmidt & Moust, 2000). The formulation of these learning issues can be seen as a SRL activity (Loyens et al., 2008). Some first-year students mentioned they sometimes could easily formulate learning issues, without first analyzing and discussing the problem in a tutorial meeting, because problems did not always elicit sufficient group discussion. However, some other students believed collaborative learning leads to better formulated learning issues, especially because not every student has sufficient prior knowledge to formulate a good learning issue.

Both first- and second-year students mentioned they sometimes felt insecure about their search for relevant learning materials. Most students wished tutors were more controlling or directive, for instance by giving them tips about core literature resources. Some students mentioned they selected literature based on what they thought the course coordinator wanted them to read, instead of determining what they need to read based on the learning issues that were defined in the group meeting. First-year students mentioned they would rather have a predetermined course book instead of having to search for different empirical articles, so that they would have more certainty that they studied the right literature.

Rest category: mandatory presence

PBL students in the curriculum under study need to be present for every tutorial meeting to ensure the group process. The subject mandatory presence elicited a lot of discussion in both focus groups. All students described the mandatory presence as too restrictive, because no exceptions are made. The compensation assignment (i.e., making a schematic summary or so-called "concept map" of the literature) was also seen as a form of punishment. Second-year students mentioned they were not given sufficient responsibility in dealing with absence of tutorial meetings and the information they missed because of that.

In summary, based on the focus groups, some factors were perceived as demotivating, namely mandatory presence, whereas the most motivating factor was collaboration.

DISCUSSION

This study examined the effects of two learning environments on student motivation. More specifically, students from a problem-based learning (PBL) environment were compared to students from a lecture-based (LB) environment. Most of the previous studies that have investigated the relation between motivation and PBL used interventions in which PBL was only a small part of the entire program (e.g., L. Martin et al., 2008; Pedersen, 2003; Sungur & Tekkaya, 2006). Therefore, this study examined students already enrolled in an existing PBL and LB curriculum. In the second study, we investigated which specific features of PBL can foster students' motivation. We hypothesized that PBL students would score higher on autonomous motivation compared to LB students, because one of the goals of PBL is to intrinsically motivate students (e.g., Hmelo-Silver, 2004). However, based on the results of this study, this claim does not seem entirely justified.

Effects of Learning Environments on Student Motivation

In contrast to our expectations, no differences were found between the PBL and LB learning environments under study on the latent motivational constructs autonomous and controlled motivation. To explain these results, we looked at the focus group results. Two things need to be mentioned. First, students described several controlling elements in the PBL learning environment. The way the PBL curriculum was implemented, more specifically the mandatory presence to tutorial groups, and the procedure to discuss problems, was seen as rather directive instead of autonomy supportive. Moreover, students in focus groups mentioned they are often regulated by external influences, such as other students' need for approval. When students have extrinsic goals for studying (e.g., avoiding punishment, getting high GPAs) or select and study literature based on what others want them to read, their behavior is less self-determined (Deci & Ryan, 2000; R. M. Ryan & Deci, 2000a, 2000b). Second, focus group results showed students experienced uncertainty and insecurity about selecting the correct literature resources. Lack of perceived competence in selecting literature could diminish students' autonomous or intrinsic motivation (Mac Iver et al., 1991; R.M. White, 1959).

Based on the focus group results two explanations could be provided why no differences were found between PBL and LB students on autonomous motivation. First, based on a self-determination theory perspective (Deci & Ryan, 2000), students seem to experience an imbalance between controlling elements (i.e., mandatory presence) and the emphasis on students' own responsibility (i.e., selecting relevant literature). This perceived imbalance could explain why there is no difference between the two learning environments on autonomous and controlled motivation. If this is the case, an important implication for PBL learning environments is providing students with the right amount of structure. Although PBL students had higher perceptions of competence that they could successfully finish their courses as demonstrated by the higher scores on the latent constructs competence and goal strategies; they mentioned in the focus groups they felt uncertain about the selected literature resources. Therefore, a second explanation could be that students' feelings of insecurity in selecting literature resources could have negatively influenced students' autonomous motivation (Mac Iver et al., 1991). Future research should more closely examine the influence of both controlling elements and diminished perceptions of competence on PBL students' intrinsic motivation.

Another possibility for the lack of differences on the constructs autonomy and control is that some motivational constructs, such as mastery and performance goals, are more considered a trait than a state (Kaplan & Maehr, 2007; Maehr & Zusho, 2009). Some achievement goal models view achievement goals as a more or less stable trait, whereas other approaches put more emphasis on environmental/contextual influences. It is likely that both individual and contextual influences determine the goals students adopt, therefore both should be considered.

PBL students scored significantly higher on the latent construct competence. From the SDT perspective, meaningful learning tasks as used in PBL environments (i.e., problems) might increase one's perception of competence. That is, problems are designed to be optimally challenging, meaningful, and realistic (Barrows, 1996; Schmidt & Moust, 2000). They often describe situations that can be observed or experienced in daily life. For example, the problem on arachnophobia in the clinical psychology course describes the situation in which a woman comes home from work and becomes very frightened and starts screaming and sweating because she found two spiders in her bath tub (Schmidt & Moust, 2000). Students need to explain what happens to the woman and why. Optimally challenging tasks can help students feel more competent, because these tasks are in their range of competence and because prior knowledge can be activated (Deci & Ryan, 2000; Katz & Assor, 2007; Pintrich, 2003b).

Effects of Learning Environments on Self-Regulated Learning

PBL students also scored higher on affective strategies, measuring study effort (e.g., time management, concentration, self-testing). The higher scores on affective strategies might be explained by the curriculum structure of PBL. As mentioned, PBL students meet twice a week to discuss a new problem and as a result students have natural deadlines and are encouraged by the instructional format structure to prepare/study on a regular base. In addition, social control/pressure in small group meetings appears to influence students' study preparations. Because of mechanisms of social control, students are more inclined to put effort in their studies and prepare themselves for group meetings. For instance, students mentioned in focus groups that they prepared themselves because they did not want to look bad in the eyes of others and because they felt responsible for the group's functioning. In addition, PBL students are responsible for their own learning process and have to select and evaluate their own learning resources based on learning issues that were formulated during group meetings; this requires a lot of study effort.

Moreover, PBL students had a higher score on the latent construct goal strategies, indicating students could better cope with examinations and test anxiety than LB students. The sequential order of courses could have helped students to cope more efficiently with examination. Students do not have to divide their attention between different courses or conflicting exams. Therefore, PBL students might feel more confident in dealing with examinations than LB students.

Surprisingly, LB and PBL students did not differ on comprehension monitoring strategies, measuring self-regulated learning (SRL) and control strategies (such as elaboration, monitoring, and organization). Self-directed learning (SDL), which is related to SRL, is encouraged in PBL to achieve new knowledge and consists of SRL skills such as planning and time management (Loyens et al., 2008). In line with previous research (Downing et al., 2009) and because elaboration is an important aspect of PBL (e.g., Schmidt & Moust, 2000), we expected PBL students to score higher on SRL, which was not the case. A possible explanation lies in the structured nature of PBL, which might lead to ritual behavior, and hence hinder deep information processing (Dolmans, Wolfhagen, Van der Vleuten, & Wijnen, 2001). Students might appear to be involved, without processing information on a deeper level (e.g., connecting new information to prior knowledge). In other words, these students might not activate prior knowledge and actively elaborate on it. As mentioned in the focus groups, when students have not fully processed learning resources and only read their notes aloud without explaining and giving evidence of a good understanding, this is perceived as detrimental for study motivation. If the lack of difference in comprehension monitoring strategies is caused by ritual behavior in group meetings, it could be useful to learn and instruct students more how to self-regulate their learning process to prevent this study behavior. However, SRL is also an important aspect in most LB environments, so this could also explain the fact no differences were found on the construct comprehension monitoring strategies.

Sierens, Vansteenkiste, Goossens, Soenens, and Dochy (2009) demonstrated that providing structure in an autonomy-supportive manner has a positive effect on students' use of SRL skills. Structure entails that educators help students to learn how to regulate study activities, provide guidance, and positive, constructive feedback, which in turn could positively affect students' competence. However, providing structure in a controlled way (e.g., "you have to") may not lead to SRL. Because students of both learning environments did not differ on autonomous and controlled motivation, this could possibly explain why no differences were found on SRL as measured with comprehension monitoring strategies. This is clearly in need of further investigation.

Conclusions and Directions for Further Research

In sum, although PBL intends to give students responsibility and control over their own learning process, students did not always perceive autonomous motivation and internal control, which might be explained by the restrictive way in which PBL environments are sometimes implemented. Although the PBL environment under study is undoubtedly student centered, it is interesting to notice that students are aware of and report controlling elements such as mandatory presence. Assor et al. (2002) also demonstrated that when students are given a rationale for performing a task when choice is limited, this positively enhanced autonomous motivation. Hence, giving students a clear explanation about the need to be present for the sake of the group functioning and the usefulness of making a concept map for their own learning, might positively affect students' perceived autonomy. Therefore, further research could experimentally investigate the type/number of explanations for mandatory presence and examine its effects on students' perceived autonomy.

It was also interesting to note that although the procedure to discuss problems (i.e., Seven Jump) was intended to scaffold student learning, this was perceived as controlling, especially by second-year students. In addition, students also expressed they needed more structure or scaffolding, such as tips about relevant literature resources. In further studies it is therefore important to more specifically determine what amount of scaffolding or structure is ideal and how this subsequently influences students' competence and autonomous motivation. Nevertheless, although PBL students experienced uncertainties, this was not expressed in their scores on the latent constructs competence and goal strategies.

Moreover, this study demonstrated that introducing subject matter in a meaningful and challenging way to students (i.e., by problems), implementing natural deadlines by regular student meetings as well as active group discussion and a sequential order of courses, may be beneficial for students' feelings/perceptions of competence and development of affective and goal strategies.

As with any study, some constraints are worth mentioning. For instance, current LB environments do not exclusively rely on lectures anymore, but also include some active learning techniques, such as work groups (Lammers & Murphy, 2002). The use of active learning techniques, such as complementary workgroups, in the LB environment could have affected our study findings. Nevertheless, the PBL curriculum under study did give students significantly more opportunities for active learning, such as collaboration, than the LB environment and is undoubtedly more student centered compared to LB environments. Besides looking at students' self-reported motivation it is also important to investigate teachers' behavior and intentions in both the PBL and LB classroom (Kaplan, 2010). Did the tutors in PBL really demonstrate autonomy-supportive behavior or could the LB lecturers have been autonomy supportive? This issue should be addressed in future research examining the motivational dynamics of different learning environments. Although the progress test is used in several PBL curricula (Schmidt et al., 2009), it is not a central feature of PBL. Given that students in the focus groups indicated that the progress test was demotivating, this could have influenced the results of this study. Future research could address this issue by investigating other PBL environments.

We did not include a pre-assessment of students' motivation. Future research should include a pre-assessment of motivation or should examine the motivational effects of learning environments longitudinally. However, large differences in preexisting motivation are unlikely. Both universities dealt with very similar student populations. A preliminary interview study among first-year students indicated that the majority of PBL students (62.41%) reported that the most important reason for choosing their university was the proximity of the university (Loyens, 2005), not the educational system (PBL versus LB). An additional 10.64% of the students reported the proximity of the university as the second most important reason. In contrast, only 15.60% of the first-year students reported the PBL curriculum as the most important reason and only 13.48% of students mentioned the PBL curriculum as an additional reason for choosing this university. The remaining students chose this university because of the city, or because family or friends studied there. Although we believe that large differences in preexisting motivation between the PBL and LB group are unlikely, self-selection to either the PBL or LB environment could have influenced the results of this study and makes it difficult to make causality claims. It is insightful to more closely examine the motivational changes and differences in PBL versus LB students longitudinally in future research.

As mentioned earlier, the hypothesized motivational model did not fit that well for the PBL group compared to the LB and overall group. It is therefore possible that an alternative model of motivation would better fit the data for PBL students. Future research could elaborate on the proposed motivational model and incorporate different motivational questionnaires to examine this model more fully.

Both situational influences (e.g., learning environment) and individual characteristics of the student (e.g., prior knowledge and experience, subject-specific interest, gender) can influence motivation (Tsai, Kunter, Lüdtke, Trautwein, & Ryan, 2008). Although this study took into account the influence of students' gender and age, it could be useful to control for other variables such as prior interest and knowledge.

Despite the above mentioned limitations, this study is among the first that investigated motivation in PBL in which the entire curriculum was problem-based. Besides quantitative survey data, we also collected qualitative data to get more insight into the survey results. In conclusion, students from the PBL and LB environments under study seem to differ on some motivational dimensions. Although students did not differ in autonomous motivation, PBL students had higher scores on competence, affective, and goal strategies. This study contributes that the claim that PBL learning environments are intrinsically motivating is not completely justified. Results further demonstrate that both too controlling elements (i.e., mandatory presence) and too much uncertainty (i.e., selecting literature without guidance) could have a negative effect on students' autonomous motivation. Therefore, it is crucial to find the right balance between scaffolding and autonomy in learning environments.

Chapter 3

Do students' topic interest and tutors' instructional style matter in problem-based learning?

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The research reported in this chapter was also presented at the meeting of the Junior Researchers of the European Association for Research on Learning and Instruction (JURE), Exeter, United Kingdom, August 2011; the American Educational Research Association (AERA), Vancouver, Canada, April 2012; the International Conference on Motivation, Frankfurt am Main, Germany, August 2012; and the ICO international fall school, Gerona, Spain, November 2012.

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ABSTRACT

Two studies investigated the importance of initial topic interest (i.e., expectation of interest) and tutors' autonomy-supportive or controlling instructional styles for students' motivation and performance in problem-based learning (PBL). In Study 1 ($N = 93$, a lab experiment), each student participated in a simulated group discussion in which tutor instructions were manipulated to be autonomy supportive, internally controlling, or externally controlling. Controlling tutor instructions led to higher controlled motivation, but autonomy-supportive instructions did not relate to students' autonomous motivation and performance measures. Higher topic interest resulted in higher autonomous motivation and contributed indirectly to more self-study time and persistence. Self-study time was in turn associated with better test performance. A field study ($N = 287$, Study 2) supported the findings of Study 1. Tutor-provided autonomy support was unrelated to autonomous motivation, while a controlling instructional style led to higher controlled motivation and negatively affected performance. Again, topic interest positively influenced autonomous motivation and subsequent performance. Both studies demonstrate the importance of students' initial topic interest for subsequent performance in PBL. Results also indicate that in PBL, tutor-provided autonomy support does not improve autonomous motivation and performance, whereas controlling tutoring can promote controlled motivation and hamper performance. Implications and further research opportunities are discussed.

INTRODUCTION

Teachers and tutors are often confronted with unmotivated students who seem unwilling to participate actively and seem disengaged from learning. Lack of motivation often results in poor outcomes from studying, procrastination, and lack of persistence (Deci & Ryan, 2008a; Pintrich, 2003b; Vallerand & Bissonnette, 1992). In contrast, when students perceive the learning material as interesting, motivation and performance can be enhanced (Deci & Ryan, 2000; Schraw & Lehman, 2001). The manner in which teachers communicate their expectations and give feedback to students can also influence students' motivation and learning (Deci & Ryan, 2008a; Pintrich, 2003b). The main goal of the research reported in this article is to examine the joint effects of students' interest and tutors' instructional style on motivation and performance in a collaborative, student-centered, problem-based learning (PBL) environment. To this end, two empirical studies (one lab experiment and one field study) were conducted.

In PBL, small groups of students work together on meaningful problems under the guidance of a tutor (Barrows, 1996). A PBL cycle generally consists of three phases: initial problem discussion, a self-study phase, and a reporting phase (Barrows, 1996; Schmidt et al., 2009). During the initial discussion, the problem is presented to students before they receive any other curriculum input. It usually describes a phenomenon that can be observed in daily life (Schmidt & Moust, 2000). In a clinical psychology course, for example, the problem could be a case description of a person who suffers from social phobia. Students read and discuss the problem by use of prior knowledge and common sense and eventually formulate learning issues for further self-study, which are questions that guide their self-study activities (e.g., "What causes social phobia?" or "How can social phobia be treated?"). Then an individually conducted self-study period takes place in which students select and study literature resources to answer these questions. After this self-study period (e.g., in two to three days) students meet again in their tutorial groups to discuss their findings.

One of the goals of PBL is to enhance students' intrinsic motivation (Hmelo-Silver, 2004; Norman & Schmidt, 1992). Intrinsic motivation has been shown to affect the type, quality, and amount of student contributions to discussion in a PBL environment (Rienties, Tempelaar, Van den Bossche, Gijselaers, & Segers, 2009). PBL is believed to enhance intrinsic motivation for two reasons; first, through the use of problems that spark students' interest (Norman & Schmidt, 1992) and second, through student-centered learning that is described as autonomy supportive (Black & Deci, 2000; Schmidt et al., 2009). However, as yet it is unclear whether a PBL student-centered learning environment does foster autonomous motivation. The present studies address this issue in two different versions of the standard PBL context. In particular, we investigate the possible contribution of tutoring style (autonomy supportive or controlling). In addition, we investigate the role of students' topic interest in relation to motivational and learning outcomes.

THE ROLE OF INTEREST

Students' interest can factor into their emotional and cognitive engagement in study tasks, and can therefore play a part in what and how students choose to learn (Schraw & Lehman, 2001; Tsai et al., 2008). When students perceive a task as interesting, they can become intrinsically motivated (Deci & Ryan, 2000). A distinction is often made between individual and situational interest (e.g., Krapp, 2002; Renninger, 2000; Schraw & Lehman, 2001). Individual interest is considered to be a relatively stable, enduring, intrinsic desire for specific domains, activities, or learning in general (Schraw & Lehman, 2001). In contrast, situational interest is more short term, context specific, and is triggered by aspects of the environment, such as novelty, but can eventually develop into individual interest (Hidi & Renninger, 2006).

Topic interest is a third form of interest that can be distinguished; it concerns the level of interest that is elicited by a word or a paragraph when a specific topic is presented (Ainley et al., 2002). It can therefore be considered an anticipatory response to a topic that is influenced by both individual and situational interest (Hidi, 2006; Mason et al., 2008; Renninger, 2000). Topic interest has been associated with students' subsequent affective response and indirectly with persistence and test performance (Ainley et al., 2002).

Interest has been described as the catalyst for student learning in PBL (Schmidt et al., 2011). The problem is believed to elicit students' situational interest during the course of the discussion: Due to their limited prior knowledge, students will be unable to explain the problem completely during the initial discussion and will experience a knowledge gap that will spark their interest. Prior research has indicated that students' situational interest indeed increased when the problem was presented and decreased afterward when students gained more knowledge about the problem (Rotgans & Schmidt 2011b). Although consideration of situational interest is important, students do not come to a course as blank slates. At the beginning of a course they have specific expectations about the content of the course that can affect their learning (Ainley et al., 2002). Therefore, we aimed to examine the role of topic interest as measured *before* the problem is presented or the course has started.

AUTONOMY-SUPPORTIVE AND CONTROLLING TEACHING

Besides students' interest, the social context of a learning environment can also support or suppress students' motivation and subsequent learning (Deci & Ryan, 2000, 2008a; R. M. Ryan & Deci, 2000a, 2000b). Self-Determination Theory (SDT) distinguishes several types of motivation that differ in terms of the degree of autonomy or self-determination that is experienced (Vansteenkiste et al., 2006). Autonomously motivated students experience volition and study in a self-empowered way. They perceive studying as valuable for obtaining personal goals or for development (i.e., identified motivation) or because studying is fun or satisfying in itself (i.e., intrinsic motivation; Deci & Ryan, 2000; R. M. Ryan & Deci, 2000a, 2000b). In contrast, students with controlled motivation are regulated by external pressures, such as rewards from or demands of others (i.e., external motivation) or internal pressures, such as feelings of shame or guilt (i.e., introjected motivation). Autonomous motivation has been associated with more favorable outcomes relative to controlled motivation, such as better learning performance, positive affect, long-term persistence, diminished dropout, and greater psychological well-being (Deci & Ryan, 2000, 2008a; R. M. Ryan & Deci, 2000b; Vansteenkiste et al., 2006).

Teachers can enhance or diminish students' motivation through autonomy-supportive or controlling teaching (e.g., Soenens, Sierens, Vansteenkiste, Dochy, & Goossens, 2012). Autonomy support can be achieved by offering students a certain degree of choice in learning materials; by showing respect; by understanding students' perspective and feelings concerning learning materials, but communicating why (uninteresting) study activities are relevant for students' goals; and by using noncontrolling language (Assor et al., 2002; Black & Deci, 2000; Katz & Assor, 2007; Vansteenkiste, Simons, Lens, Sheldon, et al., 2004; Vansteenkiste, Simons, Lens, Soenens, & Matos, 2005; Wang, Hu, & Guo, 2012). In contrast, controlling teaching occurs when teachers ignore the students' perspective and use their own opinions as the frame of reference or pressure students to behave or think in a certain way (Soenens & Vansteenkiste, 2010).

Within SDT, externally and internally controlling styles can be differentiated. External control takes place when students are pressured by external contingencies, such as rewards, deadlines, or punishment, whereas internal control relies on internal contingencies, such as shaming and guilt induction. Studies have demonstrated that autonomy-supportive instructions such as "you can" or "we ask you to" enhanced autonomous motivation, free-choice persistence, and performance when compared to externally controlling instructions such as "you have to" or "you must". The effect of autonomy-supportive versus controlling instructions on students' learning, performance, and persistence was mediated by students' autonomous motivation (Vansteenkiste, Simons, Lens, Sheldon, et al., 2004). In subsequent studies, these effects were replicated using internally controlling instructions, such as "for your own good" (Vansteenkiste et al., 2005).

Consideration of tutor behaviors in PBL is important, because tutors can (indirectly) influence several factors at the individual and group levels (Van Berkel & Dolmans, 2006). Although autonomy support by PBL tutors has not been investigated, research has shown that other tutor behaviors such as cognitive congruence (CC) can influence situational interest (Rotgans & Schmidt, 2011a). CC can be described as the ability to express oneself using the students' language and concepts and to understand the problems students encounter with the subject matter. Besides the influence of CC, it has also been reported that tutor behaviors that are too dominant and too directive have a negative effect on students' commitment and learning (Hendry et al., 2003). However, the negative effects of directive tutoring seem to depend on students' level of prior knowledge. When their prior knowledge is too low to support active discussion, directive tutoring can have beneficial effects on learning (Budé, Van de Wiel, Imbos, & Berger, 2011). Finally, research has shown that tutors' content expertise was unrelated to student learning outcomes (Leary, Walker, Shelton, & Fitt, 2013).

Investigating effects of autonomy-supportive and controlling teaching in PBL is important because most studies investigating instructional styles have been conducted in teacher-centered environments (e.g., Jang et al., 2010; Vansteenkiste et al., 2012). Although student-centered learning environments such as PBL are assumed to be autonomy supportive (e.g., Black & Deci, 2000), empirical evidence to support this claim is lacking, as is knowledge about the effects of autonomy-supportive and controlling tutoring on motivation and subsequent performance. The present studies investigated whether levels of topic interest and tutors' use of an autonomy-supportive or a controlling instructional style in PBL are associated with students' autonomous and controlled motivation and subsequent investment in self-study time and with their performance during group discussions and on a test. This was examined in both an experimental study (Study 1) and a field study (Study 2). The context in each study was a version of a standard PBL environment sharing the six core PBL features: (Barrows, 1996; Hmelo-Silver, 2004): (1) student-centered learning; (2) collaboration in small groups; (3) use of problems as the starting point of the learning process; (4) more focus on self-study than on lectures; (5) learning is achieved through self-directed study; and (6) tutors have a guiding, facilitating role instead of a directive one.

STUDY 1

Topic interest concerning intergroup conflict was measured before the presentation of the problem and tutor instructions were manipulated following Vansteenkiste and colleagues. (Vansteenkiste et al., 2005; Vansteenkiste, Simons, Lens, Sheldon, et al., 2004). Students were randomly assigned to condition. To check randomization, we looked at whether there were differences between conditions on motivation to study psychology and perceived realism of the simulated group discussion. The associations of topic interest with and the effects of tutor instructions on participants' autonomous and controlled motivation, self-study time, quality of discussion input, persistence, and performance on immediate and delayed tests were investigated. Both factual and conceptual knowledge were measured on the immediate and delayed tests, because this type of assessment has been proven to be important in studies of PBL (e.g., Gijbels, Dochy, Van den Bossche, & Segers, 2005).

Table 3.1 gives an overview of the hypotheses of Study 1. We hypothesize that participants who receive internally and externally controlling tutor instructions will score higher on controlled motivation (Hypothesis 1a) and lower on autonomous motivation (Hypothesis 1b) when compared to participants who receive autonomy-supportive tutor instructions. Second, we expect that topic interest is associated with autonomous motivation (Hypothesis 2). We did not expect an association between topic interest and controlled motivation: Students with higher topic interest will more likely experience volition after participating in the tutorial meetings, but this will not necessarily affect their feelings of internal or external pressure.

In addition, we hypothesize that autonomy-supportive tutor instructions will lead to longer self-study time invested, better quality discussion input, higher test scores, and more persistence, compared to controlling tutor instructions (Hypothesis 3). We also expect positive associations between topic interest and self-study time invested, quality of discussion input, test performance, and persistence (Hypothesis 4). Moreover, we expect that the effects of topic interest and autonomy support on quality of discussion contributions, self-study time, and persistence are mediated through autonomous motivation (Hypothesis 5; cf. Ainley et al., 2002; Vansteenkiste, Simons, Lens, Sheldon, et al., 2004). Finally, we hypothesize that autonomous motivation will have an indirect effect on achievement on the immediate test through self-study time and the quality of students' discussion contributions (Hypothesis 6; cf. Loyens, Gijbels, Coertjens, & Côté, 2013; Rienties et al., 2009).

Table 3.1
Overview of Hypotheses and Analyses

	Hypotheses	Analyses Study 1	Path analyses Study 2
1a:	Controlling instructional styles are associated with higher controlled motivation versus an autonomy-supportive style	ANOVA	Direct path
1b:	Controlling instructional styles are associated with lower autonomous motivation versus an autonomy-supportive style	ANCOVA	Direct path
2:	Higher topic interest is associated with higher autonomous motivation	ANCOVA	Direct path
3:	An autonomy-supportive instructional style will lead to longer self-study time, better performance in group discussion[a], higher test scores, and more persistence[b] versus controlling styles	MANCOVA (self-study time and quality of discussion input); logistic regression (persistence); mixed ANOVAs (test performance)	H3 not tested
4:	Topic interest is positively associated with self-study time, better performance in group discussion, higher test scores, and more persistence	MANCOVA (self-study time and quality of discussion input); logistic regression (persistence); mixed ANOVAs (test performance)	H4 not tested
5:	(Autonomous) motivation mediates the effects of instructional style/topic interest on performance in group discussion, self-study time, and persistence	Bootstrapping procedure for indirect effects	Indirect effects
6:	Self-study time and performance in discussion mediate the effects of (autonomous) motivation on immediate test performance	Bootstrapping procedure for indirect effects	Indirect effects

Note. ANOVA = analyses of variance; ANCOVA = analysis of covariance; MANCOVA = multivariate analysis of covariance.
[a]Performance in group discussion was measured in Study 1 through the quality of discussion input and through preparation and participation in Study 2. [b]Persistence was not measured in Study 2.

Method

Participants and design

Participants were 93 undergraduate students enrolled in the same PBL psychology curriculum. They were randomly assigned to one of three conditions: Autonomy-supportive instructions ($n = 32$), externally controlling instructions ($n = 31$), or internally controlling instructions ($n = 30$). In line with the regulations of the psychology program under study, participants received research credits or money for their participation. Participants had a mean age of 20.82 years old ($SD = 3.65$); 70 students were female and 23 were male. On average, participants had taken 6.74 ($SD = 4.04$) PBL courses. All participants were tested in two individual sessions in soundproof cubicles. All materials and measures were delivered via computer. A flowchart of the experiment is presented in Figure 3.1.

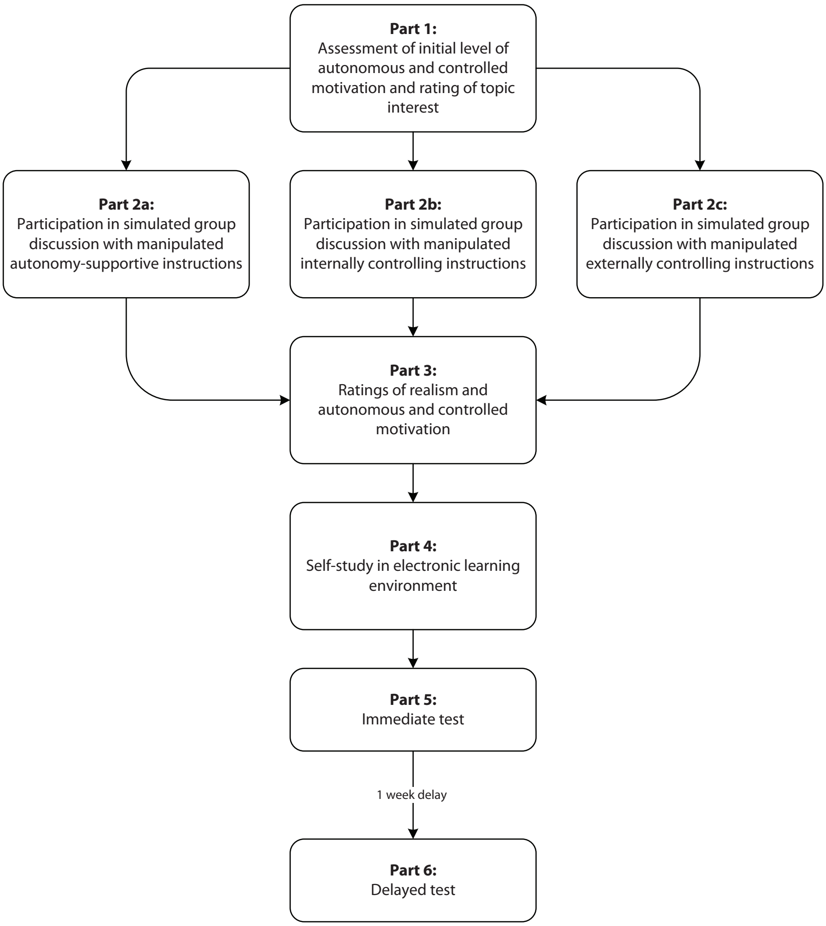

Figure 3.1. Flowchart of the experimental procedure. The experiment was conducted in two sessions. Session 2 took place 1 week later.

Materials and measures

For this experiment a standardized discussion and an electronic learning environment were created to simulate the first two phases of the PBL cycle: the initial problem discussion and the self-study phase. For our instruments, Cronbach's alphas between .70 and .80 were considered acceptable and above .80 were considered good (George & Mallery, 2007).

Standardized simulated group discussion with tutor manipulation and problem. A standardized simulated group discussion was developed consisting of an initial discussion of the problem (i.e., Phase 1 of the PBL cycle), according to the method used by Van Blankenstein, Dolmans, Van der Vleuten, and Schmidt (2011, 2013). Highly dynamic group processes can influence learning outcomes and make research on small group learning complex. To rule out the effects of other influences than topic interest or a tutor's instructional style, we set up an experimental study in which the group process was standardized. A group discussion was video-recorded in a room where PBL group meetings are usually held. In this video, four students carried out the initial discussion of a problem under the guidance of a human tutor using the Seven Jump method. This is a procedure for tackling problems that participants use during their regular PBL meetings in the curriculum under study (see Schmidt & Moust, 2000, for a more detailed description). The problem was a description of the Robbers Cave experiment by Sherif (1966), in which two small groups of 11- and 12-year old boys become very competitive and hostile toward each other when competing over desirable prizes that only one of the groups can obtain (see Appendix A). This topic was chosen because it was not covered as part of the social psychology course in the curriculum under study. Participation in the group discussion used in the simulation took approximately 15 minutes.

During the simulated discussion participants first watched a video in which the tutor and the four students in the video introduced themselves and the tutor gave instructions concerning this meeting. After this introduction, participants were presented with the problem on a computer screen; they could use the space bar to indicate when they had finished reading the problem. Then a video was shown in which the group in the video carried out the first three steps of the Seven Jump: clarification of unknown concepts (Step 1), formulation of a problem definition (Step 2), and brainstorming (Step 3). At the end of the brainstorming step the tutor talked directly into the camera to prompt the participant to give his or her contribution to the brainstorming activity or to react to what had been discussed in the video. The video then stopped and participants could contribute by speaking out loud. E-Prime (Version 2.0) was used to present the videos and to record participants' spoken discussion contributions. Participants could indicate with the space bar that they had given their contribution and continue watching the videotaped discussion. Participants then watched a video of the fourth step of the Seven Jump: problem analysis. Again, at the end of the problem analysis step the tutor directed her instructions toward the camera to prompt the participant for a contribution. After the participant had given his or her contribution to the problem analysis activity, he or she watched the group formulate learning goals for further self-study.

Autonomous versus controlled forms of tutor instructions (adapted from Vansteenkiste et al., 2005; Vansteenkiste, Simons, Lens, Sheldon, et al., 2004) were manipulated at five time points during the simulated group discussion: during the introductory instructions, the brainstorming step, the problem analysis step and the formulation of learning goals, and at the end of the simulated meeting to give instructions for the self-study phase. In the autonomy support condition, the tutor gave instructions such as “try to contribute to the discussion” (at the start of the discussion), “what is your opinion about this?” (to prompt students for contributions to the brainstorming activity and problem analysis) or “you can now select two literature resources, but you can decide for yourself how well you study those resources” (at the end of the simulated discussion). In the external control condition, the tutor explicitly used controlling language, such as “you have to make good contributions during the discussion,” “you must now contribute to the group discussion,” or “you must now select two literature resources and I expect you to do this as well as possible.” Finally, the internal control condition was intended to enhance feelings of internal pressure, for instance, by emphasizing students’ responsibility toward the group and themselves, such as “it is in the best interest of the group and yourself to contribute to the group discussion,” “what is your opinion, your contribution is important for the group process,” or “you can now select two literature resources, it is for your own good to study those resources as well as possible.” In short, during the simulated discussion, all participants watched and reacted to the same discussion by activating prior knowledge about the Robbers Cave experiment or intergroup conflict; only the tutor instructions differed per condition.

Electronic learning environment. Participants selected and studied learning resources in an electronic learning environment. This environment was a website containing brief directions stating that they could study for a maximum of 45 minutes, along with six links to the literature resources. Five resources were taken directly from social psychology textbooks that contained information concerning the Robbers Cave experiment, such as theoretical explanations or possible solutions for resolving intergroup conflict. The sixth text was taken from a book by Sherif (1966) on the Robbers Cave experiment. Resources were between three to eight pages long. Which resources were opened and for how long was logged. Participants could indicate that they were finished studying by clicking a button.

Motivation to study psychology. Before the experiment, motivation was measured with a 16-item questionnaire to check for preexisting differences between participants in the three conditions (based on Vansteenkiste, Sierens, Soenens, Luyckx, & Lens, 2009; Vansteenkiste, Simons, Lens, Sheldon, et al., 2004). Participants had to indicate why they studied psychology (i.e., “I study psychology because…”). The questionnaire consisted of four subscales: external motivation (e.g., "…because I'm supposed to do so"), introjected motivation (e.g., "…because I want others to think I am smart"), identified motivation (e.g., "…because I want to learn new things"), and intrinsic motivation (e.g., "…because I am highly interested in doing this"). Responses used a 4-point Likert scale ranging from 1 (*completely not important*) to 4 (*very important*). The subscales were combined into autonomous (Cronbach's $\alpha = .79$) and controlled (Cronbach's $\alpha = .85$) composite scores (see Vansteenkiste et al., 2009; Vansteenkiste, Simons, Lens, Sheldon, et al., 2004).

Topic interest. Topic interest was measured before the experiment with a 10-item questionnaire (e.g., "If I came across a TV program that talked about intergroup conflict, I would be eager to understand it.") developed by Mason et al. (2008). Items were rated on a 5-point scale ranging from 1 (*not at all*) to 5 (*very true*) to measure participants' interest in intergroup conflict (Cronbach's $\alpha = .78$).

Quality of contributions. To investigate the quality of the discussion contributions, participants' discussion input was analyzed with content analyses using multiple coding. Based on the coding schemes developed by Veerman and Veldhuis-Diermanse (2001) and Le Bigot and Rouet (2007), responses were coded into five categories: no discussion input (0), borrowed information (1), elaboration (2), new idea (3), and critical evaluation (4). The discussion categories were assumed to have a hierarchical order, with no discussion input (0 points) and borrowed information (1 point) scoring low in quality, whereas a critical evaluation (4 points) scored high in quality. Discussion input was considered borrowed when information presented earlier in the discussion was directly repeated or paraphrased (Le Bigot & Rouet, 2007). Elaboration referred to further elaboration and fine-tuning of ideas mentioned earlier in the discussion (Le Bigot & Rouet, 2007; Veerman & Veldhuis-Diermanse, 2001). The presentation of new information concerned bringing new information into the context of the discussion, such as facts, personal experiences, or opinions. Finally, evaluation concerned critical discussion of ideas presented earlier. This discussion went further than a simple confirmation or rejection of ideas and included justification of or argumentation with earlier ideas (see Appendix B for illustrations of discussion input codings).

The contributions were segmented into different ideas or topics discussed (e.g., the influence of gender in intergroup conflict or the influence of authority in intergroup conflict; Chi, 1997) and then coded. The majority of the discussion contributions (68%) were coded by two independent researchers, resulting in a moderate weighted kappa of .50, CI [.43, .58] (see Landis & Koch, 1977). Differences in scoring were resolved through discussion. A weighted score for total quality of discussion input was calculated by dividing the total score for all idea units by the number of idea units a student brought into the discussion. Weighted scores yielded in an intraclass correlation coefficient ICC of .68, which can be interpreted as fair to good (Fleiss, 1986).

Realism. After the group discussion participants were asked to rate the simulated group discussion for realism on a scale from 1 (*not realistic at all*) to 10 (*very realistic*).

Motivation to participate in group discussion. After the group discussion, autonomous and controlled motivation was measured again, but this was now a situation-specific measure of their motivation experienced while participating in the group discussion (based on Vansteenkiste, Simons, Lens, Sheldon, et al., 2004). The questionnaire consisted of 16 items on a 4-point Likert scale ("I participated in the group discussion because…"). Cronbach's alphas were .82 for autonomous and .84 for controlled motivation.

Self-study time and literature resources. The time participants spent with resources open in the electronic learning environment was recorded as a measure of total self-study time. Participants could spend a maximum of 45 minutes on self-study. The number of literature resources participants accessed during the self-study period was also determined.

Factual and conceptual knowledge. To measure factual and conceptual knowledge, participants took a test immediately after having studied the literature resources (Time 1) and they also took a delayed test 1 week later (Time 2). Participants took the same test on both occasions. The test consisted of 12 true or false questions and two open-ended questions. The 12 true or false items measured factual knowledge participants could answer using information from the individual resources available. Integration of multiple literature resources was not necessary for answering the true or false questions (e.g., "Henri Tajfel is the founder of realistic conflict theory"; false; Krathwohl, 2002). Both open-ended questions measured conceptual understanding (e.g., "Explain which conditions are necessary for a realistic conflict."; "Describe two ways in which intergroup conflicts can be resolved."). The answers to these questions needed in-depth processing and integration of information from different literature resources (Krathwohl, 2002). Two raters independently graded 33% of the answers to the open-ended questions, resulting in good interrater agreement (ICC = .88). The scores on the factual and conceptual knowledge questions were each transformed to represent a score on a 10-point scale (0-10).

Free-choice persistence. To measure free-choice persistence, at the end of the first experimental session participants were asked if they would like to receive additional learning resources to read about intergroup conflict (0 = *no*, 1 = *yes*), adapted from Vansteenkiste, Simons, Lens, Sheldon, et al. (2004). Participants received the supplementary literature after they completed the second test 1 week later.

Procedure

Participants were tested in two individual sessions. The first session consisted of five parts (see Figure 3.1). First, students filled out questionnaires concerning their autonomous and controlled motivation to study psychology and topic interest concerning intergroup conflict (Part 1). Second, participants took part in the video-based simulated group discussion and performed the initial discussion phase of PBL (Part 2). Note that tutor instructions were manipulated during this discussion and the quality of discussion input was based on participants' recorded contributions. After taking part in the discussion, participants rated the degree of realism of the discussion and indicated their autonomous and controlled motivation for participating in the discussion (Part 3). Then they entered an electronic learning environment for the self-study phase (Part 4). After the self-study phase, students took a test (Part 5). After a 1-week delay, participants returned to the lab for the second session to take the test again (Part 6).

Results and Discussion

Preliminary analyses

Outlier analyses suggested excluding one participant in the externally controlling condition from the analyses. We had missing data for five of the remaining 92 participants: Three participants did not show up for the second meeting (two in the externally controlling and one in the internally controlling conditions), and due to a computer error the discussion input of one student (externally controlling condition) and the immediate test and persistence data of another student were not correctly recorded (autonomy support condition). First, we used analyses of variance (ANOVAs) to check that the three groups did not differ on topic interest, prior study motivation, or perceived realism of the simulated group meeting. Participants generally experienced the simulated group discussion as realistic ($M = 7.44$, $SD = 1.14$). Results indicated the three conditions did not differ significantly on prior topic interest, prior autonomous/controlled motivation, and ratings of realism (all $ps > .10$). Table 3.2 presents the means, standard deviations, and correlations between the different measures.

Topic interest and instructional styles as determinants of motivation

Table 3.1 presents an overview of the hypotheses and associated analyses. First, an ANOVA was performed to examine the effects of tutor instructions on controlled motivation. The results indicated that tutor instructions had a significant effect on controlled motivation, $F(2, 89) = 6.16$, $p = .003$, $\eta_p^2 = .12$. Follow-up Bonferroni post hoc tests indicated that students in the autonomy-supportive condition scored lower on controlled motivation ($M = 2.04$, $SD = 0.52$) than students in both the external control ($M = 2.47$, $SD = 0.50$, $p = .006$) and internal control ($M = 2.42$, $SD = 0.57$, $p = .017$) conditions. In line with Hypothesis 1a, these results

Table 3.2

Descriptive Statistics and Correlations for the Measures of Study 1

Variables (possible range)	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Topic interest (1-5)	3.62	0.41	-												
2. Autonomous motivation (1-4)[a]	2.86	0.44	.52***	-											
3. Controlled motivation (1-4)[a]	2.31	0.56	−.06	<.01	-										
4. Quality of discussion input (0-4)[b]	2.14	0.54	.12	.12	.04	-									
5. Self-study time (0-2,700 s)	1,368.35	665.16	.27**	.36***	−.03	.22*	-								
6. Number of resources (0-6)	3.62	1.70	.04	.05	−.02	.12	−.01								
7. Factual knowledge T1 (0-10)[b]	8.43	1.39	.26*	.11	−.02	.16	.39***	.15	-						
8. Conceptual knowledge T1 (0-10)[b]	4.62	2.12	.12	.16	−.13	.17	.16	.10	.32**	-					
9. Factual knowledge T2 (0-10)[c]	8.35	1.19	.06	.08	.03	.05	.34**	.09	.66***	.36**	-				
10. Conceptual knowledge T2 (0-10)[b]	4.71	2.00	.13	.21*	<−.01	.27**	.18	.18	.40***	.72***	.34**	-			
11. Free-Choice persistence (0-1)[b]	0.34	0.48	.28**	.33**	−.02	.03	.39***	−.13	.19	.11	.12	.12	-		
12. Number of PBL courses (3-23)	6.74	4.04	−.10	−.23*	−.02	.14	.01	.17	.17	.13	.09	.07	−.09	-	
13. Realism (1-10)[b]	7.44	1.14	.19	.08	.01	.10	.31**	.11	.13	.03	.19	.09	.07	<.01	-

Note. $N = 92$. T1 = Time 1; T2 = Time 2; PBL = problem-based learning.
[a]Motivation in relation to participation in the discussion is reported. [b]$N = 91$. [c]$N = 89$.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

indicated that students who received internally or externally controlling tutor instructions experienced more pressure after the group discussion.

Second, an analysis of covariance was performed on autonomous motivation for participating in the group discussion, with tutor instructions as between-subjects factor and topic interest as covariate. In contrast to Hypothesis 1b, no significant differences for autonomous motivation were found between students receiving the autonomy-supportive ($M = 2.81$, $SE = 0.07$), externally ($M = 2.97$, $SE = 0.07$), and internally controlling ($M = 2.80$, $SE = 0.07$) tutor instructions, $F(2, 88) = 2.05$, $p = .135$, $\eta_p^2 = .05$. However, in support of Hypothesis 2, topic interest had a significant effect on autonomous motivation, $F(1, 88) = 36.15$, $p < .001$, $\eta_p^2 = .29$. Students who reported higher topic interest before the experiment were more likely to experience autonomous motivation during the simulated group discussion ($b = 0.57$, $SE = 0.10$, $p < .001$), regardless of their instructional condition.

Effects of topic interest and instructional styles on performance and study behavior

Table 3.3 reports descriptive statistics by tutor instructional style condition for self-study time and performance measures. A multivariate analysis of covariance was performed with tutor instructions as the between-subjects variable and topic interest as the covariate to investigate effects on self-study time and discussion input. Results indicated no effect of tutor instructions on self-study time and discussion input, Wilks's $\lambda = 0.95$, $F(4, 172) = 1.11$, $p = .353$, $\eta_p^2 = .03$. However, topic interest was significantly associated with students' discussion

Table 3.3
Means and Standard Errors for Study Behavior and Performance Measures by Condition

	Autonomy supportive (n = 32)		Internally controlling (n = 30)		Externally controlling (n = 30)	
	M	*SE*	*M*	*SE*	*M*	*SE*
Self-study time (s)	1248.54	114.32	1488.86	117.98	1368.89	120.22
Quality of discussion input	2.09	0.10	2.08	0.10	2.26	0.10
Immediate factual knowledge	8.02	0.24	8.87	0.25	8.34	0.25
Delayed factual knowledge	8.17	0.22	8.59	0.22	8.31	0.23
Immediate conceptual knowledge	3.97	0.38	4.93	0.39	4.91	0.40
Delayed conceptual knowledge	4.32	0.36	4.97	0.37	4.85	0.38
Persistence (%)	31.30%		43.30%		26.70%	

Note. Reported means and standard errors are corrected for the effect of topic interest.

input and self-study time, Wilks's $\lambda = 0.92$, $F(3, 86) = 3.89$, $p = .024$, $\eta_p^2 = .08$. Univariate results indicated that topic interest was positively related to self-study time invested ($b = 445.44$, $SE = 164.72$, $p = .008$), but not to the quality of discussion input ($b = 0.17$, $SE = 0.14$, $p = .210$).

The effects of tutor instructions and topic interest on factual and conceptual knowledge were examined with two mixed ANOVAs with topic interest as covariate, tutor instructions as the between-subjects variable, and test time point (i.e., immediate or delayed) as the within-subjects factor. A mixed ANOVA for factual knowledge indicated a significant main effect of test time point, Wilks's $\lambda = 0.93$, $F(1, 84) = 6.73$, $p = .011$, $\eta_p^2 = .07$, indicating that participants' scores declined from the immediate ($M = 8.41$, $SE = 0.14$) to the delayed test ($M = 8.36$, $SE = 0.13$). No significant main effect for tutor instructions, $F(2, 84) = 2.31$, $p = .106$, $\eta_p^2 = .05$, or topic interest was found, $F(1, 84) = 3.32$, $p = .072$, $\eta_p^2 = .04$. Tutor condition and test time point did not interact, Wilks's $\lambda = 0.97$, $F(2, 84) = 1.25$, $p = .292$, $\eta_p^2 = .03$. However, there was a significant interaction between topic interest and test time point, Wilks's $\lambda = 0.92$, $F(1, 84) = 7.10$, $p = .009$, $\eta_p^2 = .08$. Follow-up tests indicated that higher topic interest was associated with a better score on the immediate test ($b = 0.86$, $SE = .35$, $p = .014$), but not on the delayed test ($b = 0.18$, $SE = 0.31$, $p = .553$). In addition, topic interest was associated with a steeper decline from the immediate to the delayed test ($b = -0.72$, $SE = 0.27$, $p = .009$). The mixed ANOVA for conceptual knowledge indicated no significant main effect for tutor instructions, $F(2, 84) = 1.66$, $p = .196$, $\eta_p^2 = .04$, or topic interest, $F(1, 84) = 1.78$, $p = .186$, $\eta_p^2 = .02$. Also, no significant main effect or interactions for test time point were found, all Fs < 1.

On the persistence measure, 31 of the 91 participants (34.07%) indicated that they would like to read further literature. A logistic regression was conducted with tutor conditions (included as two dummy variables with autonomy support as the reference group) and topic interest as predictors. Topic interest was a significant predictor of persistence ($b = 1.50$, $SE = 0.58$, $p = .010$). The odds ratio was higher than 1 (4.47, 95% CI [1.42, 14.03]), indicating that participants with higher topic interest were more likely to persist. The two tutor condition dummy variables were unrelated to persistence: externally controlling tutoring ($b = -0.18$, $SE = 0.59$, $p = .764$) and internally controlling tutoring ($b = 0.53$, $SE = 0.56$, $p = .346$).

In sum, Hypothesis 3 was not supported by our data; tutor instructions did not affect study behavior or performance. Hypothesis 4 was partially supported: Topic interest was positively associated with self-study time, persistence, and score on the immediate factual knowledge test, although it was unrelated to quality of discussion input and conceptual knowledge.

Indirect effects on performance

Indirect effect analyses were performed using the macro developed by Preacher and Hayes (2008), a bootstrapping technique that estimates a 95% bias-corrected confidence interval for indirect effects.

Indirect effects of topic interest. We hypothesized that the effect of topic interest on self-study time, persistence, and the quality of discussion input would be mediated through autonomous motivation (Hypothesis 5). However, as can be seen in Table 3.3, neither autonomous motivation nor topic interest was significantly related to the quality of discussion input. Therefore, only the indirect effects of topic interest on self-study time and persistence were investigated. As can be seen in Figure 3.2, we found that topic interest did have an indirect effect on self-study time and persistence through motivation. When autonomous motivation was taken into account, the path between topic interest and self-study time and persistence became statistically nonsignificant. Together topic interest and autonomous motivation

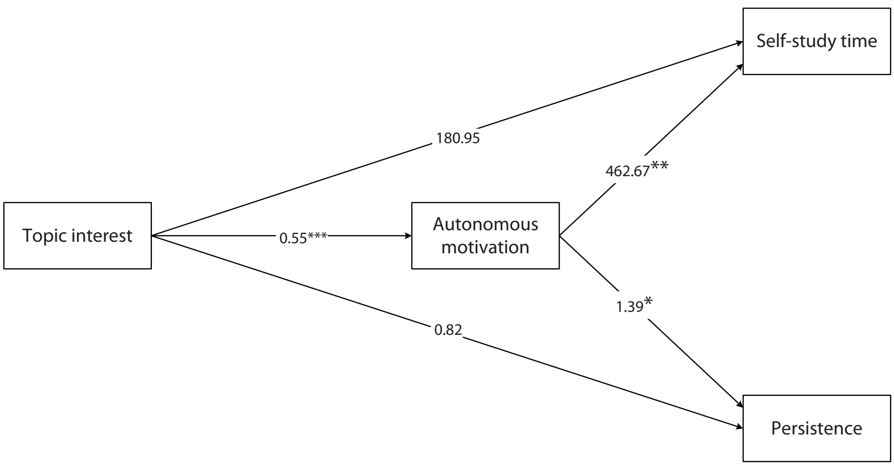

Figure 3.2. Indirect effects of topic interest on self-study time and persistence. Indirect effects through autonomous motivation on self-study time (95% CI [61.27, 540.44]) and persistence (95% CI [0.03, 2.07]) were significant. * $p < .05$, ** $p < .01$, *** $p < .001$.

explained 14% of the variance in self-study time and 12%-17% of the variance in persistence. Therefore, Hypothesis 5 was mostly supported.

Indirect effects of autonomous motivation. Next, we tested the indirect effects of autonomous motivation on factual and conceptual knowledge on the immediate test through self-study time and quality of discussion input (Hypothesis 6, see Figure 3.3).

Although autonomous motivation was not directly related to factual knowledge ($b = 0.35$, $SE = 0.34$, $p = .290$) and conceptual knowledge ($b = 0.78$, $SE = 0.50$, $p = .126$), it could still have indirect effects on immediate factual knowledge through self-study time and quality of discussion input (see Preacher & Hayes, 2008). Results indicated that autonomous motivation was significantly related to the mediator of self-study time, but not to the quality of discussion input (see Figure 3.3). The indirect effect of autonomous motivation on immediate factual knowledge through self-study time was supported (95% CI [0.21, 0.81]), but the indirect effect through the quality of discussion input was not (95% CI [−0.05, 0.34]). Sixteen percent of the variance in immediate factual knowledge was explained in this way. With respect to immediate conceptual knowledge, neither self-study time nor the quality of discussion input was associated with this variable. No indirect effect of autonomous motivation on immedi-

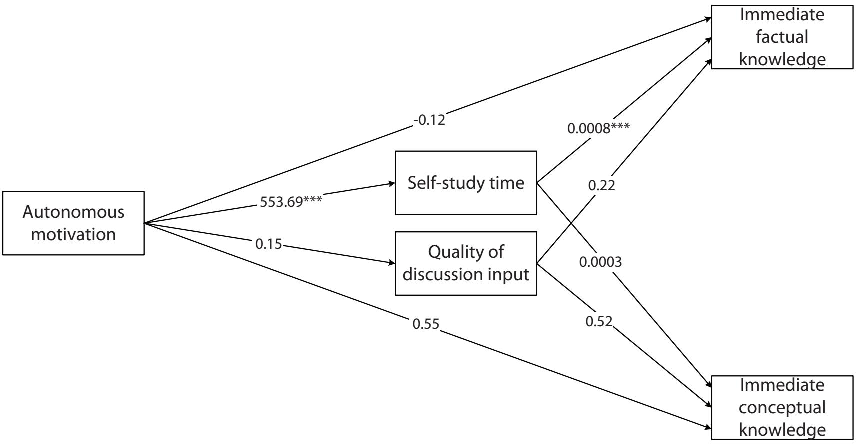

Figure 3.3. Indirect effects of autonomous motivation on test performance. Total indirect effect through self-study time and quality of discussion input was significant for immediate factual knowledge (95% CI [0.20, 0.89]), but not for immediate conceptual knowledge (95% CI [−0.21, 0.72]). *** $p < .001$.

ate conceptual knowledge was found. In sum, Hypothesis 6 was partially supported by our finding that autonomous motivation had an indirect effect on immediate factual knowledge through self-study time.

Discussion

In line with Hypothesis 1a, internally and externally controlling instructions enhanced students' feelings of pressure as indicated by the higher score on controlled motivation for students in these conditions when compared to autonomy-supportive instructions. However, in contrast to Hypothesis 1b, no significant association between autonomy-supportive tutor instructions and autonomous motivation was found. In addition, in contrast to Hypothesis 3, tutor instructions were not associated with self-study time, performance measures or persistence. These results diverge from those in an earlier study by Vansteenkiste, Simons, Lens, Sheldon, et al. (2004), where written autonomy-supportive instructions mostly affected students' autonomous motivation and subsequent performance and persistence. The fact that tutors' instructional style did not influence students' autonomous motivation and subsequent performance might be explained by the PBL context in which this experiment was conducted. In PBL, students are offered responsibility for their own learning, and tutors have only a guiding role. Therefore, autonomy-supportive language such as "you can" might have been less salient for students' autonomous motivation in this particular educational setting that is already student centered, whereas controlling teaching does affect controlled motivation.

In support of Hypotheses 2 and 4, topic interest was significantly associated with students' autonomous motivation, self-study time, and persistence. With respect to the knowledge tests, a significant interaction was found between test time point and topic interest. Higher topic interest was associated with higher performance on the immediate test, but also with a greater decrease in knowledge from immediate to delayed test. These results are similar to Mason et al. (2008). All in all, topic interest seems to be an important variable that needs to be taken into account when investigating motivation and performance in PBL. In support of Hypothesis 5, the effect of topic interest on self-study time and persistence was mediated by autonomous motivation. In support of Hypothesis 6, autonomous motivation affected test performance indirectly through self-study time, whereas controlled motivation was not associated with any performance measures in our experiment (see Table 3.2).

In contrast to prior research, no association was found between autonomous motivation and the quality of discussion input (Rienties et al., 2009). Further, no effects of the quality of discussion input were found on factual or conceptual knowledge scores. In this study, we measured the quality of discussion input in the initial discussion phase (i.e., brainstorming and problem-analysis). It is possible that autonomous motivation would have a stronger effect on the quality of discussion input in the reporting phase of PBL, when students share their literature findings with each other. The measure of the quality of discussion input might not have been sensitive enough for students' initial discussion contributions.

Topic interest and tutor instructions did not affect conceptual knowledge. On average, participants performed rather poorly on this test both immediately after the experiment and 1 week later (i.e., means of 4.62 and 4.71 on a scale from 0-10, respectively). The 23 minutes they dedicated to self-study on average was possibly not sufficient to achieve conceptual understanding of the literature. Alternatively, the questions could have been too difficult for students given the relatively short time span allowed for self-study.

Moreover, participants' experience with the simulated PBL discussions might differ from their experiences in a real-life, face-to-face PBL setting, even though students rated the experiment overall as realistic (i.e., 7.44 on a 1-10 scale). For example, in a real setting students might experience more pressure to pass a test; they also interact with their tutors over a longer timeframe than just one meeting. To enhance ecological validity, a follow-up study (Study 2) was conducted in the field to investigate whether the Study 1 findings could be replicated in a natural PBL setting.

STUDY 2

Study 2 aimed to cross-validate the results of Study 1. We used similar measures as in Study 1, with the exception of persistence. As it would be unethical to manipulate tutor instructions in a real PBL setting, we used two questionnaires to have students rate their tutor on autonomy-supportive and psychologically controlling teaching. Psychologically controlling teaching refers to intrusive behaviors that pressure students into thinking or behaving in certain ways and resembles internally controlling teaching (Soenens et al., 2012; Soenens & Vansteenkiste, 2010). We investigated whether the results of Study 1 could be replicated (see Table 3.1 for an overview of the hypotheses).

Method

Participants and design

All 343 first-year psychology students enrolled in the 5-week course, "Differences Between People", were asked to participate. The course content focused on individual differences such as personality and intelligence. Students had an average age of 20.24 years old ($SD = 3.23$). Eighty-nine students were male, 230 were female, and 24 students did not indicate their gender. Students were asked to rate their topic interest ($N = 319$) a few weeks before the course started and were asked to rate their tutor and their own motivation during the second half of the course ($N = 288$). These data were coupled with their tutors' ratings of the quality of the students' preparation and participation during group discussions ($N = 320$), students' self-reported self-study time ($N = 320$), and their course test performance ($N = 317$).

Problem-based learning environment

Study 2 was conducted during the second course of a first-year PBL psychology bachelor's program. The first bachelor year contains eight 5-week courses that each deal with a specific psychology topic, such as personality and individual differences or clinical psychology. Courses are offered in succession. Each week consists of two compulsory 3-hr tutorial meetings in which the initial discussion of the problem (first meeting) and the reporting of students' self-study findings (second meeting) take place. A tutorial group consists of 10-12 students and one tutor (i.e., a faculty member). Each course is graded through a course test that is taken at the end of each 5-week period. In addition, students' quality of preparation and participation in group meetings and discussions are assessed by their tutors.

Student measures

A few weeks before the course started, students were asked to indicate their interest in the topic of the course using a 10-item questionnaire (Cronbach's $\alpha = .73$; Mason et al., 2008). During the second half of the course, students were asked to rate their tutor on perceived autonomy support and psychologically controlling teaching. Autonomy support was measured with the Dutch translation (Sierens et al., 2009) of the 8-item subscale from the Teacher as a Social Context Questionnaire (Cronbach's $\alpha = .60$; Belmont, Skinner, Wellborn, & Connell, 1988). Psychologically controlling teaching (Cronbach's $\alpha = .83$) was measured using a 7-item questionnaire developed by Soenens et al. (2012). We also measured autonomous (Cronbach's $\alpha = .88$) and controlled motivation (Cronbach's $\alpha = .87$) for taking the course, "Differences Between People" (Vansteenkiste et al., 2009). All student questionnaires used a 5-point Likert scale response format. During the course evaluation at the end of the course, students reported their average self-study time for group meetings in hours. A study by Moust (1993) indicated that this method of self-reported study-time is an accurate reflection of the actual time spent on self-study.

Performance in group discussion

In Study 2, performance in group discussion was measured through tutor ratings of students' participation and preparation in group discussions, instead of the quality of discussion input. Participation and preparation were measured on a 5-point Likert-type scale with 19 items, resulting in a grade between 1-10 (see Loyens et al., 2007a).

Test performance

The course test consisted of 40 four-option multiple-choice items and 4 short-answer open-ended questions. Course tests were graded by the course coordinator and scores were corrected for guessing (25%). Test performance had a possible range of 0-10 points. Note that test performance in Study 2 differed from test performance as measured in Study 1 as no differentiation was made between factual and conceptual knowledge. We therefore only had one total score for test performance.

Analyses

Students were nested in 31 tutorial groups. Therefore a multilevel analysis is required, because students' ratings of their tutor in the same tutorial group are not independent from each other (Hox, 2010). ICCs were calculated as a measure of nonindependence of variables due to group membership (Bliese, 2000). The data were analyzed with multilevel path analysis in Mplus with tutorial group as the cluster variable (Muthén & Muthén, 2010). Maximum likelihood estimation with robust standard errors was applied in the analyses. Given that we only measured variables at the student level (within level), we do not report results on the tutorial group level (between levels). Variables were centered around the group mean, because we were only interested in person-level predictors (Enders & Tofighi, 2007). Assessment of model fit was based on multiple fit indices: chi-square, Tucker-Lewis index (TLI; Tucker & Lewis, 1973), and the comparative fit index (CFI; Bentler, 1990), the root-mean-square error of approximation (RMSEA; Steiger, 1990), and the standardized root-mean-square residual (SRMR). A RMSEA and SRMR value of .08 or lower and CLI and TLI values greater than .90 (CFI ranging between 0 and 1) are considered to indicate an acceptable fit to the data (Kline, 2005).

Table 3.4

Descriptive Statistics, Correlations, and Intraclass Correlation Coefficients for the Measures of Study 2

Variable (possible range; *N*)	*M*	*SD*	1	2	3	4	5	6	7	8
1. Topic interest (1-5; *N* = 319)	4.11	0.40	*.04*							
2. Autonomy support (1-5; *N* = 288)	3.81	0.43	.14*	*.07*						
3. Psychologically controlling teaching (1-5; *N* = 288)	1.94	0.60	−.12*	−.52***	*.05*					
4. Autonomous motivation (1-5; *N* = 288)	3.75	0.61	.32***	.19**	−.16**	*.02*				
5. Controlled motivation (1-5; *N* = 288)	2.74	0.75	−.12	−.18**	.29***	−.06	*.02*			
6. Participation and preparation (1-10; *N* = 320)	7.51	1.00	.02	.12*	−.19**	.15*	−.09	*.19*		
7. Self-study time (2-45 hours[a]; *N* = 320)	13.87	6.94	.07	.02	.05	.12*	<.01	<.01	*<.01*	
8. Grade (0-10; *N* = 317)	6.31	1.42	.04	−.05	.02	−.02	−.04	.29***	−.03	*.02*

Note. Intraclass correlation coefficients are presented on the diagonal.
[a]Real range is reported instead of the possible range.
* $p < .05$, ** $p < .01$, *** $p < .001$.

Results and Discussion

Descriptive statistics and correlations of the measures in our study are presented in Table 3.4. The ICCs are reported on the diagonal. As can be seen, up to 19% of the variance in these measures could be attributed to tutorial group membership. The model presented in Figure 3.4 had a good fit to the data, $\chi^2(18, N = 287) = 14.94$, $p = .666$; CFI = 1.00; TLI = 1.04; RMSEA < .01; SRMR = .03.

Topic interest and instructional styles as determinants of motivation

In line with Study 1, higher levels of psychological control by the tutor were associated with higher scores on controlled motivation ($R^2 = .11$). Hence, Hypothesis 1a was supported. Although a trend emerged that indicated that higher perceived autonomy support was associated with higher autonomous motivation, this failed to reach statistical significance (see Figure 3.3). Therefore, Hypothesis 1b was not supported in our field study, again in line with our findings in Study 1. Psychologically controlling teaching and autonomy-supportive teaching were not significantly associated with autonomous motivation ($R^2 = .14$). However, again in line with Study 1's findings, topic interest was a significant predictor of autonomous motivation, thereby supporting Hypothesis 2.

Indirect effects of topic interest and controlling teaching

We further examined the indirect effects of topic interest on students' performance during group discussion and self-study time. As can be seen in Figure 3.4, autonomous motivation had a statistically significant positive association with tutor ratings of students' participation and preparation in group meetings, whereas only a positive trend emerged for the path between autonomous motivation and students' self-reported self-study time. These results are in contrast to Study 1, in which autonomous motivation was associated with self-study time, but was unrelated to the quality of discussion input (see Figure 3.3). The indirect effect of topic interest on tutor ratings of students' participation and preparation during group meetings through autonomous motivation was significant ($b = 0.10$, $SE = 0.04$, $p = .029$). However, the indirect effect of topic interest on self-study time was not significant ($b = 0.56$, $SE = 0.36$, $p = .116$).

We also investigated the indirect effects of psychologically controlling teaching. Controlled motivation had a statistically significant negative association with tutor ratings of participation and preparation during tutorial meetings, but was unrelated to invested self-study time (see Figure 3.4). The indirect effect of controlling teaching on participation and preparation through controlled motivation was significant ($b = -0.06$, $SE = 0.03$, $p = .045$), but the indirect effect on self-study time was not ($b = 0.06$, $SE = 0.23$, $p = .794$).

In sum, indirect effects of topic interest and instructional style were found for discussion preparation and participation through autonomous and controlled motivation. Together, controlled and autonomous motivation explained 5% of the variance in tutor ratings of participation and preparation. In contrast, no indirect effects were found on self-study time. Therefore, Hypothesis 5 was only partially supported.

Indirect effects of motivation

As can be seen in Figure 3.4, tutor ratings of participation and preparation were a significant

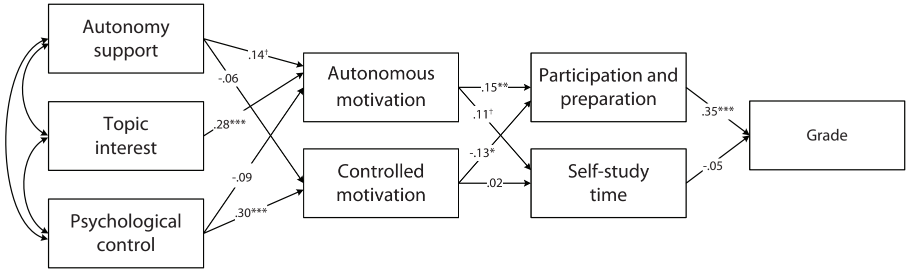

Figure 3.4. Model tested for Study 2. Standardized coefficients are reported. † $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

predictor of course test grades ($R^2 = .13$), whereas students' self-reported self-study time was not. To examine Hypothesis 6, we considered the indirect effects of autonomous and controlled motivation on grade through participation and preparation. Analyses revealed that both autonomous motivation ($b = 0.13$, $SE = 0.06$, $p = .023$) and controlled motivation ($b = -0.09$, $SE = 0.04$, $p = .035$) had an indirect effect on test performance by way of preparation and participation. The indirect effect of motivation on test performance through self-study time was not examined, because self-study time was unrelated to test performance. Therefore, Hypothesis 6 was only partially supported.

Discussion

In sum, Study 2 findings are largely in line with Study 1 findings. Again, we found that perceived autonomy support from tutors was not significantly associated with students' autonomous motivation, whereas perceived controlling teaching was associated directly with higher controlled motivation and indirectly with lower test scores. Topic interest again proved to be a predictor of students' autonomous motivation and subsequent performance. With respect to self-study time and participation and preparation for tutorial meetings, a different pattern emerged. In contrast to Study 1, the field study indicated that self-study time was unrelated to performance, whereas tutor ratings of students' participation and preparation in group meetings appeared to be an important predictor of achievement.

GENERAL DISCUSSION

In two studies, the association of topic interest and autonomy-supportive and controlling teaching with motivation, self-study time, and performance was measured in a PBL setting. In the first study, autonomy-supportive and controlling instructional style were manipulated (cf. Vansteenkiste, Simons, Lens, Sheldon, et al., 2004; Vansteenkiste et al., 2005) through the type of instructions a tutor gave during the initial discussion phase of the PBL cycle. The second study aimed to investigate whether the results of the first study could be replicated in a natural PBL setting.

Topic Interest Determinative for Autonomous Motivation and Subsequent Performance

Both studies found similar results with respect to the effect of topic interest on autonomous motivation. Specifically, students who indicated higher levels of initial topic interest scored higher on autonomous motivation. It could be argued that topic interest and autonomous motivation are associated, considering that one aspect of autonomous motivation is studying because it is fun or interesting. Nevertheless, the correlation tables for Studies 1 and 2 suggest they are related, but distinct constructs. Interest has been conceptualized as a unique motivational variable and a psychological state that occurs through interaction between the student and the topic of interest (Hidi, 2006; Hidi & Renninger, 2006). It includes both affective and cognitive elements. In contrast, Hidi (2006) has argued that in SDT, intrinsic value (as an aspect of intrinsic motivation) is more viewed as a cognitively determined variable (see for example "cognitive evaluation theory" in Deci & Ryan, 2000; R. M. Ryan & Deci, 2000a, 2000b).

It is important to consider students' topic interest, because students do not enter a course as blank slates. The results of the current studies indicate that students' anticipatory response to a topic affects their autonomous motivation and subsequently their study behaviors and performance. In Study 1, topic interest was indirectly associated with invested self-study time and persistence. In Study 2, topic interest had an indirect effect on students' preparation and participation during group discussions. Therefore, it is crucial not only to take into account the interestingness of learning materials such as problems, but also to consider students' expectation of interest in the topic addressed.

Controlling Teaching Harmful in PBL

Results of Studies 1 and 2 further indicated that psychologically controlling teaching and internally and externally controlling tutor instructions increased feelings of pressure, as indicated by higher scores on controlled motivation. This is in line with earlier research that has reported the hindering effects of teaching that is too dominant or directive (Hendry et al., 2003). In Study 1, controlling instructions did not influence study behavior or performance in group discussions. However, in Study 2, perceived controlling teaching had an indirect, negative effect on students' preparation and participation in group discussions through controlled motivation. Perhaps controlled motivation is not maladaptive for performance in group discussions in the context of a short-term experience, but becomes more maladaptive when motivation and performance are measured over the duration of a 5-week course.

With respect to tutor-provided autonomy support, surprising results emerged. In contrast to studies investigating teacher-centered environments, tutor-provided autonomy support was not (Study 1) or was only marginally, but not significantly (Study 2) related to autonomous motivation in a student-centered PBL environment. The limited role of tutor-provided autonomy support may be explained by the context in which the study was conducted. First, autonomy-supportive elements, such as offering choice, are already built into the design of the PBL learning environment. For example, students formulate their own learning issues within the tutorial group and have the freedom to select their own literature resources (e.g., Barrows, 1996). Additional tutor-provided autonomy support might therefore be less important for enhancing autonomous motivation.

Second, PBL has been described as chaotic, stressful, and too cognitively demanding (Duke et al., 1998; Kirschner et al., 2006; Sierens et al., 2006; Wijnia, Loyens, & Derous, 2011). The emphasis on students' autonomy in PBL is potentially stressful. Therefore, tutoring styles that attempt to alleviate the burden of students' responsibility might be better than autonomy-supportive tutoring. Hence, it might be more important to support other needs, such as competence, by providing structure. Structure can be provided through communication of clear expectations with respect to student behavior, guidance during lessons, and constructive feedback (Reeve, 2006).

Several studies have suggested that it is important to look at both structure and autonomy support (Jang et al., 2010; Sierens et al., 2009; Vansteenkiste et al., 2012). Sierens et al. (2009) found an interaction effect of autonomy support and structure on self-regulated learning, although not in a PBL environment. Specifically, they found that providing structure combined with moderate or high levels of autonomy support influenced self-regulated learning, whereas structure did not affect self-regulated learning when low autonomy support was provided. Also, Vansteenkiste et al. (2012) found that a teacher style characterized by autonomy support and clear expectations resulted in the most positive outcomes in terms of self-regulated learning, motivation, and problem behavior.

Tutor-provided structure during the learning activity in combination with autonomy support might be especially beneficial in terms of supporting students' learning and performance in PBL as well. Future studies could investigate whether tutor-provided autonomy support in combination with tutor-provided structure during the learning process is the most optimal instructional style in PBL.

Indirect Effects of Motivation on Performance

Motivation had an indirect effect on test performance in both Studies 1 and 2. In Study 1, autonomous motivation had an indirect effect on immediate factual knowledge through self-study time but not through the quality of discussion input. In Study 2, both controlled motivation and autonomous motivation had an indirect effect on test performance through tutor ratings of participation and preparation, but not through self-study time. Therefore, inconsistent results were found for the role of self-study and participation in group discussion.

With respect to self-study time, inconsistent results have been found for its contribution to academic achievement in PBL. Some studies have reported a positive effect of self-reported self-study time on performance (Loyens et al., 2013), whereas others did not find an effect (Loyens et al., 2007a). Differences in the results of Studies 1 and 2 might be explained by the different operationalization of self-study time: In Study 1, study time was objectively logged by a computer, whereas in Study 2, a subjective measure was used. Although self-study time was objectively logged in Study 1, we only know for certain that participants opened the resources for a particular length of time, but we do not know how well they studied the resources. In future studies it could be interesting to examine the quality of students' self-study and not just the extent of self-study time. For example, Plant, Ericsson, Hill, and Asberg (2005) found that the overall length of study time only appeared to be a significant predictor of college students' performance when the quality of study (e.g., study environment, planning) and previous performance levels were taken into consideration.

Autonomous motivation was only related to students' quality of preparation and participation in group meetings in Study 2, but not to the quality of discussion input in Study 1. The latter is in contrast to findings from Rienties et al. (2009). As mentioned before, the quality of discussion input as measured in Study 1 might not have been sensitive enough and might have been more effective if it were measured during the reporting phase of PBL in which students share their literature findings with each other. The contrasting results of Studies 1 and 2 might also be explained by the difference between a real-life, face-to-face PBL discussion (Study 2) and a simulated discussion (Study 1). In the simulated discussion input, students were prompted to give a contribution at two time points, whereas in a real-life, face-to-face PBL discussion context over multiple meetings, contributions occur more naturally.

In Study 2, tutor ratings of students' preparation and participation in group meetings were related to achievement on the course test. This finding is in line with several other studies that have found that tutor ratings of students' preparation and participation are one of the best predictors of achievement (De Koning et al., 2012; Loyens et al., 2007a).

Conclusions and Implications

The current studies investigated the effects of topic interest and tutor-provided autonomy support versus controlling teaching using two different approaches: an experimental study and a field study. Both topic interest and autonomy support have been considered to be important factors enhancing motivation in PBL, although these two aspects have not as yet been considered simultaneously in one study.

Moreover, the results of these studies suggest that students' expectations of a course, as measured through topic interest, should be considered. Topic interest proved to be an important predictor of students' autonomous motivation and subsequent study behavior and performance. When designing courses, more attention needs to be paid to the effects of the impressions and expectations students have at the start of a course, because students' expectations can be influential for motivation and performance during the course.

Our results indicated that in a student-centered learning environment, controlling instructional styles hamper motivation directly and subsequent performance indirectly. In contrast, tutor-provided autonomy support seems to be less influential for PBL students' autonomous motivation and learning than was previously thought (see Schmidt et al., 2009). The fact that autonomy support and autonomous motivation are not significantly associated in PBL also stands in contrast to earlier studies conducted in teacher-centered settings (e.g., Vansteenkiste, Simons, Lens, Sheldon, et al., 2004; Vansteenkiste et al., 2005). Future research is needed to examine whether our findings concerning instructional styles can be replicated and extended to other student-centered environments. For tutors, our results imply that they should avoid psychologically controlling teaching and use of controlling language. Tutors also need to consider whether needs besides autonomy, such as competence, are sufficiently supported.

Chapter 4

Is there a role for direct instruction in problem-based learning? Comparing student-constructed versus integrated model answers

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ABSTRACT

Problem-based learning (PBL) requires students to formulate learning issues that need to be answered by studying multiple literature resources. Advocates of high instructional guidance argue that this is too cognitively demanding for students and ineffective for learning. Therefore, we examined the effects of studying an integrated model answer in the self-study phase in PBL. Participants ($N = 62$) engaged in a simulated group discussion, ending with the establishment of learning issues. Then they either studied integrated model answers to the learning issues, or undertook a standard PBL self-study phase in which students needed to construct their own answers based on multiple literature resources. Studying integrated model answers was both effective and efficient: Participants scored higher on both immediate and delayed tests within less study-time. Although studying student-constructed answers resulted in lower test scores, participants' knowledge did not decline between tests, whereas knowledge in the integrated model answer condition did decline.

INTRODUCTION

Problem-based learning (PBL) was first introduced in the mid-sixties of the last century in medical education. Since then it has been implemented in various education curricula, such as economics and business education, engineering, science education, law, psychology, and K-12 education (Barrows, 1996; Loyens, Kirschner, & Paas, 2012; Schmidt et al., 2009). Schmidt et al. described PBL as "one of the few curriculum-wide educational innovations surviving the 60s" (Schmidt et al., 2009, p. 228).

PBL was developed to demonstrate the relevance of learning subject matter by offering a more realistic context through the use of problems. After students are presented with a problem scenario, the PBL cycle generally consists of three phases: (1) initial discussion phase, (2) self-study phase, and (3) a reporting phase. Collaborative learning takes place in the initial discussion phase and the reporting phase, whereas self-study is conducted individually. During the initial discussion phase the problem is presented to students before they receive any other curriculum input (Barrows, 1996; Schmidt, 1983b; Schmidt & Moust, 2000). The problem is complex and usually describes a phenomenon or event that can be observed in daily life. Small groups of students collaboratively discuss this problem using their prior knowledge and common sense to come up with possible explanations for the problem. Because their prior knowledge is insufficient to explain the problem completely, they formulate learning issues (i.e., questions) for further self-directed study. During the self-study phase, students prepare themselves for the next tutorial meeting by selecting, studying, and integrating information from multiple relevant learning resources (e.g., scientific articles or book chapters) with the aim of finding an answer to the learning issues. Afterward, students meet again to discuss their findings and to come to an integrated answer to the learning issues (i.e., reporting phase).

In the present experimental study we investigate the effectiveness and efficiency of the self-study phase in terms of learning. First, the effectiveness and efficiency of PBL when compared to direct instruction are discussed. Second, potential benefits and disadvantages of the standard PBL self-study phase are discussed.

THE EFFECTIVENESS AND EFFICIENCY OF PBL VERSUS DIRECT INSTRUCTION

Different views exist about whether or not PBL is an effective instructional approach. Proponents of PBL assume that the elaboration of knowledge that occurs at the time of learning will enhance subsequent retrieval and retention (Norman & Schmidt, 1992). A meta-analysis has found positive effects of PBL on long-term retention that were believed to be caused by students' active engagement with the learning materials (Dochy, Segers, Van den Bossche, & Gijbels, 2003). For example, several studies have demonstrated that PBL students score lower than a conventional lecture-based instruction group on multiple choice tests administered immediately after a course, but that their performance does not deteriorate on a follow-up test – on which they might therefore even score better than the conventional instruction group (Eisenstaedt, Barry, & Glanz, 1990; Tans, Schmidt, Schade-Hoogeveen, & Gijselaers, 1986). Based on these studies, one might conclude that the PBL approach is an effective and efficient instructional method.

However, some researchers have questioned the effectiveness and efficiency of PBL. For instance, the responsibility and autonomy that students are offered is experienced as unstructured, chaotic, and stressful (Duke et al., 1998; Sierens et al., 2006). Kirschner and colleagues (2006) described PBL as an unguided or minimally guided instructional approach. They argued that such approaches lead to ineffective use of limited cognitive resources, and thus, are not optimally designed for learning. Solving complex problems without any prior knowledge of the solution procedure imposes high load on working memory and leads to slow and inefficient learning (i.e., schema formation or elaboration in long-term memory; Clark, Kirschner, & Sweller, 2012; Kirschner et al., 2006; Sweller, Kirschner, & Clark, 2007). Accordingly, Kirschner and colleagues stated that PBL would be less effective and efficient than direct instruction, such as worked examples that show students the step-by-step procedure for solving a problem (Cooper & Sweller, 1987; Sweller & Cooper, 1985). In line with this view, a recent meta-analysis indicated that unassisted discovery learning in science, math, or problem-solving is less effective than explicit instruction as worked examples and offering feedback (Alfieri, Brooks, Aldrich, & Tenenbaum, 2011). During unassisted discovery learning students have to discover the target information or come to conceptual understanding independently with only the provided materials.

In their reply to Kirschner et al. (2006), Schmidt and colleagues (2007) explained why PBL should not be qualified as an unguided instructional approach and that sufficient scaffolding in various ways is present to reduce ineffective working memory load, for example by offering students a limited set of literature to choose from during the self-study phase. Alfieri et al. (2011) demonstrated that enhanced discovery learning, in which scaffolding and guidance was present, was beneficial not only compared to unassisted discovery learning, but also when compared to explicit instruction. These findings suggest that PBL approaches can be beneficial for learning when sufficient scaffolding is present.

Moreover, as Schmidt et al. (2007) pointed out, the vast majority of studies favoring direct instruction, such as worked examples, over unguided instruction, have used well-defined problems. Well-structured problems have a clearly defined goal state and a constrained set of logical operators to reach that goal state and are commonly found in mathematics or science curricula (Jonassen, 1997). In contrast, the problems encountered in PBL are ill defined. These problems do not have clearly specified goals or operators, and can have multiple correct solutions or solution procedures (Jonassen, 1997). As a consequence, Schmidt et al. stated that the findings with respect to well-structured problems might not generalize to a PBL context.

Nevertheless, recent studies indicated that instructional formats that provide high levels of guidance, such as worked examples or modeling examples, may also be effective for less well-defined tasks (e.g., Kostons, Van Gog, & Paas, 2012; Nievelstein, Van Gog, Van Dijck, & Boshuizen, 2013; Rourke & Sweller, 2009; Rummel & Spada, 2005; Schworm & Renkl, 2007). Modeling examples provide learners with the opportunity for learning by observing a peer or an adult model performing a to-be-learned task (Van Gog & Rummel, 2010). Findings from studies on worked examples and modeling examples suggest that direct instruction techniques might also be effective for acquiring knowledge of less well-defined problems, such as those encountered in PBL.

In sum, proponents of PBL emphasize the importance of students' active role during the learning process, such as giving them autonomy and having them actively construct their own knowledge based on multiple information sources, whereas advocates of high instructional guidance are concerned that the level of instructional guidance that is offered during the learning process is too low and that this might be detrimental to students' learning outcomes. In the present study, we investigate these contrasting views during the self-study phase of PBL. Specifically, we compared a group of participants who needed to construct their own answer to the learning issues by selecting, studying, and integrating information from multiple literature resources during self-study to a group of participants who studied integrated model answers. The integrated model answer constitutes an adequate "solution" or expert answer in which information from several resources is integrated. The model answer is comparable to the type of answer tutors in PBL receive to prepare themselves for group meetings.

BENEFITS AND DISADVANTAGES OF THE SELF-STUDY PHASE IN PBL

One of the essential goals of PBL is to develop autonomous learners and enhance students' self-directed learning (SDL) skills (Norman & Schmidt, 1992; Schmidt et al., 2009). SDL refers to the ability of students to be in control of their own learning process, rather than being directed by their teachers (Loyens et al., 2008). The experience of autonomy is not only a central concept in SDL; it also is a central component of self-determination theory (SDT; Deci & Ryan, 2000). SDT differentiates between autonomous and controlled motivation. Students are autonomously motivated when they experience self-determination, volition, and internal control over their learning process. Students study because the task is interesting (i.e., intrinsic motivation) or personally meaningful for future life goals (i.e., identified motivation). An autonomous learner is therefore also self directed. In contrast, students with controlled motivation experience either internal pressure to study, such as avoiding feelings of shame or guilt (i.e., introjected motivation) or external pressure, such as threat of punishment (i.e., external motivation).

Thus, SDL can be seen as a skill a learner already has (e.g., learners who are more autonomously motivated are more self directed), or as a design feature of the learning environment (e.g., the way instruction is organized) that leads to more autonomous motivation and self-direction (Candy, 1991). For example, in most PBL programs students have the responsibility to choose their own literature resources, based on the learning issues that were formulated during the group discussion (Schmidt et al., 2009).

Benefits of the Self-Study Phase in PBL

The standard PBL self-study phase in which students need to choose or select, study, and integrate information from multiple literature resources with the aim of finding an answer to the learning issues, might have potential motivational benefits. First, choosing one's own literature resources might yield benefits for students' intrinsic motivation and perceived competence. A meta-analysis indicated that offering choices can increase task performance, intrinsic motivation, and perceived competence (Patall et al., 2008). However, choices should not be too numerous or complex, so that students feel competent to handle the choice responsibility (Katz & Assor, 2007; Patall et al., 2008). Studying an integrated model answer does not offer students any choice at all. In contrast, letting students construct their own answer to the learning issues based on their own selection of literature from a limited set of resources that all contain relevant information, does offer some control and might therefore enhance their intrinsic motivation without the risk of choices being too numerous or information being missed.

Second, based on the assumptions about the role of active elaboration during learning (Norman & Schmidt, 1992), and prior research in PBL (e.g., Dochy et al., 2003), letting students construct their own answers to the learning issues might be beneficial for retention. Prior research has demonstrated that when students actively explained and elaborated on their prior knowledge during (a simulated) PBL prediscussion, they remembered more from a text studied after this prediscussion on a posttest one month later (Van Blankenstein et al., 2011).

Disadvantages of the Self-Study Phase in PBL

Although PBL might arguably have certain advantages in terms of motivation and knowledge retention, a case could also be made for providing more guidance during the self-study phase in PBL. Both staff members and students sometimes report frustrations or uncertainties with respect to students' responsibility during the PBL process (Dahlgren & Dahlgren, 2002; Miflin et al., 1999, 2000; Moust et al., 2005). In addition, the productivity of group meetings during the reporting phase is not always optimal (De Grave, Dolmans, & Van der Vleuten, 2002). For example, students sometimes leave learning issues unanswered. Superficial discussion of the subject matter sometimes occurs, with students reading from notes or articles instead of answering learning issues in their own words. The complexity of self-study might explain some of these incidents. After all, selecting and integrating literature during self-study can be very cognitively demanding for learners. During the selection and integration process across multiple resources, students need to keep in mind the problem and the learning issues formulated for this problem. In addition, to formulate an answer to the learning issues, students often need to study two or more literature resources. To comprehend the content and come to an answer to the learning issues, they therefore need to compare, extract, and integrate relevant information across these resources. From a cognitive load theory (CLT) perspective, this entire process of selecting, reading, and mentally integrating literature resources while keeping the learning issues in mind, will impose a very high load, through high element interactivity (see Sweller, 2010). That is, for learning to occur, numerous interactive elements need to be processed simultaneously. This places high demands on working memory, because working memory is limited in capacity: It can only hold approximately seven elements of information at once (Miller, 1956), and even less (i.e., approximately four) when processing is required (Cowan, 2001). Moreover, working memory is limited in duration, meaning that information decays rapidly (Peterson & Peterson, 1959).

Although first-year students are often given only a limited set of literature resources (e.g., various articles/book chapters) to choose from, in order to control the cognitive load involved in literature search to some extent (Schmidt et al., 2007), these processes are still very cognitively demanding. This is especially the case for novice learners who lack domain knowledge and experience (e.g., Rouet, Favart, Britt, & Perfetti, 1997; Strømsø, Bråten, & Samuelstuen, 2008). Determining the relevance and importance of resources in light of the learning issues can also be difficult for novice students. Prior knowledge has been shown to influence students' judgments of usefulness and trustworthiness of resources (e.g., Bråten, Strømsø, Salmerón, 2011; Rouet et al., 1997). From a CLT perspective, this also makes sense, because for people with more prior knowledge, working memory load imposed by a task is reduced, as certain information elements have already been combined into cognitive schemas that can be processed as a single element in working memory.

In sum, the activities students undertake during self-directed study consist of juggling many interacting information elements, and therefore impose very high load on working memory, while not all of these activities are crucial for learning to occur. For example, Nievelstein, Van Gog, Van Dijck, and Boshuizen (2011) have demonstrated that it is important to prevent students from engaging in irrelevant search processes that do not benefit learning. Reducing novice law students' search processes for laws in the civil code by offering them a condensed civil code, instead of the entire civil code, enabled them to learn better. Using a condensed code prevented cognitively demanding search processes that were not directly related to learning. Instead, students could focus their attention on making sense of the relevant information in the civil code and relating it to the law case they were trying to solve. On a subsequent test, in which they had to solve a new but similar case, using the entire civil code, participants who had practiced cases with the condensed code outperformed participants who had practiced with the entire code. As such, it could be expected that studying an integrated model answer, might be more effective for students' learning than letting them formulate their own answers through selecting and integrating information from several literature resources.

PRESENT STUDY AND HYPOTHESES

To summarize the above, based on prior research, arguments can be made in favor of both studying integrated model answers and of letting students construct their own answers, as both have been shown to have beneficial effects on cognitive load, motivation, and learning outcomes. However, a direct comparison of which self-study method is more effective in terms of motivation, cognitive load, and learning outcomes has not been made. Therefore, in the current study, we examined the effects of studying integrated model answers during self-study versus engaging in a typical self-study period in PBL involving selection and integration of literature resources from a presented subset with the aim of finding an answer to the learning issues (i.e., student-constructed answers). Specifically, we investigated the effects on students' study time invested, mental effort (as indication of cognitive load) invested, and performance on an immediate and delayed test a week later. Test performance was measured by a combination of closed and open-ended questions, since type of assessment has been proven to be an important aspect in PBL effect studies (e.g., Gijbels et al., 2005). The closed-answer questions focused more on remembering facts, whereas the open-ended questions focused more on the integration and application of knowledge. In addition, we investigated the effects of studying integrated model answers versus student-constructed answers on students' autonomous and controlled motivation and perceived competence.

Research on small group learning can be challenging, because highly dynamic group processes can affect students' learning outcomes (Van Blankenstein et al., 2011, 2013). In the present study, we were interested in the role of studying integrated model answers versus student-constructed answers during the self-study phase in PBL, so we wanted to rule out the influences of group dynamics on student outcomes. Therefore, we conducted an experimental study with a standardized group process. This was done by creating a video simulation of a problem-based discussion about intergroup conflict, guided by a tutor (see also Van Blankenstein et al., 2011, 2013). Individual participants watched and reacted to the video of a group performing an initial discussion of the problem, while sitting in soundproof cubicles (see the Method section for a more elaborate description of the video-recorded simulation). With a realism rating we checked how realistic participants experienced the simulated group discussion. Prior to the experiment we measured students' interest in the topic to be discussed and students' general autonomous and controlled motivation to study. These variables were measured, because they have been shown to influence students' academic achievement (e.g., Deci & Ryan, 2000; Rotgans & Schmidt, 2011b) and we wanted to check that there were no preexisting differences between the students in the integrated model answer and student-constructed answer condition.

First, we hypothesize that students who were presented with integrated model answers would need less study time (Hypothesis 1). Second, we expect that studying integrated model answers will lead to less mental effort invested during the study phase of the experiment when compared to participants in the student-constructed answer condition (Hypothesis 2). In addition, we measured mental effort during the test phase of the experiment. Mental effort ratings in combination with test performance measures will provide us with an indication of the quality of learning outcomes in the different conditions (see Van Gog & Paas, 2008). Specifically, this gives an indication of the efficiency of the cognitive schemata acquired as a result of studying integrated model answers versus student-constructed answers. We would expect that participants who gained more knowledge during self-study as a result of studying integrated model answers should have to invest less mental effort than participants who needed to construct their own answers in solving closed and open-ended test questions (Hypothesis 3a and 3b). Regarding test moment, we expect to find an interaction effect between timing of the test (i.e., immediate or delayed) and condition for both the closed and open-ended questions given that prior research has shown that knowledge of students in traditional, direct instruction curricula often declines on the long term (cf. Tans et al., 1986), whereas PBL students retain acquired knowledge (Hypothesis 4a and 4b). Specifically, we expect that students in the integrated model answer condition outperform participants in the student-constructed answer condition on the immediate test, whereas this difference becomes nonsignificant on the delayed test. In addition, we expect that participants in the student-constructed answer condition would not decline in knowledge between the immediate and delayed test, whereas this decline is expected for the students in the integrated model answer condition.

With respect to motivation, we expect higher scores on autonomous motivation and perceived competence (Hypothesis 5a and 5b; cf. Patall et al., 2008). Finally, we hypothesize that participants in the student-constructed answer condition would score lower on controlled motivation compared to students in the integrated model answer condition (Hypothesis 5c; cf. Patall et al., 2008).

METHOD

Participants

Participants were 62 Dutch undergraduate psychology or pedagogy students (mean age = 20.15, *SD* = 1.96; 12 male, 50 female), who took part in the experimental study on a voluntarily basis. In return for their participation, they received course credit or a payment of 15 Euros, in line with the regulations of the department in which the study took place. All participants were enrolled in a PBL curriculum and had taken at least three PBL courses prior to this study (32 were first-year students, 20 second-year students, 10 third-year students, evenly distributed over conditions).

Design and Procedure

Figure 4.1 depicts the flowchart of the procedure. Participants were tested in two individual sessions. All materials and measures were delivered via computer. Participants were quasi-randomly assigned to one of two conditions, matching for study-year: the integrated model answer condition (*n* = 31) or the student-constructed answer condition (*n* = 31). The first session consisted of 5 parts. To check for preexisting differences, participants first rated their general autonomous and controlled motivation to study and topic interest (Part 1). Then, participants took part in the video-based simulated group discussion and carried out the initial discussion phase of PBL that ended with the presentation of learning issues (Part 2). Afterward, participants entered an electronic learning environment, for the self-study phase (Part 3). During self-study participants either studied integrated model answers to the learning issues or studied several sources with the aim of finding an answer to the learning issues. After the self-study phase, participants rated how realistic they experienced the simulated group discussion and how much effort they invested during the self-study phase (Part 4). In addition, autonomous and controlled motivation and perceived competence were measured. Finally, participants took a test and rated how much mental effort they invested immediately after responding to each question or group of questions (Part 5). After a 1-week delay, in the second session, students took the test again.

Measures and Materials

Motivation and interest before the experiment

The motivation questionnaire consisted of 16 items and was developed by Vansteenkiste et al. (2009). Participants had to indicate why they generally studied for tutorial meetings (i.e., "I am motivated to study psychology/pedagogy…"). The questionnaire consisted of four subscales: external motivation (e.g., "…because I'm supposed to do so"), introjected motivation (e.g., "…because I want others to think I am smart"), identified motivation (e.g., "…because I want to learn new things"), and intrinsic motivation (e.g., "…because I am highly interested in doing this"). All items were rated on a 5-point Likert scale ranging from 1 (*completely not important*) to 5 (*very important*).

The subscales were combined into an autonomous motivation (i.e., average of identified and intrinsic motivation) and controlled motivation (i.e., average of external and introjected motivation) composite score according to the procedure described by Vansteenkiste et al. (2009). The Cronbach's alphas were .83 for autonomous and .87 for controlled motivation.

Topic interest concerning intergroup conflict was measured using a 10-item questionnaire developed by Mason et al. (2008). Before filling out these questions students were told that during this experiment they would discuss and study the social psychology topic intergroup conflict. An example of an item was "I would be excited about studying intergroup conflict." Items were rated on a 5-point scale ranging from 1 (*not at all*) to 5 (*much*). The scale had a satisfactory reliability (Cronbach's $\alpha = .82$).

Video-based simulated group discussion and problem

For this study, a standardized, simulated group discussion of the initial discussion phase of the PBL cycle was developed according to the method used by Van Blankenstein et al. (2011, 2013). A small group discussion was video-recorded in a room where PBL group meetings are usually held. During this discussion, the tutor and the four students in the video first introduced themselves. After this introduction, participants were presented with the problem. The problem described the Robbers Cave experiment by Sherif (1966), in which two small groups of 11- and 12-year old boys become very competitive and hostile toward each other when competing over desirable prizes that only the winning group could obtain (see Appendix A). Subsequently, participants took part in the initial discussion of the problem together with the simulated group. The initial discussion consisted of the first four steps of the "Seven Jump method": clarification of unknown concepts (Step 1), formulation of a problem definition (Step 2), brainstorming (Step 3), and problem analysis (Step 4). The Seven Jump method is a procedure for tackling problems that the participating students use during their regular PBL meetings (see Schmidt & Moust, 2000, for a more detailed description). At two points in the video (i.e., during the brainstorming and problem analysis steps) the tutor talked directly at the camera to prompt the participant to give his or her discussion contribution about the problem or react to what the other group members had contributed. The video then stopped and participants could contribute by speaking out loud. With the space bar participants could indicate that they had given their contribution and continue watching the video-based discussion. Therefore in the simulated discussion, participants watched and participated in the discussion by activating their own prior knowledge about the Robbers Cave experiment.

At the end of the simulated group discussion participants received two learning issues that were formulated (i.e., Step 5 of the Seven Jump method) by the group, so they were the same for all participants. The two learning issues were "What causes intergroup conflict?" and "How can intergroup conflicts be resolved?" Part-taking in the video-based simulated group discussion took approximately 10-15 minutes.

Electronic learning environments for self-study

A separate electronic learning environment was created for each of the two conditions. In the student-constructed answer condition, the electronic learning environment contained four literature resources. Each resource was between 2,097 and 3,582 words in length. All resources were texts taken from social psychology text books suitable for an introductory social psychology course. All texts contained relevant information with respect to the problem and the learning issues, such as a description of the Robbers Cave experiment, relevant theories concerning intergroup conflict and resolving conflicts with respect to the Robbers Cave experiment. The resources differed in the extent to which each of the theories or solutions were explained.

The integrated model answer condition differed from the student-constructed answer condition in that it contained two model answers to the learning issues that had been formulated at the end of the simulated group discussion instead of four social psychology texts. Each model answer stated the learning issue and an answer to this learning issue. The model answer contained relevant, integrated information derived from the literature resources that students in the student-constructed answer condition received. It did not contain any additional information (e.g., specific cases or examples to further clarify the theories). The two model answers were respectively 1,431 and 559 words long (see Appendix C for the model answer to the second learning issue).

In both electronic learning environments, participants could access the files containing the problem and the learning issues any time they wanted. The time (in seconds) participants spent navigating the electronic learning environment (maximally 45 minutes) was recorded as a measure for total self-study time. We also logged for each literature resource or model answer whether it was accessed and for how long. Based on these log-files, we could also determine the number of literature resources participants accessed during self-study in the student-constructed answer condition.

Motivation and perceived competence after the learning phase

After the self-study phase participants' autonomous and controlled motivation was measured again, but now concerned a situation-specific measure of their motivation experienced during the study phase of the experiment (i.e., "I studied the texts…"). The questionnaire consisted of 16 items rated on a 4-point Likert scale, and was developed by Vansteenkiste, Simons, Lens, Sheldon, et al. (2004). Again the questionnaire consisted of four subscales:

external, introjected, identified, and intrinsic motivation that were combined into an autonomous motivation and a controlled motivation composite score according to the procedure described by Vansteenkiste, Simons, Lens, Sheldon, et al. (2004). The Cronbach's alphas for the two subscales were .83 for autonomous and .77 for controlled motivation experienced after the group discussion.

Participants' perceived competence about the studied subject matter was measured using the 4-item questionnaire of Williams and Deci (1996), which requires ratings on a 5-point Likert scale ranging from 1 (*not at all true*) to 5 (*very true*). Reliability analysis revealed the scale had a satisfactory Cronbach's alpha (.80). An example of an item was "I think I am able to master the subject matter related to this problem."

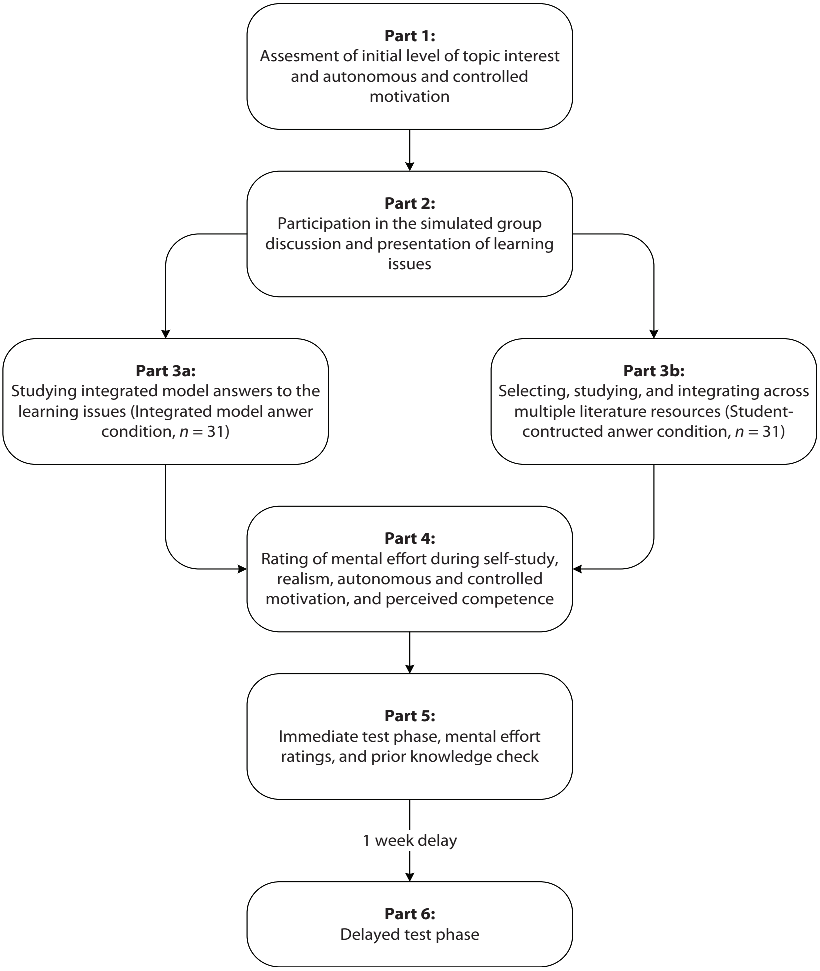

Figure 4.1. Flowchart of the experimental procedure. The experiment consisted of two individual sessions. The second session took place 1 week later.

Test performance

The first part of the test consisted of 15 true or false questions and four multiple-choice questions, while the second part consisted of four open-ended questions. Example items for the true or false questions and multiple choice questions were "Superordinate goals are goals that can only be achieved when both groups work together" (true) and "Which of the following conditions is NOT necessary to elicit conflict according to realistic conflict theory? A) Scarce, important resources, B) Dominant/ Authoritarian personality, C) Direct competition" (B is the correct alternative). The true or false questions and multiple-choice questions concerned facts that could be found in several resources. Integration of several different literature resources was not necessary in order to be able to answer these questions. The four open-ended questions measured conceptual understanding and application of the theories participants studied. For the first question they had to provide theoretical explanations that explain intergroup conflict in the Robbers Cave experiment. This question is similar to learning issue 1: "What causes intergroup conflict?" Second, they had to provide solutions to resolve intergroup conflict (see also learning issue 2: "How can intergroup conflicts be resolved?"). For the third question they had to indicate the strengths and limitations of realistic conflict theory as a possible explanation for intergroup conflict in the Robbers Cave experiment. Finally, they were asked to name both strengths and limitations of the manner in which the Robbers Cave experiment was conducted. The answers to these questions needed in-depth processing and integration of information from different literature resources or students were asked to apply what they had learnt.

Performance on the closed-answer (i.e., true or false and multiple-choice) test questions was scored by assigning 1 point for each correct answer, and these scores were then summed (i.e., max. 19 points). Performance on the open-ended test questions was scored according to a coding scheme (see Appendix D), with a maximum of 4 points per question (i.e., 16 points in total). Two raters independently scored 50% of the answers to the open-ended questions, resulting in an intraclass correlation coefficient of .92.

Mental effort ratings

Mental effort invested in the self-study phase was measured on a 9-point scale, ranging from (1) very, very low mental effort to (9) very, very high mental effort (Paas, 1992) immediately after the self-study phase. In addition, immediately after each test question of the immediate test (see Van Gog, Kirschner, Kester, & Paas, 2012), participants rated the mental effort they invested in answering that question, on the 9-point scale developed by Paas (1992). Because we had multiple ratings for mental effort during the test phase, we calculated an average score of mental effort for both the immediate closed-answer (i.e., true or false and multiple-choice questions) and open-ended questions.[1]

Ratings of realism

The realism rating asked participants to indicate how realistic they experienced the simulated group discussion to be, by indicating a score on a slide bar of 10 centimeters ranging from 0 (*not realistic*) to 10 (*very realistic*).

Prior knowledge

To check possible differences in prior knowledge, we asked students to indicate whether they had ever heard or read anything about the Robbers Cave experiment, social identity theory, and realistic conflict theory prior to the experiment (i.e., the two main theories discussed in the literature and model answer). Their score on prior knowledge could range from 0 (*no prior knowledge*) to 3 (*some familiarity with all three concepts*).

RESULTS

Preliminary Analyses

We conducted outlier analyses by transforming the scores of the dependent variables into *z*-scores (Field, 2009). All outliers above 2.58 were winsorized by substituting the extreme value by the next highest or lowest value: the controlled motivation during self-study data of one participant (student-constructed answer condition), the perceived competence and test performance mental effort data for the immediate open-ended questions of one participant (student-constructed answer condition), the study phase mental effort data of one participant (student-constructed answer condition), the test performance data on the delayed closed-answer questions of three participants (student-constructed answer condition), the test performance data on the delayed open-ended questions of one participant (integrated model answer condition), and the test performance mental effort data for the delayed open-ended questions of two participants (integrated model answer and student-constructed answer conditions).

First, we checked whether the two conditions did not differ on topic interest, initial study motivation, ratings of realism of the simulated group design, and self-reported level of prior

1. On the delayed test, we also measured mental effort invested. There were no effects on this measure and for reasons of length, the editor suggested that we delete this information from the manuscript. Statistics can be obtained from the first author.

knowledge with independent *t*-tests. As can be seen in Table 4.1, results indicated that both conditions did not significantly differ on initial topic interest, $t(60) = 0.69$, $p = .492$; and initial autonomous $t(60) = 1.57$, $p = .122$; and controlled study motivation $t(60) = -1.86$, $p = .068$. These results indicate that before the manipulation, equal levels of initial topic interest and motivation between conditions could be assumed.

Participants generally experienced the simulated group discussion as realistic, and realism ratings did not differ between conditions, $t(60) = -1.15$, $p = .254$. This implies that the simulated group discussion was effective for the purpose of this experiment. The analyses also indicated that there were no significant differences between the two conditions on level of prior knowledge, $t(59) = 0.28$, $p = .778$. In addition, there were no significant correlations between students' level of prior knowledge and performance measures (correlations ranging between $r = -.05$ and $r = .14$). These results indicate that possible differences in test performance between conditions cannot be attributed to differences in prior knowledge.

Table 4.1

Initial Motivation and Interest, Perceived Realism and Prior Knowledge

Variable (possible range)	Integrated model answer condition ($n = 31$)		Student-constructed answer condition ($n = 31$)	
	M	*SD*	*M*	*SD*
Topic interest (1-5)	3.75	0.40	3.82	0.48
Initial autonomous motivation (1-5)	4.04	0.53	4.25	0.51
Initial controlled motivation (1-5)	2.71	0.63	2.37	0.80
Perceived realism (0-10)	7.96	1.15	7.65	0.98
Prior knowledge (0-3)[a]	0.32	0.54	0.37	0.67

Note. [a]Prior knowledge data was missing for one participant in the student-constructed answer condition.

Self-Study Phase: Accessed Resources, Time on Task, and Mental Effort

Table 4.2 reports the frequency and average durations with which a file was accessed per condition. All participants in the integrated model answer condition accessed the two model answers. In the student-constructed answer condition the majority of the participants (80.60%) accessed all four of the literature resources. Log-files indicated that most students chose to read one of the resources in depth (as indicated by the amount of time dedicated to that resource) and looked for additional or new information in the remaining resources. Total time invested on self-study did not correlate with test performance for the participants in the integrated model answer condition (range $r = -.03$ to $r = .24$). For the student-constructed answer condition, there was a significant correlation between the amount of time spent on self-study and the score on the delayed closed-answer test ($r = .40$, $p < .05$), but not for the other test performance scores (range $r = .10$ to $r = .21$). The average amount of time resource A was accessed correlated with test performance on the delayed open-ended questions ($r = .38$,

$p < .05$) and the amount of time resource C was accessed correlated positively with the score on the delayed closed-answer questions ($r = .37$, $p < .05$). Other correlations between the amount of time a resource was accessed and test performance failed to reach significance. All in all, these results indicate that the time a specific resource was accessed contributes little to test performance scores.

Time on task and mental effort during the learning task were analyzed (see Table 4.2). On average, in line with our hypothesis (Hypothesis 1), participants who were presented with model answers (15.31 minutes) spent less time studying than participants who had to select, and study, and integrate literature resources (22.66 minutes). This difference was statistically significant, $t(45.86) = 3.09$, $p = .003$; indicating a medium-sized effect, $r = .42$. However, in contrast to our expectation (Hypothesis 2), no statistically significant differences were found on mental effort invested in the study phase between the integrated model answer condition and the student-constructed answer condition, $t(60) = 0.56$, $p = .575$. Therefore, the conditions did not differ in invested mental effort during learning.

Table 4.2

Number of Participants Accessing Files and Average Duration and Mental Effort During the Self-Study Phase

	Integrated model answer condition			Student-constructed answer condition		
	Frequency	*M*	*SD*	Frequency	*M*	*SD*
Problem	10	3.39	8.80	0	-	-
Learning issues	17	2.35	3.04	14	2.74	4.91
Model answer 1[a]	31	674.61	291.88	-	-	-
Model answer 2[a]	31	244.23	99.57	-	-	-
Resource A[b]	-	-	-	31	698.77	390.14
Resource B[b]	-	-	-	26	195.26	208.49
Resource C[b]	-	-	-	28	210.55	254.13
Resource D[b]	-	-	-	26	255.23	389.21
Total self-study time		918.84	374.28		1359.81	700.04
ME during learning		4.06	1.21		4.26	1.48

Note. ME = mental effort. Duration of accessed files is reported in seconds.
[a]Files that could only be accessed in the integrated model answer condition. [b]Files that could only be accessed in the student-constructed answer condition.

Test Phase: Mental Effort and Test Performance

In Table 4.3, mental effort ratings during the immediate test phase are reported. Differences between the two conditions on mental effort during the test phase were analyzed with two independent *t*-tests. In line with Hypothesis 3a, results indicated that participants in the integrated model answer condition reported lower mental effort in answering the closed-answer questions than participants in the student-constructed answer condition, $t(60) = 3.03$,

$p = .004$, indicating a medium-sized effect, $r = .36$. In contrast to Hypothesis 3b, conditions did not differ in the amount of mental effort invested in answering the open-ended questions, $t(60) = 0.07$, $p = .945$.

In Table 4.3, test scores on the immediate and delayed tests are also reported. Two mixed analyses of variance (ANOVAs), with condition as between-subjects factor and test moment as within-subjects factor were conducted to examine the effects of condition on performance on the closed-answer questions and the open-ended questions. For the closed-answer questions a statistically significant main effect of test moment was found, $F(1, 60) = 6.66$, $p = .012$, $\eta_p^2 = .10$. Participants scored significantly lower on the delayed than on the immediate closed-answer test. In addition, there was a statistically significant main effect of condition in favor of the integrated model answer group on performance on the closed-answer questions, $F(1, 60) = 32.00$, $p < .001$, $\eta_p^2 = .35$. In addition, in line with our hypothesis (Hypothesis 4a) a statistically significant interaction effect between condition and test moment emerged, $F(1, 60) = 5.80$, $p = .019$, $\eta_p^2 = .09$. Four post hoc *t*-tests were conducted using Bonferroni adjusted alpha levels of .0125 per test (.05/4). Two independent *t*-tests demonstrated that the participants in the integrated model answer condition outperformed the participants in the student-constructed answer condition on both the immediate, $t(60) = -5.98$, $p < .001$, $r = .61$ (large effect); and the delayed closed-answer test, $t(60) = -4.13$, $p < .001$, $r = .47$ (medium to large effect). In addition, two paired *t*-tests demonstrated that on average participants in the student-constructed answer condition did not significantly differ in performance on the immediate and delayed test, $t(30) = 0.12$, $p = .906$; whereas performance of the participants in the integrated model answer condition significantly declined, $t(30) = 3.63$, $p = .001$, $r = .55$ (large effect). In sum, in contrast to Hypothesis 4a, participants who studied model answers not only outperformed students in the self-constructed answer condition on the immediate test, but also on the delayed test. In line with our hypothesis, students in the integrated model answer condition showed a decline in knowledge from immediate to delayed test, whereas the participants in the student-constructed answer condition did not.

The analysis of the open-ended questions also resulted in a statistically significant main effect of test moment, $F(1, 60) = 16.72$, $p < .001$, $\eta_p^2 = .22$. Again, participants scored lower on the delayed test than on the immediate test. A main effect of condition was found in favor of the integrated model answer condition, $F(1, 60) = 13.55$, $p < .001$, $\eta_p^2 = .18$. In line with our hypothesis (Hypothesis 4b) a statistically significant interaction effect was found between test moment and condition, $F(1, 60) = 5.29$, $p = .025$, $\eta_p^2 = .08$. Again, four post hoc *t*-tests were conducted using Bonferroni adjusted alpha levels of .0125 per test (.05/4). Two independent *t*-tests demonstrated that the participants in the integrated model answer condition outperformed the participants in the student-constructed answer condition on the immediate open-ended questions, $t(54.22) = -4.41$, $p < .001$, $r = .51$ (large effect). In addition, a marginal significant trend emerged that indicated that participants who studied model answers scored higher on the delayed open-ended questions than participants in the student-constructed answer condition, $t(60) = -2.46$, $p = .017$, $r = .30$ (medium effect). Finally, two paired t-tests demonstrated that, on average, participants in the student-constructed answer condition did not significantly differ in performance on the immediate versus delayed test, $t(30) = 1.21$, $p = .236$; whereas performance of the participants in the integrated model answer condition significantly declined, $t(30) = 4.74$, $p < .001$, $r = .65$ (large effect). In sum, Hypothesis 4b, was only partially supported. In line with our hypothesis, students in the integrated model answer showed a decline in knowledge from immediate to delayed test, whereas the participants in the student-constructed answer condition did not. A trend emerged, indicating that participants who studied model answers not only outperformed students in the self-constructed condition on the immediate test, but also on the delayed test.

Table 4.3
Test performance scores and mental effort during the test phase

	Integrated model answer condition ($n = 31$)		Student-constructed answer condition ($n = 31$)	
	M	*SD*	*M*	*SD*
Mental effort closed-answer questions	4.47	0.87	5.13	0.86
Mental effort open-ended questions	4.81	0.89	4.83	0.95
Immediate closed-answer questions	15.74	1.59	13.13	1.84
Delayed closed-answer questions	14.81	1.60	13.10	1.66
Immediate open-ended questions	6.99	2.56	4.51	1.82
Delayed open-ended questions	5.58	2.49	4.11	2.20

Motivation and Perceived Competence

Finally, we analyzed students' motivation and perceived competence after they studied the learning materials. Table 4.4 presents the scores on the motivation variables. In contrast to Hypothesis 5a and 5c, independent t-tests showed no statistically significant differences in autonomous and controlled motivation between both conditions. In addition, in contrast to Hypothesis 5b, participants did not differ in their perceived competence. Perceived competence was high in both conditions.

Table 4.4
Motivation after the study phase

	Integrated model answer condition ($n = 31$)		Student-constructed answer condition ($n = 31$)			
	M	*SD*	*M*	*SD*	*t*	*p*
Autonomous motivation	3.05	0.44	3.04	0.49	−0.03	.973
Controlled motivation[a]	2.45	0.46	2.32	0.54	−1.02	.313
Perceived competence	3.55	0.44	3.59	0.56	0.32	.752

Note. [a]Pattern of results did not change if initial controlled motivation was included in the model.

DISCUSSION

This study aimed to investigate whether studying model answers (i.e., integrated model answer condition) would be more effective and efficient for learning than the self-study phase in PBL in which students need to construct their own answers by selecting, studying, and integrating multiple literature resources. On the one hand, choosing and integrating information from one's own literature resources might be more effective in terms of long term retention of acquired knowledge because of active engagement with the learning material. It also might enhance students' intrinsic motivation and perceived competence. On the other hand, self-study in PBL might be too cognitively demanding and lead to lower (initial) learning outcomes because of high element interactivity (e.g., Rouet et al., 1997).

Effectiveness and Efficiency of Integrated Model Answers

Our results showed that the implementation of integrated model answers as a type of direct instruction in a PBL setting was effective. Participants who studied integrated model answers scored higher on both an immediate and delayed test on closed-answer (factual) questions, as well as on open-ended (conceptual and application) questions on the immediate test. Moreover, participants who studied integrated model answers attained that higher test performance with less time spent on studying the learning materials, equal investment of effort in the learning phase, and equal or lower investment of effort in the test phase, indicating higher efficiency of the learning process as well as learning outcomes (Van Gog & Paas, 2008). These results are in line with earlier studies that investigated the effects of direct instruction, such as worked examples, in less well-defined tasks (e.g., Nievelstein et al., 2013).

An additional explanation for the beneficial effects of studying integrated model answers might lie in the redundancy effect. The redundancy effect occurs when additional information presented to students hampers learning when compared to the presentation of less or reduced information (Kalyuga & Sweller, 2014). Redundancy can take place when additional information is presented to enhance or elaborate information, for instance a full text when compared to a summary. In our experiment, the participants in the integrated model answer condition might have benefitted from the fact that additional explanations or examples of the theories were not included in the integrated model answer when compared to the texts extracted from social psychology books.

Regarding retention of knowledge, we found an interaction effect between condition and timing of the test, in line with our hypothesis. Follow-up analyses indicated that the test scores of students in the integrated model answer condition significantly declined from the immediate to the delayed test, whereas the test scores of students who chose and selected their own literature resources remained constant. Participants who studied the integrated model answers still scored higher on the delayed closed-answer questions than students who chose, studied, and integrated their own literature resources, but not on the delayed open-ended questions. These results seem to indicate that although students who select, study, and integrate information from multiple literature resources scored lower on both test moments, they do not decline in knowledge between the immediate and delayed test. Therefore, student-constructed answers to the learning issues seem to have some beneficial effects in terms of consolidation of knowledge, and this effect might even become more pronounced at longer delays than the 1-week delay implemented in our study. This result regarding knowledge retention is in line with earlier studies that indicated that PBL students seem to score lower on immediate knowledge tests, but seem to remember most of this knowledge on delayed tests (Eisenstaedt et al., 1990; Tans et al., 1986). Van Blankenstein et al. (2011) found that active participation in a simulated PBL discussion resulted in better remembering 1 week later. The current study demonstrates that selecting one's own literature resources and the integration of information from these resources to answer learning issues can also facilitate long-term retention. When students have to select and study own literature resources, they need to integrate knowledge from these different learning resources to be able to answer the learning issues. This active engagement with the learning materials might lead to better consolidation of acquired knowledge (Dochy et al., 2003). Nevertheless, further research is needed to examine whether this result will remain with different learning materials, over a longer time delay, and in a real-life PBL setting.

Effects on Motivation

It has been argued that when students are offered more responsibility over their learning process, such as selecting own literature resources; this might lead to higher perceptions of autonomy (Schmidt et al., 2009). In addition, offering choices has been shown to enhance task performance, intrinsic motivation, and perceived competence (Patall et al., 2008). However, the present results indicated no differences in students' autonomous and controlled motivation and perceived competence during self-study between the two conditions. These results seem to indicate that having a choice in literature resources versus studying integrated model answers does not seem to affect students' autonomous and controlled motivation or perceived competence.

As can be seen in Table 4.4, perceived competence and autonomous motivation to study the learning materials were on average quite high (i.e., respectively 3.55 or 3.59 on a scale from 1-5 and 3.04 or 3.05 on a scale from 1-4). Since perceived competence to study the subject matter was high in both conditions, self-study with the aim of letting students construct their own answers does not seem to have been perceived as overwhelming or too difficult. This is in contrast to anecdotal evidence that the responsibility offered to students during the PBL process can be too stressful for some students and lead to confusion (Duke et al., 1998). In addition, because there were no differences in autonomous and controlled motivation, studying integrated model answers did not seem to be perceived as undermining autonomy or self-determination during self-study when compared to self-selection of one's own resources.

Limitations and Future Studies

Although participants rated the simulated group discussion overall as realistic (see Table 4.1), their experience with the simulated PBL cycle in the lab might differ from their experiences in a real, face-to-face PBL setting. For instance, interaction with others was limited due to our design, therefore students could not alter the groups' learning issues in the simulated discussion and the amount of self-study time available was limited to 45 minutes. However, learning issues were based on the simulated group discussion and participants did provide input during this discussion. In addition, the 45 minutes students could spend on self-study seemed to be sufficient: Participants who selected their own literature resources on average dedicated approximately 22 to 23 minutes (i.e., 1,348.84 s.) on self-study. Another issue in this respect is that we did not include the reporting phase in our study in which typically, students collaboratively come to an integrated answer to the learning issues. Future research should investigate whether effects are generalizable to a real-life PBL setting, where students have more opportunity for collaboration and that also includes a reporting phase.

A second limitation of our study is that we did not have a pretest of prior knowledge. We did not include a pretest because of the PBL context in which the experiment was conducted. In PBL the problem is used as the starting point of the learning process and should be presented to students before any other curriculum input (Barrows, 1996). We were concerned that implementing a pretest would influence the simulated group discussion and self-study phase. When selecting the problem for this experiment we chose a topic that was not covered in the regular psychology and pedagogy courses to ensure that the problem was new for participating students. Indeed, students' self-reported level of prior knowledge was low and did not seem related to the performance measures.

In addition, it could be interesting to more closely examine the influence of having a choice in literature resources on students' performance, mental effort, and motivation. Instructor-selected literature resources are assumed to lead to less study time invested and more superficial processing of the subject matter than studying self-selected literature resources (Moust et al., 2005). Therefore, in a PBL setting, it could be interesting to compare students who have to study instructor-selected learning resources versus letting students select resources.

Moreover, it has been argued that allowing learners to select their own resources develops this important skill alongside their content knowledge, and we did not measure effects on learning to seek relevant literature or self-regulated learning skills. It should be noted though that the question whether simply engaging in a skill is the best way of developing that skill, or whether other instructional methods might be more effective (cf. the findings by Nievelstein et al., 2011, on learning to reason about law cases with a condensed civil code, while test conditions were with the full code). Future studies could address this question.

Conclusion and Implications

In conclusion, results demonstrated that studying integrated model answers during self-study in a PBL setting was more effective than letting students construct their own answers by selecting and integrating information across multiple literature resources during self-study. Both on the immediate and delayed test, studying integrated model answers resulted in better learning outcomes in terms of test performance. In addition, studying integrated model answers seemed to be efficient in terms of the learning process and the quality of learning outcomes, since these higher learning outcomes were obtained with lower or equal investment of mental effort during the study or test phase. However, we found some evidence that letting students construct their own answers based on several literature resources to answer learning issues was beneficial in terms of retention of knowledge when compared to studying integrated model answers. Specifically, we found no decline in knowledge from the immediate to delayed test for the student-constructed answer condition. Nevertheless, participants in the integrated model answer condition still outperformed them on the delayed test. Finally, studying integrated model answers or student-constructed answers did not affect students' autonomous motivation and perceived competence. This is in contrast to the idea that direct instruction might lower feelings of autonomy or that the greater responsibility in PBL of selecting one's own literature resources would be too confusing or uncertain for students (cf. Duke et al., 1998).

Even though PBL students are often provided with a limited set of literature resources to choose from, to prevent students from irrelevant literature searches (Schmidt et al., 2007), integrating information from different resources to answer learning issues can be quite cognitively demanding (Rouet et al., 1997). Nevertheless, the skill of being able to integrate information across multiple texts is important to acquire (e.g., Strømsø et al., 2008). Therefore, it might be important to investigate whether PBL students might benefit from a type of support in which they learn how to extract and integrate relevant information from different literature resources to explain the problem and answer the learning issues. Example-based learning has been used successfully to teach additional skills next to content knowledge, such as collaboration (Rummel & Spada, 2005) or self-assessment and task selection (Kostons et al., 2012). Therefore, it would be an interesting question for future research whether worked examples or modeling examples could also be used to train students in answering learning issues with use of multiple resources.

Chapter 5

How important are student-selected versus instructor-selected literature resources for students' learning and motivation in problem-based learning?

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ABSTRACT

In problem-based learning (PBL) students are responsible for their own learning process, which becomes evident when they must act independently, for example, when selecting literature resources for individual study. It is a matter of debate whether it is better to have students select their own literature resources or to present them with a list of mandatory instructor-selected literature resources. The current study investigated the effect of using instructor-selected literature resources or student-selected literature resources (from a pre-determined set of literature) on several learning outcome variables. The results demonstrated that students in the student-selected literature condition scored higher on autonomous motivation and perceived competence, and lower on perceptions of mental effort during studying. Students in the instructor-selected condition had better test performance on factual test items, whereas no difference was found for the conceptual questions. Overall, the results indicate that letting students select their own literature resources can be beneficial in terms of autonomous motivation, perceived competence, and perceptions of mental effort invested during learning and does not differentially affect conceptual knowledge.

INTRODUCTION

Problem-based learning (PBL) is a type of student-centered learning environment in which small groups of students work on meaningful problems under the guidance of a tutor (Barrows, 1996; Schmidt & Moust, 2000). These problems are used as the starting point for the learning process, and usually describe a phenomenon or event that can be observed in daily life but needs to be explained (e.g., irrational fear of spiders might be a problem considered in a clinical psychology course). Students participate in an initial discussion to explain the phenomenon by use of prior knowledge and common sense. Because their knowledge is insufficient to explain the problem completely, they formulate learning issues (i.e., questions) for further individual self-directed study. After a period of self-study, students meet again in their groups to report their findings.

One of the goals of PBL is to help students become autonomous learners by promoting their self-directed learning (SDL) skills (Norman & Schmidt, 1992; Schmidt et al., 2009). In PBL, formulating learning issues and selecting literature resources for self-study are considered SDL skills (Schmidt, 2000). To prevent students from selecting irrelevant literature, they are often offered a limited set of literature resources (e.g., various articles, books) to choose from (Loyens et al., 2012; Schmidt et al., 2007, 2009). Nonetheless, instructors and students sometimes report uncertainties or frustrations concerning students' responsibilities during the PBL process (Dahlgren & Dahlgren, 2002; Miflin et al., 1999, 2000; Moust et al., 2005). In the present study, we compare differences in the impact of instructor-selected literature resources versus student-selected literature resources on students' motivation, perceptions of competence, self-reported learning uncertainties, perceptions of mental effort, and test performance in a PBL setting. Instructor-selected literature resources is operationalized as providing students with two mandatory literature resources to study. By student-selected literature resources we mean that students can select literature resources from a predetermined subset of five resources, allowing them a choice in learning materials.

In PBL, students are often provided with a rich learning environment containing multiple learning resources. Te Winkel, Rikers, Loyens, and Schmidt (2006) demonstrated that the number of resources that are provided to students can influence their performance in PBL. When students were provided with more primary resources (i.e., recommended book chapters or articles), they had higher achievement scores. There was also a trend toward longer self-reported self-study time in courses that offered more resources. By offering more learning resources about a topic, it is expected that students will be able to construct a more complete and richer mental model of the mechanisms underlying the problem, which promotes learning. However, information-rich learning environments might be overwhelming. For example, Jeong and Hmelo-Silver (2010) demonstrated that students, especially low-achieving students, need guidance to use resources effectively in a rich (i.e., with plentiful resources) online PBL course.

Some instructors worry that the freedom or responsibility offered to students will result in insufficient coverage of the subject matter, and consequently make changes to the original PBL process by requiring students to study specific literature resources. Moust and colleagues (2005) warn against these "signs of erosion" and report that studying only instructor-provided literature will result in inadequate self-study and shallow discussion of the subject matter. However, students sometimes indicate that they prefer to receive literature resources from their instructors. They express worries concerning whether they will read enough of the right literature to get a satisfactory grade at the end of the course (Wijnia et al., 2011), even if this type of guided reading might result in superficial discussion of the subject matter. Furthermore, Miflin et al. (1999) reported that students expected to receive a higher amount of guidance than that was offered by the instructors who provided the resources. In short, with respect to students' selection of literature resources in PBL, room for autonomy and sufficient guidance are both crucial.

AUTONOMY AND MOTIVATION

Autonomy is an important dimension of SDL (Candy, 1991) and a central concept within self-determination theory (SDT; Deci & Ryan, 2000; R. M. Ryan & Deci, 2000a, 2000b). According to SDT, all humans have three basic needs (i.e., autonomy, competence, and relatedness) that need to be satisfied so that optimal motivational and learning outcomes can be achieved. Student motivation is not a unitary concept, but different types of motivation can be distinguished based on the amount of autonomy or self-determination students experience. The most important distinction is that between autonomous and controlled motivation (Deci & Ryan, 2008a).

When students are autonomously motivated they experience volition and self-determination (Deci & Ryan, 2000). They perform an activity because it is interesting (i.e., intrinsic motivation) or because the activity is personally meaningful to them. In contrast, controlled motivation consists of feelings of pressure or coercion (Deci & Ryan, 2000). These feelings of pressure can come from within an individual, such as feelings of shame and guilt, or from an external source such as demands of significant others or threat of punishment. Generally, autonomous motivation is associated with better learning outcomes relative to controlled motivation (Deci & Ryan, 2000, 2008a).

The context of a learning environment has the potential to promote or hinder students' autonomous motivation. Learning environments that offer autonomy support have been associated with higher autonomous motivation and more adaptive learning outcomes (Deci & Ryan, 2000; R. M. Ryan & Deci, 2000a, 2000b). A student-centered learning approach and offering meaningful choices in learning materials are examples of autonomy support (e.g., Black & Deci, 2000; Katz & Assor, 2007; Schmidt et al., 2009).

A meta-analysis on the effects of choice indicated that choice enhanced intrinsic motivation, effort, task performance, and perceived competence (Patall et al., 2008). Specifically, the meta-analysis showed that all types of choices promoted intrinsic motivation, indicating that offering choices provides students with an opportunity to experience autonomy and competence that enhances intrinsic motivation. However, further moderator analysis suggested that it is important to find a balance between the effort expended in making the choice and the experience of autonomy. For example, a trend emerged that indicated that in terms of students' intrinsic motivation, the ideal number of options to choose from is between three and five. Offering too many choices may result in expending too much effort, whereas offering fewer than three options may not be sufficient to enhance students' sense of autonomy. Based on this meta-analysis, selecting or choosing literature resources to study might lead to better motivational and learning outcomes in PBL, if students have a sense of autonomy and are not overwhelmed by this responsibility. For a PBL environment, this implies restriction of the number of resources to choose from (Schmidt et al., 2007). In addition, all provided resources should supply relevant information addressing the learning issues, so that students' choices are relevant with respect to the task at hand (cf. Katz & Assor, 2007; Patall et al., 2008).

SELF-DIRECTED STUDY AND PERCEPTIONS OF MENTAL EFFORT

Although offering choice in literature resources during self-directed study might enhance intrinsic motivation, perceived competence, and performance (e.g., Patall et al., 2008), self-selection of literature resources can be cognitively demanding for students. A recent study has shown the importance of preventing students from engaging in irrelevant search processes that do not benefit learning (Nievelstein et al., 2011). When novice law students were offered a condensed civil code that reduced the scope of their search process for laws, they benefitted more in terms of learning, than when they were offered the entire civil code. Specifically, Nievelstein et al. found that students who practiced with the condensed code had better performance on a test case, as well as on a subsequent case in which they had to use the entire civil code as the students who had practiced with the entire civil code. Better performances were obtained with the same amount of mental effort investment. Using a condensed code prevented cognitively demanding search processes that were not directly related to learning. Therefore, students' attention could be devoted to making sense of the relevant information in the civil code and relating it to the law case they were trying to solve.

In most PBL environments, students are instructed to select learning resources to address the learning issues formulated in their small discussion groups (Loyens et al., 2012; Schmidt et al., 2007, 2009). Therefore, students need to determine the most relevant learning resources and should extract and integrate relevant information from these learning resources to come to an answer regarding their learning issues. The scope of students' search activities could be reduced by offering them a few mandatory instructor-selected literature resources in which they can find an answer to the learning issues. They could then focus their attention on extracting the relevant information from these resources and relating it to the problem, instead of first having to select from among a subset of resources (cf. Nievelstein et al., 2011). Therefore, in the current study we examined whether students benefit more in terms of test performance and perceptions of mental effort during learning and test performance when the resources are instructor selected or student selected.

PRESENT STUDY AND HYPOTHESES

Research in small-group learning is difficult because of highly dynamic group processes that affect students' learning outcomes (Van Blankenstein et al., 2011, 2013). Because we were interested in the effects of student-selection versus instructor-selection of literature, we needed to rule out the influences of group dynamics on students' outcomes. Therefore, we set up an experimental study in which we standardized the group process by creating a video-based simulation of a problem-based discussion guided by a tutor (see Van Blankenstein et al., 2011, 2013). Specifically, participants individually watched and reacted to this video simulation while sitting in soundproof cubicles (see the Method section for a more elaborate description of the video-recorded simulation). Prior to the experiment we measured students' interest in the topic to be discussed, and students' autonomous and controlled motivation, perceived competence, and learning uncertainty about studying psychology in general. These variables were measured because they have been shown to influence students' self-study time and performance (e.g., Deci & Ryan, 2000; Loyens et al., 2007a), and we wanted to check that there were no preexisting differences between the students in the instructor- and student-selected literature resources conditions. The current study aims to answer three research questions.

Research Question 1: Do participants in the instructor- or student-selected literature condition differ in the amount of time spent on self-study and perceptions of mental effort during self-study? We hypothesized that students who could select resources from a subset of resources would invest more self-study time (Hypothesis 1; Te Winkel et al., 2006). We explored the effects on perceptions of mental effort during the self-study phase. Having to select resources and come to an integrated answer to the learning issues based on student-selected literature might require more mental effort (cf. Nievelstein et al., 2011). On the other hand, having to read "mandatory" instructor-selected literature resources might be effortful as well, because students must still integrate information from multiple resources to formulate an answer to the learning issues, and do not have the option to switch to another resource when they find an article or chapter difficult to read, for example.

Research Question 2: To what extent does instructor- or student-selection of literature resources affect motivational variables such as students' autonomous and controlled motivation, perceived competence, and learning uncertainty? We expected that having a choice of which literature resources to study would result in higher perceptions of autonomous motivation (Hypothesis 2a) and lower controlled motivation (Hypothesis 2b) than having to study two mandatory literature resources (cf. Patall et al., 2008). In addition, we explored the effects on students' perceptions of competence and learning uncertainty. Perceived competence was included because Patall et al. (2008) demonstrated an effect of choice on perceived competence. Learning uncertainty was included because it has been suggested that selecting one's own literature resources can lead to feelings of uncertainty about what to study (e.g., Miflin et al., 1999, 2000; Moust et al., 2005; Wijnia et al., 2011).

Research Question 3: To what extent does instructor- or student-selection of literature resources affect test performance and perceptions of mental effort invested in answering test questions? Because the type of assessment has been proven to be an important aspect in PBL effect studies (e.g., Gijbels et al., 2005), we explored the effect of having a choice on test performance for both closed-answer and open-ended questions and on perceptions of mental effort during the test. Perception of mental effort during test performance was included because it will provide us with an indication of the quality of learning outcomes in the different conditions (see Van Gog & Paas, 2008). Specifically, it gives an indication of the efficiency of the cognitive schemata acquired as a result of studying instructor-selected resources when compared to studying student-selected resources. Based on the study by Te Winkel et al. (2006), it might be expected that having more literature resources available will result in higher achievement scores on a test. However, because the resources available in either condition contained sufficient relevant information for addressing the learning issues, it is possible that no differences in test performance will be found.

METHOD

Participants

Participants were 60 Dutch undergraduate psychology students enrolled in a PBL curriculum (mean age 20.44 years old, $SD = 1.75$; 20 male, 40 female; 35 first-year students, 24 second-year students, and 1 third-year student). All participants had taken six or more PBL courses prior to this study. They took part in the experimental study on a voluntary basis and, in line with the regulations of the department in which the study took place, received course credit or a payment of 10 Euros in return for their participation.

Design and Procedure

Participants were tested in individual sessions in soundproof cubicles. All materials and measures were delivered via computer. Participants were quasi-randomly assigned to one of two conditions, matching for study-year: the instructor-selected ($n = 30$) and the student-selected literature resources condition ($n = 30$). Participants first rated their autonomous and controlled motivation to study psychology, perceived competence, self-reported uncertainty about studying psychology, and topic interest to check for possible preexisting differences (Part 1). Then, participants entered the video-based simulated group discussion. The video-based simulated discussion was the same for all participants (Part 2). After participants saw the video, they were allowed to study instructor-selected literature resources or student-selected literature resources (for a maximum of 45 minutes; Part 3). After the self-study phase, participants rated how realistic they found the simulated group meeting and how much effort they invested during self-study (Part 4). In addition, autonomous and controlled motivation, and perceived competence and self-reported learning uncertainties about studying during the self-study phase were measured. At the end of the experiment, participants took a test and rated their perceived mental effort immediately after responding to each question or group of questions (Part 5). A flowchart of the procedure is presented in Figure 5.1.

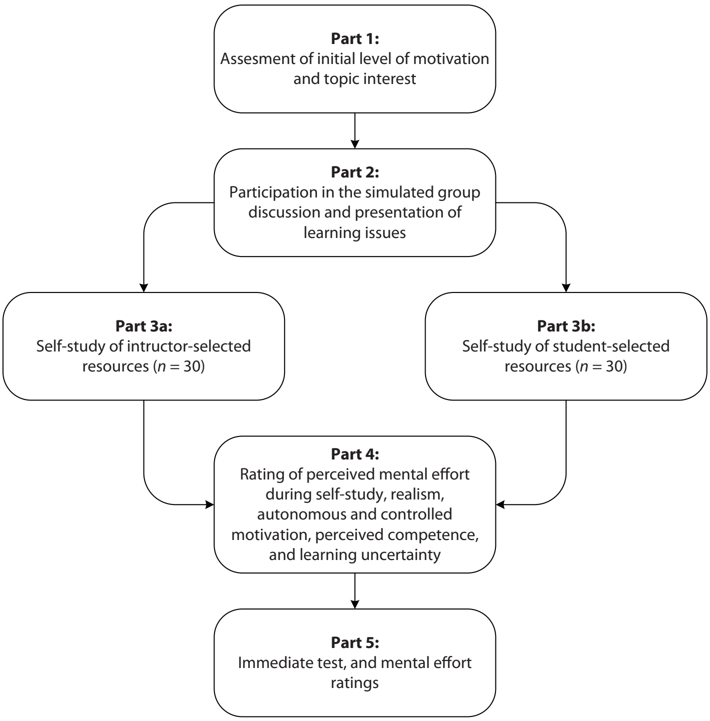


Figure 5.1. Flowchart of the experimental procedure.

Part 1: Pre-assessment

To check whether preexisting differences between conditions were present, initial levels of autonomous and controlled motivation, perceived competence, students' learning uncertainty, and topic interest were measured. Motivation was measured with the Self-Regulation Questionnaire (Vansteenkiste et al., 2009). Participants had to indicate why they studied psychology (i.e., "I am motivated to study psychology…"). The questionnaire consisted of 16 items divided over four subscales: intrinsic motivation (e.g., "because I enjoy doing it"), identified motivation (e.g., "because it is personally important to me"), introjected motivation (e.g., "because I would feel ashamed if I didn't do so"), and external motivation (e.g., "because others [e.g., family, friends, teachers] oblige me to do so"). Items were rated on a 5-point Likert scale ranging from 1 (*completely not important*) to 5 (*very important*). Composite scores for autonomous (i.e., average intrinsic and identified motivation) and controlled motivation (i.e., average introjected and external motivation) were calculated (see Vansteenkiste et al., 2009). Reliability analyses of these subscales resulted in Cronbach's alphas of .87 for autonomous and .88 for controlled motivation.

In addition, students' perceived competence and learning uncertainty were measured. Participants' perceived competence about studying psychology (e.g., "I think I am able to master the subject matter of most psychology courses") was measured using the 4-item Perceived Competence Scale (PCS; Williams & Deci, 1996). Participants' learning uncertainty was measured with a 7-item questionnaire based on the self-perceived inability to learn subscale developed by Loyens et al., (2007b). An example item was "I often feel uncertain about what I have to study." All items were rated on a 5-point Likert scale ranging from 1 (*not at all true*) to 5 (*very true*). Reliability analyses revealed Cronbach's alphas of .69 for the PSC and .78 for the learning uncertainty scale.

5

Finally, topic interest concerning the topic to be discussed, intergroup conflict, was measured using a 10-item questionnaire (e.g., "I would be excited about studying intergroup conflict"; Mason et al., 2008). All items were rated on a 5-point Likert scale ranging from 1 (*not at all*) to 5 (*very true*). The Cronbach's alpha for the topic interest scale was .82.

Part 2: Video-based simulated group discussion

Participants took part in a video-based, simulated group discussion (see Van Blankenstein et al., 2011, 2013). A small-group discussion was video-recorded in a room where PBL group meetings are usually held. In this video, four students carried out the initial discussion of a problem under the guidance of a tutor (see Figure 5.2 for a screenshot of the simulated group discussion).

The problem described the Robbers Cave experiment by Sherif (1966, see Appendix A). Specifically, the description of the problem told how two groups of young boys at a summer camp became very hostile towards each other when competing over desirable prizes that only the winning group could obtain. During the simulation, the four students and tutor in the video first introduced themselves and then individual research participants were presented with the problem. Subsequently, participants carried out – together with the simulated group – the first five steps of the "Seven Jump method": clarification of unknown concepts (Step 1), formulation of a problem definition (Step 2), brainstorming (Step 3), problem analysis (Step 4), and formulation of learning issues (Step 5). The Seven Jump method is a procedure for tackling problems in PBL. Participants were familiar with this method because it was used during their regular tutorial meetings (see Schmidt & Moust, 2000, for a more detailed description). At two points the tutor directed her attention directly at the camera (i.e., during the brainstorming and problem analysis steps) to prompt the participant to give his or her ideas about the problem and contribute to the group discussion. The video then stopped and participating students could give their contribution to the discussion by speaking out loud. Participants could indicate with the space bar that they had given their contribution and continue watching the videotaped discussion. The simulated group discussion took approximately 10-15 minutes.

Figure 5.2. Screenshot of the simulated group discussion that was shown to the participants during the simulated discussion. The simulated group discussion consisted of five members (i.e., actors): four students and a tutor (on the far right).

Part 3: Self-study

A separate electronic learning environment was created for each of the two conditions. In the instructor-selected resources condition, the learning environment contained two resources. Participants were instructed to study those two resources (one consisting of 3,437 words and one of 3,582 words). In the student-selected resources condition, the learning environment contained five resources (including the two resources for the instructor-selected literature condition), which ranged in length from 2,097 to 6,266 words. Participants were instructed that they could self-select and study the resources. All literature resources were texts taken directly from social psychology textbooks. In both conditions, student could study for a maximum of 45 minutes. In addition, both electronic learning environments contained files presenting the problem and the learning issues that were formulated during the simulated group discussion.

Students could have open only one resource at a time. Whether each resource was accessed and for how long was tracked in a log-file. Based on these log-files, we could determine the number of literature resources participants accessed during self-study in each condition. The time (in seconds) participants spent with resources open in the electronic learning environment was recorded as a measure of total self-study time (maximally 45 minutes). Participants could indicate that they were finished studying by clicking a button.

Part 4: Ratings of realism, mental effort, motivation, perceived competence and learning uncertainty

First, participants were asked to indicate the perceived realism of the video-based group discussion experience, on a scale from 0-10. Second, perceptions of mental effort invested during the self-study phase was measured on a 9-point scale (see Paas, 1992), ranging from 1 (*very, very low effort*) to 9 (*very, very high mental effort*).

In addition, participants' autonomous and controlled motivation was measured with a situation-specific measure concerning their motivation experienced during the self-study phase of the experiment (see Vansteenkiste, Simons, Lens, Sheldon, et al., 2004). The questionnaire contained 16 items that were rated on a 4-point Likert scale, with composite scores calculated for autonomous and controlled motivation. Cronbach's alphas were .77 for autonomous motivation and .79 for controlled motivation during self-study.

Finally, participants' perceptions of competence and learning uncertainty about studying the subject matter during the self-study phase of the experiment were measured with an adapted, situation-specific version of the PCS (Williams & Deci, 1996) and the self-perceived inability to learn scale (Loyens et al., 2007b). The items were scored on a 5-point scale. Cronbach's alphas for the scales were .87 for the PCS and .89 for learning uncertainty.

Part 5: Test

The test consisted of 15 true or false questions, four multiple-choice questions, and four open-ended questions. All questions on the test could be answered with information from the two instructor-selected literature resources, which were also available in the student-selected literature resources condition. The true or false questions and multiple-choice questions concerned factual statements and focused on testing factual knowledge of the subject matter studied. Examples of these questions were "Superordinate goals are goals that can only be obtained when both groups work together" (true) and "Which of the following conditions is NOT necessary to elicit conflict according to realistic conflict theory? A) Scarce, important resources, B) Dominant/Authoritarian personality, C) Direct competition" (B is the correct alternative). The true or false items and multiple-choice items could be answered using information from the individual resources available. Integration of multiple literature resources was not necessary for answering the closed-answer questions (Krathwohl, 2002). Performance on the true or false and multiple-choice test questions was scored by assigning 1 point for each correct answer. These were summed to create one score for performance on the closed-answer questions (i.e., a possible 19 points in total).

In contrast, the four open-ended questions focused on the recall, integration, and application of knowledge (e.g., "Describe two solutions to solve intergroup conflict."). The answers to these questions needed in-depth processing and integration of information from different literature resources (Krathwohl, 2002). For the open-ended questions, participants could score a maximum of four points per question (and a maximum of 16 points in total). Answers were scored according to a coding scheme (see Appendix D). Two raters independently scored 50% of the answers to the open-ended questions, resulting in an intraclass correlation coefficient of .95. All disagreements were resolved and the first author coded the remainder of the answers.

Participants rated their perceptions of mental effort in answering the test questions after the true or false questions, the multiple-choice questions, and after each of the open-ended questions (see Van Gog et al., 2012). The perceived mental effort ratings for the closed-answer responses (i.e., true or false and multiple-choice questions) were summed and averaged, as was the case for the four perceived mental effort ratings for the open-ended questions.

RESULTS

Preliminary Analyses

First, we checked whether students in the two conditions differed in topic interest or initial autonomous and controlled study motivation, perceived competence or learning uncertainty about studying psychology (in general), with independent *t*-tests. The pre-assessment data for one participant in the instructor-selected literature condition was not logged due to a computer error. Results indicated that participants in the instructor-selected literature condition ($n = 29$) did not differ from the students in the student-selected literature condition ($n = 30$) on topic interest ($p = .65$), initial autonomous ($p = .74$) and controlled motivation ($p = .69$), perceived competence ($p = .24$), and self-reported learning uncertainty ($p = .94$). In addition, participants generally experienced the simulated group discussion as realistic ($M = 7.47$, $SD = 1.34$), while realism ratings did not differ between conditions, $t(58) = 1.86$, $p = .07$, $r = .24$.

Second, we performed an outlier analyses by transforming the scores of the dependent variables into *z*-scores (Field, 2009). All outliers with *z*-scores above 2.58 were removed: the autonomous motivation data for one participant (instructor-selected literature resources), the controlled motivation data for one participant (student-selected literature resources), and the perceived mental effort data for the open-ended questions for one participant (instructor-selected literature resources).

In Table 5.1, correlations between the dependent variables after removal of the outliers are reported. According to Tabachnick and Fidell (2007), multivariate analyses of variance (MANOVAs) are best conducted with highly negatively correlated dependent variables or moderately positively or negatively (i.e., .49-.60) correlated variables. Based on theoretical consideration about which dependent variables can be grouped together (e.g., perceived competence and learning uncertainty) and the correlation between dependent variables, the data were further analyzed with a combination of independent *t*-tests and MANOVAs.

The number of participants accessing files during the self-study phase per condition is reported in Table 5.2. Although students in the instructor-selected literature condition were instructed to study both resources, one participant accessed none of the two resources, and a second participant only opened one of the resources. Nevertheless, we included these participants in the analyses, because in a real setting, students may not read the recommended resources.[2] Participants in the student-selected literature condition on average opened 4.00 ($SD = 1.31$) of the resources. Over half of the participants (56.70%) in this condition accessed all five resources. Log-files for the student-selected resources condition indicated that most students chose to read one of the resources in depth (as indicated by the amount of time dedicated to that resource) and scanned the remaining resource(s) for additional or new information.

Table 5.1

Means, SDs, and Correlations between Dependent Variables

Variable (possible range)	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
1. Autonomous motivation[a] (1-4)	2.78	0.36	-									
2. Controlled motivation[a] (1-4)	2.63	0.43	−.09	-								
3. Perceived competence (1-5)	3.44	0.61	.45***	−.14	-							
4. Learning uncertainty (1-5)	2.39	0.69	−.23	.43**	−.52***	-						
5. Self-study time (0-2,700 s.)	1551.50	784.42	.20	−.19	.05	−.26*	-					
6. ME self-study (1-9)	4.80	1.52	−.11	.16	−.53***	.46***	.16	-				
7. Closed-answer test (0-19)	15.07	2.36	−.04	−.14	<−.01	−.13	.35**	−.03	-			
8. ME closed-answer test (1-9)	4.95	1.13	−.17	.09	−.29*	.31*	−.37**	.29*	−.17	-		
9. Open-ended test (0-16)	4.58	2.24	.23	−.19	.21	−.05	.30*	−.12	.30*	−.17	-	
10. ME open-ended test[a] (1-9)	5.76	1.10	−.14	.17	−.24	.19	−.25	.06	−.13	.41**	−.21	-

Note. $N = 60$. ME = Perceptions of Mental Effort.

[a]$N = 59$, after removal of outliers.

* $p < .05$, ** $p < .01$, *** $p < .001$.

2. Results of all analyses were the same with and without including these participants.

Table 5.2
Number of Participants Accessing Files During the Self-Study Phase per Condition

	Student-selected literature condition ($n = 30$)	Instructor-selected literature condition ($n = 30$)
Problem	5	7
Learning goals	12	15
Resource A[a]	30	-
Resource B[a]	26	-
Resource C	22	29
Resource D	23	28
Resource E[a]	19	-

Note. [a]Files that could only be accessed in the student-selected literature condition.

Self-Study Period: Time and Perceptions of Mental Effort Invested

First, we analyzed self-study time (range 0-2,700) and perceived mental effort (range 1-9) invested during studying with two independent *t*-tests. In contrast to Hypothesis 1, participants in the student-selected literature condition ($M = 1{,}468.97$ s [24.50 minutes], $SD = 796.13$) did not significantly differ in amount of study time invested from the instructor-selected literature condition ($M = 1{,}634.03$ s [27.23 minutes], $SD = 777.14$), $t(58) = -0.81$, $p = .42$, $r = .11$. Analysis revealed a significant effect of condition for perceived mental effort, $t(58) = -2.69$, $p = .009$, $r = .33$, indicating a medium effect. Participants in the student-selected literature condition reported less perceived mental effort ($M = 4.30$, $SD = 1.51$) during the study phase than participants in the instructor-selected literature condition ($M = 5.30$, $SD = 1.37$).

Motivational Variables

To test Hypothesis 2, we conducted two independent *t*-tests with autonomous and controlled motivation (range 1-4) as dependent variables. In support of Hypothesis 2a, a significant difference was found for autonomous motivation, $t(57) = 2.06$, $p = .04$, $r = .26$ (small to medium effect). Students in the student-selected literature condition scored higher on autonomous motivation ($M = 2.88$, $SD = 0.32$), than students in the instructor-selected literature condition ($M = 2.69$, $SD = 0.39$). However, no differences were found on controlled motivation, $t(57) = 0.23$, $p = .82$, between the student-selected ($M = 2.65$, $SD = 0.48$) and instructor-selected ($M = 2.62$, $SD = 0.38$) literature conditions.[3] Therefore, Hypothesis 2b was not supported.

We explored the effects of literature conditions on participants' perceptions of competence and self-reported learning uncertainties (range 1-5) using a MANOVA. There was an overall significant effect on students' perceptions of competence and uncertainty, Hotelling's

3. Results before removal of outliers: Autonomous motivation, $t(58) = 2.32$, $p = .02$; Controlled motivation, $t(58) = -0.24$, $p = .82$.

$T^2 = .19$, $F(2, 57) = 5.32$, $p = .008$, $\eta_p^2 = .16$, which can be interpreted as a large effect. When examining the univariate results, only the effect on perceived competence reached statistical significance, $F(1, 58) = 10.02$, $p = .002$, $\eta_p^2 = .15$. Participants in the student-selected literature condition ($M = 3.68$, $SD = 0.47$) scored higher on perceived competence than the students in the instructor-selected literature condition ($M = 3.21$, $SD = 0.65$). No differences were found between the student-selected literature condition ($M = 2.31$, $SD = 0.70$) and the instructor-selected literature condition ($M = 2.47$, $SD = 0.68$) for learning uncertainty, $F(1, 58) < 1$.

Test Phase: Test Performance and Perceptions of Mental Effort

The effects of literature condition on students' test performance were examined with a MANOVA. Box's test of equality of covariance matrices was significant (Box's $M = 12.57$, $p = .007$), indicating that the assumption of the homogeneity of covariances was not met. However, according to Stevens (2002) the MANOVA is relatively robust in the case of equal *n*'s per condition, as was the case in this study. There was an overall significant effect of condition on students' test performance, Hotelling's $T^2 = .16$, $F(2, 57) = 4.51$, $p = .02$, $\eta_p^2 = .14$. When examining the univariate results, only the effect on the closed-answer questions (range 0-19) reached statistical significance, $F(1, 58) = 4.57$, $p = .04$, $\eta_p^2 = .07$, indicating a medium effect. Specifically, participants who received the instructor-selected literature resources obtained higher closed-answer test scores ($M = 15.70$, $SD = 2.83$), than participants who received the student-selected literature resources ($M = 14.43$, $SD = 1.59$). In contrast, for the open-ended questions (range 0-16) participants in the student-selected literature condition ($M = 4.93$, $SD = 1.99$) obtained higher scores than participants in the instructor-selected literature condition ($M = 4.22$, $SD = 2.44$), but this difference failed to reach statistical significance, $F(1, 58) = 1.55$, $p = .22$, $\eta_p^2 = .03$.

5

Participants in the student-selected literature condition indicated an average perceived mental effort score of 4.83 ($SD = 0.95$, range 1-9) on the closed-answer questions and 5.72 ($SD = 1.13$) on the open-ended questions. In the instructor-selected literature condition, participants on average indicated a perceived mental effort score of 5.01 ($SD = 1.29$) on the closed-answer questions and 5.81 ($SD = 1.09$) on the open-ended questions. A MANOVA with perceptions of mental effort during the test phases as dependent variables, demonstrated no significant effect of condition, Hotelling's $T^2 = .01$, $F(2, 56) < 1$.[4]

4. Results before removal of outliers: Hotelling's $T^2 = .01$, $F(2, 57) < 1$.

DISCUSSION

In PBL, students are responsible for their own learning processes, including selecting literature resources for self-study. On the one hand, it is believed that the responsibility students are offered will help them to become autonomous learners and promote the development of their SDL skills (Schmidt et al., 2009). On the other hand, PBL instructors sometimes express doubts about the effectiveness of having students select literature resources (Moust et al., 2005). In addition, students may experience uncertainties or frustrations concerning the responsibilities they are offered in PBL (Dahlgren & Dahlgren, 2002; Miflin et al., 1999, 2000; Wijnia et al., 2011). The present study aimed to investigate the effects of providing mandatory instructor-selected literature resources on students' motivation, perceived competence, self-reported learning uncertainty, self-study time, perceptions of mental effort, and test performance when compared to student-selected resources.

Self-Study Time, Perceptions of Ability, Mental Effort, and Motivation

With respect to amount of self-study time invested, we did not find significant differences between the instructor-selected and student-selected literature conditions. Students in the instructor-selected literature condition allocated their study time to the two provided resources. In the student-selected literature condition students could choose between five different resources, and over half of the participants (56.70%) opened all five resources. This was in contrast to our hypothesis (Hypothesis 1) and differed from what was seen in earlier research by Te Winkel et al. (2006). Despite the fact that students in the student-selected literature condition could access more resources, this did not result in a greater investment of self-study time. The unexpected results might be explained by the different operationalization of self-study time. Te Winkel et al. (2006) measured self-study time by letting students self-report their self-study time in a field study, whereas in the current experimental study, self-study time was objectively logged with a computer.

In support of Hypothesis 2a, we found that participants in the student-selected literature condition reported higher levels of autonomous motivation than the participants in the instructor-selected literature condition. No differences were found on controlled motivation. The higher scores on autonomous motivation are in line with the meta-analysis by Patall et al. (2008) that indicated that offering choices can positively affect intrinsic motivation (which is part of autonomous motivation; Deci & Ryan, 2000). The results of this study suggest that offering students more responsibility during the learning process by letting them choose resources to study from a predetermined set of resources can promote their perceptions of being an autonomous learner. On the other hand, student-selected resources did not matter with respect to feelings of pressure or coercion, since no differences in controlled motivation were found when compared to use of instructor-selected literature resources.

In addition, we explored the effects of instructor-selection or student-selection of literature resources on perceptions of mental effort, perceived competence, and self-reported learning uncertainties during the self-study phase of the experiment. Analyses demonstrated that participants in the student-selected literature condition reported lower perceptions of mental effort during the self-study phase than the participants in the instructor-selected condition. In addition, participants in the student-selected literature condition scored higher on perceived competence, indicating that they felt more confident that they had met the goals for studying and that they were able to do well on a subsequent test. No differences were found for self-reported learning uncertainties about what and how to study. Although PBL students sometimes express uncertainties, frustrations, and concerns about having to select their own literature resources to address learning issues (e.g., Wijnia et al., 2011), this did not seem to result in lower perceived competence or higher perceptions of learning uncertainty in this study, nor did it lead to higher perceived mental effort during self-study.

The higher scores on perceived competence are in line with the meta-analysis by Patall et al. (2008) that indicated that offering choice can have a positive effect on perceived competence. As can be seen in Table 5.1, perceptions of mental effort were correlated with perceived competence and self-reported learning uncertainty. It is possible that the higher levels of perceived competence reported by the participants in the student-selected literature condition are associated with participants' lower perceptions of mental effort in the study phase. To investigate this further, we conducted a Sobel test to examine whether the effect of condition on perceptions of mental effort was mediated through perceived competence. Results demonstrated that perceived competence was a significant mediator ($z = 2.47$, $SE = .22$, $p = .01$). In future studies, it could be interesting to further explore the relationship between motivational variables such as perceived competence and perceptions of mental effort during learning and studying.

Instructors' doubts concerning the responsibility students are offered during the PBL learning process sometimes result in providing mandatory literature resources to study (Moust et al., 2005). The results of this study do not indicate that instructor-provided literature resources lead to the most beneficial outcomes in terms of students' motivation. The results demonstrate that PBL students seem to be able to handle the responsibility of selecting literature from a restricted set of resources, in terms of perceived competence and autonomous motivation. In addition, perceptions of mental effort were lower during the self-study phase for students who had this responsibility.

5

Test Performance and Mental Effort during the Test

No differences were found on participants' perceptions of mental effort in answering the questions on the test. With respect to test performance we found a significant effect of condition on test performance. Specifically, the students in the instructor-selected literature condition scored higher on the closed-answer questions. The closed-answer questions measured factual knowledge that could be answered through the reading of the individual literature resources and did not need integration of multiple resources. This result seems in contrast to the study by Te Winkel et al. (2006), who found that when more resources were available in the learning environment higher achievement scores were obtained. However, the higher score on the closed-answer questions might be explained by the fact that participants in the instructor-selected and student-selected literature resources conditions did not differ in the length of time dedicated to self-study (approximately 25-26 minutes). The participants in the instructor-selected literature condition only needed to divide their attention over two resources. In contrast, the participants in the student-selected literature condition on average devoted these 25-26 minutes to reading 3-4 resources. Therefore, it is likely that the participants in the instructor-selected literature condition read the resources in more detail and therefore were better in responding to the questions assessing factual knowledge.

The goals of PBL include the development of a flexible knowledge base that can be applied to new problems and contexts (Norman & Schmidt, 1992). According to Gijbels et al. (2005) assessment of application of knowledge is important in PBL. In the current study, we did not find an effect of using instructor-selected or student-selected literature resources on the application of knowledge. Although participants in the student-selected literature resources condition scored higher on the application questions, this difference failed to reach statistical significance. Closer inspection of the test scores indicated all participants scored rather poorly on the open-ended questions. In the experiment, we only logged which resources were accessed and for how long, but we did not measure the quality of self-study. Since the quality of self-study is more important than the quantity of self-study (Plant et al., 2005), it is possible that deep learning was not established during the 25-26 minutes spent on reading the resources. In addition, the present study did not include the reporting phase of PBL, but focused only on the initial problem discussion and the following self-study period, as will be discussed further in the next section.

Limitations and Further Research

There are some limitations to this study. Participating students on average rated the video-based simulated group discussions as realistic (i.e., 7.47 on a 0-10 scale). Although participants rated the experiment overall as realistic, their experience with the simulated PBL cycle in the lab might differ from their experiences in a real, face-to-face PBL setting. For instance, during this experiment the amount of self-study time available was restricted to 45 minutes. However, participants on average dedicated approximately 25 to 26 minutes to self-study. Therefore, the 45 minutes students could spend on self-study seemed to be plenty.

With respect to test performance, it is important to determine whether the effects of instructor-selection when compared to student-selection of literature are similar in a real-life

PBL setting. In a real PBL environment students meet again in their groups after self-study to report their findings, but the current experiment did not include a reporting phase. It is possible that this might have affected the results for the open-ended questions. In addition, we only examined effects on immediate test performance and did not examine long-term effects, while the latter have often emerged in favor of PBL in prior studies (e.g., Dochy et al., 2003).

It would be interesting to investigate whether these results could be replicated in a real PBL course. Nevertheless, we chose an experimental approach to examine more specifically the effects of instructor-selection when compared to student-selection of resources. As mentioned before, a PBL meeting is susceptible to many factors that influence motivation and achievement outcomes (see Van Blankenstein et al., 2011, 2013), such as tutorial group functioning (Van Berkel & Schmidt, 2000). We did not include a reporting phase because we were more interested in students' learning outcomes immediately after self-study and before the reporting phase takes place, because the outcomes of their self-study then influence the quality of the discussion in the reporting phase (De Grave et al., 2002).

Future research should also focus on the role of the quality of self-study and not just the quantity. Research in real PBL settings has demonstrated that the productivity of group meetings during the reporting phase is not always optimal (e.g., superficial discussion, leaving learning issues unclarified; De Grave et al., 2002). Integrating different literature resources to find a complete explanation of the learning issue is a difficult learning activity for students, which requires practice and experience. This is reflected in students' low scores on the open-ended questions. In a future study it would therefore be interesting to examine whether more advanced graduate students would have less difficulty in integrating information from multiple resources than first-year students. Moreover, this would also allow further investigation of whether and what kind of study strategies contribute to the quality of information processing and self-study over and above the number of resources available to be studied.

Conclusion and Implications

The responsibility students are offered during the learning process in PBL can sometimes raise concerns, doubt, and uncertainties in students and instructors. These concerns sometimes result in offering "mandatory" instructor-provided literature resources (Moust et al., 2005). The results of this study do not indicate that this practice leads to the most beneficial outcomes in terms of students' motivation and the application of knowledge. Although providing specific literature resources was beneficial for answering questions measuring factual knowledge, it was better to offer students some degree of choice by letting them select resources from a predetermined set in terms of autonomous motivation, perceived competence, and perceptions of mental effort during self-study. No differences were found on questions measuring conceptual knowledge that required integration from different literature resources. All in all, the results of our study suggest that in terms of autonomous motivation and perceived competence, it seems more beneficial to let students select their own resources from a predetermined list than to have the instructor mandate which should be used.

Chapter 6

Direct and indirect effects of motivation on achievement in problem-based learning: The role of affect and engagement

This chapter is in preparation as: Wijnia, L., Noordzij, G., Loyens, S. M. M., Derous, E., & Schmidt, H. G. (2014). *Direct and indirect effects of motivation on achievement in problem-based learning: The role of affect and engagement*. Manuscript in preparation.

The research reported in this chapter was also presented at the 5th interactional conference on Self-Determination Theory, Rochester, New York, June 2013.

ABSTRACT

The current study examines the relationships among motivation, affect, social-behavioral engagement, and academic achievement during the first year of college in a student-centered bachelor's program ($N = 413$). Three alternative models were tested to examine relationship between motivation and academic achievement. Analyses indicated that motivation had both direct effects as well as indirect effects on achievement. Autonomous motivation at the beginning of the first year had both a direct, negative effect on achievement and a positive indirect effect through positive affect and social-behavioral engagement. Amotivation had both a direct, negative effect on achievement and an indirect, negative effect through social-behavioral engagement. Controlled motivation only had a significant, indirect effect on achievement through social-behavioral engagement. The results indicate that the relationship between motivation and achievement is complex and that it is important to examine why motivation affects achievement. In addition, teacher judgments of students' engagement in class proved to be important predictors of achievement and can be potentially useful in identifying students at risk of dropping out or study delays.

INTRODUCTION

Preventing study delays and attrition are major concerns in higher education. According to Tinto (1993) the first year of college is especially important for persistence in college. Students' experiences in that first year of higher education shape subsequent persistence. Promotion of students' social integration is a key factor that could diminish dropout (e.g., Tinto, 1975, 1998). Social integration concerns students' involvement in the social system of a college that can be promoted through faculty and peer interactions. In line with this view, student-centered, active learning environments, such as problem-based learning (PBL), usually have lower dropout rates (Braxton et al., 2000; Schmidt et al., 2010; Van den Berg & Hofman, 2005). Those collaborative learning environments provide ample opportunity for social integration on the one hand through frequent student-teacher interactions and on the other hand through student interactions by means of working cohesively and peer support. Linnenbrink and colleagues refer to these student interactive behaviors as social-behavioral engagement (see Linnenbrink-Garcia, Rogat, & Koskey, 2011, Pekrun & Linnenbrink-Garcia, 2012).

In PBL research, social-behavioral engagement is often measured through teacher ratings of observed learning activities in class such as students' preparation for the tutorial meetings, active participation, and skills that support the group process during group meetings (Loyens et al., 2007a). These ratings have been identified as one of the best predictors of academic achievement and dropout in PBL environments (De Koning et al., 2012; Loyens et al., 2007a). However, less is known about the student characteristics that influence students' engagement in student-centered learning (Loyens et al., 2007a). In the current study we investigate the role of students' academic motivation and affect in predicting social-behavioral engagement in class and subsequent academic achievements. Motivation and affect have been identified as important antecedents of engagement in teacher-centered learning environments (e.g., Pekrun & Linnenbrink-Garcia, 2012; Reeve, 2012), whereas their impact in student-centered, small group learning is less examined (Linnenbrink-Garcia et al., 2011).

MOTIVATION, AFFECT, AND ENGAGEMENT

Students can have different reasons for entering college. Self-determination theory (SDT) distinguishes between several types of motivation that differ in quality based on the amount of autonomy that is experienced (Deci & Ryan, 1985, 2000; R. M. Ryan & Deci, 2000a, 2000b; Vansteenkiste et al., 2006). An important distinction is made between autonomous and controlled motivation. Autonomously motivated students experience volition and study in a self-empowered, self-directed way. These students perceive studying as fun or satisfying in itself (i.e., intrinsic motivation) or perceive it as valuable for obtaining personal goals or for personal development (i.e., identified motivation). In contrast, students scoring high on controlled motivation experience external or internal pressures for studying. External pressure can come in the form of rewards from or demands of others (i.e., external motivation). Internal pressures are feelings of shame or guilt (i.e., introjected motivation). In addition to autonomous and controlled motivation, amotivation can be distinguished (Deci & Ryan, 2000; Vallerand, 1997). Amotivation refers to the relative absence of (autonomous or controlled) motivation. Autonomous motivation-types or motivational profiles characterized by autonomous motivation have been associated with more favorable learning outcomes in higher education relative to controlled motivation or amotivation (Donche, De Maeyer, Coertjens, Van Daal, & Van Petegem, 2013; Ratelle, Guay, Vallerand, Larose, & Senécal, 2007; Vallerand & Bissonnette, 1992; Vansteenkiste et al., 2009).

Motivation and Affect

In SDT-based research a link has been found between motivation and affect. Affect can be described as a genuine feeling or mood that can be consciously accessed at any moment (Fredrickson, 2001; Russell & Carroll, 1999). Often a distinction is made in valence of affect, such as positive versus negative or pleasantness versus unpleasantness (e.g., Russell & Carroll, 1999; Watson, 1988; Watson, Clark & Tellegen, 1988). Positive affect includes emotions such as interested, excited, and alert. Negative affect consists of emotions such as ashamed, scared, or guilty. Affect is often measured as an indicator of well-being, which is conceptualized as the presence of life satisfaction and positive affect, and the absence of negative affect (Diener, Suh, Lucas, & Smith, 1999).

Autonomous motivation has been positively associated with pleasant affect, such as studying out of interest and enjoyment, and subjective well-being (R. M. Ryan & Deci, 2001). Controlled motivation has been associated with the experience of pressure and tension (Deci & Ryan, 1985, 2000). Similarly, autonomous goal pursuit has been associated with the presence of positive affect and the absence of negative affect. Although goal attainment in itself can lead to experience of well-being, effects are stronger for goal pursuits resulting from autonomous motives (Sheldon & Elliot, 1999; Sheldon & Kasser, 1998; Sheldon, Ryan, Deci, & Kasser, 2004). In addition, only autonomously regulated goals will be associated with vitality (Nix, Ryan, Manly, & Deci, 1999). In line with these results, several studies have found a positive relationship between autonomous regulation and positive affect or well-being in educational settings (Litalien, Lüdtke, Parker, & Trautwein, 2013; Niemiec et al., 2006; Waaler, Halvari, Skjesol, Bagøien, 2013).

Motivation and Engagement

Moreover, motivation has been connected to engagement. Engagement concerns the extent of students' active involvement in a learning activity. It can best be understood as a multifaceted construct that can include cognitive (e.g., superficial versus deep processing), behavioral (e.g., effort, attention, persistence, and conduct), emotional (interest versus boredom), and social components (e.g., social interactions, group cohesion; Fredricks, Blumenfeld, & Paris, 2004; Pekrun & Linnenbrink-Garcia, 2012; Reeve, 2012).

Skinner, Kindermann, and Furrer (2009) have shown that autonomous motivation was positively related to both students' and teachers' reports of emotional and behavioral engagement. According to Reeve and Tseng (2011) students' engagement is important because it connects students' motivation to highly valued achievement outcomes. Students' autonomous motivation can therefore be a source of engagement and engagement can mediate the relationship between motivation and achievement (Reeve, 2012, 2013). However, as of yet it is unclear whether engagement fully mediates the relationship between motivation and achievement or can only be considered a partial mediator. Reeve and Tseng (2011), for instance, demonstrated that the motivation-academic achievement relationship was fully mediated by engagement. Nevertheless, several studies have reported direct relationships between motivation and academic achievement as well (e.g., Fortier, Vallerand, & Guay, 1995; Ratelle et al., 2007).

Affect and Engagement

In short, motivation has both been associated with affect and engagement (e.g., Litalien et al., 2013; Skinner et al., 2009). Moreover, it was suggested that engagement is a mediator in the relationship between motivation and academic achievement (Reeve, 2012, 2013). In addition to these associations, it is important to consider the relationship between affect and engagement. Because the current study was conducted in a small group setting, we were mainly interested in social-behavioral engagement. Social-behavioral engagement includes aspects of behavioral engagement, such as attendance, active participation, and listening to other students, but it also requires social participation, such as working cohesively and supporting other students during learning (see Linnenbrink-Garcia et al., 2011; Pekrun & Linnenbrink-Garcia, 2012). In collaborative, PBL settings, student behaviors such as attendance, effort, persistence in class, working cohesively, and supporting other students in their contributions are essential (cf. Dolmans et al., 2001).

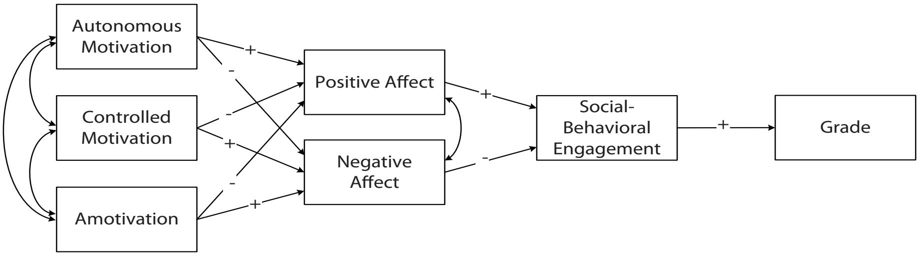
According to Linnenbrink (2007) affect mediates the relationship between motivation and engagement in classrooms. Research in classroom settings has indeed supported a link between affect and social-behavioral engagement (cf. Linnenbrink, 2007; Linnenbrink-Garcia et al., 2011; Pekrun & Linnenbrink-Garcia, 2012). For example, Linnenbrink-Garcia et al. (2011)

have found that unpleasant affect, such as feeling tired and tense, was associated with higher rates of social loafing. Feeling tired also had a negative impact on positive group interactions, such as listening to others. In contrast, positive affect facilitated positive group interactions. Bramesfeld and Gasper (2008) also found in two experiments that happy moods facilitated group performance more than sad moods, because group members in a happy mood focused more on critical information, even when non-critical information was more accessible. In addition, Do and Schallert (2004) found that pleasant affect positively influenced attention, listening and talking during classroom discussions, whereas students experiencing negative affect tuned out from discussions. Finally, Wosnitza and Volet (2014) found that positive affect was related to more positive general views of group work.

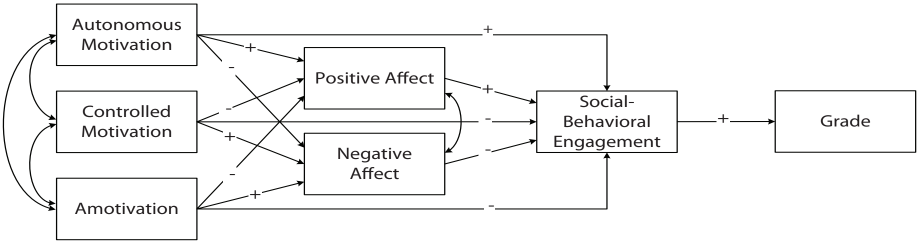
PRESENT STUDY AND HYPOTHESES

The current study examines the role of students' motivation, affect, and engagement in class in predicting academic achievement during the first year of a student-centered, psychology bachelor's program. A strength of this study is that not only self-reported measures were used, but also teacher ratings. Motivation is measured with a self-reported, domain-specific measure of motivation toward education (i.e., Academic Motivation Scale; Vallerand et al., 1992). These data were coupled with students' self-reported affect later in the year, teacher ratings of students' social-behavioral engagement, and achievement.

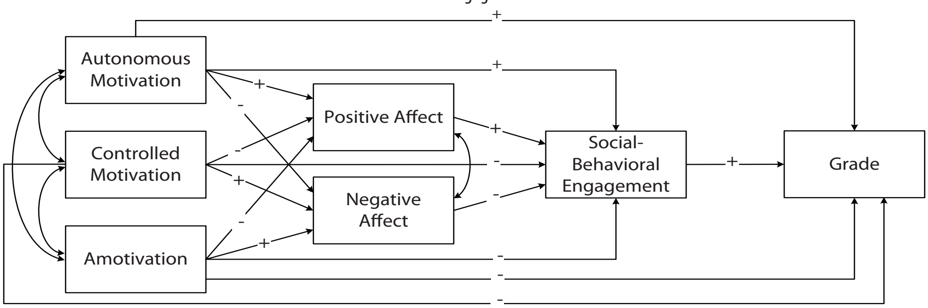
The goal of the current study is to gain more insight into the association between motivation, affect, and engagement. Specifically, we want to replicate and extend the findings concerning the link between affect and social-behavioral engagement in a student-centered, PBL context (see Linnenbrink-Garcia et al., 2011). In addition, we examine whether affect and engagement can fully mediate the relationship between students' motivation for entering college, measured at the beginning of the year, and academic achievement (e.g., Linnenbrink, 2007; Reeve, 2012, 2013). To this end, three alternative models are tested (see Figure 6.1). Model A represents a full mediation model in which the effect of motivation on achievement is completely mediated through affect and engagement. In Model A, motivation has a direct effect on affect, which in turn affects students' social-behavioral engagement and subsequent achievement. Second, Model B, consists of a partial mediation model. Motivation at the beginning of the year has both a direct and an indirect effect on engagement through affect. However, engagement fully mediates the relationship between motivation and achievement (see Model B). Finally, Model C also represents a partial mediation model. In Model C, motivation has both direct and indirect effects on students' engagement and achievement.



Model A. Full mediation model.



Model B. Partial mediation model: Direct effects of motivation on engagement.



Model C. Partial mediation model: Direct effects of motivation on engagement and achievement.

Figure 6.1. Conceptual models of the relationship between motivation, affect, and engagement in PBL

METHOD

Participants and Design

The data used in the present study were collected as part of a longitudinal study "generation PBL" on motivation, affect, and academic achievement in the psychology program of a Dutch university. All 544 first-year psychology students enrolled in the three-year bachelor's program during academic years 2011-2012 and 2012-2013 were asked to participate. Participants had an average age of 19.87 years old (*SD* = 2.71). The sample consisted of 120 (22.10%) male students and 370 female students. For 54 students gender was unknown.

Students were asked to rate their motivation or reasons for going to college in the beginning of the academic year (*N* = 414). In June, students were asked to rate their experience of positive and negative affect (*N* = 359). These data were coupled with tutor ratings of observed learning activities as a measure of social behavioral engagement (*N* = 519), and average course test performance (*N* = 508). Students were only included in the analyses if they had filled out the motivation questionnaire and if we had data on at least one other measurement (*N* = 413; 75.92%).

Learning Environment

In the current study, we examined the associations between motivation, affect, tutor ratings of social-behavioral engagement, and academic achievement in a student-centered, problem-based, psychology bachelor's program. Small groups of ten to twelve students work together on meaningful problems under the guidance of a tutor (Barrows, 1996; Schmidt & Moust, 2000). The role of the tutor is to facilitate and stimulate the discussion and group dynamics and make sure all relevant content related to the problem is discussed in sufficient depth (Loyens et al., 2012). In addition, tutors monitor and provide feedback on the individual progress of students during group discussions.

The first bachelor year contains eight 5-week courses that are offered in succession. Each 5-week course deals with a specific psychology course, for instance developmental psychology, clinical psychology, and statistics. Each week consists of two compulsory tutorial meetings in which students discuss, analyze, and explain problems (i.e., 3-hr per meeting), an optional lecture (2 hr), and a compulsory 2 or 3-hr practical session (Schmidt et al., 2009). Approximately 30 hours are reserved for self-study. Each course is graded through a practical assignment and a course test that is taken at the end of each course. After each 5-week course, the students are randomly assigned to a new tutorial group with a new tutor.

Measures

Motivation

Motivation was measured with the Academic Motivation Scale (AMS; Vallerand et al., 1992). The AMS consists of 28 items that reflect possible answers to the question "Why do you go to college?" Responses are measured on a 7-point Likert-type scale ranging from 1 (*does not correspond at all*) to 7 (*corresponds exactly*). The AMS contains seven subscales.

Intrinsic motivation is measured with three subscales: intrinsic motivation to know, to accomplish things, and to experience stimulation. Intrinsic motivation to know consists of behavior being performed for the pleasure that is experienced while studying or learning new things (e.g., "because I experience pleasure and satisfaction while learning new things").

Intrinsic motivation to accomplish things refers to engaging in an activity for the pleasure that is experienced when one tries to accomplish things (e.g., "for the experience when I discover new things never seen before"). Intrinsic motivation to experience stimulation reflects behavior being performed to experience stimulating sensations (e.g., "for the intense feelings I experience when I am communicating my own ideas to others").

Three other subscales reflect extrinsic reasons for going to college: identified, introjected, and external motivation. The subscale identified motivation consists of behavior that is valued and is experienced as chosen by oneself (e.g., "because I think that a college education will help me better prepare for the career I have chosen"). The introjected motivation subscale consists of behavior that is regulated by internal coercion, such as guilt or shame (e.g., "to prove to myself that I am capable of completing my college degree"). In contrast, external regulation reflects behavior that is regulated by an external contingency (e.g., "because with only a high-school degree I would not find a high-paying job later on"). Amotivation is measured with the seventh subscale (e.g., honestly, I don't know; I really feel that I am wasting my time in school").

In line with SDT and prior research, three composite scores were calculated: autonomous motivation (i.e., intrinsic motivation subscales and identified motivation; $k = 16$), controlled motivation (i.e., introjected and external motivation; $k = 8$), and amotivation ($k = 4$; see Deci & Ryan, 2008a; Donche et al., 2013). Reliability analyses resulted in Cronbach's alphas of .90 for autonomous motivation, .87 for controlled motivation, and .89 for amotivation.

Affect

Positive and negative affect were measured with the Positive and Negative Affect Schedule (PANAS; Watson, 1988; Watson et al., 1988). Students were asked to rate on a 5-point scale the extent to which they had experienced each mood state during the past few weeks ranging from 1 (*very slightly or not at all*) to 5 (*very much*). The questionnaire consists of 20 mood states evenly divided over the Positive Affect and Negative Affect scale. Reliability analyses resulted in Cronbach's alphas of .85 for positive affect and .85 for negative affect.

Observed learning activities

Social-behavioral engagement was measured with the observed learning activities scale. During each course (with the exception of the first course and the statistics course) in the program under study, tutors rate students' observed learning activities during group meetings, such as the level of preparation, active participation, and skills that facilitate the group process. The scale consists of 19 items rated on a 5-point Likert-type scale, resulting in a grade between 1-10 (see Loyens et al., 2007a). Example items are "The student gave evidence of high-quality self-study activities," "The student took actively part in the discussion of the problem," "The student listened carefully to contributions of other group members," and "The student stimulated all group members to contribute to the discussion." An average score was calculated by averaging the available tutor ratings (a total of 6 ratings could be available).

Achievement

The average course test grade was taken as measure of achievement. Grade was calculated by averaging the available grades (a maximum of 8 course test grades were available). An average course test grade of 6.0 (on a scale from 0 to 10) is necessary to successfully finish the year.

Analysis

The data were analyzed with path analysis in Mplus (Muthén & Muthén, 2010). Assessment of model fit was based on multiple fit indices: chi-square, Tucker-Lewis index (TLI; Tucker & Lewis, 1973), the comparative fit index (CFI; Bentler, 1990), the root-mean-square error of approximation (RMSEA; Steiger, 1990), and the standardized root-mean-square residual (SRMR). RMSEA and SRMR were used as absolute fit indices; values of .08 or lower are considered to indicate an acceptable fit to the data (Kline, 2005). The TLI and CFI were used as incremental fit indices. These indices range between 0 and 1 and for both indices values greater than .90 are considered as a good fit (Kline, 2005). Because multiple models were compared in this study, the Akaike information criterion (AIC) was also used. A lower AIC value is indicative of a better fit. Indirect effects of motivation on achievement were investigated. A bias-corrected (BC) bootstrapping procedure was used for testing indirect effects. When testing for indirect effects the product of two or more regression coefficients are tested, which are often not normally distributed. Therefore, the use of conventional tests of significance for testing indirect effects can be unreliable (MacKinnon, Lockwood, & Williams, 2004; Preacher & Hayes, 2008).

Table 6.1

Means and Correlations between Measures

Variable (possible range; *N*)	*M*	*SD*	1	2	3	4	5	6	7
1. Autonomous Motivation (1-7; *N*=414)	5.27	0.78	-						
2. Controlled Motivation (1-7; *N*=414)	4.96	1.12	.38***	-					
3. Amotivation (1-7; *N*=414)	1.65	0.96	−.52***	−.17**	-				
4. Positive Affect (1-5; *N*=359)	3.21	0.61	.22***	.02	−.06	-			
5. Negative Affect (1-5; *N*=359)	1.77	0.59	−.02	.19**	.24***	−.22***	-		
6. Social-Behavioral Engagement (1-10; *N*=519)	7.53	0.74	.17**	−.08	−.24***	.18***	−.13*	-	
7. Average Grade (1-10; *N*=508)	6.46	0.99	.03	−.07	−.18***	.08	−.20***	.50***	-

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

RESULTS

Of the 544 enrolled in the first year, 148 students did not successfully finish the program (27.20%). Table 6.1 presents the means, standard deviations, and correlations between motivation, affect, engagement, and achievement. Of the 544 students enrolled in the psychology bachelor's program only 413 students (75.92%) were included in the analyses. One participant was excluded because only motivation data was available. For the other excluded participants ($n = 130$) no motivation data were available. We checked whether the excluded students differed from the students that were included in the analyses. The excluded students received significantly lower scores on social-behavioral engagement, $t(517) = -4.08$, $p < .001$; and test performance, $t(148.76) = -6.01$, $p < .001$. In addition, the odds of dropping out of or not successfully completing the first year was 4.58 (95% CI [3.00, 6.98]) times higher for students who did not complete the first motivation questionnaire.

Hypothesized Models

First we tested the full (Model A) and partial mediation models (Model B and C, see Figure 6.1). The full mediation model showed a poor fit to the data, $\chi^2(8, N = 413) = 33.59$, $p < .001$, RMSEA = .09, SRMR = .05, CFI = .88, TLI = .74. The model improved substantially when direct paths were included from motivation to social-behavioral engagement (i.e., Model B), $\chi^2(5, N = 413) = 14.88$, $p = .011$, RMSEA = .07, SRMR = .03, CFI = .96, TLI = .84. The χ^2 difference test indicated that Model B was a significant improvement of the full mediation model (Model A). These results seem to indicate that the relationship between motivation and engagement is only partially mediated by affect, and that motivation also has a direct effect on students' social-behavioral engagement. Subsequently, we compared Models B and C. In Model C, direct paths between motivation and average grade were included, $\chi^2(2, N = 413) = 6.64$, $p = .036$, RMSEA = .08, SRMR = .02, CFI = .98, TLI = .81. The χ^2 difference test demonstrated Model C was a significant improvement when compared to Model B (see Table 6.2). The final model (Model C) is presented in Figure 6.2. The motivation variables explained 6% of the variance in positive affect and 13% of negative affect. Twelve percent of the variance in social-behavioral

Table 6.2
Model Comparison

Model description	AIC	χ^2	df	$\Delta\chi^2$	Δ df	Statistical significance
Model A (full mediation)	2828.75	33.59	8	-	-	-
Model B (partial mediation)	2816.04	14.88	5	18.71	3	$p < .001$
Model C (partial mediation)	2813.81	6.64	2	8.24	3	$p < .05$

Note. $\Delta\chi^2$ = the difference in χ^2 values between the models; Δ df = the difference in degrees of freedom between the models.

engagement could be explained by the motivation and affect variables. Finally, 26% of the variance in average grade was explained by the other variables.

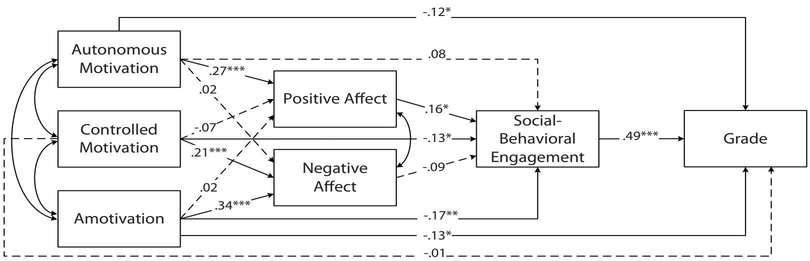


Figure 6.2. Final model. Standardized regression weights are reported. Dashed lines depict nonsignificant paths. * $p < .05$, ** $p < .01$, *** $p < .001$.

Indirect Effects

Indirect effects for motivation on achievement in the final partially mediated model were examined according to the bias-corrected bootstrap procedure based on 5000 samples (see MacKinnon et al., 2004; Preacher & Hayes, 2008). First, we examined the indirect effects of autonomous motivation. There was a significant indirect effect of autonomous motivation on average grade through positive affect and social-behavioral engagement, $b = 0.02$, BC 95% CI [0.01, 0.06]. The other indirect effects for autonomous motivation were not significant: the indirect effect through negative affect and social-behavioral engagement ($b = -0.001$, BC 95% CI [−0.01, 0.01]) and the indirect effect through social-behavioral engagement ($b = 0.05$, BC 95% CI [−0.03, 0.13]).

For controlled motivation only the indirect effect through social-behavioral engagement on average grade was significant, $b = -0.05$, BC 95% CI [−0.10, −0.01]. In contrast, both indirect paths through positive affect ($b = -0.004$, BC 95% CI [−0.02, 0.001]) or negative affect ($b = -0.01$, BC 95% CI [−0.02, 0.003]) and social-behavioral engagement were not significant. Similar results were found for the indirect effects of amotivation on average grade. The indirect effect through social-behavioral engagement was significant ($b = -0.08$, BC 95% CI [−0.14, −0.03]), whereas the indirect effects through negative affect ($b = -0.01$, BC 95% CI [−0.04, 0.01]) and positive affect ($b = 0.002$, BC 95% CI [−0.01, 0.02]) and social behavioral engagement were not significant.

DISCUSSION

The current study examined direct effects and indirect effects of motivation on achievement through affect and engagement. Affect has been described as a potential mediator between motivation and engagement (e.g., Linnenbrink, 2007). Studies have indicated that positive affect has a facilitating effect on social-behavioral engagement, whereas negative affect has a diminishing effect (Linnenbrink-Garcia et al., 2011). In addition, autonomous motivation has been associated with the presence of positive affect and absence of negative affect (Litalien et al., 2013). Other researchers have focused on the connecting role of engagement in the relationship between motivation and achievement (Reeve, 2012, 2013). It is unclear whether engagement can fully mediate the relationship between motivation and achievement (e.g., Reeve, 2012; Reeve & Tseng, 2011). We investigated this question here. We intended to bridge the gap in the literature by examining both affect and engagement as mediators between the relationship between motivation and achievement in one model. Specifically, this is examined in a student-centered, collaborative learning environment. These type of learning environments become more and more wide spread and it is unclear whether associations that are found between affect, engagement, motivation, and achievement also apply to more student-centered environments, such as PBL, since these learning environments specifically aim to foster students´ engagement and motivation. Based on the literature on the associations between motivation, affect, engagement, and achievement three alternative models were generated and compared with each other: one full mediation model and two partial mediation models (see Figure 6.1).

Motivation and Achievement

Analyses and comparison of these models indicated that Model C in which both direct effect and indirect paths between motivation and achievement were included had the best fit with the data. Autonomous motivation at the beginning of the first year had both a direct, negative effect on achievement and a positive indirect effect on achievement through positive affect and social-behavioral engagement. Amotivation had both a direct, negative effect on achievement and an indirect, negative effect through social-behavioral engagement. Finally, controlled motivation only had a significant, indirect effect on achievement through social-behavioral engagement.

In our final model, autonomous motivation had both a direct, negative effect and an indirect, positive effect on achievement. However, when examining the correlation table (see Table 6.1) no relationship was found between motivation and achievement. The results indicate that the relationship between motivation and achievement is a complex one and demonstrates the importance of examining underlying factors, such as affect and engagement, that can explain the relationship between motivation and achievement.

The direct, negative effect between autonomous motivation and achievement was in contrast to our expectations (see Model C, Figure 6.1). This effect might be explained by the fact that students' motivation profiles were not taken into account. Ratelle et al. (2007) demonstrated that an autonomous motivation profile characterized by higher autonomous motivation and low controlled and amotivation was especially beneficial for college students in terms of persistence. Vansteenkiste et al. (2009) also identified four different motivational profiles: a good quality motivation profile (i.e., high autonomous, low controlled motivation); a poor quality motivation profile (i.e., low autonomous, high controlled motivation); a low quantity motivation profile (i.e., low autonomous and low controlled motivation); and a high quantity motivation profile (i.e., high autonomous and high controlled motivation). The high quality group outperformed the high quantity group on several learning outcomes. In future studies it could be interesting to conduct person-level analysis and compare the relationship between different motivational profiles and academic achievement.

Limitations and Suggestions for Future Research

A limitation of our study is that not all students enrolled in the bachelor's program could be included in our path models due to incomplete data. Analyses indicated that the students who were not included in the model received lower teacher ratings of social-behavioral engagement, obtained lower average grades, and were more likely to drop out or not successfully finish the program. It is likely that these students would have higher amotivation. In addition, constructs such as motivation, affect, and engagement are likely to have a reciprocal and dynamic relationship (e.g., Reeve, 2012; Pekrun & Linnenbrink-Garcia, 2012). In the current study, motivation and affect were only measured once. In future studies, it might be interesting to measure all three constructs several times throughout the year to learn more about the interrelationships between these constructs.

In contrast to Reeve and Tseng (2011) our results did not indicate that the relationship between motivation and achievement was fully mediated by engagement. Differences in results can be explained by the different operationalization of engagement. In the current study social-behavioral engagement was measured through teacher judgments of observed learning activities. Reeve and Tseng (2011) conceptualized engagement as consisting of four aspects: emotional, behavioral, cognitive, and agentic engagement. Agentic engagement refers to the process in which students intentionally and proactively personalize and enrich both what is to be learned and the conditions under which it is to be learned. It is possible that a more complete assessment of engagement is needed in the current study in order for engagement to fully mediate the relationship between motivation and achievement (cf. Reeve, 2012). In future studies, it could be interesting to examine the role of agentic engagement, which could be especially important in a student-centered learning environment that emphasizes the importance of students' responsibility during the learning process (e.g., Schmidt et al., 2009).

Conclusion

The current study demonstrated that motivation measured at the start of the academic year both directly and indirectly affected students' achievement in a student-centered PBL environment. A strength of this study is that not only self-reported measures were used, but also teacher ratings of students' observed behavior in class throughout the year (i.e., ratings of social-behavioral engagement).

The results of the current study emphasize the complex relationship between motivation and achievement and indicate that it is important to examine possible mediators in the relationship between motivation and achievement, such as affect and engagement. Motivation proved to be predictive of students' achievements in the first year. Autonomous motivation had both a direct, negative effect on achievement and a positive, indirect effect through positive affect and social-behavioral engagement. Higher levels of controlled motivation and amotivation at the start of the academic year were negatively associated with achievement, both directly and indirectly through social-behavioral engagement. In line with earlier studies, teacher judgments of students' engagement in class proved to be important predictors of achievement (De Koning et al., 2012; Loyens et al., 2007a). These results imply that tutor judgments can be potentially useful in identifying students at risk of dropping out or study delays.

Chapter 7

Predicting educational success and attrition in problem-based learning: Do first impressions count?

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The study in this chapter was also presented at the conference of the Junior Researches of the European Association for Research on Learning and Instruction (JURE), Frankfurt am Main, Germany, July, 2010; and the conference of the European Association for Research on Learning and Instruction (EARLI), Exeter, United Kingdom, September, 2011.

ABSTRACT

This study examines whether tutors ($N = 15$) in a problem-based learning curriculum were able to predict students' success in their first year and their entire bachelor's program. Tutors were asked to rate each student in their tutorial group in terms of the chance that this student would successfully finish their first year and the entire bachelor's program. The results indicated that tutors can predict students' first-year success and attrition in the bachelor's program, even on top of prior grades. Moreover, tutors seem to be better at predicting completion of the first year and bachelor's program versus failure or non-completion. The results suggest that tutors can assess whether students will be successful at an early stage of the program. Tutor judgments of students' future success have the potential to be used as an additional source of information to identify students at risk of leaving college without a degree.

INTRODUCTION

In Europe approximately one third of all students that enter tertiary education leave before obtaining a degree (Organisation for Economic Co-Operation and Development, 2010). In the Netherlands, only 65% of the university students from the cohort 2002-2003 completed their bachelor's degree within six years (Central Bureau for Statistics, 2009). Moreover, social sciences students often exceed the available time to complete the bachelor's degree by 1.5 years (Central Bureau for Statistics, 2011). Attrition and delays in finishing a course of study are major concerns in higher education as they lead to financial losses for universities, and are also costly and time-consuming for students.

Several student and curricular characteristics can predict whether students will successfully obtain a degree or drop out. For example, students' prior achievements in secondary education (Central Bureau for Statistics, 2009; Harackiewicz, Barron, Tauer, & Elliot, 2002; Tinto, 1975) can positively predict students' persistence and success in higher education. Commitment to study in higher education (Georg, 2009) can predict dropout; when students feel more committed they are less likely to drop out. With respect to curricular characteristics, Georg (2009) found that students were less likely to drop out when teaching quality was perceived as high (e.g., when the aim of the course was clearly defined).

Promotion of students' social and academic integration can diminish attrition (Tinto, 1975, 1988, 1997, 1998). Social involvement refers to a students' integration in the social system of a college and can be promoted through peer and faculty interactions, whereas academic integration is reflected in students' involvement in the academic system, such as grade performance. Consistent with this view, active learning environments, such as problem-based learning (PBL), usually have lower dropout rates (Braxton et al., 2000; Van den Berg & Hofman, 2005; Schmidt et al., 2009, 2010). Active learning environments promote collaboration, and, therefore, students have more opportunity to form networks of peer support which make them feel less isolated. Also, these types of learning environments in higher education offer more student-teacher interaction which can increase academic and social involvement (Van den Berg & Hofman, 2005). Students become active learners, whereas "the teacher becomes the guide at the side rather than the sage on the stage" (Slavin, 2006, 243). The sage refers to an instructor who almost exclusively lectures and "transmits" knowledge to his or her students; whereas the guide helps students with and facilitates their knowledge acquisition process.

As shown, prior achievements, commitment, and active learning environments have been positively associated with educational success and persistence. However, less is known about the role of teacher judgments, especially in higher education (Harackiewicz et al., 2002; Georg, 2009; Van den Berg & Hofman, 2005). In this study we explore whether tutor judgments in PBL can be used as a predictor of students' short- and long-term performance, in which performance consists of a productive (i.e., passing the first year or obtaining a degree) or counterproductive component (i.e., failing the first year or non-completion because of attrition or delays). In PBL, the tutors are "the teachers". Their role is to facilitate the discussion process, to stimulate discussion, and to make sure all content is touched upon in sufficient depth (Loyens et al., 2012). In addition, the tutor monitors students' progress and contributions during group meetings.

TEACHER JUDGMENTS IN PRESCHOOL AND PRIMARY SCHOOL

Teachers often have to make judgments about students' performance. For example, primary school teachers make referral decisions for special education, remedial teaching, or acceleration (Abidin & Robinson, 2002; Begeny, Eckert, Montarello, & Storie, 2008; Gerber & Semmel, 1984). In higher education, teachers take instructional decisions regarding the design and selection of appropriate assignments, tasks, and exams. Assessment of the validity and reliability of teacher judgments is essential. Valid assessment of student performance improves teaching quality, because teachers can create the right amount of difficulty for students in their educational programs (Eckert, Dunn, Codding, Begeny, & Kleinmann, 2006; Martens & Witt, 2004). For example, in PBL, tutors need to assess when to intervene during group discussions and what questions to ask to guide the learning process in the right direction (Barrows, 1996).

Several studies indicate that teacher judgments can accurately reflect students' performance. In a review of 16 studies (Hoge & Coladarci, 1989) a median correlation of .66 (ranging from .28 to .92) was found between teacher judgments and actual student achievement. Also, more recent studies have found significant correlations between teacher judgments and student performance (Demaray & Elliott, 1998; Meisels, Bickel, Nicholson, Xue, & Atkins-Burnett, 2001; Schappe, 2005). Furthermore, several studies indicate that teacher judgments are fairly accurate in assessing problem behavior (Abidin & Robinson, 2002) and learning difficulties (Gresham, Macmillan, & Bocian 1997; Taylor, Anselmo, Foreman, Schatschneider, & Angelopoulos, 2000). However, the studies described above on teacher judgments were conducted in preschool or primary schools, whereas only a few studies have examined teacher judgments in higher education (Kaufman & Hansell, 1997; Loyens et al., 2007a; Van de Watering & Claessens, 2003; Whitfield and Xie, 2002).

HOW ACCURATE ARE TEACHER JUDGMENTS?

Although the studies described above seem to suggest teacher judgments are fairly accurate, there are several reasons to assume that examining correlations alone is not sufficient. Correlations do not give insight in the causality of the relation between student performance and teacher judgments (Jussim, 1991). Moreover, correlations do not specify teachers' accuracy in predicting specific ability levels of students (Feinberg & Shapiro, 2003) or their discriminative ability to predict success or failure (Gijsel, Bosman, & Verhoeven, 2006).

First, Jussim (1991) argues that a significant correlation between teacher judgments and students' performance can indicate three things: (1) teacher accuracy, (2) teacher expectancy effects (e.g., self-fulfilling prophecy), and (3) perceptual bias. *Teacher accuracy* reflects teacher judgments predicting student behavior or achievement without causing it (Jussim, 1991), based on relevant background information, such as students' prior ability level and motivation. *Teacher expectancy effects* consist of self-fulfilling prophecy effects, where teachers' expectations or judgments about students will change student behavior so that the initial teacher expectations or judgments are confirmed (Trouilloud, Sarrazin, Bressoux, & Bois, 2006). *Perceptual bias* takes place when teachers explain, remember, or interpret student achievement (i.e., grades) in ways that are consistent with their initial judgment, instead of standardized test results (Jussim, 1991; Trouilloud, Sarrazin, Martinek, & Guillet, 2002). Perceptual bias may depend on stereotypical beliefs teachers have about what factors (e.g., ethnicity, social economic status) influence students' performance. Studies that examined the magnitude of teacher accuracy, teacher expectancy effects, and perceptual bias indicate that teachers are mostly accurate in judging student performance and base their judgments on relevant information, such as prior achievements (De Boer, Bosker, & Van der Werf, 2010; Jussim & Harber, 2005). Although self-fulfilling prophecies exist, they are usually not significant and are likely to stay the same or dissipate over time (Smith, Jussim, & Eccles, 1999).

Second, Feinberg and Shapiro (2003, 2009) demonstrated that primary school teachers can recognize relative differences in students' performance strength, but are less accurate in predicting specific levels of performance. When teacher ratings were compared to performances on standardized tests, significant correlations of .62 and .70 were found. Nevertheless, effect sizes between teacher judgments of oral reading and actual student performance in reading fluency (i.e., effect sizes are calculated as the mean teacher judgments - the mean standardized test score / pooled standard deviation of teacher judgment and student performance) showed large differences, indicating that teachers have difficulty in predicting specific levels of student performance.

Finally, correlations do not give insight in the discriminative ability (i.e., specificity and sensitivity) of teacher judgments. Teachers seem better at predicting which learners will not develop learning difficulties than those who will (Flynn & Rahbar, 1998; Gijsel et al., 2006; Taylor et al., 2000), indicating that the specificity of teacher judgments is higher than the sensitivity. Specificity refers to the proportion of "true negatives" (i.e., children without a learning disorder) that are correctly identified by a test or a judgment (Altman & Bland, 1994). In contrast, sensitivity reflects the proportion of "true positives" (i.e., children with a learning disorder) that are correctly diagnosed. To our knowledge this is the first study of teacher judgments in higher education that examines teachers' discriminative ability to predict success or attrition.

RESEARCH ON TEACHER JUDGMENTS IN PBL

As mentioned, most research on teacher judgments has been conducted in primary schools. The few studies that did examine teacher judgments in higher education were conducted in a PBL environment (Kaufman & Hansell, 1997; Loyens et al., 2007a; Van de Watering & Claessens, 2003; Whitfield & Xie, 2002). PBL is a student-centered instructional method, in which students work in small groups (at most 12 students) on realistic problems, guided by a tutor (Barrows, 1996; Schmidt & Moust, 2000). The goal of these problems is to activate prior knowledge and promote active, self-directed learning. A great deal of variability exists in PBL, but six core characteristics are always present (Barrows 1996; Schmidt et al., 2009): student-centered learning, working with problems, collaborative learning, a guiding role of the tutor, a prominent role of self-study activities, and a limited amount of lectures. The four studies that examined teacher judgments in PBL (Kaufman & Hansell, 1997; Loyens et al., 2007a; Van de Watering & Claessens, 2003; Whitfield & Xie, 2002) came to different conclusions about the usefulness of tutor judgments for assessing student performance and knowledge.

Kaufman and Hansell (1997) examined whether tutors were able to predict actual student achievement. Each tutor was asked to rate the students in their tutorial group on their functioning during group meetings, such as reasoning, knowledge acquisition and integration, co-operation, interpersonal skills, and self-assessment. Student achievement was measured by a short-answer examination. Overall, a significant positive correlation was found between tutor ratings and actual student achievement, but only a small percentage of the variance (i.e., 4%) in student achievement was explained by tutor ratings. Of the five rated areas, only knowledge acquisition and integration correlated significantly with student achievement scores. Kaufman and Hansell therefore concluded that tutors cannot predict student achievement.

Similar results were found by Whitfield and Xie (2002), who examined a larger group of students over a longer time period (four courses in 1992-1994). Tutors were asked to judge students' knowledge base for each course on a 0-100% scale. Tutors did not have access to prior grades and examination scores. Overall low to moderate positive correlations were found between tutor judgments of knowledge and actual exam performance. Tutor judgments could explain about 14.5% of the variance in actual exam grades. However, tutor ratings were generally higher than students' actual exam scores, especially in the bottom 25% of the class. Whitfield and Xie concluded that tutor ratings are not useful to assess students' knowledge base, because tutors overrated performance.

It may not be surprising that only a small percentage of the variance in student achievement could be explained by tutor ratings in prior studies (Kaufman & Hansell, 1997; Whitfield & Xie, 2002). Achievement grades are predicted by various other factors besides tutor ratings, such as amount and quality of study time invested, intelligence, and quality of the course materials (Gijselaers & Schmidt, 1990; Van Berkel & Schmidt, 2000). However, this does not mean that tutor ratings are not a useful predictor. Loyens et al. (2007a) found that tutor ratings of students' observed learning activities during tutorial meetings were a good predictor of dropout. In this study, tutors rated their students on how well they prepared themselves for tutorial meetings, their active participation and involvement during discussion, and how well they performed in the role as chair and scribe at the end of a course (i.e., a five-week period). The results showed that higher tutor ratings of observed learning activities were associated with higher grades on the course test and a lower probability of dropout during the first year of study.

In addition, Van de Watering and Claessens (2003) demonstrated that PBL students classified by their teachers as barely, moderately, or highly competent differed in their actual performance on multiple-choice and essay questions. Their results indicated that students' exam scores corroborated with tutor judgments: barely competent students had low performances, moderately competent students had moderate performances, and highly competent students had high performances.

In sum, earlier research that examined teacher judgments in PBL seems inconclusive. Two previous studies on the accuracy of tutor judgments in PBL did not find a strong predictive relation between tutor ratings and actual student achievement (Kaufman & Hansell, 1997; Whitfield & Xie, 2002). In contrast, Loyens et al. (2007a) and Van de Watering and Claessens (2003) demonstrated tutor ratings did predict student performance.

PRESENT STUDY AND HYPOTHESES

The goal of the current study is to examine whether tutors can predict student performance in the first year and the entire three-year bachelor's program. To the best of our knowledge no other studies have investigated the predictive value of teacher judgments over a three-year timeframe in higher education. Alvidrez and Weinstein (1999) indicated that teacher judgments about cognitive ability made before kindergarten predicted school achievement 14 years later, beyond the effect of perceived behavioral attitude (e.g., assertiveness, independence), IQ, and socioeconomic status. Therefore, it could be useful to examine whether teacher judgments in higher education made at the beginning of the first year are predictive of performance three years later.

We hypothesize that students who were rated more positively by their tutors would be more likely to pass their first year than students who were rated less positively (Hypothesis

1). Because of small-group learning in PBL, tutors are able to become more involved with their students, which might enable them to identify which students will be successful and which will not. Second, we expect that tutor judgments are predictive of long-term success regarding a timely completion of the bachelor's program (Hypothesis 2; Alvidrez & Weinstein, 1999). Because earlier research indicated that dropout can be influenced by past achievements (Harackiewicz et al., 2002), we also examined whether tutor judgments could uniquely predict educational success above and beyond prior grades in secondary education. We expect that tutor ratings could predict students' performance in the first year (Hypothesis 3a) and the entire bachelor's program even after controlling for prior grades in secondary education (Hypothesis 3b). Finally, we examined how well teachers can discriminate between successful and unsuccessful students by calculating specificity and sensitivity indices. Earlier studies indicated that teachers are better at determining which students will not develop learning difficulties (Flynn & Rahbar, 1998; Gijsel et al., 2006; Taylor et al., 2000), therefore we hypothesize that tutors are better at determining which students will successfully finish the first year and bachelor's program than to determine which students are likely to leave the program without a degree (Hypotheses 4a/b).

METHOD

Participants

Participants were all first-year tutors ($N = 15$; 73% female). All tutors were staff tutors who had already finished their psychology degree. In addition, all tutors had a similar amount of experience with guiding PBL tutorial meetings (i.e., no more than one year of experience in guiding PBL tutorial meetings). Tutors made predictions about 211 first-year psychology students (73% female; $M_{age} = 20.01$, $SD_{age} = 3.11$), who were enrolled in a PBL curriculum. The majority of the students had finished Dutch pre-university education (74.40%); others had finished at least one year of higher education (21.30%) or had followed another type of prior education (e.g., international school; 4.30%).

Learning Environment

In the investigated PBL environment, students work on meaningful problems in small groups under the guidance of a tutor (Schmidt & Moust, 2000). A problem reflects phenomena that can be observed in real life or a description of psychological experiments or theories. For example, in the social psychology course, students read a problem about the bystander effect. The problem is in the form of a newspaper clipping in which students read about a woman who was raped in a train full of people while none of the witnesses intervened. After reading the problem, students generate possible "solutions" or explanations about why none of the bystanders intervened, using their common sense and prior knowledge (Schmidt & Moust, 2000). During the initial discussion of the problem, students will come to the conclusion that their prior knowledge is insufficient and formulate learning issues for further self-directed study. Based on these learning issues students select and study relevant literature resources. In the next tutorial meeting, students share their literature findings (tutors and students meet twice a week during a course).

The PBL curriculum entails eight successive 5-week courses per year. For each course, tutors and students are randomly assigned to a tutorial group, so that they can experience different tutors and students each course. The tutors have a facilitating role and are not involved in formal assessments of students' performance. At the end of each course, students take a formative course test (i.e., no course credits are associated with it). This test is formative because it aims to give students feedback about their performance during that course (Van Berkel, 1990). Course credits are obtained through progress tests and practical assignments such as research reports and presentations. The progress tests are administered three times a year. The test consists of 190 true or false questions covering the complete knowledge domain of the first two years of the psychology curriculum. The test scores are norm-referenced, meaning that the cut-off between passing and failure is determined by the scores of all students in one cohort (McHarg et al., 2005). Students need to attain at least 42 of the 60 European Credit Transfer System (ECTS) credits to pass their first bachelor year. The entire bachelor's program consists of three years in which students need 180 ECTS credits to receive a bachelor's degree.

Procedure

After the first 5-week course of the academic year, tutors were asked to write down the likelihood (0-100% scale) that each of the students in their tutorial group would (a) successfully finish the first year of study (i.e., obtain 42 of the 60 ECTS credits), and (b) successfully complete the entire bachelor's program (i.e., obtain all 180 ECTS credits). Tutors had no relevant prior knowledge about students, such as achievements in secondary education.

Students' first-year performance was coded "1" if they earned at least 42 ECTS credits (i.e., "pass") or "0" for less than 42 ECTS credits (i.e., "fail"). Students' performance in the bachelor 'sprogram was coded "0" if they had left the program without a degree, "1" when they had a delay in finishing the bachelor's program (i.e., were still enrolled but less than 180 ECTS credits), or "2" when they had completed the entire bachelor's program in time. The categorical outcomes were chosen instead of the number of ECTS credits obtained to get a clearer cut-off between failure or attrition and passing the first year or the bachelor's program.

Analyses

Because of the categorical outcome variables, a series of (hierarchical) logistic regressions were performed (Field, 2009). To predict first-year performance a binary logistic regression analysis was used with two categorical outcomes (pass vs. fail). A multinomial logistic regression predicted bachelor's program success (no degree, delay, completion) with Hosmer and Lemeshow's R^2, Cox and Snell's R^2, and Nagelkerke's R^2 as R^2-statistics, which are similar in terms of interpretation to the R^2-values in linear regression (Field, 2009). The odds ratio for the analyses is reported. When this value is larger than 1 this indicated a positive relationship, when it is less than 1 a negative relationship was found.

We also examined whether tutor ratings predicted student performance over students' examination grades in secondary education, using hierarchical logistic regression. In Model 1 only prior grades were included. In Model 2 both prior grades and tutor ratings were included as predictors. For 53 students, data about prior grades in secondary education were not available, and therefore these students were dropped from further analyses.

Finally, we examined how well teachers could discriminate between successful and unsuccessful students. As depicted in Table 7.1, the number of misses (A), hits (B), correct rejections (C), and false alarms (D) were determined to calculate tutor accuracy in predicting future student performance (Gijsel et al., 2006). A *hit* refers to a student who was predicted to be successful by his or her tutor and indeed passed the first year or completed the bachelor's degree. A *miss* refers to a student who was predicted to be unsuccessful (i.e., fail or no degree), but did pass the first year or completed the program. A *correct rejection* concerns students who were predicted to be unsuccessful and eventually failed or left the program without a degree, whereas a *false alarm* refers to students who failed or dropped out but who were classified as successful by their tutors. *Specificity*, then, refers to the proportion of students who were correctly identified by tutors to fail or to leave without a degree ("correct rejection") given all those who eventually failed or dropped out [C/ (C + D)]. *Sensitivity* is the

Table 7.1
Classification of Hits, Misses, Correct Rejections, and False Alarms

Outcome	Tutor ratings at the start of the first year	
	Low Chance of Success (0-25%)	High Chance of Success (75-100%)
Passed/ Completion	A (Miss)	B (Hit)
Failed/ Attrition	C (Correct Rejection)	D (False Alarm)

proportion of students who were correctly identified to pass the first year or to complete the bachelor's degree ("hit") relative to all those who finally passed the first year or completed the bachelor's degree [B/ (A + B)]. We calculated z-tests to determine whether sensitivity and specificity indices differed significantly from each other.

RESULTS

Descriptive Statistics

On average, tutors rated students to have a 69.44% chance ($SD = 25.47$) for passing the first year and a 65.69% chance ($SD = 27.00$) for finishing the bachelor's program. Of the 211 students enrolled in the PBL curriculum, 175 (82.90%) passed the first year, whereas 36 students (17.10%) failed. Eighty students (37.90%) successfully completed the bachelor's degree in three years, 72 (34.10%) left the program without a degree, and 59 (28.00%) students were still enrolled but had not finished the program at the end of the third year. Most students who did not obtain a degree (56.94%) left the program in their first year or immediately after the first year.

First-Year and Bachelor's Program Performance

First, a binary logistic regression was performed to examine whether tutor ratings could predict first-year performance. As can be seen in Table 7.2, tutor ratings significantly predicted first-year performance. Because the odds ratio was larger than 1 this result indicates that when tutor ratings increased, the chance of passing the first year also increased (i.e., Hypothesis 1 supported). Overall, the model with tutor ratings as the only predictor could explain about 13%-22% of the variance in first-year performance.

Table 7.2
Logistic Regression First Year Study Success

Variable	*b*	*SE*	*OR*	95% CI for *OR*	
				Lower	Upper
Constant	–0.77	0.47			
Tutor prediction	0.04*	0.01	1.04	1.02	1.05

Note. OR = odds ratio; CI = confidence interval. Model: $\chi^2(1) = 29.90$, $p < .001$, $R^2_{\text{Hosmer and Lemeshow}} = .16$, $R^2_{\text{Cox and Snell}} = .13$, $R^2_{\text{Nagelkerke}} = .22$.
* $p < .001$.

Regarding completion of the bachelor's program a multinomial logistic regression model was performed with tutor ratings as the predictor variable (see Table 7.3). Completing a bachelor's degree in three years was used as the reference category, because this category reflects success, compared to the other two categories (no degree and delay). Overall, the model with tutor ratings as the only predictor could explain about 10 to 11% of the variance in bachelor's program success. As can be seen in Table 7.3, results indicated that tutors could differentiate between students who left the program without a degree compared to those who completed their degree on time. The odds value was less than 1, indicating that students with higher tutor ratings were less likely to leave the program without a degree. However, tutor ratings did not predict which students would experience delays compared to students who obtained the degree on time. Therefore, Hypothesis 2 was partially supported.

Table 7.3

Logistic Regression Bachelor's Program Success

	b	*SE*	*OR*	95% CI for *OR*	
				Lower	Upper
No degree vs. Completion[a]					
Intercept	1.53*	0.46			
Tutor predictions	–0.03**	0.01	0.98	0.96	0.99
Study delay vs. Completion[a]					
Intercept	–0.29	0.56			
Tutor predictions	< 0.01	0.01	1	0.99	1.01

Note. OR = odds ratio; CI = confidence interval. Model with tutor predictions as predictor: $\chi^2(2) = 21.36$, $p < .001$, $R^2_{\text{Cox and Snell}} = .10$, $R^2_{\text{Nagelkerke}} = .11$.
[a]Completion was use as the reference category.
* $p < .01$, ** $p < .001$.

Tutor Judgments and Prior Grades

The average prior grade in secondary education was 6.57 ($SD = 0.42$), ranging from 5.5 (lowest grade) to 10 (highest grade). Overall, a significant positive relation was found between tutor ratings and prior grade, $r = .18$, $p < .05$. A hierarchical logistic regression analysis was performed to examine whether tutor ratings (Model 2) could predict students' success above and beyond prior grades from secondary education (Model 1).

As indicated in Table 7.4, results demonstrated that prior grades significantly predicted students' first-year performance. Students who obtained a higher grade in secondary education were more likely to pass their first year (see Model 1 of Table 7.4). Overall prior grades could explain 7 to 12% of the variance in first-year success. When tutor predictions were entered in Step 2, results indicated that tutor predictions additionally explained 6 to 11% of the variance in first-year success (see Model 2 of Table 7.4), supporting Hypothesis 3a.

Regarding performance in the bachelor's program, again a hierarchical logistic regression analysis was performed to examine whether tutor ratings (Model 2) could predict students' success above and beyond prior grades from secondary education (Model 1). These results are reported in Table 7.5. Completion of the bachelor's degree in three years was used as the reference category.

As can be seen in Model I of Table 7.5, prior grade could significantly predict completion versus non-completion. Students who performed better in secondary education were less likely to leave without a degree or to experience delays. Prior grades could explain up to 6%-7% of the variance in bachelor's program. When tutor predictions were included in Model 2, the results indicated that tutor predictions remained a significant predictor above and beyond the influence of prior grade (see Model 2 of Table 7.5). More specifically, Table 7.5 indicates that prior grade can differentiate between students who completed the bachelor's degree on time compared to students who dropped out or suffered delays in finishing the bachelor 's program. However, tutor ratings could only differentiate between students who

Table 7.4

First-Year Study Success With Prior Grades and Tutor Ratings as Predictors

Variable	Model 1		Model 2				
	b	*SE*	*b*	*SE*	*OR*	95% CI for *OR*	
						Lower	Upper
Constant	−12.43*	4.83	−12.06*	5.17			
Prior grade	2.22**	0.76	1.89*	0.82	6.64	1.34	32.89
Tutor prediction			0.03**	0.01	1.03	1.01	1.05

Note. OR = odds ratio; CI = confidence interval. Model 1: $\chi^2(1) = 10.81$, $p < .01$, $R^2_{\text{Hosmer and Lemeshow}} = .09$, $R^2_{\text{Cox and Snell}} = .07$, $R^2_{\text{Nagelkerke}} = .12$. Model 2: $\chi^2(2) = 21.46$, $p < .001$, $R^2_{\text{Hosmer and Lemeshow}} = .19$, $R^2_{\text{Cox and Snell}} = .13$, $R^2_{\text{Nagelkerke}} = .23$.
* $p < .05$, ** $p < .01$.

Table 7.5

Bachelor's Program Success with Prior Grades and Tutor Ratings as Predictors

	Model 1		Model 2				
	b	*SE*	*b*	*SE*	*OR*	95% CI for *OR*	
						Lower	Upper
No degree vs. Completion[a]							
Intercept	8.79**	3.33	8.15*	3.53			
Prior grade	−1.39**	0.51	−1.07*	0.54	0.34	0.12	1.00
Tutor predictions			−0.02**	0.01	0.98	0.96	0.99
Study delay vs. Completion[a]							
Intercept	7.28*	3.20	7.04*	3.17			
Prior grade	−1.15*	0.49	−1.21*	0.49	0.30	0.12	0.78
Tutor predictions			0.01	0.01	1.01	0.99	1.03

Note. OR = Odds Ratio; CI = confidence interval.
[a]Model 1 with prior grade as predictor: $\chi^2(2) = 10.16$, $p < .01$, $R^2_{\text{Cox and Snell}} = .06$, $R^2_{\text{Nagelkerke}} = .07$. Model 2 with prior grade and tutor predictions as predictors: $\chi^2(4) = 27.31$, $p < .001$, $R^2_{\text{Cox and Snell}} = .16$, $R^2_{\text{Nagelkerke}} = .18$. [c]Completion was used as the reference category.
* $p < .05$, ** $p < .01$.

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completed the program in time and students who left without obtaining a degree, therefore partially supporting Hypothesis 3b. Together the two predictors could explain up to 16%-18% of the variance in bachelor's program success.

Tutor Discriminative Ability

To determine how well tutors can differentiate between successful and unsuccessful students, the number of hits, misses, correct rejections, and false alarms were calculated (see Table 7.6). For the calculations only the students who received a high tutor rating (i.e., a 75% chance of passing or higher) or low tutor ratings (less than 25% to pass) were used (Gijsel et al., 2006). A chance of 25% or lower to pass the first year demonstrates that a tutor thinks the student is at risk of non-completion. In addition, a chance of 75% percent or higher indicates a tutor has high hopes for this student to pass the first year or bachelor's program. For the bachelor's degree only the most extreme outcomes were used: no degree versus completion.

Sensitivity indices were high, indicating that respectively 92% and 95% of the students that passed the first year or completed a degree were predicted to have a 75-100% chance of success (see Table 7.6). Note that sensitivity indices regarding first-year performance and bachelor's program success did not differ significantly from each other ($z = -0.87$, $p = .80$), indicating that educational success was well predictable over one year (i.e., short-term success) and three years (i.e., long-term success). However, specificity indices indicated that only 63% of the students that failed in the first year and 44% of the students who left the program

Table 7.6
Predictive Validity of Tutor Judgments

	First study year	Bachelor's program[a]
Hit	98	40
Miss	8	2
Correct rejection	10	17
False alarm	6	22
Sensitivity	.92	.95
Specificity	.63	.44

Note. Only the lowest (0-25%) and highest (75-100%) tutor ratings were used.
[a]For bachelor's program success only the outcome categories "no degree" and "completion" were used.

without a degree received a 0-25% chance rating. *Z*-tests further showed that the sensitivity and specificity indices differed significantly for both first-year performance ($z = 5.42$, $p < .001$) and bachelor's program success ($z = 5.47$, $p < .001$). This implies - as expected - that tutors are better in predicting success compared to failure or attrition, supporting Hypotheses 4a/b.

CONCLUSION AND DISCUSSION

The goal of this study was to investigate whether PBL tutors are able to predict students' short- and long-term performance. In addition, this study examined whether tutors can differentiate between successful and unsuccessful students. Earlier research that examined tutor judgments in PBL found mixed results and seemed inconclusive about the usefulness of these judgments. Two previous studies on the accuracy of tutor/teacher judgments in PBL did not find a strong predictive relation between tutor ratings and actual student achievement (Kaufman & Hansell, 1997; Whitfield & Xie, 2002). In contrast, two more recent studies indicated that tutor ratings did predict student performance (Loyens et al., 2007a; Van de Watering & Claessens, 2003).

In line with previous research (Tinto, 1993, 1998), most students who did not obtain a degree (56.94%) left the program in their first year or immediately after the first year. Tutors were able to predict students' first-year performance in a PBL environment. PBL is a form of active small-group learning in which tutors frequently get the chance to interact and observe student behavior in tutorial meetings. It is likely that tutors mostly based their expectations on observed learning activities and perceived motivation in group meetings since they had no further information about the students' learning activities and history in prior education.

As regards bachelor's program performance, tutors could only significantly differentiate between students who obtained a degree or left the program without a degree. They could not differentiate between students who obtained the degree in a timely fashion and those who suffered delays in finishing the bachelor's program. Although tutor ratings were still predictive of students' performance three years later, the ratings were not specific enough to measure more subtle differences in educational success, such as study pace.

As was the case in previous research, prior grades were predictive of short- and long-term performance. Prior grades could even differentiate between students who timely obtained their degree and those who dropped out or experienced delays in finishing the bachelor's program. After controlling for prior achievements, the predictive value of tutor judgments remained, indicating that tutor judgments obtained very early on in the curriculum have incremental validity in predicting students' first-year and bachelor's program performance and seem to measure a different aspect of students' learning potential than prior grades. Because tutor judgments could not differentiate between completion on time and delays in finishing the program, prior grades may still be a more specific predictor of students' long-term performance compared to tutor judgments.

Sensitivity and specificity indices showed tutors seem to be better at identifying students who will be successful (sensitivity) compared to students who will fail or leave before obtaining a degree (specificity). These results are in line with previous research, which found that teachers were better at identifying students who would not develop a learning disorder compared to those who would develop it (Flynn & Rahbar, 1998; Gijsel et al., 2006; Taylor et al., 2000). The higher sensitivity rates can be explained by examining Table 7.6. As can be seen in Table 7.6 there is a higher base rate of success (i.e., passing the first year or completing the program in time) than of failure, indicating that more students successfully finish the first year or the program compared to students who fail or drop out. This might also explain why tutors can better predict first-year and bachelor's program success and raises the question of how accurate tutors really are in predicting educational success.

Overall, tutor judgments can predict students' performance even after controlling for prior grades. Tutor ratings may reflect stable student characteristics, such as learning potential. However, tutors' judgments were more sensitive in identifying success than failure or attrition and could not differentiate between students who completed the program in a timely way versus those with delays. Therefore, tutor judgments may not be sufficient to identify students at risk of non-completion after the first year and should be combined with other predictors, such as first-year success or personality factors (e.g., De Koning et al., 2012).

As with any study, some limitations are worth mentioning. First, although all first-year tutors participated in this study, 15 tutors is still a small sample size. Also, we did not control for the possible existence of self-fulfilling prophecy effects and perceptual bias. However, earlier research has shown that self-fulfilling prophecy effects are usually small and teacher expectations are mostly accurate (Jussim & Harber, 2005). Also, self-fulfilling prophecy effects are largest in the first two weeks of a course, where after teachers become more accurate by judging student performance on relevant information like motivation and prior performances. In the current study, predictions were made after the first five weeks of the start of the academic year and therefore self-fulfilling prophecy effects would be minimal.

In addition, it could be interesting to investigate students' reasons for non-completion in more detail. Failure and non-completion can be caused by many things, such as disappointment in courses, financial or personal problems, and transfer to other courses or universities (Meeuwisse, Severiens, & Born, 2010). Poor results or inadequate learning strategies only explain a small part of failure and dropout. Therefore, to get a clearer image of the predictive value of tutor judgments it is important to examine reasons for non-completion in more detail. In addition, non-completion of college should not always be seen as failure (Tinto, 1993). The decision to leave college may be an important part of the social and intellectual development of a student.

This study examined whether tutor ratings were predictive of educational success in terms of completion and non-completion rates. Further research could examine how tutors make their judgments (e.g., which information tutors use for decision-making) and how tutors motivate their predictions. In addition, future studies can examine whether tutor characteristics such as implicit theories of intelligence (Dweck & Leggett, 1988) or teaching experience influence predictions.

In conclusion, contrary to some earlier findings in PBL environments, tutor judgments can predict educational success and give some indication which students are at risk of leaving the bachelor's program without a degree. Although tutor ratings alone are not enough to identify students at risk of failing and other predictors could be included such as commitment to study and first-year performance (e.g., De Koning et al., 2012; Georg, 2009), we believe tutor ratings have the potential to be used as an additional source of information to identify students at risk of failing the first year. Tutors could help these students by referring them to student counselors, who can advise and help these students to determine the right course of action for their social and intellectual growth, whether that concerns staying in college or leaving.

Chapter 8

The accuracy of and reasons behind teacher judgments: The role of first impressions

This chapter is in preparation as: Wijnia, L., Loyens, S. M. M., Derous, E., & Schmidt, H. G. (2014). *Academic success and failure in problem-based learning: The accuracy of and reasons behind teacher judgments*. Manuscript in preparation.

ABSTRACT

The present study investigates the accuracy of and reasons behind teacher judgments of students' academic success. Teachers ($N = 14$) were asked to rate the chance each student ($N = 250$) in their group would successfully finish the first year of a three-year bachelor's program. Teachers were asked to motivate their chance ratings. Results indicated teachers are relatively accurate in predicting academic success, but are more accurate in predicting success compared to failure. Results also demonstrated that teacher judgments of academic success do not only rely on general cognitive ability, but rather on other student characteristics, such as the level of preparation and participation in tutorial group meetings, expressed motivation and interest, and personality characteristics as extraversion and conscientiousness. Although many of these student characteristics have been associated with actual academic performance in higher education, judgment accuracy might be biased by teachers' perceptions of student characteristics.

INTRODUCTION

Preventing dropout and study delays are major concerns in higher education. On average, 30% of the students enrolled in tertiary education leave without a degree (Organisation for Economic Co-Operation and Development, 2013). In the Netherlands, about 48% of the students who entered higher education in 2002, dropped out during the bachelor's program (Educational Inspectorate, 2009). Most of these students dropped out after the first year (31%). In addition, 22% of the students experience study delays larger than one year. Study delays and dropout can both be time-consuming and costly for students, as well as for institutes of higher education. For example, in several European countries, the amount of funding universities receive from the government depends on the number of students who graduate (De Koning, Loyens, Rikers, Smeets, & Van der Molen, 2014; Hovdhaugen, 2009).

Because most students who leave higher education without a degree drop out during or immediately after the first year (Educational Inspectorate, 2009; Tinto, 1993, 1998), measures that target dropout or attrition should focus on the first study year. The current study aims to investigate the predictive value of teacher judgments for identifying students at risk of dropping out or delays, and to investigate which student characteristics (i.e., demographic, intellectual, and non-intellectual characteristics) teachers consider important when making judgments of success or failure during the first bachelor year. Specifically, this study was conducted in a problem-based learning (PBL) environment. A learning environment characterized by student-centered, collaborative learning in small groups of 10 to12 students (Barrows, 1996).

THE ACCURACY OF TEACHER JUDGMENTS

Teachers are often asked to make judgments about students' performance or behavior (Südkamp, Kaiser, & Möller, 2012). These judgments are often the primary source of information on students' study behavior in class and academic achievement and are used for diverse purposes, such as formal assessment or referral decisions for special education, remedial teaching, or acceleration (Abidin & Robinson, 2002; Begeny et al., 2008; Gerber & Semmel, 1984; Südkamp et al., 2012). Also various instructional decisions, such as the selection of tasks, difficulty levels of tasks, and the organization of learning rely heavily on teacher judgments of students' capacities (Eckert et al., 2006; Südkamp et al., 2012). Moreover, teacher judgments can cause teacher expectation effects and can influence students' performance and other life outcomes, such as educational attainment and socioeconomic achievement (Jussim, 1991; Fischbach, Baudson, Preckel, Martin, & Brunner, 2013; Trouilloud et al., 2002). Because of these implications, the accuracy of teacher judgments about students' performance is crucial.

Judgment accuracy is often defined as the correlation between teacher judgments of students' academic achievement and students' actual academic achievement, such as on standardized tests (e.g., Südkamp et al, 2012). Two meta-analyses demonstrated that teacher judgments of students' performance are relatively accurate (Hoge & Coladarci, 1989; Südkamp et al., 2012). Hoge and Coladarci reported a median correlation of .66 (range $r = .28$ to $r = .92$) between teacher judgments and students' achievement on a standardized test. The meta-analysis by Südkamp and colleagues of research conducted from 1989 to 2009 resulted in a mean correlation of .63 (range $r = -.03$ to $r = .84$) across 75 studies. The studies included in the meta-analyses have mostly focused on students from primary and secondary education, although a few studies have indicated that teachers or tutors in higher education can also accurately assess performance (Van de Watering & Claessens, 2003) or predict student success in completing a bachelor's program (Wijnia, Loyens, Derous, Koendjie, & Schmidt, 2014).

Most of the studies investigating teacher judgment accuracy are correlational in design. Some studies that looked further than correlations have found that primary school teachers can assess relative differences in students' performance strength, but are less accurate in predicting specific levels of performance (Feinberg & Shapiro, 2003, 2009). Specifically, judgment accuracy seems to be higher for high-achieving students relative to low-achieving students (Demaray & Elliott, 1998). Likewise, teachers seem to be better at predicting which children will not develop learning difficulties than those who will (Flynn & Rahbar, 1998; Gijsel et al., 2006; Taylor et al., 2000), or which students will be successful rather than unsuccessful in a higher educational bachelor's program (Wijnia et al., 2014). Teachers seem to overestimate students' performance, especially for low-achieving students (Bates & Nettelbeck, 2001; Feinberg & Shapiro, 2009; Whitfield & Xie, 2002).

In sum, prior research has indicated that teacher judgments are relatively accurate, especially for high-achieving, successful students. However, the reported median and mean correlation of both meta-analyses also suggests there is room for improvement, because substantial variance is left unexplained (Hoge & Coladarci, 1989; Südkamp et al., 2012). Therefore, it is essential to identify the factors that influence judgment accuracy.

HOW DO TEACHERS MAKE THEIR JUDGMENTS?

To gain more insight in possible moderating factors that influence judgment accuracy, it is important to learn more about what information teachers use when making judgments about students' performance and ability. For example, Kaiser et al. (2013) demonstrated that teacher judgments of achievement are not only influenced by students' actual academic achievement, but also by other student characteristics, such as the number of questions a student asks in class. In short, teacher judgments of achievement were also influenced by students' behavioral engagement, besides their actual academic achievement. This was even the case in two experimental studies in which teachers needed to make judgments about students in a simulated classroom. In these simulated classrooms, the correlation of students' actual engagement with actual achievement was constrained to zero. However, teacher judgments of achievement were still unjustifiably influenced by students' actual engagement in class (e.g., asking questions) and vice versa. These results demonstrate that teachers are not completely able to keep student characteristics separate when making judgments, and that they take other student characteristics into consideration besides achievement.

Kaiser and colleagues (2013) suggested that teachers may have taken the collinearity of engagement and actual achievement in account when making their judgments. That is, they might assume high engagement and high achievement go hand in hand. Earlier research has supported this relationship. For example, Kuh, Cruce, Shoup, Kinzie, and Gonyea (2008) have demonstrated that indicators of engagement (e.g., asking questions in class, preparation, and participation in class) can be predictive of performance in higher education. If teacher judgments are indeed influenced by students' engagement because of its assumed relationship with achievement, it is possible that other non-intellectual factors play a role as well (e.g., personality characteristics). However, less is known about the range of factors that might affect teacher judgments. Therefore, in addition to examining the accuracy of teacher judgments in predicting academic success and failure, we investigate on which information, observations, and student characteristics teachers base their judgments. Specifically, we examine the role of non-intellectual factors in their responses. By specifically investigating on which student characteristics and observations teacher judgments are based, we address the recent call from Kaiser et al. (2013) to identify other student characteristics than engagement that might moderate or even bias judgment accuracy.

STUDENT CHARACTERISTICS ASSOCIATED WITH ACADEMIC ACHIEVEMENT

Student characteristics that have been associated with academic achievement can be grouped in three factors: demographic variables, cognitive ability, and non-intellective constructs (Richardson, Abraham, & Bond, 2012).

Demographic Variables

Several demographic variables have been associated with academic achievement in higher education. For example, Van den Berg and Hofman (2005) have demonstrated that female students, younger students, and students from an ethnic majority group obtain higher academic achievements. Likewise, Richardson et al. (2012) found small positive effects for higher socioeconomic background, older students, and female students.

Cognitive Ability

Indicators of past performance or cognitive ability are often used to predict academic achievement in higher education. Several studies have indicated that prior educational attainment is determinative for educational success in higher education (e.g., Central Bureau for Statistics, 2009; De Koning et al., 2012; Jansen, 2004; Jansen & Bruinsma, 2005; Richardson et al., 2012). Also, general measures of students' cognitive ability, such as intelligence or intellectual ability are associated with achievement in higher education (De Koning et al., 2012; Richardson et al., 2012). However, the relationship between intelligence and achievement is often larger in primary and secondary school (e.g., Deary, Strand, Smith, & Fernandes, 2007) than in higher education, due to restriction of range in intelligence (e.g., Kappe & Van der Flier, 2012).

Non-Intellective Constructs

It has been argued that intelligence or other indicators of cognitive ability largely determine what a student *can* do or achieve, whereas student characteristics such as personality factors determine what a student *will* do (e.g., Poropat, 2009). A meta-analysis of the Big Five personality factors and achievement demonstrated that academic performance was significantly correlated with agreeableness, openness, and conscientiousness. Conscientiousness was as strong a predictor as intelligence in tertiary education. In addition, the correlation between academic performance and conscientiousness was unaffected by intelligence (Poropat, 2009).

De Koning et al. (2012) investigated the association of several student characteristics with achievement in a problem-based bachelor's program. Results demonstrated that conscientiousness and teacher ratings of observed learning activities were consistent predictors of academic achievement throughout the bachelor's program (De Koning et al., 2012). Teacher ratings of observed learning activities are ratings of student preparation, participation, critical thinking, and fulfillment of roles such as chairing a meeting (i.e., providing structure to the meeting; Loyens et al., 2007a).

Richardson et al. (2012) investigated the impact of 42 non-intellective correlates of university students' academic performance. These constructs were divided into five conceptually overlapping but distinct research domains: personality traits, motivational factors, self-regulatory learning strategies, students' approaches to learning, and psychosocial contextual influences. Stable individual characteristics such as intelligence, procrastination, conscientiousness, approaches to learning, and psychological contextual factors (e.g., general stress) had small correlations with GPA. Motivation and self-regulatory variables such as self-efficacy, effort, regulation, and grade goal (i.e., self-assigned minimal goal with respect to GPA) proved to be the strongest correlates of university GPA alongside previous educational attainments. Because non-intellectual factors, such as engagement, motivation, and personality have been associated with academic achievement in higher education, it is possible that teacher judgments of performance are influenced by these student characteristics in addition to students' cognitive ability (cf. Kaiser et al., 2013).

PRESENT STUDY AND HYPOTHESES

The current study investigated the predictive value of teacher judgments in a student-centered, problem-based, psychology program. Teachers were asked – early in the first year – to judge the chance (0-100%) that students would be successful during the first bachelor year and to provide information on what student characteristics or behavior they based their judgments. Finally, teachers were asked to judge students' behavioral engagement during meetings by judging observed learning activities, such as preparation and participation.

The aims of our study are threefold. First, we aimed to investigate whether teacher ratings of a student's chance to successfully complete the first year are predictive of academic success. We hypothesize that teacher judgments of success are accurate (Hypothesis 1). In addition, we expect that teachers are better in predicting success than failure (Hypothesis 2; Wijnia et al., 2014).

Second, we aimed to examine the relation between teacher judgments of success with ratings of observed learning activities. As mentioned, tutor ratings of observed learning activities, such as preparation and participation were a consistent predictor of academic success (De Koning et al., 2012). In addition, Kaiser et al. (2013) demonstrated that teacher judgments of performance were correlated with their judgments of engagement. We hypothesize that judgments of success are highly correlated with teacher judgments of observed learning activities (Hypothesis 3; Kaiser et al., 2013).

Finally, this study aimed to identify the student characteristics that teachers take into account when making judgments. We expect that, in addition to variables related to cognitive ability, such as intelligence or prior educational attainments, also student characteristics such as demographic variables and non-intellectual constructs such as personality and motivation will be mentioned (Hypothesis 4; cf. Kaiser et al., 2013). In doing so we extend previous findings from Kaiser and colleagues.

METHOD

Participants and Procedure

During the third week of the academic year (in the first course) all first-year tutors were asked to fill out a questionnaire for all the students in their tutorial groups. In this questionnaire, tutors had to indicate each student's chance of success (0-100%) and were asked to motivate their predictions. Finally, tutors were asked to rate students' observed learning activities. Fourteen (1 male, 13 female) of the 15 first-year tutors participated in the study. Tutors received a 10 euro gift certificate for participation. All tutors were academic staff members who had already finished their psychology degree. Half of the participating tutors had been enrolled in a PBL course as a student in the past. Four tutors had no experience in guiding a tutorial meeting before this course, 3 tutors had less than 1 year of experience, 1 tutor had between 1-2 years of experience, and 5 tutors had more than two years of experience in guiding PBL tutorial meetings. One tutor failed to indicate the amount of experience in guiding tutorial meetings. The 14 tutors made predictions about 250 first-year students.

Learning Environment

In the current study, we examine teacher judgments in a student-centered PBL psychology bachelor's program. In PBL, small groups of ten to twelve students work together on meaningful problems under the guidance of a tutor (Barrows, 1996; Schmidt & Moust, 2000). In PBL, the tutor is the teacher; therefore, we will use the term teacher and tutor interchangeably. The first bachelor year contains eight 5-week periods (i.e., courses). Each 5-week period deals with a specific psychology course, for instance social psychology, statistics, or clinical psychology. Therefore, courses are offered in succession. Problems are used as the starting point of the learning process and describe a phenomenon or event that can be observed in daily life that needs to be explained (e.g., irrational fear of spiders in a clinical psychology course). The cycle of a problem discussion consists of three phases: (1) initial group discussion of the problem based on prior knowledge and common sense, (2) individual self-study, and (3) collaborative reporting of the self-study findings. The role of the tutor is to facilitate and stimulate the discussion and make sure all relevant content related to the problem is discussed in sufficient depth (Loyens et al., 2012). In addition, the tutor monitors students' progress and contributions during group meetings.

Each week consists of two compulsory tutorial meetings (i.e., 3 hours per meeting) in which the initial discussion and reporting phase of the problem cycle take place, an optional lecture (2-hr), and a compulsory 2 or 3-hr practical session (Schmidt et al., 2009). Each course is graded through a practical assignment and a course test that is taken at the end of each 5-week period. After each 5-week course, the students are randomly assigned to a new tutorial group with a new tutor.

In the first year, students need to obtain 60 European Credits (EC). Forty of the 60 EC represent a "knowledge" cluster. Students obtain these 40 EC if their average grade on eight course tests is a 6.0 or higher (on a scale from 0 to 10). In addition, none of the course tests should have received a grade lower than 4.0. The remaining 20 EC can be obtained through practical assignments associated with each course (e.g., academic writing skills, research skills, clinical communication skills, presentation skills), representing a "skills" cluster. Again, students receive these 20 EC when the average grade associated with the practical assignments is a 6.0 or higher and none of the grades is lower than a 4.0.

Measures

Tutor ratings of first year success

Tutors were asked to predict the chance each student would pass the first year. Tutors had to indicate the chance of success on a scale from 0-100%, by marking a student's chance of success on a bar of 10 centimeters long. For example, when a tutor marked the bar at 5 centimeters, this indicated a 50% chance of success. In addition, tutors were asked to motivate their chance rating: "Please indicate on which observations, facts, or information you have based your judgment about this student."

Tutor ratings of observed learning activities

Besides the chance rating of success, tutors were asked to rate students' observed learning activities on a scale from 0 to 100%. The scale consisted of six items: preparation, active participation during the brainstorming or problem analysis phase, active participation during the reporting phase, understanding, self-confidence, and interest. The six items were based on the scale for observed learning activities as described by Loyens et al. (2007a) and can be seen as tutor ratings of behavioral engagement. Principal component analysis demonstrated that the six items loaded on one factor "observed learning activities", explaining 73.41% of the variance. In addition, the scale had a satisfactory reliability (Cronbach's $\alpha = .93$).

Successful completion

Students have successfully completed the first year if they have earned all 60 EC (coded as 1). Students fail if they have obtained less than 60 EC (coded as 0).

Coding scheme tutor-provided reasons for success

Finally, we examined on which student characteristics tutors based their judgments. We developed a coding scheme consisting of three broad categories: (A) demographic characteristics, (B) intellectual factors, and (C) non-intellectual factors (see Richardson et al., 2012). In addition, for each statement it was coded whether its influence on academic success was perceived as being positive, negative, or neutral by the tutor (see Appendix E for an overview of the coding scheme).

The category demographic variables consisted of statements reflecting students' age, gender, or ethnicity (see De Koning et al., 2012). The category intellectual factors were divided into three subcategories: (B.1) general cognitive ability, (B.2) verbal ability, and (B.3) prior educational experiences and attainments. The subcategory general cognitive ability included statements concerning students' cognitive capabilities (e.g., smart, intelligent) and understanding of the subject matter, whereas the verbal ability category reflected specific statements about the quality of students' spoken and written language skills.

The category with non-intellectual factors was divided into nine subcategories (De Koning et al., 2012; Poropat, 2009; Richardson et al., 2012). Three subcategories were devoted to statements referring to stable personality traits: (C.1) personality – not specified, (C.2) extraversion-introversion, and (C.3) conscientiousness. Extraversion-introversion was included because of the collaborative nature of the PBL environment in which tutors observe interactions between students and might therefore be inclined to take traits such as talk activeness, socializing, and initiative taking into account. Conscientiousness (e.g., organization, planning, and discipline) was included because of its consistent relationship with academic achievement (De Koning et al., 2012; Poropat, 2009). Other subcategories included: (C.4) collaboration readiness, (C.5) (in)stability, (C.6) study priority, (C.7) motivation and interest, and (C.8) preparation and participation in group discussions. Collaboration readiness was included because of the collaborative nature of PBL. It included statements concerning help-seeking behavior, listening skills, and collaboration with other students. The subcategory (in)stability reflects both statements concerning general nervousness and statements concerning test or presentation anxiety. Statements concerning balancing work, study-related activities, and social life were included in the subcategory study priority. The subcategory motivation and interest reflects statements about reasons for studying and expressed interest. The subcategory preparation and participation in group discussions includes statements such as the level of preparation for tutorial meetings but also participation such as one's contributions and questions during the tutorial meetings (see De Koning et al., 2012, Loyens et al. 2007a). Finally, a rest category was included: (C.9) other non-intellectual factors and consisted of, for example, personal or psychological problems of students.

Tutors' answers were divided into meaningful and distinguishable units. For example, one tutor motivated her prediction by stating "Very motivated and enthusiastic, always prepared, active during discussions, smart, reads more than one resource." This answer was subdivided and coded as followed: very motivated and enthusiastic (C.7, positive); always prepared (C.8, positive); active during discussion (C.8, positive); smart (B.1, positive); reads more than one resource (C.8; positive). Fifty percent of the tutor answers were coded by two independent raters, resulting in a kappa coefficient of .84. Differences in scoring were resolved through discussion and the remainder of the answers was coded by the first author.

RESULTS

Successful Completion of the First Year

On average, students received a 73.04% ($SD = 19.16$) chance to successfully complete the first year. Actual results indicated that 58 students (23.20%) failed to pass the first year and 192 (76.80%) students successfully completed the year. Chance ratings of first-year success were nested within tutor groups. To examine whether tutor ratings of success were predictive of successful completion of the first year, we first checked whether a multilevel approach for dichotomous outcomes was necessary by examining a random intercept and a random slope model (Heck, Thomas, & Tabata, 2012). In the random intercept model we examined whether actual successful completion of the first year differed across the 14 tutors, students were assigned to (i.e., "Does the tutor students are assigned to affect successful completion of the first year?"). With a random slope model we investigated whether tutors differ in their ability to accurately predict students' academic success.

Using an intercept only model (i.e., a model without predictors, see Heck et al., 2012), with a random intercept across the cluster "tutor", we first examined whether successful completion of the first year varied across the 14 tutors that the students were assigned to. The odds ratio of the intercept-only model demonstrated that students were 3.44 (95% CI [2.38, 4.98]) times more likely to succeed than to fail during the first year. The intraclass correlation indicated that about 6% of the variability in successful completion could be explained by the tutor that the students were assigned to for the first course. The intercept variance of successful completion did not significantly vary between tutors ($z = .94$, $p = .350$), suggesting that students' successful completion did not differ across tutors. In subsequent models, we therefore chose to use a fixed intercept for successful completion.

Second, we examined whether all tutors were equally able to predict students' first-year success (i.e., a random slope for tutor ratings). Analyses revealed that the slope of the tutor ratings did not significantly differ across tutors ($z = .34$, $p = .74$), indicating that tutors did not differ in their ability to make accurate judgments.

Because our analyses indicated a random intercept and slope were appropriate, we used a single-level binary logistic regression to examine whether tutor chance ratings could predict first-year completion. As can be seen in Table 8.1, tutor ratings significantly predicted successful completion of the first year. Because the odds ratio was larger than 1, this result indicates that when tutor ratings increased, the chance of passing the first year also increased, which supports Hypothesis 1. Overall, the model with tutor ratings as the only predictor could explain about 7%-13% of the variance of successful completion.

Table 8.2 reports the classification table which compares the predicted values of successful completion based on tutor predictions with the observed successful completion scores.

As can be seen in Table 8.2, 78.40% of the students were accurately classified by their tutors. In line with Hypothesis 2, we found that tutors were better at predicting successful completion (98.40% correctly classified) relative to failure (12.10% correctly classified).

Table 8.1
Logistic Regression for First Year Academic Success

Variable	*b*	*SE*	*OR*	95% CI for *OR*	
				Lower	Upper
Constant	−1.41*	0.58			
Tutor prediction	0.04***	0.01	1.04	1.02	1.06

Note. OR = odds ratio; CI = confidence interval. Model: $\chi^2(1) = 23.06$, $p < .001$, $R^2_{\text{Hosmer and Lemeshow}} = .07$, $R^2_{\text{Cox and Snell}} = .09$, $R^2_{\text{Nagelkerke}} = .13$.
* $p < .05$, *** $p < .001$.

Table 8.2
Classification Table

Observed	**Teacher judgments**		**Successfully classified**
	Failure	Successful completion	
Failure	7	51	12.10%
Successful completion	3	189	98.40%

Note. N = 250.

Association between Chance Ratings and Observed Learning Activities

Overall, ratings of observed learning activities in tutorial groups, such as expressed preparation and participation were high. On average students obtained a score of 70.04 (*SD* = 17.13, possible range 0-100). In line with Hypothesis 3, there was a high correlation between tutor ratings of successfulness and tutor judgments of engagement ($r = .83$, $p < .001$). This high correlation suggests that observed learning activities and a student's chance of success are highly intertwined in the eyes of tutors.

Tutor-Provided Reasons for Success

Of the 250 students in our sample, tutors provided a motivation for their predictions for 238 students. Coding of tutor-provided reasons resulted in 897 separate units (i.e., identified reasons for success). The units mostly reflected positive student characteristics (67.45%) when compared to negative (30.88%), or neutral characteristics (1.67%). Table 8.3 presents an overview of the frequency in which different categories were mentioned. In line with Hypothesis 4, only 194 (21.63%) of the 897 identified units were related to intellectual factors. However, non-intellectual characteristics were more often mentioned (77.70%), whereas demographic characteristics were hardly mentioned (< 1%). A chi-square test revealed that statements more often reflected non-intellectual factors than intellectual factors, $\chi^2(1) = 283.96$, $p < .001$.

With respect to "demographic characteristics," only statements about participants' age were mentioned as a possible factor that influences first-year success (see Appendix E for examples). The majority of statements within the category "intellectual factors" concerned statements about general cognitive ability (79.90%), such as a students' ability to understand the subject matter, whereas statements about verbal abilities (5.15%) and prior educational experiences were mentioned less often (14.95%).

Almost half of the non-intellectual statements (46.92%) concerned the level of preparation and participation in group discussions. In fact, observed preparation and participation reflected more than a third of all tutor-provided reasons. Other non-intellectual factors that were often mentioned were motivation and interest (23.10% of non-intellectual statements and 17.95% of all statements), and personality characteristics such as extraversion-introversion (9.90% of non-intellectual statements and 7.69% of all statements) and conscientiousness (7.46% of non-intellectual statements and 5.80% of all statements).

Overall, these results suggest that tutors believe that indicators of general cognitive ability, observed level of preparation and participation, expressed motivation and interest, and personality factors such as extraversion and conscientiousness are important student characteristics that influence a student's chance to complete the first bachelor year. Also, these results indicate that tutors are often influenced by other student characteristics than cognitive ability when judging academic success.

Table 8.3
Frequency of Tutor-Provided Reasons

	Frequency			
Student Characteristics	Positive	Negative	Neutral	Total
A. Demographic characteristics				
A.1. Demographic variables (i.e., age)	0	4	2	6
Total Category A	*0*	*4*	*2*	*6*
B. Intellectual factors				
B.1. General cognitive ability	122	30	3	155
B.2. Verbal ability	2	8	0	10
B.3. Prior education experiences	4	21	4	29
Total Category B	*128*	*59*	*7*	*194*
C. Non-intellectual factors				
C.1. Personality – not specified	10	0	0	10
C.2. Extraversion – Introversion	28	41	0	69
C.3. Conscientiousness	39	13	0	52
C.4. Collaboration readiness	16	5	0	21
C.5. (In)stability	6	23	0	29
C.6. Study priority	0	8	1	9
C.7. Motivation and interest	129	31	1	161
C.8. Preparation and participation	247	79	1	327
C.9. Other non-intellectual factors	2	14	3	19
Total Category C	*477*	*214*	*6*	*697*

DISCUSSION

In the present study we investigated whether teacher judgments of students' chance to successfully complete the first academic year were accurate. In addition, we investigated on which student characteristics or observations teachers' chance predictions were based. Earlier research has indicated that teacher judgments of performance are not only influenced by students' actual performance, but also by student characteristics such as engagement in class (Kaiser et al., 2013). By asking on what information and observations teachers base their judgments we address the research call from Kaiser et al. to further unearth student characteristics that might moderate or bias teacher judgment accuracy.

Accuracy of Teacher Judgments?

In line with prior research, we found that teachers' chance ratings could predict actual academic success in terms of successfully obtaining all course credits (Hoge & Coladarci, 1989; Südkamp et al., 2012; Wijnia et al., 2014). Tutor ratings could explain between 9% and 13% of the variance of successful completion of the first bachelor year. In addition, we found that tutors were better at identifying successful students relative to unsuccessful students, which is also consistent with earlier findings (e.g., Wijnia et al., 2014). This calls into question how accurate teachers really are in predicting students' academic success. First of all, the base rate of students' success is higher than that of failure. Therefore, the majority of the students in our sample (76.80%) successfully completed the first year, which might have influenced the results. Second, teachers might be inclined to give students the benefit of the doubt when judging their performance and are less inclined to give low predictions (Whitfield & Xie, 2002). This is also supported by the finding that when tutors had to indicate on which information or observations teachers based their judgments, they mostly reported characteristics that were positive indicators of success.

In the current study, we examined whether there were differences in judgment accuracy in our sample. We did not find an indication that tutors differed in their ability to make accurate tutor judgments. This is in contrast to earlier studies that have identified individual differences with respect to teachers' ability to make judgments (e.g., Coladarci, 1986; Impara & Plake, 1998). It is believed that certain teacher characteristics might influence teachers' ability to accurately judge students' performance, such as teaching experience or teaching philosophy. However, as of yet, it is not known which teacher characteristics influence judgment accuracy (Südkamp et al., 2012).

The fact that we did not find differences in teachers' ability to make accurate judgments might be explained by the PBL setting in which this study was conducted. PBL settings have been characterized as high in autonomy support, because of their student-centered nature in which students are responsible for their own learning process and where teachers have more of a guiding and facilitating role (Schmidt et al., 2009). Trouilloud et al. (2006) have found that the level of autonomy support that was present in the classroom moderated the effect of early teacher expectations on students' later perceived competence. Specifically, they found that teacher expectation effects (e.g., self-fulfilling prophecy effects) were larger when classrooms were low in autonomy support. According to Jussim (1991), teacher accuracy and the potential for self-fulfilling prophecy or teacher expectation effects are perfectly inversely correlated. Therefore, greater self-fulfilling prophecy effects indicate less accuracy. In future research, it could be interesting to examine the role of autonomy support as a moderator of teacher accuracy.

How Do Teachers Make Their Judgments?

Earlier research has indicated that when judging students' performance, teachers were not only influenced by students' actual performance but also by other (and possibly unrelated) student characteristics such as engagement (Kaiser et al., 2013). This suggests that teachers are potentially influenced and/or biased by student characteristics that they believe are important or predictive of academic success. Also, Kaiser et al. demonstrated that teacher judgments of performance are correlated with judgments of engagement. Similar results were found in our study, the correlation between tutor chance ratings and tutor ratings of observed learning activities such as preparation and participation was high.

However, and in addition to Kaiser et al., our study further shows that tutors were often influenced by non-intellectual factors such as observed preparation and participation in group meetings, expressed motivation and interest, and personality characteristics such as extraversion and conscientiousness. Many of these student characteristics have been associated with actual academic performance in tertiary education, such as tutor ratings of preparation and participation, conscientiousness, and motivational variables (e.g., De Koning et al., 2012; Richardson et al., 2012).

Even though many of the student characteristics that teachers perceive as important have in reality been associated with actual academic achievement, it is possible that teachers are biased by their own beliefs. For example, in the current study, tutors perceived extraversion as a positive predictor of academic achievement in the first year, whereas De Koning et al. (2012) has demonstrated that in an actual PBL environment extraversion was negatively associated with first-year academic success. In addition, the meta-analysis by Poropat (2009) demonstrated that extraversion was unrelated to academic achievement. Although teachers might assume that extraversion is predictive of academic success in small-group learning, this is not corroborated by actual research findings. The belief that certain student characteristics influence academic achievement, when they are in fact unrelated or differently associated, might lead to inaccurate judgments of students' performance. For example, Alvidrez and Weinstein (1999) found that teachers tended to overestimate a child's intelligence at age

4 when they perceived the child as independent, assertive, and interesting. Also, Hinnant, O'Brien, and Ghazarian (2009) indicated that children's social skills were positively associated with teacher expectations for reading and math, indicating that teachers may overestimate the academic ability of students they find easy to manage during lessons. Future research should examine this further.

Finally, it is unknown whether tutors can accurately identify which non-intellectual characteristics students actually possess. Although teacher judgments of performance have been found to be relatively accurate (Hoge & Colardarci, 1989; Südkamp et al., 2012), less is known about teacher judgments of other student characteristics. Kaiser et al. (2013) reported that teacher judgments of engagement were less accurate than teacher judgments of performance. Also, others have reported low accuracy of teacher judgments of student motivation (Gagné & St Père, 2001; Givvin, Stipek, Salmon, & MacGyvers, 2001).

Conclusions and Implications

The results of this study demonstrate that teachers are relatively accurate in predicting academic success in a first-year bachelor's program. Therefore, teachers seem able to assess students' performances and teacher judgments can give some indication which students are at risk of failing the first bachelor year. However, tutor judgments alone are not sufficient to identify students at risk. Results showed that tutors are better at identifying successful students rather than unsuccessful students.

In addition, the results show that teacher judgments of academic success were often influenced by teachers' perceptions of student characteristics other than cognitive ability, such as participation and preparation, motivation and interest, and personality factors. Tutors were most often influenced by observed learning activities in tutorial meetings, such as preparation and participation, which have been found to be a strong and consistent predictor of academic success in PBL settings (De Koning et al., 2012; Loyens et al., 2007a). Tutor judgments of observed learning activities might therefore reveal important information about students' academic success in the bachelor's program. Although many of these student characteristics have been associated with actual academic performance in higher education, it is still important to consider whether or not teacher judgments are biased. Student characteristics perceived to be important by teachers may very well be unrelated to actual achievement.

Chapter 9

Summary and discussion

BACKGROUND

Problem-based learning (PBL) is a student-centered learning method in which small groups of students work together on meaningful problems under the guidance of a tutor (Barrows, 1996). These problems are introduced to students before they have received any other curriculum input and can therefore be considered the starting point of the learning process. When PBL was first introduced in the mid-sixties of the last century it was developed to bridge the gap between what was learned in school and future professional practice. Moreover, it was developed with the intend the help students become intrinsically motivated, self-directed, autonomous learners (e.g., Norman & Schmidt, 1992; Schmidt et al., 2009). Autonomous motivation occurs when students study in a self-empowered manner and perform study-related activities out of interest or because they are personally meaningful (e.g., Deci & Ryan, 2000). Within self-determination theory (SDT), autonomous motivation is contrasted with controlled motivation and amotivation. Whereas study activities in the case of controlled motivation are regulated by an external (e.g., rewards) or internal (e.g., shaming) contingency, amotivation is characterized by the lack of intention to engage in activities.

The present dissertation examined motivation and (subsequent) achievement in PBL. PBL is believed to enhance intrinsic motivation for two reasons. First, the use of problems is believed to spark students' interest (Norman & Schmidt, 1992). Because these problems are discussed with limited prior knowledge, students cannot explain the problem completely during the initial discussion and will experience a knowledge gap that will trigger their interest and motivation. Research investigating the development of interest during a PBL cycle has indicated that interest indeed increased when the problem was presented and decreased afterward when students gained more knowledge about the problem (Rotgans & Schmidt 2011b, 2014). A second reason why PBL might enhance intrinsic motivation is the student-centered nature of the learning environment in which tutors have a facilitating instead of a directive role. These environments give students ample opportunity to experience autonomy (Black & Deci, 2000; Schmidt et al., 2009).

SUMMARY OF THE MAIN FINDINGS

The aim of this dissertation can be summarized into three research goals that build on each other. First, we wanted to examine differences in motivation between PBL and lecture-based (LB) students. Second, we aimed to unearth various factors that influence motivation and (subsequent) achievement in PBL. Finally, we examined predictors of academic success and achievement in PBL.

Investigating Differences between PBL and LB Students

The first objective of this dissertation was to examine potential differences in motivation and self-regulated learning (SRL) between PBL and LB students. Prior research examining students' motivational beliefs in PBL mostly concerned short interventions or quasi-experimental studies that constituted only a small part of the entire curriculum (e.g., L. Martin et al., 2008; Pedersen, 2003; Sungur & Tekkaya, 2006). In **Chapter 2**, we therefore conducted a survey study to examine potential differences between students enrolled in existing problem-based versus LB learning environments. A subsequent focus group study was conducted to explain the survey results in depth.

Differences in motivation

In contrast to our expectations, students enrolled in the PBL and LB learning environments under study did not differ in autonomous and controlled motivation. The claim that PBL can intrinsically motivate students (e.g., Norman & Schmidt, 1992) seemed not entirely justified based on the results of Chapter 2. Based on the focus group results, students seemed to experience an imbalance between controlling elements (e.g., mandatory presence) and the emphasis on students' own autonomy or responsibility (e.g., student-selection of literature resources). This perceived imbalance might explain why there was no difference between PBL and LB students in autonomous and controlled motivation.

A significant difference was found in competence beliefs. Specifically, PBL students scored higher on the latent construct competence than LB students. The higher scores on competence, might be explained by the use of problems. The problems in PBL are designed to be optimally challenging, meaningful, and realistic (e.g., Barrows, 1996; Schmidt & Moust, 2000). Optimally challenging tasks that are in the range of students' competence and for which prior knowledge can be activated, are believed to help students feel more competent (Deci & Ryan, 2000; Katz & Assor, 2007; Pintrich, 2003b).

Differences in SRL

As mentioned earlier, PBL intends to help students become more motivated and self-directed (e.g., Norman & Schmidt, 1992; Schmidt et al., 2009). Self-directed learning (SDL) is a multi-faceted concept. Measures of students' autonomy and SRL skills have been used as indicators of SDL (Candy, 1991; Loyens et al., 2008). Therefore, in addition to examining differences in motivation, we were interested in examining differences in SRL as well. To examine differences between PBL and LB students on study strategies and SRL, the Learning and Study Strategies Inventory was used. Students were compared on three latent constructs: affective strategies, measuring study effort (e.g., time management, concentration, self-testing); goal strategies, concerning strategies for coping with examinations and anxiety; and comprehension monitoring, measuring SRL and control strategies (see Cano, 2006). Based on the goal of PBL to promote students' SDL skills, we expected differences in favor of the PBL group on these constructs.

PBL students scored higher on affective strategies and goal strategies, whereas no differences were found on comprehension monitoring strategies (e.g., elaboration, monitoring, and organization). The higher scores on affective strategies might be explained by the manner in which the PBL curriculum was structured. In the PBL curriculum under study, students meet twice a week to discuss a new problem and as a result students have natural deadlines that encourage them to prepare or engage in self-study regularly. Moreover, based on the focus group results, the small-group meetings provide a form of social control or pressure that make students feel more inclined to prepare themselves for group meetings. For example, students do not want to let their group members down or do not want to be perceived as a weak or social loafing student. PBL students' higher scores on goal strategies suggest that PBL students could better cope with examinations and test anxiety than LB students. Due to the sequential order of courses, students do not have to divide their attention between conflicting courses or examinations. This could have helped students to feel more capable in coping with examinations and could have also influenced their perceptions of competence to study psychology in general.

In contrast to our hypothesis, PBL and LB students did not differ on comprehension monitoring strategies. In the focus group study it was mentioned that superficial discussion of the subject matter sometimes occurs, with students reading from notes or articles without explaining and processing the subject matter on a deeper level. This observation has also been documented by other PBL researchers (e.g., De Grave et al., 2002; Dolmans et al., 2001). These behaviors hinder the productivity of group meetings during the reporting phase and are detrimental for students' motivation. If the lack of difference in comprehension monitoring strategies is caused by these type of behaviors in group meetings, it could be useful to help students to become more effective in their self-directed study.

Nevertheless, although PBL intends to increase students' SDL skills, it needs to be noted that SRL skills are considered important in other education settings as well, including LB environments (e.g., Sierens et al., 2009). This might also explain why no differences were found on the construct comprehension monitoring strategies.

Factors that can Stimulate or Hinder Motivation and Achievement in PBL

A second objective of this dissertation was to identify important factors that can enhance motivation and achievement in PBL. Partially based on the results of the focus group study in Chapter 2, the role of students' initial topic interest, tutors' instructional styles, and self-directed study during the self-study phase in PBL were investigated. In the experimental study and the field study presented in **Chapter 3**, we investigated the effects of students' topic interest about a problem or course and the role of tutor-provided autonomy support or controlling teaching on study behaviors and performances. In the experimental studies presented in **Chapters 4** and **5**, the self-study phase of PBL was examined.

The role of topic interest for motivation and achievement

Students' initial topic interest was considered because students do not enter a course as blank slates. At the beginning of a course they have specific expectations about the course that can affect their learning (Ainley et al., 2002). Both studies presented in Chapter 3 demonstrated that students' anticipatory response to a topic affects their autonomous motivation and subsequently their study behaviors and performance. Specifically, students who indicated higher levels of initial topic interest scored higher on autonomous motivation and, in turn, invested more time in self-study and were more persistent (Study 1). In addition, they received higher tutor ratings of preparation and active participation during group discussions (Study 2). Furthermore, in Study 1, higher topic interest was associated with higher performance on the immediate test, but also with a greater decrease in performance on the delayed test (1 week later). The pattern of these results is similar to Mason et al. (2008). Topic interest is both influenced by situational (i.e., short-term interest, triggered by environmental features) and individual interest (i.e., general positive attitude toward a task that is relatively stable). It is therefore possible that the preexperimental topic interest was mainly an expression of situational interest elicited by the words and sentences that were used to introduce the topic of the problem.

The role of tutor-provided autonomy support versus controlling teaching

Second, the role of tutor-provided autonomy support versus controlling teaching was investigated in Chapter 3. Examples of an autonomy-supportive instructional style include offering students a certain degree of choice in learning materials; communicating why (uninteresting) study activities are relevant for students' goals; and using non-controlling language (e.g., Assor et al., 2002; Black & Deci, 2000; Katz & Assor, 2007). In contrast, examples of controlling instructional styles are ignoring the student's perspective or pressuring students to behave or think in a certain way (Soenens & Vansteenkiste, 2010). These instructional styles have been proven to be influential in teacher-centered learning environments (e.g., Jang et al., 2010; Vansteenkiste et al., 2012). Although student-centered learning environments are considered to be autonomy supportive (e.g., Black & Deci, 2000), tutor-provided autonomy support had not yet been investigated in a PBL context. Following Vansteenkiste and colleagues (Vansteenkiste et al., 2005; Vansteenkiste, Simons, Lens, Sheldon, et al., 2004) tutors' instructional styles were manipulated to be autonomy supportive or controlling through the type of language tutors used when framing instructions in Study 1. In a subsequent field study, students' perceptions of their tutor's instructional style were measured.

Results of Studies 1 and 2 demonstrated that a controlling instructional style increased students' controlled motivation. This is in support of earlier research that has reported the hindering effects of tutoring that is too dominant or directive in PBL (Hendry et al., 2003). In Study 1, controlling instructions did not influence study behavior or performance. However, in Study 2, perceptions of controlling tutoring had an indirect, negative effect on students' preparation and participation in group discussions through controlled motivation.

In contrast to our expectations and studies conducted in teacher-centered environments, tutor-provided autonomy support was not (Study 1) or only marginally, positively (Study 2) related to autonomous motivation. These results imply that tutor-provided autonomy support may not be as important in student-centered learning when compared to teacher-centered learning. In PBL, autonomy-supportive elements, such as offering choice, are already built into the design of the learning environment (e.g., student-selection of literature resources). Additional tutor-provided autonomy support might therefore be less important for enhancing autonomous motivation.

The role of self-directed study

In Chapters 4 and 5, the self-study phase in PBL was examined. In a conventional self-study phase, students select and integrate information from a restricted set of relevant literature resources, and study those with the aim of finding an answer to the learning issues. On the one hand, letting students choose and integrate information from self-selected literature resources might be more effective in terms of long-term retention of acquired knowledge because of active engagement with the learning material (cf. Dochy et al., 2003). It also might enhance students' intrinsic motivation and perceived competence (cf. Patall et al., 2008). On the other hand, self-study in PBL might be too cognitively demanding and lead to lower (initial) learning outcomes because of high element interactivity (see Sweller, 2010). Difficulties encountered during self-directed study (e.g., selecting relevant literature resources or integrating information from multiple texts), might also explain why students sometimes only discuss the subject matter superficially as reported in the focus group study of Chapter 2. Therefore, the study presented in Chapter 4 compared studying student-constructed answers versus integrated model answers to the learning issues. In Chapter 5, we examined the role of student-selected versus instructor-selected literature resources during self-study in PBL.

Student-constructed versus integrated model answers. Kirschner and colleagues (2006) have described PBL as a minimally guided instructional approach. According to Kirschner et al., PBL would be less effective and efficient than direct instruction, such as worked examples that show students a step-by-step procedure for solving the problem (Cooper & Sweller, 1987; Sweller & Cooper, 1985). Inspired by this debate, the experimental study presented in Chapter 4 examined the role of direct instruction during the self-study phase of PBL. Specifically, it was investigated whether providing students with an integrated model answer to the learning issues, in which information of several literature resources was integrated, would be more effective and efficient than letting students construct their own answers as is the case during a conventional PBL self-study phase.

Our results demonstrated that the implementation of integrated model answers as a type of direct instruction in the PBL self-study phase was both effective and efficient. Students who studied integrated model answers obtained higher learning outcomes on immediate and delayed (i.e., 1 week later) closed-answer (factual) questions, as well as on immediate open-ended (conceptual and application) questions when compared to students who had to construct their own answers. These higher learning outcomes of the students in the integrated model answer condition were obtained with less time spent on studying the learning materials, equal investment of effort in the learning phase, and equal or lower investment of effort in the test phase. In addition, no differences were found in students' motivational beliefs (i.e., autonomous motivation, controlled motivation, and perceived competence). The combination of the test scores, self-study time, and mental effort invested are indicative of higher efficiency of the learning process as well as learning outcomes for students in the integrated model answer condition (Van Gog & Paas, 2008).

In support of our expectations, an interaction effect was found between condition and timing of the test. The test scores of students who studied integrated model answers significantly declined from the immediate to the delayed test, whereas the test scores of students who had to perform the conventional self-study phase remained constant. These results seem to indicate that although students who select, study, and integrate information from multiple literature resources scored lower on both test moments, they do not decline in knowledge between the immediate and delayed test. Therefore, student-constructed answers to the learning issues seem to have some beneficial effects in terms of consolidation of knowledge, that might be explained by a more active engagement with the study materials (cf. Dochy et al., 2003; Van Blankenstein et al., 2011).

Student-selected versus instructor-selected literature resources. In Chapter 5 we investigated the role of having a choice in literature resources for motivation and achievement. Both instructors and students in PBL have indicated frustrations or uncertainties with respect to students' responsibility (e.g., in selecting literature resources) during the PBL process (Dahlgren & Dahlgren, 2002; Miflin et al., 2000; Moust et al., 2005). To cope with these frustrations, in several PBL environments students no longer self-select their own literature resources, but instead read mandatory, instructor-selected literature resources. The study described in Chapter 5 compared a student-selected literature condition in which students could choose between five different resources, with an instructor-selected literature condition in which students were instructed to read two provided resources.

Participants in the student-selected literature condition reported higher levels of autonomous motivation and perceived competence for studying than the participants in the instructor-selected literature condition. The higher scores on autonomous motivation and perceived competence are in line with a meta-analysis on the effect of choice (Patall et al., 2008). Analyses further demonstrated that participants in the student-selected literature condition reported lower investment of mental effort during the self-study phase than the participants in the instructor-selected condition. No differences were found on controlled motivation or self-reported learning uncertainty. Although PBL students sometimes express uncertainty, frustration, and concerns about having to select their own literature resources to address learning issues in qualitative studies (see for example Study 2 of Chapter 2), this did not seem to result in lower perceptions of competence or higher perceptions of learning uncertainty, nor did it lead to higher investment of mental effort during self-study.

In addition to motivation and mental effort, self-study and learning outcomes were examined. Participants in the student-selected literature condition on average opened four of the five available resources. No differences were found in the length of time dedicated to self-study between condition. With respect to the learning outcomes, we found a significant effect of condition on test performance. Students in the instructor-selected literature condition scored higher on the closed-answer (factual) questions that could be answered through the reading of the individual literature resources and did not need integration of multiple resources. This difference might be explained by the fact that no differences were found on self-study time. Students in the instructor-selected literature condition only needed to divide their attention over two resources. In contrast, participants in the student-selected literature condition on average devoted their self-study time to reading four resources. It is possible that the students in the instructor-selected literature condition read the resources in more detail and were therefore better in responding to the questions assessing factual knowledge. No differences were found on the open-ended (conceptual and application) questions. This is encouraging, because application of knowledge is important in PBL (Norman & Schmidt, 1992).

In summary, the studies presented in Chapters 4 and 5 suggest that self-directed study can be cognitively demanding. Offering mandatory, instructor-provided resources does not seem to be more beneficial in terms of application of knowledge and motivation, than the standard self-study phase in which students select their own literature resources. However, offering integrated model answers to study was effective and efficient for learning and did not negatively affect students' motivation.

Predictors of Academic Achievement in PBL

The final objective of this dissertation was to identify predictors of academic achievement and success in PBL. Dropout is detrimental from both a student and institutional perspective. Research has demonstrated that approximately one third of the students enrolled in tertiary education leave without a degree (De Koning & Loyens, 2011; Organisation for Economic Co-Operation and Development, 2013). Most students who leave higher education without a degree, dropout during or immediately after the first year (e.g., Educational Inspectorate, 2009; Tinto, 1993, 1998). Measures that target dropout or attrition should focus on identifying students at risk in the first study year. In Chapters 6 to 8 we therefore examined the predictive value of students' motivation and tutor judgments, both measured at the beginning of the first academic year, for students' achievement and academic success.

Direct and indirect effects of motivation on achievement

The direct and indirect effects of motivation on students' achievement were examined in **Chapter 6**. Affect and engagement have been suggested as possible mediators of the relationship between motivation and achievement. Motivation was measured at the start of the academic year, whereas affect was measured near the end of the first year. Social-behavioral engagement was measured through tutor ratings of observed learning activities in group meetings.

Based on the literature on the associations between motivation, affect, engagement, and achievement three alternative models were generated and compared with each other (e.g., Linnenbrink, 2007; Reeve, 2012, 2013). The first model proposed a full mediation model (Model A) in which the relationship between motivation and engagement was fully mediated by affect. In turn, engagement predicted achievement. This model was compared with two partial mediation models. In the first partial mediation model (Model B), the relationship between motivation and achievement was fully mediated by affect and engagement, but motivation had both indirect and direct effects on engagement. In the final partial mediation model (Model C), also indirect effects of motivation on achievement were included.

Analyses and comparison of these models indicated that the model in which both direct and indirect paths between motivation and achievement were included had the best fit with the data. Amotivation had both a direct, negative effect on achievement and an indirect, negative effect through social-behavioral engagement. Controlled motivation only had a significant indirect, negative effect on achievement through social-behavioral engagement. Finally, autonomous motivation had both a direct, negative effect and an indirect, positive effect on achievement through positive affect and social-behavioral engagement, whereas the correlation table between motivation and achievement suggested no relationship. These results suggest that the relationship between motivation and achievement is a complex one and illustrates the importance of examining underlying factors such as affect and engagement that can explain the relationship between motivation and achievement.

The accuracy of tutor judgments

One of the roles of tutors is to monitor students' progress and contributions during group meetings. Two meta-analyses that investigated the accuracy of teacher judgments of performance in primary and secondary education settings have indicated that teachers can accurately assess students' actual performance (Hoge & Coladarci, 1989; Südkamp et al., 2012).

Moreover, De Koning et al. (2012) and Loyens et al. (2007a) indicated that teacher ratings of observed learning activities are one of the best predictors of achievement in PBL. The final empirical chapters of this dissertation examined whether tutor judgments made early in the first year could be used to identify students at risk for attrition or study delays. Specifically, tutors were asked the rate the chance that each student in their tutorial group would successfully finish the first year (**Chapters 7** and **8**) and the bachelor's program (Chapter 7).

Results of Chapters 7 and 8 indicated that tutors' chance ratings were predictive of academic success in the first year. With respect to academic success in the bachelor's program, tutors could only significantly differentiate between students who obtained a degree or left the program without a degree. However, tutor ratings could not differentiate between students who obtained the degree in a timely fashion and those who suffered delays in finishing the bachelor's program. Tutor judgments of academic success were still predictive of students' actual academic success after controlling for prior grades in secondary education. Further analyses indicated that tutors seem to be better at identifying students who will be successful compared to students who will fail the first year or who will leave before obtaining a degree. These findings are in accordance with previous research, that demonstrated that teachers were better at identifying students who would not develop a learning disorder compared to those who would (Flynn & Rahbar, 1998; Gijsel et al., 2006; Taylor et al., 2000).

The reasons behind tutor judgments

Earlier research has indicated that teacher judgments often not only reflect students' actual ability, but are also influenced by other student characteristics such as motivation or engagement (Kaiser et al., 2013). Therefore, in Chapter 8, it was investigated which student characteristics (e.g., intelligence, motivation, personality, and engagement during meetings) tutors consider important for academic success.

The study reported in Chapter 8 demonstrated that tutors were often influenced by non-intellectual factors such as observed learning activities during group meetings, expressed motivation and interest, and personality characteristics such as extraversion and conscientiousness. Many of these student characteristics have been associated with actual academic performance in PBL, such as tutor ratings of observed learning activities, conscientiousness, and motivational variables (e.g., De Koning et al., 2012; see also Chapter 6). Nevertheless, it is possible that tutors might be biased by their own beliefs about which student characteristics are predictive of success. For instance, tutors reported extraversion as a positive predictor of academic achievement in the first year, whereas De Koning et al. (2012) showed that extraversion was negatively associated with first-year academic success in PBL. Furthermore, it is unclear whether tutors can accurately judge students' non-intellectual characteristics. Even though teacher judgments of performance have been found to be relatively accurate (Hoge & Colardarci, 1989; Südkamp et al., 2012), judgment accuracy of student motivation was often low (Gagné & St Père, 2001; Givvin et al., 2001).

DISCUSSION AND DIRECTIONS FOR FURTHER RESEARCH

The overarching aim of this dissertation was to gain a deeper understanding of motivation and achievement in PBL. Two central themes emerged from the studies presented in Chapters 2 to 8: finding the right balance between students' responsibility and instructor-provided guidance in PBL environments and the usefulness of tutor judgments in predicting students' performance.

Imbalance between Responsibility and Guidance

According to SDT, both the needs for autonomy and competence have to be sufficiently supported in the learning environment by providing both high freedom and high structure (Reeve, Deci, & Ryan, 2004). Misconceptions often arise concerning freedom and structure. Freedom and autonomy are often mistakenly described as independence or leaving students to their own devices. In contrast, structure and guidance are often described to be controlling or dominant. In fact, a right balance between autonomy and structure is needed to achieve optimal motivation and learning outcomes (e.g., Jang et al., 2010; Sierens et al., 2009). The focus group study discussed in Chapter 2 suggests that freedom or autonomy and structure are not optimally balanced in PBL.

Even though PBL students scored higher on competence beliefs and felt they were better able to cope with examinations when compared to LB students, it is still possible that the perceived imbalance between freedom and structure affected their motivation (cf. Mac Iver et al., 1991). For some aspects of the learning environment, such as self-directed study, it is possible that students experience an autonomy gap between the level of responsibility they can handle (i.e., their autonomy competency) and the level of responsibility that instructors expect from students and is therefore required for successful learning (cf. Anderson, 2009). When students' learning strategies and teachers' teaching strategies are not entirely compatible friction occurs (Vermunt & Verloop, 1999). If this difference challenges students to increase their skills, constructive friction takes places. However, if this difference is too large, destructive friction occurs. If the gap between the degree of autonomy students can handle and the degree of autonomy that is expected based on the instructional strategies that are used is too large, this can have negative effects on learning. This can have implications for the role of the tutor and the learning environment in general.

Tutor-provided autonomy support and structure

In contrast to what was previously thought, this dissertation demonstrated that tutor-provided autonomy support seemed to be less influential for PBL students' autonomous motivation and learning (see Schmidt et al., 2009). Future research is needed to examine whether our findings can be replicated and extended to other student-centered learning environments. As mentioned above, PBL has been described as chaotic, stressful, and too cognitively demanding (Duke et al., 1998; Kirschner et al., 2006; Sierens et al., 2006). The emphasis on students' responsibility during the learning process is potentially stressful. Therefore, other tutor instructional styles, such as tutor-provided structure, might be more beneficial for students' motivation and achievement, because they can alleviate some of the burdens associated with students' responsibility.

Several studies have suggested that it is important to look at teacher-provided structure *and* autonomy support (Jang et al., 2010; Sierens et al., 2009; Vansteenkiste et al., 2012). Structure can take place during different stages of the learning process and for example, entails the communication of clear expectations with respect to student behavior, guidance during lessons, and constructive feedback attenuated to students (Reeve, 2006). In a teacher-centered learning environment, Sierens et al. (2009) found that providing structure combined with moderate or high levels of autonomy support influenced self-regulated learning, whereas structure did not affect self-regulated learning when low autonomy support was provided. Tutor-provided structure during the learning activity in combination with autonomy support might be especially important in PBL curricula. For example, a study by Budé et al. (2011) suggests that when the subject matter is complex and students have limited prior knowledge, it could be effective when tutors take on a more active role by asking directive questions during discussion that are aligned with the students' perspective and understanding.

There are several reasons to assume that an optimal balance between tutor-provided autonomy support and structure can be beneficial for motivation and achievement in PBL environments. First, Rotgans and Schmidt (2011a) have demonstrated that tutor-provided cognitive congruence enhances students' situational interest. Cognitive congruence in the PBL literature is described as a tutor's ability to take the perspective of students, to understand the problems students encounter with the subject matter, and to explain concepts in ways easily grasped by students (Schmidt & Moust, 1995). It is possible that these tutor behaviors are also effective in terms of autonomous motivation because they combine autonomy support and structure.

Second, research has shown that it can be difficult for tutors to find an optimal balance between providing students with clear guidance and structure on the one hand and being autonomy supportive on the other hand. A greater emphasis by tutors on subject matter is sometimes associated with more directive tutoring (Dolmans et al., 2002). For instance, Hendry et al. (2003) mentioned that students perceived too dominant or directive tutors as hindering their commitment and learning process. However, if prior knowledge is insufficient to stimulate active discussions, directive tutoring can be beneficial (Budé et al., 2011). Moreover, asking questions to stimulate activation of prior knowledge is only beneficial if this prior knowledge is actual available. The optimal balance between autonomy and guidance is therefore likely to depend on the complexity of the learning materials and students' prior knowledge.

Future research could focus on the conceptual overlap between cognitive congruent tutor behavior and tutor-provided autonomy support and structure and how they are related to students' motivation and learning. Since constructs as autonomy support and structure are broad and can consist of many different behaviors (e.g., choice, feedback, help, expectations) that can take place during different stages of the learning process, it is essential to consider students' perceptions of specific tutor behaviors as well. For example, by examining what type of tutor behaviors are important at each phase of the PBL cycle.

Autonomy support and structure as a design feature

Finding the optimal balance between freedom and structure is not only important for tutors' instructional style, but also for the learning environment in general. A study by Leppink, Broers, Imbos, Van der Vleuten, and Berger (2013) suggests that offering guidance, in the form of offering predetermined learning issues can be beneficial for students' learning and motivational beliefs. In their experiment, they compared conventional PBL groups to guided PBL in a statistics course. When learning a complex knowledge domain such as statistics, it is possible that students lack sufficient prior knowledge to formulate good learning issues. In the guided PBL groups the learning issues were therefore predetermined by the instructor and were used during this discussion to activate prior knowledge and to structure self-study. Results demonstrated that guided PBL enhanced students' conceptual understanding of statistics and increased students' awareness of the value and usefulness of the learning activity. These results seem in contrast to a study by Verkoeijen, Rikers, Te Winkel, and Van den Hurk (2006) that found that when potential learning issues were included in a problem concerning eyewitness interviews, students read less articles, invested less time in self-study, and spent less time reporting the studied literature than students who received the same problem without potential learning issues. Moreover, there was a trend indicating that students who received a problem without potential learning issues indicated more mastery of the subject matter after the reporting phase than students who received a problem that did include potential learning issues. It is likely that the differences in results between both studies were caused by differences in the level of students' prior knowledge or the complexity of the subject domain. Future studies could examine whether the amount of guidance that is needed in PBL interacts with students' prior knowledge or the complexity of the knowledge domain.

Is self-directed study too cognitively demanding?

In the standard PBL self-study phase, students need to select, study, and integrate information from multiple literature resources (e.g., various articles or book chapters) with the aim of finding an answer to the learning issues. As has been shown in Chapter 5 letting students select their own resources from a subset of literature resources can be beneficial in terms of autonomous motivation and perceived competence. However, students' scores on the open-ended questions in Chapters 3 to 5 suggest this approach is less optimal in terms of acquiring a flexible and extensive knowledge base.

Although first- and second-year students are often given a limited set of literature resources to choose from, in order to control the cognitive load involved in literature search to some extent (Schmidt et al., 2007), these processes are still cognitively demanding due to element interactivity and lack of prior knowledge. First of all, the activities students undertake during self-directed study consist of juggling many interacting information elements, and therefore impose a high load on working memory (see Sweller, 2010), while not all of these activities are crucial for learning to occur. For example, during self-directed study, students need to keep in mind the problem and the learning issues formulated for the problem. Moreover, they often need to base their answer to the learning issue by integrating information from two or more literature resources. Second, self-directed study is cognitively demanding, because these students are novice learners who lack prior knowledge or sufficient domain knowledge and experience, which makes it difficult for them to determine the relevance, importance, and trustworthiness of resources in light of the learning resources (e.g., Bråten et al., 2011; Rouet et al., 1997; Strømsø et al., 2008). This makes sense from a cognitive load theory perspective as well, since novice learners have not developed cognitive schemas that can be processed as a single element in working memory.

Nevertheless, the skill of being able to select relevant resources and integrate information across multiple literature resources is important to acquire (e.g., Strømsø et al., 2008). In addition, the more active engagement with the learning material might be beneficial in terms of long-term retention (see Chapter 4). Future research could investigate how students might develop such necessary skills. For example, it could be investigated whether worked examples or modeling examples could also be used to train students in answering learning issues with use of multiple resources. Research has indicated that example-based learning was effective for teaching collaboration skills (Rummel & Spada, 2005) or self-assessment and task selection skills (Kostons et al., 2012). Therefore, it might be effective for learning self-directed learning skills as well.

Are Tutor Judgments Useful?

A second theme that emerged from this dissertation concerned the usefulness of tutor judgments. In addition to facilitating and stimulating the group discussion, the role of the tutor includes monitoring and providing feedback on students' individual progress (Loyens et al., 2012). Student behaviors such as attendance, effort, persistence in class, working cohesively, and supporting other students in their contributions are essential in PBL (cf. Dolmans et al., 2001). In the curriculum under study, tutors are asked to monitor and rate these skills using the tutor rating scale of observed learning activities (e.g., Loyens et al., 2007a). Some researchers in PBL have questioned the usefulness and accuracy of tutor judgments in PBL

(Kaufman & Hansell, 1997; Whitfield & Xie, 2002), whereas others have suggested tutor ratings of observed learning activities in group meetings are a strong predictor of students' achievement and academic success in PBL (De Koning et al., 2012; Loyens et al., 2007a).

The results of Chapters 3 and 6 to 8 underscore the findings by De Koning et al. (2012) and Loyens et al. (2007a) and indicate that tutor ratings of observed learning activities are predictive of students' achievements in PBL and that tutor judgments of academic success are relatively accurate. Nevertheless, with respect to the accuracy of tutors' chance predictions, the results also indicated there was room for improvement. For example, tutors were better at identifying successful students when compared to unsuccessful students. Future research could examine possible moderators that influence judgment accuracy, such as student characteristics (see also Südkamp et al., 2012). Within collaborative small-group settings beliefs about students' traits such as extraversion-introversion or social skills are worth examining. There is some indication that teachers tend to overestimate students that are perceived to score high on extraversion. For example, Alvidrez and Weinstein (1999) demonstrated that teachers tended to overestimate a child's intelligence at age 4 when they perceived the child as independent, assertive, and interesting. Moreover, Hinnant et al. (2009) found that teachers may overestimate the academic ability of students they find easy to manage during lessons, because their results indicated that children's social skills were positively associated with teacher expectations for reading and math.

Methodological Considerations

Besides considering theoretical issues such as the imbalance between responsibility and guidance and the usefulness of tutor judgments, methodological issues with respect to investigating motivation and achievement in PBL are worth mentioning as well.

Effectiveness studies in PBL

A strength of the comparison study between PBL and LB students is that it included students from existing curricula that were entirely problem-based or lecture-based in nature. Findings in this study concerning motivation will less likely be caused by novelty effects, as is possible with the short-term PBL interventions.

Nevertheless, comparison studies between curricula that aim to examine the effectiveness of different learning environments on motivation and achievement are difficult. Learning environments consist of many different interacting elements, such as student, course, teacher, and institutional characteristics, which make it difficult to determine which factors caused the (null)findings. Comparison studies are further complicated by the fact that LB environments do not exclusively rely on lectures, but include active learning opportunities as well (Lammers & Murphy, 2002). In addition, there can be large variations in PBL environments as well, that makes generalization of the findings of different studies challenging (e.g., Newman, 2006; Schmidt et al., 2009). Therefore, future research needs to focus more on specific elements in the learning environment that are effective, for example through experimental manipulations as conducted in Chapters 3 to 5.

Moreover, longitudinal studies that take into account students' perceptions of certain aspects of the learning environment are important. These studies should take into account between- (i.e., differences between students) and within-student (i.e., differences within students) variance. Students' motivation and interest are not fixed entities and research has indicated that there is substantial intraindividual variation in students' motivational, emotional, and interest experiences on a day-to-day basis (e.g., Ahmed, Van der Werf, Minnaert, & Kuyper, 2010; Tsai et al., 2008). Even if students like studying psychology in general, they will like certain topics more than others. Fluctuations in motivation, interest, and emotions indicate that these experiences are sensitive to the learning conditions, but also have implications for future research designs that need to capture this intraindividual variability.

Experimental simulations in PBL research

Chapters 3 to 5 concerned experimental studies using a simulated group design (Van Blankenstein et al., 2011, 2013). Research in small group settings are complex, because many factors on the group level can influence the results, but we were mainly interested in the effect of certain factors such as students' interest, tutors' instructional styles, and self-directed study. Therefore, a standardized simulated group discussion was developed.

Although participants rated the simulated group discussion as realistic across the three experiments, their experience with the simulated PBL cycle in the lab might differ from their experiences in a real, face-to-face PBL setting. For example, interaction with others was limited due to our design, the amount of self-study time available was limited to 45 minutes, and the reporting phase was not included. Replications in real-life PBL settings are therefore important.

Nevertheless, we feel the simulated group discussion was representative of a real PBL environment. First of all, the six core PBL features were not violated in the experimental simulation: (1) student-centered learning; (2) collaboration in small groups; (3) use of problems as the starting point of the learning process; (4) more focus on self-study than on lectures; (5) learning is achieved through self-directed study; and (6) tutors have a guiding, facilitating role instead of a directive one (Barrows, 1996; Hmelo-Silver, 2004). Second, in Chapter 2, similar results were obtained using two different approaches: an experimental simulation and a field study.

CONCLUSIONS AND IMPLICATIONS

Overall, the results of this dissertation suggest that the claim that PBL environments promote intrinsic motivation, may not be entirely justified. At least not when it is assumed that PBL environments are more motivating than LB environments. Therefore, it is important to pay closer attention to how specific elements in PBL (i.e., the role of interest, tutors, and self-directed study) affect students' motivation and achievement.

Implications for Students' Interest

With respect to students' interest this dissertation demonstrated that students' expectations of a course or a specific problem, as measured through topic interest, should be considered. Topic interest proved to be an important predictor of students' autonomous motivation and subsequent study behavior and performance. When designing courses, attention could be paid to the effects of the impressions and expectations students have at the start of a course, because students' expectations can be influential for motivation and subsequent performance (see Ainley et al., 2002).

Implications for Tutors

As for tutor behaviors, our results indicated that controlling instructional styles hamper motivation directly and subsequent performance indirectly. For tutors, our results imply that they should avoid psychologically controlling teaching and the use of controlling language. Tutors can also consider whether needs besides autonomy, such as competence, are sufficiently supported. However, further research is needed to support this claim.

In addition, the results of this dissertation suggest that tutor judgments of observed learning activities or academic success can provide valuable information concerning students' performance. However, tutors were less accurate at identifying unsuccessful students, therefore these ratings should be combined with other measures as well.

Implications for Self-Directed Study

Finally, results of this dissertation suggest that self-directed study in PBL can be cognitively demanding. Both students and instructors have expressed concerns about self-directed study. This sometimes results in asking for (see Chapter 2) and offering "mandatory" instructor-provided literature resources (Moust et al., 2005). The results of this dissertation suggest that this practice does not lead to more beneficial outcomes in terms of students' motivation and learning. Although providing specific literature resources was beneficial for answering questions measuring factual knowledge, it was better to offer students some degree of choice by letting them select resources from a predetermined set in terms of autonomous motivation, perceived competence, and perceptions of mental effort during self-study. In addition, no differences were found on questions measuring conceptual knowledge that required integration from several literature resources.

Results further demonstrated that studying integrated model answers during self-study was effective and efficient and did not negatively affect students' motivation. However, results also suggested that letting students construct their own answers based on several literature resources to answer learning issues might be beneficial in terms of retention of knowledge. Nevertheless, we believe that our results do not imply that self-directed study should be completely replaced by studying integrated model answers, but that self-directed study is a complex skill that might need more support and training in PBL than it currently receives. Moreover, in the current studies we only investigated effects on motivation and the effectiveness and efficiency of learning, whereas it is important to consider the effects of self-directed study on SRL skills and lifelong learning as well.

Student-centered learning environments are becoming more and more popular and aim to promote students' motivation and learning (e.g., Baeten et al., 2010; Loyens & Rikers, 2011). Although these environments contain elements that can be beneficial for motivation and learning, it is important to keep in mind that most optimal effects will likely be obtained if there is a right balance between students' responsibility and teachers' guidance.

Samenvatting (Summary in Dutch)

DOEL EN ACHTERGROND

Probleemgestuurd onderwijs (PGO) is een student-gestuurde leeromgeving, waarin kleine groepjes studenten samenwerken aan problemen onder de begeleiding van een tutor (Barrows, 1996; Schmidt & Moust, 2000). Deze onderwijsvorm is ontwikkeld binnen het medisch onderwijs als alternatief voor traditionele, college-gestuurde onderwijsvormen. Een PGO-cyclus bestaat doorgaans uit drie fasen: een voorbespreking van het probleem, een zelfstudiefase en een nabespreking (e.g., Barrows, 1996; Schmidt et al., 2009). Tijdens de voorbespreking krijgen studenten het probleem te lezen en op basis van hun voorkennis en logisch redeneren proberen zij verklaringen te genereren voor het fenomeen dat beschreven staat in het probleem. Omdat de voorkennis van de studenten beperkt is, zullen zij het probleem niet in één keer kunnen verklaren of oplossen. Aan het einde van de voorbespreking stellen zij daarom vragen (d.i. de zogeheten leerdoelen) op die ze gaan beantwoorden tijdens de zelfstudiefase. Tijdens de zelfstudiefase zoeken studenten naar en bestuderen zij literatuur om een antwoord te krijgen op de leerdoelen. Na de zelfstudiefase (meestal twee tot drie dagen) komen de studenten weer samen in hun groep om hun literatuurbevindingen te bespreken en het antwoord op de leerdoelen te formuleren.

PGO werd onder andere ontwikkeld om een betere connectie te creëren tussen wat er geleerd werd in de onderwijssetting en wat er later nodig was in de beroepspraktijk door te werken met betekenisvolle, realistische problemen, zoals een casus van een patiënt (Schmidt 1983b; Schmidt & Moust, 2000). Deze probleembeschrijvingen vormen het startpunt van het leerproces. Studenten voeren na het lezen van het probleem immers een eerste discussie over het probleem voordat ze andere informatie, zoals boeken of colleges, hebben geraadpleegd of bijgewoond. Naast dat PGO studenten een realistische en betekenisvolle context voor het leren wil bieden, is het ook ontwikkeld met andere doelen in het achterhoofd, zoals het bevorderen van intrinsieke motivatie en zelfgestuurde studievaardigheden (Barrows, 1986; Hmelo-Silver, 2004; Norman & Schmidt, 1992). Het werken met betekenisvolle problemen zou de interesse en nieuwsgierigheid van studenten kunnen prikkelen. Daarnaast zou de eigen verantwoordelijk voor het leerproces de zelfgestuurde studievaardigheden van studenten kunnen bevorderen. Dit proefschrift tracht een beter beeld te krijgen over de rol van PGO bij het bevorderen van intrinsieke, autonome motivatie van studenten en de daaropvolgende prestaties.

Motivatie is in dit proefschrift gedefinieerd aan de hand van de zelfdeterminatietheorie (e.g., Deci & Ryan, 2000). Deze theorie maakt onderscheid tussen autonome en gecontroleerde motivatie. Autonoom gemotiveerde studenten zijn zelf-gedetermineerd en ervaren vrijheid en interne controle over het eigen leerproces. Zij voeren studietaken uit omdat zij dit studiemateriaal interessant of persoonlijk zinvol vinden (e.g., Deci & Ryan, 2000). Intrinsieke motivatie is het ultieme voorbeeld van autonome motivatie. Studenten met gecontroleerde motivatie worden daarentegen gereguleerd door een interne of externe druk. Voorbeelden hiervan zijn het willen vermijden van gevoelens als schaamte of schuld; het tevreden stellen van belangrijke anderen, zoals ouders; of het vermijden van straf. Autonome motivatie wordt vaak geassocieerd met betere leeruitkomsten en een beter welzijn.

Er zijn verschillende redenen om aan te nemen dat PGO kan helpen bij het bevorderen van intrinsieke motivatie. Allereerst wordt er gedacht dat het gebruik van problemen de interesse van studenten zal opwekken (Norman & Schmidt, 1992). Omdat studenten beperkte voorkennis hebben tijdens het bediscussiëren van het probleem, zullen zij niet in staat zijn om het probleem volledig te verklaren. Hierdoor ervaren zij hiaten in hun kennis waardoor hun nieuwsgierigheid en motivatie geprikkeld zal worden. Uit onderzoek naar de ontwikkeling van motivatie tijdens een PGO-cyclus is inderdaad gebleken dat interesse toenam nadat het probleem gepresenteerd werd en afnam wanneer studenten meer kennis over het probleem vergaard hadden (Rotgans & Schmidt 2011b, 2014). Een tweede reden waarom PGO de intrinsieke motivatie kan verhogen is de student-gestuurde leermethode. Binnen deze methode krijgen studenten interne controle over hun leerproces en hebben docenten of tutoren een meer begeleidende rol, waardoor studenten autonomie zouden kunnen ervaren (Black & Deci, 2000; Schmidt et al., 2009).

HOOFDBEVINDINGEN VAN DIT PROEFSCHRIFT

Het hoofddoel van dit proefschrift, namelijk meer inzicht krijgen in motivatie en prestatie binnen PGO, is verder opgedeeld in drie separate doelen. Het eerste doel was om een beeld krijgen van de mogelijke verschillen in motivatie en zelfgestuurd leren tussen PGO studenten en studenten van college-gestuurde leeromgevingen. Een tweede doel was om meer inzicht te krijgen in de verschillende factoren die invloed hebben op motivatie en prestatie binnen PGO. Tot slot zijn voorspellers van studiesucces en -prestaties binnen PGO onderzocht.

Doel I: Verschillen tussen PGO en College-Gestuurde Studenten

Het eerste doel van dit proefschrift was het onderzoeken van mogelijke verschillen in motivatie en zelfregulerend leren tussen studenten van een PGO of college-gestuurde omgeving. Eerder onderzoek heeft aangetoond dat PGO de motivatie van studenten, zoals interesse of geloof in eigen kunnen kan verhogen. Echter, deze onderzoeken betroffen voornamelijk kortdurende interventie studies of quasi-experimenteel onderzoek waarbij PGO slechts was ingevoerd in een klein gedeelte van het totale curriculum (e.g., L. Martin et al., 2008; Pedersen, 2003; Sungur & Tekkaya, 2006). Het is onduidelijk in hoeverre deze uitkomsten te generaliseren zijn naar leeromgevingen waar binnen het gehele curriculum wordt gewerkt met PGO. In **Hoofdstuk 2** is een vragenlijststudie uitgevoerd in een bestaande PGO en college-gestuurde setting. Om dieper in te gaan op de resultaten van de vragenlijststudie is bovendien een focusgroep afgenomen, waarbij aan PGO studenten werd gevraagd welke aspecten van PGO (de)motiverend zijn.

Verschillen in motivatie

De claim dat PGO studenten intrinsiek kan motiveren (e.g., Norman & Schmidt, 1992), lijkt niet geheel gerechtvaardigd op basis van de resultaten van Hoofdstuk 2. In tegenstelling tot de hypothese, waren er geen verschillen op autonome en gecontroleerde motivatie tussen PGO en college-gestuurde studenten. Uit de focusgroepresultaten kwam naar voren dat studenten geen goede balans ervaren tussen controlerende elementen in het systeem (e.g., verplichte aanwezigheid) en de nadruk die wordt gelegd op de eigen autonomie en verantwoordelijkheid van studenten (e.g., het zelf selecteren van literatuurbronnen). Dit is een mogelijke verklaring voor het feit dat er geen verschillen zijn gevonden tussen PGO en college-gestuurde studenten op autonome en gecontroleerde motivatie.

Er werd daarnaast een significant verschil gevonden in waargenomen competentie: PGO studenten scoorden significant hoger op waargenomen competentie dan college-gestuurde studenten. De probleembeschrijvingen binnen PGO zijn specifiek ontworpen om optimaal uitdagend, betekenisvol en realistisch te zijn (e.g., Barrows, 1996; Schmidt & Moust, 2000). Uit eerder onderzoek is gebleken dat uitdagende taken die goed aansluiten op de bekwaamheden en voorkennis bijdragen aan de perceptie van competentie van studenten (Deci & Ryan, 2000; Katz & Assor, 2007; Pintrich, 2003b).

Verschillen in zelfregulerend leren

Naast het bevorderen van intrinsieke motivatie, is één van de doelstellingen van PGO om studenten te helpen om autonoom en zelfgestuurd te worden (e.g., Norman & Schmidt, 1992; Schmidt et al., 2009). Zelfgestuurd leren is een breed concept en in onderzoek zijn zowel metingen van autonomie als zelfregulerend leren gebruikt als indicatoren van zelfgestuurd leren (Candy, 1991; Loyens et al., 2008). Daarom zijn naast verschillen in autonome en gecontroleerde motivatie ook studiestrategieën en zelfregulerend leren onderzocht in Hoofdstuk 2. Specifiek werden PGO en college-gestuurde studenten vergeleken op strategieën gericht op het besteden van tijd en aandacht aan de studie; het omgaan met angst en tentamens; en zelfregulatie, zoals het organiseren en in de gaten houden van het leerproces (Cano, 2006).

Uit het onderzoek kwam naar voren dat PGO studenten hoger scoorden op strategieën gericht op het besteden van tijd en aandacht aan de studie. Deze hogere scores kunnen deels verklaard worden door de manier waarop PGO georganiseerd is. Binnen deze leeromgevingen hebben studenten twee keer per week een onderwijsgroep waarin een nieuw probleem wordt bediscussieerd. Deze bijeenkomsten geven studenten een natuurlijke deadline die regelmatig studeren aanmoedigt. Uit de focusgroep kwam bovendien naar voren dat de kleine onderwijsgroepen ook fungeren als sociale controle. Studenten voelen zich in zekere zin genoodzaakt om zich voor te bereiden voor de bijeenkomsten, omdat ze niet als een zwakke of meeliftende student willen worden gezien.

Daarnaast bleek dat PGO studenten hoger scoorden op strategieën die helpen bij het omgaan met testangst en tentamens dan de college-gestuurde studenten. Deze hogere scores kunnen mogelijk verklaard worden door het feit dat binnen PGO met kortere onderwijsperiodes of blokken wordt gewerkt, waarin slechts één onderwerp of vak centraal staat. Hierdoor hoeven studenten hun aandacht niet te verdelen tussen verschillende vakken en tentamens en kunnen zij zich per periode op een vak richten en dit kan positief bijdragen aan de perceptie van studenten dat ze in staat zijn om effectief met tentamens en angst op dat gebied om te gaan. In college-gestuurd onderwijs zijn de onderwijsperiodes vaak langer en worden doorgaans verschillende vakken tegelijkertijd gegeven, waardoor tentamens ook op dezelfde momenten plaatsvinden.

In tegenstelling tot de hypothese, verschilden PGO en college-gestuurde studenten niet van elkaar op het gebruik van zelfregulatiestrategieën. Uit de focusgroep bleek dat tijdens de nabespreking het probleem soms oppervlakkig wordt bediscussieerd. Studenten lezen dan slechts hun samenvattingen of aantekeningen op zonder de leerstof op een dieper niveau te verwerken. Ook PGO onderzoekers hebben dit verschijnsel geobserveerd (e.g., De Grave et al., 2002; Dolmans et al, 2001). Deze gedragingen belemmeren de productiviteit van bijeenkomsten en zijn nadelig voor de motivatie van studenten. Als het uitblijven van een verschil in zelfregulatiestrategieën toe te schrijven is aan een te oppervlakkige discussie van de leerstof, kan het nuttig zijn om te kijken of dit het gevolg is van een ineffectieve zelfstudie en of dit verbeterd kan worden.

Hoewel PGO als doelstelling heeft om zelfgestuurd leren van studenten te verhogen, moet er opgemerkt worden dat zelfregulerend leren ook van belang is binnen college-gestuurde settingen (e.g., Sierens et al., 2009). Dit kan ook mogelijk verklaren waarom er geen verschillen zijn gevonden tussen de studenten van de twee leeromgevingen op zelfregulatiestrategieën.

Doel II: Factoren die Motivatie en Prestatie in PGO Bevorderen of Belemmeren

Een tweede doelstelling van dit proefschrift was om belangrijke factoren te identificeren die de motivatie en prestatie binnen PGO kunnen verhogen. Gedeeltelijk gebaseerd op de resultaten van de focusgroep uit Hoofdstuk 2, is er gekeken naar de rol van de aanvankelijke interesse van studenten in het onderwerp, instructiestijlen van tutoren en de zelfstudiefase binnen PGO.

De rol van interesse en de tutor

In **Hoofdstuk 3** werd de rol van interesse in het onderwerp voorafgaand aan de start van een nieuw probleem of vak en de rol van tutorstijlen op studiegedrag en prestaties onderzocht. De rol van de aanvankelijke interesse van studenten werd bekeken omdat zij niet als ongeschreven blad beginnen aan een nieuw vak. Voor de start van een vak of voor de behandeling van een nieuw probleem zullen zij daar al bepaalde verwachtingen over hebben die invloed kunnen hebben op het leerproces (Ainley et al., 2002). De studies uit Hoofdstuk 3 lieten zien dat de aanvankelijke interesse van studenten invloed had op hun autonome motivatie en daaropvolgend studiegedrag en prestaties. Zo hadden de studenten met hogere interesse een hogere score op autonome motivatie, investeerden zij meer tijd aan zelfstudie, vroegen zij vaker om extra literatuur na afloop van het experiment (Studie 1) en kregen ze hogere tutorbeoordelingen over hun gedrag in de onderwijsgroep (Studie 2). Ook bleken deze studenten in Studie 1 hogere scores te behalen op een test die onmiddellijk na het experiment plaatsvond.

Daarnaast werd in Hoofdstuk 3 gekeken naar de rol van autonomie-ondersteunende en controlerende tutorinstructiestijlen. Hoewel student-gestuurde leeromgevingen vaak worden gezien als autonomie-ondersteunend (e.g., Black & Deci, 2000), was de autonomie-ondersteunde instructiestijl nog niet onderzocht in een PGO context. Een autonomie-ondersteunde instructiestijl is er op gericht om het autonoom functioneren van een student te bevorderen door hun persoonlijke interesses en waarden te identificeren, te ondersteunen en verder te ontwikkelen. Voorbeelden van een autonomie-ondersteunende instructiestijl zijn het aanbieden van keuzes in studiemateriaal en aangeven waarom (oninteressante) taken relevant zijn voor de persoonlijke doelen van de student (e.g., Assor et al., 2002; Black & Deci, 2000; Katz & Assor, 2007). Tegenover de autonomie-ondersteunende stijl staat de controlerende stijl. Contolerende leerkrachten negeren vaak het perspectief van de student of leggen hun agenda aan de student op (Soenens & Vansteenkiste, 2010). Vansteenkiste en collega's hebben aangetoond dat autonomie-ondersteunende en controlerende instructiestijlen ook beïnvloed worden door het taalgebruik van de docent (Vansteenkiste et al., 2005; Vansteenkiste, Simons, Lens, Sheldon et al., 2004). Zo worden "moet"-statements en statements gericht op verhogen van interne druk ("het is voor je eigen best wil") geassocieerd met minder positieve uitkomsten dan autonomie-ondersteunende statements ("je kan" of "probeer de taak te doen"). Gebaseerd op de onderzoeken van Vansteenkiste en collega's, werden in Studie 1 autonomie-ondersteunende of controlerende instructiestijlen gemanipuleerd via het taalgebruik van de tutor. Om te kijken of de resultaten van het experiment te generaliseren waren naar de praktijk, werd in Studie 2 de waargenomen instructiestijl door studenten gemeten met een vragenlijst.

De resultaten van Studies 1 en 2 van Hoofdstuk 3 laten zien dat een controlerende instructiestijl de gecontroleerde motivatie van studenten verhoogde. Deze bevinding is in overeenstemming met eerder onderzoek dat heeft aangetoond dat een dominante of directieve tutor binnen PGO een belemmerend effect heeft op het leerproces (Hendry et al., 2003). In Studie 1 hadden deze controlerende instructies geen verdere effecten op studiegedrag of prestatie, terwijl het in Studie 2 indirect leidde tot een slechtere voorbereiding voor en deelname aan de onderwijsgroepen.

In tegenstelling tot onze verwachting en eerder onderzoek in docent-gecentreerde leeromgevingen, was de autonomie-ondersteunende instructiestijl niet of nauwelijks verbonden aan de autonome motivatie van de student. Dit suggereert dat autonomie-ondersteunende instructiestijlen binnen student-gestuurde leeromgevingen mogelijk minder van belang zijn dan aanvankelijk werd gedacht (cf. Schmidt et al., 2009). In PGO zijn elementen van autonomie-ondersteuning al aanwezig in de manier waarop de leeromgeving is vorm gegeven. Zo wordt bijvoorbeeld een zekere mate van keuze aangeboden doordat studenten worden gevraagd om hun eigen bronnen te selecteren. Additionele autonomie-ondersteuning vanuit tutoren is daardoor mogelijk minder belangrijk voor het verder bevorderen van autonome motivatie.

De rol van zelfgestuurd leren

In **Hoofdstukken 4** en **5** is de zelfstudiefase onderzocht. In een standaard zelfstudiefase binnen PGO krijgen studenten een set van literatuurbronnen aangeboden. Van studenten wordt verwacht dat ze verschillende bronnen raadplagen en daaruit informatie selecteren en integreren om tot een antwoord op de leerdoelen te komen. Zowel docenten als studenten staan soms sceptisch tegenover de grote verantwoordelijkheid die PGO studenten krijgen over hun leerproces. Deze verantwoordelijkheid, zoals het zoeken naar literatuur, zou kunnen leiden tot gevoelens van onzekerheid en frustraties (Dahlgren & Dahlgren, 2002; Miflin et al., 2000; Moust et al., 2005). Daarom wordt er in sommige PGO omgevingen voor gekozen om studenten niet langer zelf hun eigen literatuur te laten zoeken of selecteren en werkt men in plaats daarvan met "verplichte" docent-geselecteerde literatuurlijsten.

Kirschner et al. (2006) vinden bovendien dat PGO minder effectief en efficiënt is dan directe instructie, zoals uitgewerkte voorbeelden, waarbij de oplossingsprocedure van een probleem stap voor stap is uitgewerkt (zie Cooper & Sweller, 1987; Sweller & Cooper, 1985). De zelfstudiefase kan aan de ene kant ook cognitief zeer belastend zijn. Studenten hebben nog maar weinig voorkennis bij aanvang van het probleem. Om tot een antwoord op de leerdoelen te komen, worden studenten gevraagd om zowel het probleem, de leerdoelen en informatie uit verschillende bronnen in gedachten te houden. Er is dus sprake van een hoge elementinteractiviteit (e.g., Sweller, 2010). De complexiteit van deze zelfstudieactiviteiten kan misschien verklaren waarom de materie soms te oppervlakkig wordt nabesproken in onderwijsgroepen (zie Hoofdstuk 2). Anderzijds zou het zelf kiezen en integreren van informatie positief kunnen bijdragen aan lange termijn kennis, doordat studenten actief bezig zijn met de studiematerie (cf. Dochy et al., 2003). Ook zou keuze positief kunnen bijdragen aan intrinsieke motivatie en gevoelens van competentie (cf. Patall et al., 2008). Om dit te onderzoeken werd in Hoofdstuk 4 de standaard zelfstudiefase vergeleken met het bestuderen van geïntegreerde modelantwoorden en in Hoofdstuk 5 met het bestuderen van twee verplichte literatuurbronnen.

Geïntegreerde modelantwoorden zijn antwoorden op de leerdoelen waarin de informatie uit de verschillende literatuurbronnen al geïntegreerd is. Deze antwoorden kunnen vergeleken worden met de tutorinstructie die tutoren krijgen om zich voor te bereiden op bijeenkomsten. De resultaten van **Hoofdstuk 4** lieten zien dat het aanbieden van geïntegreerde modelantwoorden tijdens de zelfstudiefase van PGO effectief en efficiënt was. De studenten die geïntegreerde modelantwoorden bestudeerden, scoorden zowel hoger op de toets die direct na het experiment werd afgenomen als de toets die een week later werd afgenomen. Deze betere leeruitkomsten werden verkregen met een kortere zelfstudietijdinvestering en gelijke mentale inspanning tijdens zelfstudie.

Voor de leeruitkomsten werd een interactie effect gevonden tussen conditie en toetsingsmoment. De testscores van de studenten die de geïntegreerde model antwoorden bestudeerden, daalden significant tussen de twee testmomenten. Deze scores bleven echter constant voor de studenten die de standaard PGO zelfstudiefase uitvoerden. Het is mogelijk dat het zelf formuleren van een antwoord op de leerdoelen leidt tot het beter onthouden van kennis doordat studenten actiever met de studiematerie bezig zijn (cf. Dochy et al., 2003; Van Blankenstein et al., 2011).

Er werden geen verschillen gevonden op autonome motivatie, gecontroleerde motivatie en gevoelens van competentie. Het bestuderen van een modelantwoord, waardoor studenten niet langer zelf hun literatuur kiezen, leek dus hun motivatie niet negatief te beïnvloeden. Maar hoe zit het met de motivatie als studenten twee verplichte bronnen opgelegd krijgen vergeleken met de standaard zelfstudiefase waarin ze (beperkte) keuzevrijheid hebben? Uit **Hoofdstuk 5** bleek dat wanneer studenten enige keuzevrijheid hadden in het kiezen van literatuurbronnen zij een hogere autonome motivatie en perceptie van competentie rapporteerden dan wanneer zijn twee verplichte bronnen opgelegd kregen. Deze bevindingen zijn in overeenstemming met een meta-analyse over het effect van keuze (Patall et al., 2008). Daarnaast rapporteerden studenten in de student-geselecteerde literatuurconditie een lagere mentale inspanning tijdens zelfstudie dan de studenten in de docent-geselecteerde literatuurconditie. Er werden geen verschillen op gecontroleerde motivatie en ook verschilden de studenten van beide condities niet in de mate van onzekerheid die ze ervaarden tijdens het bestuderen. Hoewel PGO studenten soms onzekerheid en frustraties uiten over het zelf selecteren van literatuurbronnen in kwalitatieve studies (zie bijvoorbeeld Studie 2 van Hoofdstuk 2), lijkt dit niet te resulteren in lagere percepties van competentie, meer zelfgerapporteerde onzekerheid tijdens het studeren of een hogere mentale inspanning zoals gemeten met een vragenlijst.

Naast motivatie en mentale inspanning werd er ook gekeken naar zelfstudie en leeruitkomsten. De studenten in de student-geselecteerde literatuurconditie konden kiezen uit vijf bronnen en openden gemiddeld vier van de bronnen. Zelfstudietijd verschilde niet tussen de twee condities. Wat betreft de leeruitkomsten, werd gevonden dat studenten in de docent-geselecteerde literatuurconditie hoger scoorden op gesloten vragen die gericht waren op het meten van feitenkennis. Het antwoord op deze vragen kon gevonden worden in verschillende literatuurbronnen en vereiste geen integratie van verschillende bronnen. Het feit dat er geen verschil werd gevonden in geïnvesteerde zelfstudietijd tussen de twee condities vormt een mogelijke verklaring voor de hogere score op de gesloten vragen in de docent-geselecteerde literatuurconditie. Deze studenten hoefden hun aandacht slechts te richten op twee bronnen, terwijl de deelnemers van de student-geselecteerde literatuurconditie dezelfde tijd en aandacht gemiddeld verspreidden over vier bronnen. Het is daardoor mogelijk dat de studenten in de docent-geselecteerde literatuurconditie de bronnen in meer detail hebben bestudeerd en daardoor beter waren in het beantwoorden van vragen gericht op feitenkennis. Er werden geen verschillen gevonden op de open vragen die gericht waren op het meten van begrip en toepassing. Dit is bemoedigend omdat toepassing van kennis een belangrijke doelstelling is binnen PGO (Norman & Schmidt, 1992).

Samenvattend laten de studies beschreven in Hoofdstukken 4 en 5 zien dat zelfgestuurd leren een cognitief belastende taak is. Het geven van verplichte, docent-geselecteerde bronnen lijkt niet effectiever te zijn voor het leren toepassen van kennis en motivatie dan de standaard zelfstudiefase. Het aanbieden van geïntegreerde modelantwoorden bij de leerdoelen is echter wel effectief en efficiënt voor het leerproces en heeft geen negatief effect op motivatie.

Doel III: Voorspellen van Prestaties

Het laatste doel van dit proefschrift was de identificatie van voorspellers van prestaties en studiesucces in PGO. Studieuitval is nadelig voor zowel de student als de onderwijsinstelling. Uit onderzoek is gebleken dat ongeveer een-derde van alle studenten die zich inschrijven in het hoger onderwijs, de opleiding zonder diploma verlaat (De Koning & Loyens, 2011; Organisation for Economic Co-Operation and Development, 2013). De meeste studenten die uitvallen doen dit tijdens of kort na het eerste studiejaar (e.g., Educational Inspectorate, 2009; Tinto, 1993, 1998). Maatregelen tegen studieuitval kunnen daarom het beste gericht zijn op het leren identificeren van studenten die een verhoogd risico lopen op uitval tijdens het eerste studiejaar. De studies in dit proefschrift richtten zich voornamelijk op de rol van motivatie en tutorbeoordelingen.

Motivatie als voorspeller

In **Hoofdstuk 6** is gekeken naar de directe en indirecte effecten van motivatie op studieprestaties. Betrokkenheid en affect werden onderzocht als mogelijke mediatoren in de relatie tussen motivatie en prestatie. Motivatie werd in dit onderzoek gemeten aan het begin van het collegejaar, terwijl affect tegen het einde van het eerste collegejaar werd gemeten. Daarnaast werd betrokkenheid in de onderwijsgroep gemeten met tutorbeoordelingen van geobserveerde leeractiviteiten tijdens onderwijsgroepen, zoals de mate van voorbereiding op en de participatie tijdens de onderwijsgroepen.

Uit de resultaten kwam naar voren dat motivatie zowel een direct als indirect effect op prestatie had. Studenten die hoger scoorden op amotivatie behaalden lagere cijfers. Dit effect werd gedeeltelijk veroorzaakt door het effect dat amotivatie had op betrokkenheid in de onderwijsgroep: Wanneer studenten geen motivatie hadden om te studeren, waren ze minder betrokken in de onderwijsgroep (d.i. lagere scores op voorbereiding en deelname) en scoorden ze vervolgens slechter op tentamens. Gecontroleerde motivatie had ook indirect een negatief effect op tentamencijfer. Wanneer studenten een hogere mate van gecontroleerde motivatie hadden, waren ze minder betrokken bij de onderwijsgroep en behaalden ze vervolgens slechtere cijfers.

De relatie tussen autonome motivatie en prestatie was complex. Wanneer werd gekeken naar het directe effect van autonome motivatie op prestatie bleek dat meer autonome motivatie aan het begin van het collegejaar leidde tot slechtere cijfers. Echter, uit verdere analyse bleek dat autonome motivatie indirect wel een positief effect op tentamencijfers kon hebben: Wanneer studenten hoger scoorden op autonome motivatie, ervaarden ze later in het jaar meer positieve emoties en kregen ze hogere beoordelingen voor betrokkenheid van tutoren. Dit had vervolgens een positieve uitwerking op de prestaties. Het tegenstrijdige effect van autonome motivatie op prestatie illustreert dat de relatie tussen motivatie en prestatie complex is en dat het van belang is om onderliggende factoren mee te nemen, zoals affect en betrokkenheid.

De accuratesse van tutorbeoordelingen

Twee meta-analyses hebben aangetoond dat leraar-beoordelingen over de prestaties van studenten in het primair en middelbaar onderwijs vaak een accurate weerspiegeling zijn van de daadwerkelijke prestaties van studenten (Hoge & Coladarci, 1989; Südkamp et al., 2012). Er is echter weinig bekend over de accuratesse van leraar-beoordelingen in het hoger onderwijs. Binnen PGO is een accurate inschatting van de capaciteiten van studenten zeer relevant. Eén van de taken van een tutor is het monitoren en het beoordelen van studenten inzake hun voorbereiding op en deelname aan groepsbijeenkomsten.

Binnen een PGO context hebben De Koning et al. (2012) en Loyens et al. (2007a) aangetoond dat tutorbeoordelingen van geobserveerde leeractiviteiten tijdens onderwijsgroepen één van de beste voorspellers zijn van studentprestaties in PGO. In **Hoofdstukken 7** en **8** werd onderzocht of tutorbeoordelingen, gemaakt tijdens de eerste onderwijsperiode, ook nuttig kunnen zijn voor het voorspellen van studiesucces, -uitval en -vertraging. Studiesucces werd daarbij gezien als het succesvol behalen van de verplichte studiepunten voor het eerste jaar of voor het gehele programma. Studieuitval of falen werd dan gezien als het niet succesvol afronden van het eerste jaar of het vroegtijdig stoppen met de opleiding voordat een diploma werd behaald. Studievertraging vond plaats wanneer studenten de verplichte studiepunten niet in de tijd behaalden die er voor stond, maar er langer over deden. Tutoren werden gevraagd om de kans in te schatten dat studenten uit hun onderwijsgroep succesvol het eerste jaar zouden afronden (Hoofdstukken 7 en 8) en het gehele bachelor programma (Hoofdstuk 7).

De resultaten van Hoofdstukken 7 en 8 lieten zien dat kansinschattingen van de tutor voorspellend waren voor studiesucces tijdens het eerste jaar. De kansinschattingen waren ook voorspellend voor welke studenten wel of niet hun bachelor diploma behaalden, maar konden niet gebruikt worden om te voorspellen of studenten dit diploma zonder studievertraging zouden behalen. De tutorbeoordelingen bleven voorspellend voor daadwerkelijk studiesucces, zelfs wanneer er gecontroleerd werd voor het effect van eerdere prestaties in het middelbaar onderwijs. Hoewel tutorbeoordelingen voorspellend waren voor studieprestaties, liet verdere analyse zien dat tutoren beter waren in het voorspellen van studiesucces dan studieuitval of falen. Deze bevindingen zijn in overeenstemming met eerder onderzoek dat aantoonde dat leraren over het algemeen beter zijn in het identificeren van studenten die geen leerproblemen zullen ontwikkelen dan in het identificeren van studenten die wel problemen zullen ontwikkelen (Flynn & Rahbar, 1998; Gijsel et al., 2006; Taylor et al., 2000).

In de studie beschreven in Hoofdstuk 8 werden tutoren gevraagd om naast hun kansinschatting ook hun voorspelling te motiveren om zo meer inzicht te krijgen in de redenen achter tutorbeoordelingen. Eerder onderzoek heeft aangetoond dat leraar-beoordelingen vaak meer weerspiegelen dan alleen de daadwerkelijke bekwaamheid van de student en ook worden beïnvloed door studentkenmerken als motivatie en betrokkenheid (Kaiser et al., 2013). Daarom wilden wij meer te weten komen over de studentkenmerken die tutoren als relevant beschouwen voor studiesucces zoals intelligentie, motivatie, persoonlijkheid en deelname aan onderwijsgroepen.

Uit deze studie is gebleken dat tutoren vaak worden beïnvloed door niet-intellectuele kenmerken, zoals geobserveerde leeractiviteiten tijdens onderwijsgroepen, geobserveerde motivatie of interesse van studenten, en persoonlijkheidskarakteristieken zoals extraversie en consciëntieusheid. Uit eerder onderzoek is gebleken dat kenmerken zoals geobserveerde leeractiviteiten, consciëntieusheid en motivatie voorspellend zijn voor studieprestaties in PGO (e.g., De Koning et al., 2012; zie ook Hoofdstuk 6). Desalniettemin is het mogelijk dat tutorbeoordelingen gekleurd worden door hun eigen overtuigingen dat bepaalde studentkenmerken voorspellend zijn voor succes of falen. Zo werd de karaktertrek extraversie en goede sociale vaardigheden door tutoren gezien als positieve voorspellers van studiesucces, terwijl De Koning et al. (2012) aantoonden dat extraversie een negatief verband had met studiesucces bij eerstejaars PGO studenten. Hierdoor zouden tutoren studenten met extraversie onterecht hogere beoordelingen kunnen geven of het minder snel door hebben (en daardoor minder snel ingrijpen) als deze studenten risico lopen op studieuitval of vertraging.

Bovendien is het onduidelijk of de kenmerken die tutoren opgaven accuraat zijn waargenomen. Zo is uit onderzoek gebleken dat leraar-beoordelingen over prestaties relatief accuraat zijn (Hoge & Colardarci, 1989; Südkamp et al., 2012), terwijl de accuratesse van leraar-beoordelingen van studentkenmerken als motivatie vaak laag is (Gagné & St Père, 2001; Givvin et al., 2001).

DISCUSSIE EN SUGGESTIES VOOR VERVOLGONDERZOEK

Het overkoepelende doel van dit proefschrift was om meer begrip te krijgen over motivatie en prestatie binnen PGO. In de studies beschreven in dit proefschrift kwamen twee centrale thema's naar voren: het belang van het vinden van de juiste balans tussen de verantwoordelijkheid van de student en begeleiding vanuit de docent en de bruikbaarheid van tutorbeoordelingen in het voorspellen van studiesucces.

Balans tussen Verantwoordelijkheid en Begeleiding

Volgens de zelfdeterminatietheorie moet een leeromgeving zowel de autonomie van de student ondersteunen als voldoende structuur en houvast bieden (Reeve et al., 2004). Er bestaan veel misconcepties over autonomie en structuur. Het geven van vrijheid ofautonomie wordt vaak onterecht gelijkgesteld aan onafhankelijkheid of studenten aan hun lot overlaten. Het bieden van structuur en begeleiding wordt daarentegen vaak omschreven als controlerend of dominant. In werkelijkheid is een goede balans nodig tussen autonomie en structuur om optimale uitkomsten op het gebied van motivatie en leren te bereiken (e.g., Jang et al., 2010; Sierens et al., 2009). De focusgroepstudie uit Hoofdstuk 2 ondersteunt dit ook.

Hoewel PGO studenten een hogere perceptie van competentie hadden en zich beter in staat voelden om om te gaan met tentamens en testangst dan college-gestuurde studenten, is het nog steeds mogelijk dat de disbalans tussen vrijheid en structuur invloed heeft gehad op hun studiemotivatie (cf. Mac Iver et al., 1991). Vooral voor bepaalde onderdelen van het leerproces zoals zelfgestuurd leren, is het mogelijk dat studenten een gat ervaarden tussen de autonomie en verantwoordelijkheid die ze aan kunnen tijdens het leren en de mate van verantwoordelijkheid die docenten van hun verlangen (cf. Anderson, 2009). Wanneer de leerstrategieën van de student en de instructiestijl van de docent niet complementair zijn, kan frictie plaatsvinden (Vermunt & Verloop, 1999). Als studenten door dit verschil gestimuleerd worden om hun vaardigheden te verbeteren, is deze frictie constructief. Echter, indien dit verschil te groot is kan deze frictie destructief zijn.

Implicaties voor tutoren en het ontwerp van PGO

Kortom, als het gat in autonomie dat wordt ervaren tussen de verantwoordelijkheid die de student aan kan en die van hem of haar wordt verwacht te groot is, zal dit een negatieve invloed hebben op het leerproces. Voor tutoren is het van belang om er op te letten dat ze voldoende structuur en begeleiding aan studenten bieden. PGO wordt regelmatig omschreven als chaotisch, stressvol of cognitief belastend (Duke et al., 1998; Kirschner et al., 2006; Sierens et al., 2006) en uit Hoofdstuk 3 is gebleken dat een autonomie-ondersteunende instructiestijl geen of maar een klein effect had op autonome motivatie en leren. De nadruk die in PGO wordt gelegd op de eigen verantwoordelijkheid van de student tijdens het leerproces kan stressvol zijn en daardoor is het aanbieden van structuur door tutoren misschien extra belangrijk voor de motivatie en prestaties van de student, omdat dit de last van de eigen verantwoordelijkheid kan verlagen. Zo hebben verschillende studies in andere leeromgevingen aangetoond dat het bieden van structuur én autonomie-ondersteuning tot de meest optimale leeruitkomsten leidt (Jang et al., 2010; Sierens et al., 2009; Vansteenkiste et al., 2012). Daarnaast heeft Budé et al. (2011) aangetoond dat wanneer studenten slechts een beperkte voorkennis hebben en de studiestof complex is, het effectief is dat tutoren een actievere houding aannemen tijdens onderwijsgroepen door sturende vragen te stellen die afgestemd zijn op het niveau van de student. Dus hoewel een dominante of te sturende tutor negatief kan zijn voor het leerproces (Hendry et al., 2003), kan sturing aangepast op de student wel effectief zijn. Toekomstige studies zouden specifieke gedragingen van de tutor die bijdragen aan een goede balans tussen autonomie-ondersteuning en structuur kunnen onderzoeken.

Ook bij het ontwerpen van de leeromgeving is het van belang om een goede balans tussen structuur en autonomie-ondersteuning te waarborgen. Een studie van Leppink et al. (2013) heeft bijvoorbeeld aangetoond dat het bieden van begeleiding in de vorm van vooraf opgestelde leerdoelen zowel motivatie (perceptie van nut) als leren kan bevorderen. In deze experimentele studie werd een conventionele PGO groep vergeleken met een begeleide PGO groep bij het leren van statistiek. Wanneer het kennisdomein complex is, kunnen studenten te weinig voorkennis hebben om goede leerdoelen te formuleren. Vooraf opgestelde leerdoelen zouden in dat geval sturing aan de voorbespreking kunnen geven, waardoor voorkennis beter wordt geactiveerd en zelfstudie wordt gestructureerd.

De resultaten van de studie van Leppink et al. (2013) lijken tegenstrijdig met een studie van Verkoeijen et al. (2006) waarin werd gevonden dat wanneer potentiële leerdoelen in de probleemomschrijving over ooggetuigenverklaringen werd opgenomen, studenten minder artikelen lazen, minder tijd aan zelfstudie besteedden en kortere nabesprekingen hielden dan de studenten die de leerdoelen niet in de probleembeschrijving gekregen hadden. Mogelijk zijn de verschillen tussen beide studies veroorzaakt door het verschil in voorkennis of de complexiteit van het kennisdomein. Toekomstige studies zouden kunnen onderzoeken hoe de mate van begeleiding in PGO samenhangt met voorkennis en complexiteit.

Is zelfgestuurd leren cognitief te belastend?

In de standaard zelfstudiefase van PGO moeten studenten hun eigen literatuur selecteren en informatie integreren uit verschillende bronnen om een antwoord op de leerdoelen te kunnen formuleren. Uit Hoofdstuk 5 is gebleken dat wanneer studenten een eigen selectie kunnen maken uit een vooraf opgestelde literatuurlijst dit gunstig kan zijn voor autonome motivatie en percepties van competentie. Echter uit de lage scores op de open vragen in Hoofdstukken 3 tot 5 blijkt dat deze benadering misschien minder optimaal is voor het verkrijgen van flexibele en uitgebreide kennis.

Hoewel eerste- en tweedejaars studenten vaak kunnen kiezen uit een beperkte set aan literatuur om de cognitieve belasting tijdens het zoekproces in enige mate te beperken (Schmidt et al., 2007), is het selecteren van bronnen en integreren van informatie uit bronnen nog steeds cognitief belastend voor studenten. Allereerst moeten ze veel informatie (bijvoorbeeld leerdoelen, probleem, verschillende bronnen) tegelijkertijd in de gaten houden. Dit vormt een grote belasting voor het werkgeheugen (zie Sweller, 2010), terwijl deze activiteiten niet direct cruciaal zijn voor het leren. Ook kan zelfgestuurd leren cognitief belastend zijn voor beginnende studenten, omdat zij nog maar weinig voorkennis en expertise hebben. Hierdoor is het bepalen van de relevantie, het belang en de betrouwbaarheid van verschillende informatiebronnen lastig (e.g., Bråten et al., 2011; Rouet et al., 1997; Strømsø et al., 2008).

Desalniettemin zijn het leren zoeken van relevante informatiebronnen en het leren integreren van verschillende bronnen belangrijke vaardigheden (e.g., Strømsø et al., 2008). Toekomstig onderzoek zou zich daarom meer kunnen richten op hoe deze vaardigheden het beste ontwikkeld kunnen worden. Hierbij zou onderzocht kunnen worden of uitgewerkte voorbeelden (waarin de procedure stap voor stap beschreven wordt) of modelvoorbeelden (een rolmodel doet de procedure voor of legt het uit) gebruikt kunnen worden.

Zijn Tutorbeoordelingen Bruikbaar?

De bruikbaarheid van tutorbeoordelingen was een tweede thema in dit proefschrift. Naast het stimuleren en ondersteunen van het groepsproces, houdt de tutor ook de voortgang van studenten in de gaten en geeft hij of zij feedback op het individuele proces van de student (Loyens et al., 2012). Studentgedragingen zoals aanwezigheid, meedoen tijdens bijeenkomsten en samenwerking met anderen zijn essentieel binnen PGO (cf. Dolmans et al., 2001). Deze vaardigheden worden door de tutor geobserveerd en beoordeeld (e.g., Loyens et al., 2007a). Sommige onderzoekers hebben twijfels bij de bruikbaarheid en accuraatheid van tutorbeoordelingen in PGO (Kaufman & Hansell, 1997; Whitfield & Xie, 2002), terwijl anderen hebben aangegeven dat tutorbeoordelingen van geobserveerde leeractiviteiten in onderwijsgroepen belangrijke voorspellers zijn voor prestaties en studiesucces (De Koning et al., 2012; Loyens et al., 2007a).

De resultaten van Hoofdstukken 3 en 6 tot 8 onderstrepen de bevindingen van De Koning et al. (2012) en Loyens et al. (2007a) en geven aan dat tutorbeoordelingen van geobserveerde leeractiviteiten studieprestaties kunnen voorspellen en relatief accuraat zijn. Desalniettemin is er ruimte voor verbetering. Tutoren waren bijvoorbeeld beter in het identificeren van succesvolle studenten dan onsuccesvolle studenten. Toekomstig onderzoek zou meer aandacht kunnen besteden aan het bepalen van mogelijke moderatoren die invloed hebben op de accuratesse van de beoordelingen, zoals studentkenmerken (zie Südkamp et al., 2012). Er zijn aanwijzingen dat leraren kinderen overschatten die hoger lijken te scoren op extraversie (Alvidrez & Weinistein, 1999; Hinnant et al., 2009). In samenwerkende leervormen kan het daarom interessant zijn om het effect van overtuigingen van de tutor over de rol van studentkenmerken zoals extraversie-introversie of sociale vaardigheden nader te onderzoeken.

CONCLUSIES EN IMPLICATIES

De resultaten van dit proefschrift laten zien dat PGO omgevingen niet vanzelfsprekend tot meer intrinsieke motivatie leiden dan college-gestuurde instructiemethoden. Het is daarom belangrijk om te kijken hoe bepaalde aspecten van PGO bijdragen aan motivatie en studieprestaties.

Implicaties voor Interesse

Op het gebied van interesse liet dit proefschrift zien dat het belangrijk is om de verwachtingen van een student over een vak of probleem mee te nemen. Bij het opzetten van een vak kan men meer letten op de indruk die studenten aan het begin van de cursus hebben en hoe dit eventueel motivatie en studieprestaties kan beïnvloeden.

Implicaties voor Tutoren

Over tutorgedragingen lieten de resultaten van dit proefschrift zien dat een controlerende instructiestijl negatief kan zijn voor motivatie en daaropvolgende prestaties. Dit impliceert dat tutoren “moet”-statements of ander controlerend taalgebruik het beste kunnen vermijden. Daarnaast lijk het van belang dat tutoren zorgen dat zowel de behoefte aan autonomie als competentie voldoende ondersteund worden.

Bovendien toonden de resultaten van dit proefschrift aan dat tutorbeoordelingen van geobserveerde leeractiviteiten of studiesucces nuttige informatie kunnen geven over studieprestaties. Omdat tutoren minderen accuraat zijn in het identificeren van onsuccesvolle studenten, kunnen deze beoordelingen het beste gecombineerd worden met andere meetinstrumenten.

Implicaties voor Zelfgestuurd Leren

Tot slot suggereerden de resultaten van dit proefschrift dat zelfgestuurd leren cognitief belastend kan zijn. Zowel studenten als docenten hebben hun zorgen geuit over zelfgestuurd leren. Dit leidt soms tot het vragen naar of het aanbieden van verplichte docent-geselecteerde literatuurbronnen (Moust et al., 2005). Uit de resultaten van dit proefschrift kan afgeleid worden dat dit niet tot betere motivatie- of leeruitkomsten lijkt te leiden. Hoewel het opgeven van verplichte bronnen leidde tot een hogere score op feitenkennis, was het geven van enige mate van keuze beter voor de autonome motivatie en gevoelens van competentie en leidde het tot lagere percepties van mentale belasting tijdens zelfstudie. Bovendien werden er geen verschillen gevonden op het gebied van conceptuele kennis.

Resultaten lieten verder zien dat het bestuderen van geïntegreerde modelantwoorden op de leerdoelen effectief en efficiënt was en geen negatief effect had op studiemotivatie. Deze resultaten impliceren niet dat zelfgestuurd leren vervangen dient te worden voor het bestuderen van geïntegreerde modelantwoorden. Het zelf construeren van een antwoord zou beter kunnen zijn voor de retentie van kennis. De resultaten suggereren dat zelfgestuurd leren een complexe vaardigheid is die meer ondersteuning en training vereist dan dat het nu krijgt. Daarnaast moet opgemerkt worden dat in de huidige studies alleen gekeken werd naar de motivatie en de effectiviteit en efficiëntie voor leren, terwijl onduidelijk is of zelfgestuurd leren misschien invloed heeft gehad op zelfregulerend leren.

Student-gestuurde leeromgevingen worden steeds populairder en zijn er op gericht om motivatie en leren te bevorderen (e.g., Baeten et al., 2010; Loyens & Rikers, 2011). Hoewel deze omgevingen elementen bevatten die een voordelig effect op motivatie en leren kunnen hebben, is het belangrijk om voor ogen te houden dat de meest optimale effecten behaald zullen worden wanneer er een goede balans is tussen studentverantwoordelijkheid en begeleiding vanuit de docent of leeromgeving.

References

A

Abidin, R. R., & Robinson, L. L. (2002). Stress, biases, or professionalism: What drives teachers' referral judgments of students with challenging behaviors? *Journal of Emotional and Behavioral Disorders*, *10*, 204-212. doi:10.1177/10634266020100040201

Ahmed, W., Van der Werf, G., Minnaert, A., & Kuyper, H. (2010). Students' daily emotions in the classroom: Intra-individual variability and appraisal correlates. *British Journal of Educational Psychology*, *80*, 583-597. doi:10.1348/000709910X498544

Ainley, M., Hidi, S., & Berndorff, D. (2002). Interest, learning, and the psychological processes that mediate their relationship. *Journal of Educational Psychology*, *94*, 545-561. doi:10.1037//0022-0663.94.3.545

Alfieri, L., Brooks, P. J., Aldrich, N. J., & Tenenbaum, H. R. (2011). Does discovery-based instruction enhance learning? *Journal of Educational Psychology*, *103*, 1-18. doi:10.1037/a0021017.supp

Altman, D. G., & Bland, J. M. (1994). Diagnostic tests 1: Sensitivity and specificity. *British Medical Journal*, *308*, 1552.

Alvidrez, J., & Weinstein, R. S. (1999). Early teacher perceptions and later student academic achievement. *Journal of Educational Psychology*, *91*, 731-746. doi:10.1037//0022-0663.91.4.731

Ames, C. (1992). Classroom: Goals, structures, and student motivation. *Journal of Educational Psychology*, *84*, 261-271. doi:10.1037/0022-0663.84.3.261

Anderson, J. (2009). Autonomielücken als soziale Pathologie; Ideologiekritik jenseits des Paternalismus [Autonomy gaps as social pathology: Ideologiekritik without paternalism]. In R. Forst, M. Saar, R. Jaeggi, & M. Hartmann (Eds.), *Sozialphiolosophie und Kritik*. (pp. 433-453). Frankfurt, Germany: Suhrkamp.

Araz, G., & Sungur, S. (2007). The interplay between cognitive and motivational variables in a problem-based learning environment. *Learning and Individual Differences*, *17*, 291-297. doi:10.1016/j.lindif.2007.04.003

Arbuckle, J. L. (2007). *Amos 16.0 user's guide*. Chicago: SPSS.

Assor, A., Kaplan, H., & Roth, G. (2002). Choice is good, but relevance is excellent: Autonomy-enhancing and suppressing teacher behaviours predicting students' engagement in schoolwork. *British Journal of Educational Psychology*, *72*, 261-278. doi:10.1348/000709902158883

Assor, A., Vansteenkiste, M., & Kaplan, A. (2009). Identified versus introjected approach and introjected avoidance motivations in school and in sports: The limited benefits of self-worth strivings. *Journal of Educational Psychology*, *101*, 482-497. doi:10.1037/a0014236

B

Baeten, M., Kyndt, E., Struyven, K., & Dochy, F. (2010). Using student-centered learning environments to stimulate deep approaches to learning: Factors encouraging or discouraging their effectiveness. *Educational Psychology Review*, *5*, 243-260. doi:10.1016/j.edurev.2010.06.001

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York, NY: Freeman.

Barbour, R. S. (2001). Checklists for improving rigour in qualitative research: A case of the tail wagging the dog? *British Medical Journal*, *322*, 1115-1117. doi:10.1136/bmj.322.7294.1115

Barrows, H. S. (1986). A taxonomy of problem-based learning methods. *Medical Education*, *20*, 481-486. doi:10.1111/j.1365-2923.1986.tb01386.x

Barrows, H. S. (1996). Problem-based learning in medicine and beyond: A brief overview. In L. Wilkerson & W. H. Gijselaers (Eds.), *New Directions in Teaching and Learning: Issue 68. Bringing problem-based* learning to higher education: Theory and practice* (pp. 3-12). San Francisco, CA: Jossey-Bass. doi:10.1002/tl.37219966804

Bates, C., & Nettelbeck, T. (2001). Primary school teachers' judgements of reading achievement. *Educational Psychology*, *21*, 177-187. doi:10.1080/01443410020043878

Begeny, J. C., Eckert, T. L., Montarello, S. A., & Storie, M. S. (2008). Teachers' perceptions of students' reading abilities: An examination of the relationship between teachers' judgments and students' performance across a continuum of rating methods. *School Psychology Quarterly*, *23*, 43-55. doi:10.1037/1045-3830.23.1.43

Belmont, M., Skinner, E., Wellborn, J., & Connell, J. (1988). *Teacher as social context: A measure of student perceptions of teacher provision of involvement, structure, and autonomy support* (Tech. rep. no. 102). Rochester, NY: University of Rochester.

Bentler, P. M. (1990). Comparative fit indices in structural models. *Psychological Bulletin, 107*, 228-246. doi:10.1037/0033-2909.107.2.238

Berkson, L. (1993). Problem-based learning: Have the expectations been met? *Academic Medicine, 68*(Oct. suppl.), S79-S88. doi:10.1097/00001888-199310000-00053

Black, A. E., & Deci, E. L. (2000). The effects of instructors' autonomy support and students' autonomous motivation on learning organic chemistry: A self-determination theory perspective. *Science Education, 84*, 740-756. doi:10.1002/1098-237X(200011)84:6<740::AID-SCE4>3.0.CO;2-3

Bliese, P. D. (2000). Within-group agreement, non-independence, and reliability: Implications for data aggregations and analysis. In K. J. Klein & S. W. Kozlowski (Eds.), *Multilevel theory, research, and methods in organizations* (pp. 349-381). San Francisco, CA: Jossey-Bass.

Blumberg, P. (2000). Evaluating the evidence that problem-based learners are self-directed learners: A review of the literature. In D. H. Evensen & C. E. Hmelo (Eds.), *Problem-based learning: A research perspective on learning interactions* (pp. 199-226). Mahwah, NJ: Lawrence Erlbaum.

Blumenfeld, P. C. (1992). Classroom learning and motivation: Clarifying and expanding goal theory. *Journal of Educational Psychology, 84*, 272-281. doi:10.1037/0022-0663.84.3.272

Bramesfeld, K. D., & Gasper, K. (2008). Happily putting the pieces together: A test of two explanations for the effects of mood on group-level information processing. *British Journal of Social Psychology*, *47*, 285-309. doi:10.1348/000712607X218295

Bråten, I., & Olaussen, B. S. (1998). The learning and study strategies of Norwegian first-year college students. *Learning and Individual Differences*, *10*, 309-327. doi:10.1016/S1041-6080(99)80125-3

Bråten, I., Strømsø, H. I., & Salmerón, L. (2011). Trust and mistrust when students read multiple information sources about climate change. *Learning and Instruction*, *21*, 180-192. doi:10.1016/j.learninstruc.2010.02.002

Braxton, J. M., Milem, J. F., & Sullivan, A. S. (2000). The influence of active learning on the college student departure process: Toward a revision of Tinto's theory. *The Journal of Higher Education*, *71*, 569-590. doi:10.2307/2649260

Brehm, S. S., Kassin, S. M., & Fein, S. (2002). *Social psychology* (2nd ed.). Boston, MA: Houghton Mifflin.

Brown, S. W., Lawless, K. A., & Boyer, M. A. (2013). Promoting positive academic dispositions using a web-based PBL environment: The GlobalEd 2 Project. *Interdisciplinary Journal of Problem-Based Learning*, *7*, 67-90. doi:10.7771/1541-5015.1389

Budé, L., Van de Wiel, M. W. J., Imbos, T., & Berger, M. P. F. (2011). The effect of directive tutor guidance on students' conceptual understanding of statistics in problem-based learning. *British Journal of Educational Psychology*, *81*, 309-324. doi:10.1348/000709910X513933

Byrne, B. M. (2001). *Structural equation modeling with Amos. Basic concepts, applications, and programming.* Mahwah, NJ: Lawrence Erlbaum.

C

Candy, P. C. (1991). *Self-direction for lifelong learning: A comprehensive guide to theory and practice.* San Francisco, CA: Jossey-Bass.

Cano, F. (2006). An in-depth analysis of the Learning and Study Strategies Inventory (LASSI). *Educational and Psychological Measurement*, *66*, 1023-1038. doi:10.1177/0013164406288167

Central Bureau for Statistics. (2009). *Jaarboek onderwijs in cijfers [Yearbook education in figures]*. Voorburg, the Netherlands: CBS.

Central Bureau for Statistics. (2011). *WO; gemiddelde studieduur van afgestudeerden [Academic Education; average study times of graduates]*. Retrieved from CBS StatLine: http://statline.cbs.nl/StatWeb/publication/?VW=T&DM=SLNL&PA= 71073NED&D1=a&D2=1&D3=0-1,3,7,12,18,22,25,28,33&D4=0&D5=0&D6= 1&D7=a&D8=l&HD=100322-1158&HDR=G7,G1,G3,G4,T&STB=G6,G5,G2

Cheung, G. W., & Rensvold, R. B. (1999). Testing factorial invariance across groups: A reconceptualization and proposed new model. *Journal of Management*, *25*, 1-27. doi:10.1177/014920639902500101

Chi, M. T. H. (1997). Quantifying qualitative analyses of verbal data: A practical guide. *The Journal of the Learning Sciences*, *6*, 271-315. doi:10.1207/s15327809jls0603_1

Clark, R. E., Kirschner, P. A., & Sweller, J. (2012). Putting students on the path to learning: The case for fully guided instruction. *American Educator, 36*(1), 6-11.

Coladarci, T. (1986). Accuracy of teacher judgments of student responses to standardized test items. *Journal of Educational Psychology*, *78*, 141-146. doi:10.1037%2F0022-0663.78.2.141

Cooper, G., & Sweller, J. (1987). Effects of schema acquisition and rule automation on mathematical problem-solving transfer. *Journal of Educational Psychology*, *79*, 347-362. doi:10.1037/0022-0663.79.4.347

Cowan, N. (2001). The magical number 4 in short-term memory: A reconsideration of mental storage capacity. *Behavioral & Brain Sciences*, *24*, 87-114. doi:10.1017/S0140525X01003922

D

Dahlgren, M. A., & Dahlgren, L. O. (2002). Portraits of PBL: Students' experiences of the characteristics of problem-based learning in physiotherapy, computer engineering and psychology. *Instructional Science*, *30*, 111-127. doi:10.1023/A:1014819418051

Deary, I. J., Strand, S., Smith, P., & Fernandes, C. (2007). Intelligence and educational achievement. *Intelligence*, *35*, 13-21. doi:10.1016/j.intell.2006.02.001

De Boer, H., Bosker, R. J., & Van der Werf, M. P. C. (2010). Sustainability of teacher expectation bias effects on long-term student performance. *Journal of Educational Psychology*, *102*, 168-179. doi:10.1037/a0017289

Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic rewards and intrinsic motivation in education: Reconsidered once again. *Review of Educational Research*, *71*, 1-27. doi:10.3102/00346543071001001

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior.* New York, NY: Plenum Press.

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11*, 227-268. doi:10.1207/S15327965PLI1104_01

Deci, E. L., & Ryan, R. M. (2008a). Facilitating optimal motivation and psychological well-being across life's domains. *Canadian Psychology*, *49*, 14-23. doi:10.1037/0708-5591.49.1.14

Deci, E. L., & Ryan, R. M. (2008b). Self-determination theory: A macrotheory of human motivation, development, and health. *Canadian Psychology*, *49*, 182-185. doi:10.1037/a0012801

De Grave, W. S., Dolmans, D. H. J. M., & Van der Vleuten, C. P. M. (2002). Student perspectives on critical incidents in the tutorial group. *Advances in Health Sciences Education*, *7*, 201-209. doi:10.1023/A:1021104201303

De Koning, B. B., & Loyens, S. M. M. (2011). Generation Psy, studentfactoren en studiesucces [Generation Psy, student characteristics and study success]. In *Studiesucces in de bachelor. Drie onderzoeken naar factoren die studiesucces in de bachelor verklaren [Study success in the bachelor's program: Three studies on the factors that can explain study succes in the bachelor's program]* (pp. 8-58). Den Haag, Nederland: Ministerie van Onderwijs, Cultuur en Wetenschap.

De Koning, B. B., Loyens, S. M. M., Rikers, R. M. J. P., Smeets, G., & Van der Molen, H. T. (2012). Generation Psy: Student characteristics and academic achievement in a three-year problem-based learning bachelor program. *Learning and Individual Differences*, *22*, 313-323. doi:10.1016/j.lindif.2012.01.003

De Koning, B. B., Loyens, S. M. M., Rikers, R. M. J. P., Smeets, G., Van der Molen, H. T. (2014). Impact of binding study advice on study behavior and pre-university education qualification factors in a problem-based psychology bachelor program. *Studies in Higher Education*, *39*, 835-847. doi:10.1080/03075079.2012.754857

Demaray, M. K., & Elliott, S. N. (1998). Teachers' judgment of student academic functioning: A comparison of actual and predicted performances. *School Psychology Quarterly*, *13*, 8-24. doi:10.1037/h0088969

Derous, E., & Ryan, A. M. (2008). When earning is beneficial for learning: The relation of employment and leisure activities to academic outcomes. *Journal of Vocational Behavior*, *73*, 118-131. doi:10.1016/j.jvb.2008.02.003

Diener, E., Suh, E. M., Lucas, R. E., & Smith, H. L. (1999). Subjective well-being: Three decades of progress. *Psychological Bulletin*, *125*, 276-302. doi:10.1037/0033-2909.125.2.276

Do, S. L., & Schallert, D. L. (2004). Emotions and classroom talk: Toward a model of the role of affect in students' experiences in classroom discussions. *Journal of Educational Psychology*, *96*, 619-634. doi:10.1037/0022-0663.96.4.619

Dochy, F., Segers, M., Van den Bossche, P., & Gijbels, D. (2003). Effects of problem-based learning: A meta-analysis. *Learning and Instruction*, *13*, 533-568. doi:10.1016/S0959-4752(02)00025-7

Dolmans, D. H. J. M., Gijselaers, W. H., Moust, J. H. C., De Grave, W. S., Wolfhagen, I. H. A. P., & Van der Vleuten, C. P. M. (2002). Trends in research on the tutor in problem-based learning: Conclusions and implications for educational practice and research. Medical Teacher, 24, 173-180. doi:10.1080/01421590220125277

Dolmans, D. H. J. M., Wolfhagen, I. H. A. P., Van der Vleuten, C. P. M., & Wijnen, W. H. F. W. (2001). Solving problems with group work in problem-based learning: Hold on to the philosophy. *Medical Education, 35*, 884-889. doi:10.1046/j.1365-2923.2001.00915.x

Donche, V., De Maeyer, S., Coertjens, L., Van Daal, T., & Van Petegem, P. (2013). Differential use of learning strategies in first-year higher education: The impact of personality, academic motivation, and teaching strategies. *British Journal of Educational Psychology*, *83*, 238-251. doi:10.1111/bjep.12016

Downing, K., Kwong, T., Chan, S.-W., Lam, T.-F., & Downing, W.-K. (2009). Problem-based learning and development of metacognition. *Higher Education*, *57*, 609-621. doi:10.1007/s10734-008-9165-x

Duke, M., Forbes, H., Hunter, S., & Prosser, M. (1998). Problem-based learning (PBL): Conceptions and approaches of undergraduate students of nursing. *Advances in Health Sciences Education*, *3*, 59-70. doi:10.1023/A:1009763324321

Dunlap, J. C. (2005). Problem-based learning and self-efficacy: How a capstone course prepares students for a profession. *Educational Technology Research and Development*, *53*, 65-85. doi:10.1007/BF02504858

Dweck, C. S., & Leggett, C. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, *95*, 256-273. doi:10.1037//0033-295X.95.2.256

E

Eccles, J. (1983). Expectancies, values and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motives* (pp. 75-146). San Francisco, CA: Freeman.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53*, 109-132. doi:10.1146/annurev.psych.53.100901.135153

Eckert, T. L., Dunn, E. K., Codding, R. S., Begeny, J. C., & Kleinmann, A. E. (2006). Assessment of mathematics and reading performance: An examination of the correspondence between direct assessment of student performance and teacher report. *Psychology in the Schools, 43*, 247-265. doi:10.1002/pits.20147

Educational Inspectorate. (2009). *Uitval en rendement in hoger onderwijs: Achtergrondrapport bij 'werken aan een beter rendement' [Dropout and success rates in higher education: Back report on 'working on better success rates']*. Zoetermeer, the Netherlands: Educational Inspectorate.

Eisenstaedt, R. S., Barry, W. E., & Glanz, K. (1990). Problem-based learning: Cognitive retention and cohort traits of randomly selected participants and decliners. *Academic Medicine, 65*(9, September suppl), 11-12. doi:10.1097/00001888-199009000-00020

Elliot, A. J., & McGregor, H. A. (2001). A 2x2 achievement goal framework. *Journal of Personality and Social Psychology*, *80*, 501-519. doi:10.1037/0022-3514.80.3.501

Enders, C. K., & Tofighi, D. (2007). Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. *Psychological Methods, 12*, 121-138. doi:10.1037/1082-989X.12.2.121

F

Feinberg, A. B., & Shapiro, E. S. (2003). Accuracy of teacher judgments in predicting oral reading fluency. *School Psychology Quarterly*, *18*, 52-65. doi:10.1521/scpq.18.1.52.20876

Feinberg, A. B., & Shapiro, E. S. (2009). Teacher accuracy: An examination of teacher-based judgments of students' reading with differing achievement levels. *Journal of Educational Research*, *102*, 453-462. doi:10.3200/JOER.102.6.453-462

Feldman, R. S. (2001). *Social psychology* (2nd ed.). Upper Saddle River, NJ: Prentice Hall.

Field, A. P. (2009). *Discovering statistics using SPSS: And sex and drugs and rock 'n' roll.* London: Sage Publications.

Fischbach, A., Baudson, T. G., Preckel, F., Martin, R., & Brunner, M. (2013). Do teacher judgments of student intelligence predict life outcomes? *Learning and Individual Differences*, *27*, 109-119. doi:10.1016/j.lindif.2013.07.004

Fleiss, J. (1986). *The design and analysis of clinical experiments*. New York, NY: John Wiley & Sons. doi:10.1002/9781118032923

Flynn, J. M., & Rahbar, M. H. (1998). Improving teacher prediction of children at risk for reading failure. *Psychology in the School*, *35*, 163-172. doi:10.1002/(SICI)1520-6807(199804)35:2<163::AID-PITS8>3.0.CO;2-Q

Fortier, M. S., Vallerand, R. J., & Guay, F. (1995). Academic motivation and school performance: Toward a structural model. *Contemporary Educational Psychology*, *20*, 257-274. doi:10.1006/ceps.1995.1017

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, *74*, 59-109. doi:10.3102/00346543074001059

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology. *American Psychologist, 56*, 218-226. doi:10.1037//0003-066X.56.3.218

Furrer, C., & Skinner, E. (2003). Sense of relatedness as a factor in children's academic engagement and performance. *Journal of Educational Psychology, 95*, 148-162. doi:10.1037/0022-0663.95.1.148

G

Gagné, F., & St Père, F. (2001). When IQ is controlled, does motivation still predict achievement? *Intelligence*, *30*, 71-100. doi:10.1016/s0160-2896(01)00068-x

Galand, B., Raucent, B., & Frenay, M. (2010). Engineering students' self-regulation, study strategies, and motivational beliefs in traditional and problem-based curricula. *International Journal of Engineering Education*, *26*, 523-534.

Georg, W. (2009). Individual and institutional factors in the tendency to drop out of higher education: A multilevel analysis using data from the Konstanz Student Survey. *Studies in Higher Education*, *34*, 647-661. doi:10.1080/03075070802592730

George, D., & Mallery, P. (2007). *SPSS for Windows step by step: A simple guide and reference. 14.0 update*. Boston, MA: Allyn & Bacon.

Gerber, M. M., & Semmel, M. J. (1984). Teacher as imperfect test: Reconceptualizing the referral process. *Educational Psychologist*, *19*, 137-148. doi:10.1080/00461528409529290

Gijbels, D., Dochy, F., Van den Bossche, P., & Segers, M. (2005). Effects of problem-based learning: A meta-analysis from the angle of assessment. *Review of Educational Research*, *75*, 27-61. doi:10.3102/00346543075001027

Gijsel, M. A. R., Bosman, A. M. T., & Verhoeven, L. (2006). Kindergarten risk factors, cognitive factors, and teacher judgments as predictors of early reading in Dutch. *Journal of Learning Disabilities*, *39*, 558-571. doi:10.1177/00222194060390060701

Gijselaers, W. H., & Schmidt, H. G. (1990). Development and evaluation of a casual model of problem-based learning. In Z. M. Noorman, H. G. Schmidt, & E. S. Ezzat (Eds.), *Innovation in medical education: An evaluation of its present status* (pp. 95-113). New York: Springer Publications.

Givvin, K. B., Stipek, D. J., Salmon, J. M., & MacGyvers, V. L. (2001). In the eyes of the beholder: Students' and teachers' judgments of students' motivation. *Teaching and Teacher Education*, *17*, 321-331. doi:10.1016/s0742-051x(00)00060-3

Gresham, F. M., Macmillan, D. L., & Bocian, K. M. (1997). Teachers as "tests": Differential validity of teacher judgments in identifying students at-risk for learning difficulties. *School Psychology Review*, *26*, 47-60.

Guay, F., Ratelle, C. F., & Chanal, J. (2008). Optimal learning in optimal contexts: The role of self-determination in education. *Canadian Psychology*, *49*, 233-240. doi:10.1037/a0012758

H

Hancock, G. R. (2003). Fortune cookies, measurement error, and experimental design. *Journal of Modern Applied Statistical Methods*, *2*, 293-305.

Harackiewicz, J. M., Barron, K. E., Tauer, J. M., & Elliot, A. J. (2002). Predicting success in college: A longitudinal study of achievement goals and ability measures as predictors of interest and performance from freshman year through graduation. *Journal of Educational Psychology*, *94*, 562-575. doi:10.1037//0022-0663.94.3.562

Heck, R. H., Thomas, S. L., & Tabata, L. N. (2012). *Multilevel modeling of categorical outcomes using IBM SPSS*. New York, NY: Routledge.

Hendry, G. D., Ryan, G., & Harris, J. (2003). Group problems in problem-based learning. *Medical Teacher*, *25*, 609-616. doi:10.1080/0142159031000137427

Hewstone, M., Stroebe, W., & Klaus, J. (2007). *Introduction to social psychology: A European perspective* (4th revised ed.). Malden, MA: Blackwell.

Hidi, S. (2006). Interest: A unique motivation variable. *Educational Research Review*, *1*, 69-82. doi:10.1016/j.edurev.2006.09.001

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist*, *41*, 111-127. doi:10.1207/s15326985ep4102_4

Hinnant, J. B., O'Brien, M., & Ghazarian, S. R. (2009). The longitudinal relations of teacher expectations to achievement in the early school teachers. *Journal of Educational Psychology, 101*, 662-670. doi:10.1037/a0014306

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review*, *16*, 235-266. doi:10.1023/B:EDPR.0000034022.16470.f3

Hoge, R. D., & Coladarci, T. (1989). Teacher-based judgments of academic achievement: A review of literature. *Review of Educational Research*, *59*, 297-313. doi:10.3102/00346543059003297

Hogg, M. A., & Vaughan, G. M. (2002). *Social psychology* (2nd ed.). Harlow, England: Prentice Hall.

Hox, J. (2010). *Multilevel analysis: Techniques and applications* (2nd ed.). East Sussex, UK: Routledge.

Hovdhaugen. E. (2009). Transfer and dropout: Different forms of student departure in Norway. *Studies in Higher Education*, *34*, 1-17. doi:10.1080/03075070802457009

Hwang, S. Y., & Kim, M. J. (2006). A comparison of problem-based learning in an adult health nursing course. *Nurse Education Today*, *26*, 315-321. doi:10.1016/j.nedt.2005.11.002

I

Impara, J. C., & Plake, B. S. (1998). Teachers' ability to estimate item difficulty: A test of the assumptions in the Angoff standard setting method. *Journal of Educational Measurement, 35*, 69-81. doi:10.1111/j.1745-3984.1998.tb00528.x

J

Jang, H., Reeve, J., & Deci, E. L. (2010). Engaging students in learning activities: It is not autonomy support or structure but autonomy support and structure. *Journal of Educational Psychology*, *102*, 588-600. doi:10.1037/a0019682

Jansen, E. P. W. A. (2004). The influence of the curriculum organization on study progress in higher education. *Higher Education*, *47*, 44-435. doi:10.1023/B:HIGH.0000020868.39084.21

Jansen, E. P. W. A., & Bruinsma, M. (2005). Explaining achievement in higher education. *Educational Research and Evaluation*, *11*, 235-252. doi:10.1080/13803610500101173

Jeong, H., & Hmelo-Silver, C. E. (2010). Productive use of learning resources in an online problem-based learning environment. *Computers in Human Behavior*, *26*, 84-99. doi:10.1016/j.chb.2009.08.001

Jonassen, D. H. (1997). Instructional design models for well-structured and ill-structured problem-solving learning outcomes. *Educational Technology Research and Development*, *45*, 65-94. doi:10.1007/BF02299613

Jussim, L. (1991). Social perception and social reality: A reflection-construction model. *Psychological Review*, *98*, 54-73. doi:10.1037//0022-3514.57.3.469

Jussim, L., & Harber, K. D. (2005). Teacher expectations and self-fulfilling prophecies: Knowns and unknowns, resolved and unresolved controversies. *Personality and Social Psychology Review*, *9*, 131-155. doi:10.1207/s15327957pspr0902_3

K

Kaiser, J., Retelsdorf, J., Südkamp, A., & Möller, J. (2013). Achievement and engagement: How student characteristics influence teacher judgments. *Learning and Instruction*, *28*, 73-84. doi:10.1016/j.learninstruc.2013.06.001

Kalyuga, S., & Sweller, J. (2014). The redundancy principle in multimedia learning. In R. E. Mayer (Ed.), *Cambridge handbook of multimedia learning* (pp. 247-262, 2nd revised ed.). New York: Cambridge University Press.

Kaplan, A. (2010, May). Discussant. In E. A. Patall (Chair), *Autonomy support: Identifying the essential components and motivational benefits*. Symposium conducted at the meeting of the American Educational Research Association, Denver, Colorado.

Kaplan, A., & Maehr, M. L. (2007). The contributions and prospects of goal orientation theory. *Educational Psychology Review*, *19*, 141-184. doi:10.1007/s10648-006-9012-5

Kappe, R., & Van der Flier, H. (2012). Predicting academic success in higher education: What's more important than being smart? *European Journal of Psychology of Education*, *27*, 605-619. doi:10.1007/s10212-011-0099-9

Katz, I., & Assor, A. (2007). When choice motivates and when it does not. *Educational Psychology Review*, *19*, 429-442. doi:10.1007/s10648-006-9027-y

Kaufman, D. M., & Hansell, M. M. (1997). Can non-expert PBL tutors predict their students' achievement? An exploratory study. *Academic Medicine, 72*(Suppl. 1), S16-S18. doi:10.1097/00001888-199710001-00006

Kember, D. (2009). Promoting student-centred forms of learning across an entire university. *Higher Education*, *58*, 1-13. doi:10.1007/s10734-008-9177-6

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, *41*, 75-86. doi:10.1207/s15326985sep4102_1

Kitzinger, J. (1995). Qualitative research: Introducing focus groups. *British Medical Journal*, *311*, 299-302. doi:10.1136/bmj.311.7000.299

Kline, R. N. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York, NY: Guilford Press.

Kostons, D., Van Gog, T., & Paas, F. (2012). Training self-assessment and task selection skills: A cognitive approach to improving self-regulated learning. *Learning and Instruction*, *22*, 121-132. doi:10.1016/j.learninstruc.2011.08.004

Krapp, A. (2002). Structural and dynamic aspects of interest development: Theoretical considerations from an ontogenetic perspective. *Learning and Instruction*, *12*, 383-409. doi:10.1016/S0959-4752(01)00011-1

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory Into Practice*, *41*, 212-218. doi:10.1207/s15430421tip4104_2

Kuh, G. D., Cruce, T. M., Shoup, R., Kinzie, J., & Gonyea, R. M. (2008). Unmasking the effects of student engagement of first-year college grades and persistence. *The Journal of Higher Education*, *79*, 540-563. doi:10.1353/jhe.0.0019

L

Lacante, M., & Lens, W. (2005). *Nederlandse aanpassing van de Weinstein-Palmer LASSI-scales [Dutch adaptation of the Weinstein-Palmer LASSI-scales]*. Unpublished research paper. University of Leuven, Department of Psychology. Leuven, Belgium.

Lammers, W. J., & Murphy, J. J. (2002). A profile of teaching techniques used in the university classroom. *Active Learning in Higher Education*, *3*, 54-67. doi:10.1177/1469787402003001005

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, *33*, 159-174. doi:10.2307/2529310

Leary, H., Walker, A., Shelton, B. E., & Fitt, M. H. (2013). Exploring the relationship between tutor background, tutor training, and student learning: A problem-based learning meta-analysis. *Interdisciplinary Journal of Problem-Based Learning*, *7*, 40-66. doi:10.7771/154-5015.1331

Le Bigot, L., & Rouet, J.-F. (2007). The impact of presentation format, task assignment, and prior knowledge on students' comprehension of multiple online documents. *Journal of Literacy Research*, *39*, 445-470. doi:10.1080/10862960701675317

Leppink, J., Broers, N. J., Imbos, T., Van der Vleuten, C. P. M., & Berger, M. P. F. (2013). The effect of guidance in problem-based learning statistics. *The Journal of Experimental Education*, *82*, 391-407. doi:10.1080/00220973.2013.813365

Linnenbrink, E. A. (2007). The role of affect in student learning: A multi-dimensional approach to considering the interaction of affect, motivation, and engagement. In P. A. Schutz & R. Pekrun (Eds.), *Emotion in education* (pp. 107-114). San Diego, CA: Elsevier Academic Press.

Linnenbrink-Garcia, L., Rogat, T. K., & Koskey, K. L. K. (2011). Affect and engagement during small group instruction. *Contemporary Educational Psychology*, *36*, 13-24. doi:10.1016/j.cedpsych.2010.09.001

Litalien, D., Lüdtke, O., Parker, P., & Trautwein, U. (2013). Different pathways, same effects: Autonomous goal regulation is associated with subjective well-begin during post-school transition. *Motivation and Emotion*, *33*, 444-456. doi:1007/211031-012-9328-z

Liu, M., Hsieh, P., Cho, Y., & Schallert, D. L. (2006). Middle school students' self-efficacy, attitudes, and achievement in a computer-enhanced problem-based learning environment. *Journal of Interactive Learning Research*, *17*, 225-242.

Loewenstein, G. (1994). The psychology of curiosity: A review and reinterpretation. *Psychological Bulletin*, *116*, 75-98. doi:10.1037/0033-2909.116.1.75

Loyens, S. M. M. (2005). *First-year students' reasons for choosing their place of study.* Unpublished interview.

Loyens, S. M. M., Gijbels, D., Coertjens, L., & Côté, D. J. (2013). Students' approaches to learning in problem-based learning: Taking into account professional behavior in tutorial groups, self-study time, and different assessment aspects. *Studies in Educational Evaluation*. *39*, 23-32. doi:10.1016/j.stueduc.2012.10.004

Loyens, S. M. M., Kirschner, P. A., & Paas, F. (2012). Problem-based learning. In K. R. Harris, S. Graham, & T. Urdan (Eds.), *APA Educational Psychology Handbook: Vol 3. Applications to learning and teaching* (pp. 403-425). Washington: DC: American Psychological Association. doi:10.1037/13725-016

Loyens, S. M. M., Magda, J., & Rikers, R. M. J. P. (2008). Self-directed learning in problem-based learning and its relationships with self-regulated learning. *Educational Psychology Review*, *20*, 411-427. doi:10.1007/s10648-008-9082-7

Loyens, S. M. M., & Rikers, R. M. J. P. (2011). *Instruction based on inquiry.* In R. E. Mayer & P. A. Alexander (Eds.), Handbook of research on learning and instruction (pp. 361-381). New York: NY: Routledge.

Loyens, S. M. M., Rikers, R. M. J. P., & Schmidt, H. G. (2006). Students' conceptions of constructivist learning: A comparison between a traditional and a problem-based learning curriculum. *Advances in Health Sciences Education*, *11*, 365-379. doi:10.1007/s10459-006-9015-5

Loyens, S. M. M., Rikers, R. M. J. P., & Schmidt, H. G. (2007a). The impact of students' conceptions of constructivist assumptions on academic achievement and drop-out. *Studies in Higher Education*, *32*, 581-602. doi:10.1080/03075070701573765

Loyens, S. M. M., Rikers, R. M. P. J., & Schmidt, H. G. (2007b). Students' conceptions of distinct constructivist assumptions. *European Journal of Psychology of Education*, *22*, 179-199. doi:10.1007/BF03173521

Loyens, S. M. M., Rikers, R. M. J. P., & Schmidt, H. G. (2009). Students' conceptions of constructivist learning in different programme years and different learning environments. *British Journal of Educational Psychology*, *79*, 501-514. doi:10.1348/000709908X378117

M

Maehr, M. L., & Zusho, A. (2009). Achievement goal theory: The past, present, and future. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 77-104). New York, NY: Routledge.

Mac Iver, D. J., Stipek, D. J., & Daniels, D. H. (1991). Explaining within-semester changes in student effort in junior high school courses. *Journal of Educational Psychology*, *83*, 201-211. doi:10.1037/0022-0663.83.2.201

MacKinnon, D. P., Lockwood, C. M., & Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research*, *39*, 99-128. doi:10.1207/s15327906mbr3901_4

Martens, B. K., & Witt, J. C. (2004). Competence, persistence, and success: The positive psychology of behavioral skill instruction. *Psychology in the Schools*, *41*, 19-30. doi:10.1002/pits.10135

Martin, A. J. (2004). School motivation of boys and girls: Differences of degree, differences of kind, or both? *Australian Journal of Psychology*, *56*, 133-146. doi:10.1080/00049530412331283363

Martin, L., West, J., & Bill, K. (2008). Incorporating problem-based learning strategies to develop learner autonomy and employability skills in sports science undergraduates. *Journal of Hospitality, Leisure, Sport & Tourism Education*, *7*, 18-30. doi:10.3794/johlste.71.169

Mason, L., Gava, M., & Boldrin, A. (2008). On warm conceptual change: The interplay of text, epistemological beliefs, and topic interest. *Journal of Educational Psychology*, *100*, 291-309. doi:10.1037/0022-0663.100.2.291

Mayer, R. E., & Wittrock, M. C. (2006). Problem solving. In P. A. Alexander & P. H. Winne (Eds.), *Handbook of Educational Psychology* (pp. 287-303). Mahwah, NJ: Lawrence Erlbaum Associates.

McHarg, J., Bradley, P., Chamberlain, S., Ricketts, C., Searle, J., & McLachlan, J. C. (2005). Assessment of progress tests. *Medical Education*, *39*, 221-227. doi:10.1111/j.1365-2929.2004.02060.x

Meeuwisse, M., Severiens, S. E., & Born, M. Ph. (2010). Reasons for withdrawal from higher vocational education. A comparison of ethnic minority and majority non-completers. Studies in Higher Education, 35, 93-111. doi:10.1080/03075070902906780

Meisels, S. J., Bickel, D. P., Nicholson, J., Xue, Y., & Atkins-Burnett, S. (2001). Trusting teachers' judgments: A validity study of a curriculum-embedded performance assessment in kindergarten to grade 3. *American Educational Research Journal*, *38*, 73-95. doi:10.3102/00028312038001073

Miflin, B. M., Campbell, C. B., & Price, D. A. (1999). A lesson from the introduction of a problem-based, graduate entry course: The effects of different views of self-direction. *Medical Education*, *33*, 801-807. doi:10.1046/j.1365-2923.1999.00399.x

Miflin, B. M., Campbell, C. B., & Price, D. A. (2000). A conceptual framework to guide the development of self-directed, lifelong learning in problem-based medical curricula. *Medical Education*, *34*, 299-306. doi:10.1046/j.1365-2923.2000.00564.x

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, *63*, 81-97. doi:10.1037/0033-295X.101.2.343

Moust, J. (1993). *De rol van tutoren in probleemgestuurd onderwijs: contrasten tussen student- en docent-tutoren [The role of tutors in problem-based learning: Contrasts between undergraduate teaching assistants and faculty]* (Unpublished doctoral dissertation). University of Maastricht, Maastricht, the Netherlands.

Moust, J. H. C., Van Berkel, H. J. M., & Schmidt, H. G. (2005). Signs of erosion: Reflections on three decades of problem-based learning at Maastricht University. *Higher Education*, *50*, 665-683. doi:10.1007/s10734-004-6371-z

Murphy, P. K., & Alexander, P. A. (2000). A motivated exploration of motivation terminology. *Contemporary Educational Psychology*, *25*, 3-53. doi:10.1006/ceps.1999.1019

Muthén. L. K., & Muthén, B. O. (2010). *Mplus user's guide* (6th ed.). Los Angeles, CA: Muthén & Muthén.

N

Newman, M. (2006). Fitness for purpose evaluation in problem based learning should consider the requirements for establishing descriptive causation. *Advances in Health Sciences Education*, *11*, 391-402. doi:10.1007/s10459-006-9017-3

Niemiec, C. P., Lynch, M. F., Vansteenkiste, M., Bernstein, J., Deci, E. L., & Ryan, R. M. (2006). The antecedents and consequences of autonomous self-regulation for college: A self-determination theory perspective on socialization. *Journal of Adolescence*, *29*, 761-775. doi:10.1016/j.adolescence.2005.11.009

Nievelstein, F., Van Gog, T., Van Dijck, G., & Boshuizen, H. P. A. (2011). Instructional support for novice law students: Reducing search processes and explaining concepts in cases. *Applied Cognitive Psychology*, *25*, 408-413. doi:10.1002/acp.1707

Nievelstein, F., Van Gog, T., Van Dijck. G., & Boshuizen, H. P. A. (2013). The worked example and expertise reversal effect in less structured tasks: Learning to reason about legal cases. *Contemporary Educational Psychology*, *38*, 118-125. doi:10.1016/j.cedpsych.2012.12.004

Nix, G. A., Ryan, R. M., Manly, J. B., & Deci, E. L. (1999). Revitalization through self-regulation: The effects of autonomous and controlled motivation on happiness and vitality. *Journal of Experimental Social Psychology*, *35*, 266-284. doi:10.1006/jesp.1999.1382

Noels, K. A., Pelletier, L. G., Clément. R., & Vallerand, R. J. (2003). Why are you learning a second language? Motivational orientations and self-determination theory. *Language Learning*, *53*, 33-63. doi:10.1111/1467-9922.53223

Noordzij, G., & Te Lindert, A. (2010, May). *The effects of goal orientation and quality of problems on students' motivation in a problem based learning environment*. Poster presented at the Self-Determination Theory conference, Gent, Belgium.

Noordzij, G., & Wijnia, L. (2014). *The effects of quality of problems on students' motivation.* Manuscript in preparation.

Norman, G. R., & Schmidt, H. G. (1992). The psychological basis of problem-based learning: A review of the evidence. *Academic Medicine*, *67*, 557-565. doi:10.1097/00001888-199209000-00002

O

Organisation for Economic Co-Operation and Development. (2010). *Education at a glance 2010: OECD indicators.* Paris: Organisation for Economic Cooperation and Development.

Organisation for Economic Co-Operation and Development. (2013). *Education at a glance 2013: OECD indicators.* Paris: OECD Publishing. http://dx.doi.org/10.1787/eag-2013-en

P

Paas, F. (1992). Training strategies for attaining transfer of problem-solving skill in statistics: A cognitive-load approach. *Journal of Educational Psychology*, *84*, 429-434. doi:10.1037/0022-0663.84.4.429

Papinczak, T., Young, L., Groves, M., & Haynes, M. (2008). Effects of a metacognitive intervention on students' approaches to learning and self-efficacy in a first year medical course. *Advances in Health Sciences Education*, *13*, 213-232. doi:10.10007/s10459-006-9036-0

Patall, E. A., Cooper, H., & Robinson, C. (2008). The effects of choice on intrinsic motivation and related outcomes: A meta-analysis of research findings. *Psychological Bulletin*, *134*, 270-300. doi:10.1037/0033-2909.134.2.270

Pedersen, S. (2003). Motivation orientation in a problem-based learning environment. *Journal of Interactive Learning Research*, *14*, 51-78.

Pekrun, R., & Linnenbrink-Garcia, L. (2012). Academic emotions and student engagement. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 259-292). New York, NY: Springer. doi:10.1007/978-1-4614-2018-7_12

Peterson, L. R., & Peterson, M. J. (1959). Short-term retention of individual verbal items. *Journal of Experimental Psychology*, *58*, 193-198. doi:10.1037/h0049234

Pintrich, P. R. (1999). The role of motivation in promoting and sustaining self-regulated learning. *International Journal of Educational Research, 31*, 459-470. doi:10.1016/S0883-0355(99)00015-4

Pintrich, P. R. (2003a). Motivation and classroom learning. In G. E. Miller & W. M. Reynolds (Eds.), *Handbook of psychology: Educational psychology* (Vol. 7, pp. 103-122). New York, NY: John Wiley & Sons.

Pintrich, P. R. (2003b). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational Psychology, 95*, 667-686. doi:10.1037/0022-0663.95.4.667

Pintrich, P. R., & Schunk, D. H. (2002). *Motivation in education: Theory, research, and applications.* Upper Saddle River, NJ: Prentice Hall Merrill.

Plant, E. A., Ericsson, A., Hill, L., & Asberg, K. (2005). Why study time does not predict grade point average across college students: Implications of deliberate practice for academic performance. *Contemporary Educational Psychology*, *30*, 96-116. doi:10.1016/j.cedpsych.2004.06.001

Poropat, A. E. (2009). A meta-analysis of the five-factor model of personality and academic performance. *Psychological Bulletin*, *135*, 322-338. doi:10.1037/a0014996

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, *40*, 879-891. doi:10.3758/BRM.40.3.879

R

Ratelle, C. F., Guay, F., Vallerand, R. J., Larose, S., & Senécal, C. (2007). Autonomous, controlled, and amotivated types of academic motivation: A person-oriented analysis. *Journal of Educational Psychology*, *99*, 734-746. doi:10.1037/0022-0663.99.4.734

Reeve, J. (2006). Extrinsic rewards and inner motivations. In C. M. Evertson & C. S. Weinstein (Eds.), *Handbook of classroom management: Research, practice, and contemporary issues* (pp. 645-664). Hillsdale, NJ: Lawrence Erlbaum.

Reeve, J. (2012). A self-determination theory perspective on student engagement. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 149-172). New York, NY: Springer. doi:10.1007/978-1-4614-2018-7_7

Reeve, J. (2013). How students create motivationally supportive learning environments for themselves: The concept of agentic engagement. *Journal of Educational Psychology*, *105*, 579-595. doi:10.1037/a0032690

Reeve, J., Deci, E. L., & Ryan, R. M. (2004). Self-determination theory: A dialectical framework for understanding sociocultural influences on student motivation. In D. M. McInerny & S. van Etten (Eds.), *Big theories revisited* (pp. 31-59). Greenwich, CT: Information Age Publishing.

Reeve, J., & Halusic, M. (2009). How K-12 teachers can put self-determination theory principles into practice. *Theory and Research in Education*, *7*, 145-154. doi:10.1177/1477878509104319

Reeve, J., & Tseng, C.-M. (2011). Agency as a fourth aspect of students' engagement during learning activities. *Contemporary Educational Psychology*, *36*, 257-267. doi:10.1016/j.cedpsych.2011.05.002

Renninger, K. A. (2000). Individual interest and its implications for understanding intrinsic motivation. In C. Sansone & J. M. Harackiewicz (Eds.), *Intrinsic and extrinsic motivation: The search for optimal motivation and performance* (pp. 373-404). San Diego, CA: Academic Press.

Richardson, M., Abraham, C., & Bond, C. (2012). Psychological correlates of university students' academic performance: A systematic review and meta-analysis. *Psychological Bulletin*, *138*, 353-387. doi:10.1037/a0026838

Rienties, B., Tempelaar, D., Van den Bossche, P., Gijselaers, W., & Segers, M. (2009). The role of academic motivation in computer-supported collaborative learning. *Computers in Human Behavior*, *25*, 1195-1206. doi:10.1016/j.chb.2009.05.012

Rotgans, J. I., & Schmidt, H. G. (2011a). The role of teachers in facilitating situational interest in an active-learning classroom. *Teaching and Teacher Education*, *27*, 37-42. doi:1016/j.tate.2010.06.025

Rotgans, J. I., & Schmidt, H. G. (2011b). Situational interest and academic achievement in the active-learning classroom. *Learning and Instruction*, *21*, 58-67. doi:10.1016/j.learninstruc.2009.11.001

Rotgans, J. I., & Schmidt, H. G. (2014). Situational interest and learning: Thirst for knowledge. *Learning and Instruction*, *32*, 37-50. doi:10.1016/j.learninstruc.2014.01.002

Rouet, J.-F., Favart, M., Britt, M. A., & Perfetti, C. A. (1997). Studying and using multiple documents in history: Effects of discipline expertise. *Cognition and Instruction*, *15*, 85-106. doi:10.1207/s1532690xci1501_3

Rourke, A., & Sweller, J. (2009). The worked-example effect using ill-defined problems: Learning to recognize designers' styles. *Learning and Instruction*, *19*, 185-199. doi:10.1016/j.learninstruc.2008.03.006

Rummel, N., & Spada, H. (2005). Learning to collaborate: An instructional approach to promoting collaborative problem solving in computer-mediated settings. *The Journal of the Learning Sciences*, *14*, 201-241. doi:10.1207/s15327809jls1402_2

Russell, J. A., & Carroll, J. M. (1999). On the bipolarity of positive and negative affect. *Psychological Bulletin*, *125*, 3-30. doi:10.1037/0033-2909.125.1.3

Ryan, A. M. (2000). Peer groups as a context for the socialization of adolescents' motivation, engagement, and achievement in school. *Educational Psychologist*, *35*, 101-111. doi:10.1207/S15326985EP3502_4

Ryan, R. M., & Deci, E. L. (2000a). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology, 25*, 54-67. doi:10.1006/ceps.1999.1020

Ryan, R. M., & Deci, E. L. (2000b). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*, 68-78. doi:10.1037/0003-066X.55.1.68

Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: A review of research on hedonic and eudaimonic well-being. *Annual Review of Psychology*, *52*, 141-166. doi:10.1146/annurev.psych.52.1.141

S

Schappe, J. F. (2005). Early childhood assessment: A correlational study of the relationships among student performance, student feelings, and teacher perceptions. *Early Childhood Educational Journal*, *33*, 187-193. doi:10.1007/s10643-005-0046-y

Schmidt, H. G. (1983a). Intrinsieke motivatie en studieprestatie: Enkele verkennende onderzoekingen [Intrinsic motivation and achievement: Some exploratory investigations]. *Pedagogische Studiën*, *60*, 385-395.

Schmidt, H. G. (1983b). Problem-based learning: Rationale and description. *Medical Education*, *17*, 11-16. doi:10.1111/j.1365-1983.tb01086.x

Schmidt, H. G. (2000). Assumptions underlying self-directed learning may be false. *Medical Education*, *34*, 243-245. doi:10.1046/j.1365-2923.2000.0656a.x

Schmidt, H. G., Cohen-Schotanus, J., Van der Molen, H. T., Splinter, T. A. W., Bulte, J., Holdrinet, R., & Van Rossum, H. J. M. (2010). Learning more by being taught less: A "time-for-self-study" theory explaining curricular effects on graduation rate and study duration. *Higher Education*, *60*, 287-300. doi:10.1007/s10734-009-9300-3

Schmidt, H. G., Loyens, S. M. M., Van Gog, T., & Paas, F. (2007). Problem-based learning is compatible with human architecture: Commentary on Kirschner, Sweller, and Clark (2006). *Educational Psychologist*, *42*, 91-97. doi:10.1080/00461520701263350

Schmidt, H. G., & Moust, J. H. C. (1995). What makes a tutor effective? A structural-equations modeling approach to learning in problem-based curricula. *Academic Medicine*, *70*, 708-714. doi:10.1097/00001888-199508000-00015

Schmidt, H. G., & Moust, J. H. C. (2000). Factors affecting small-group tutorial learning: A review of research. In D. H. Evensen & C. E. Hmelo (Eds.), *Problem-based learning: A research perspective on learning interactions* (pp. 19-52). Mahwah, NJ: Lawrence Erlbaum.

Schmidt, H. G., Rotgans, J. I., & Yew, E. H. J. (2011). The process of problem-based learning: What works and why. *Medical Education*, *45*, 792-806. doi:10.1111/j.1365-2923.2011.04035.x

Schmidt, H. G., Van der Molen, H. T., Te Winkel, W. W. R., & Wijnen, W. H. F. W. (2009). Constructivist, problem-based learning does work: A meta-analysis of curricular comparisons involving a single medical school. *Educational Psychologist*, *44*, 227-249. doi:10.1080/00461520903213592

Schraw, G., & Lehman, S. (2001). Situational interest: A review of the literature and directions for future research. *Educational Psychology Review*, *13*, 23-52. doi:10.1023/A:1009004801455

Schworm, A., & Renkl, A. (2007). Learning argumentation skills through the use of prompts for self-explaining examples. *Journal of Educational Psychology*, *99*, 285-296. doi:10.1037/0022-0663.99.2.285

Sheldon, K. M., & Elliot, A. J. (1999). Goal striving, need satisfaction, and longitudinal well-being: The self-concordance model. *Journal of Personality and Social Psychology*, *76*, 482-497. doi:10.1037/0022-3514.76.3.482

Sheldon, K. M. & Kasser, T. (1998). Pursuing personal goals: Skills enable progress, but not all progress is beneficial. *Personality and Social Psychology Bulletin*, *24*, 1319-1331. doi:10.1177/01461672982412006

Sheldon, K. M., Ryan, R. M., Deci, E. L., & Kasser, T. (2004). The independent effects of goal contents and motives on well-being: It's both what you pursue and why you pursue it. *Personality and Social Psychology Bulletin*, *30*, 475-486. doi:10.1177/0146167203261883

Sherif, M. (1966). *In common predicament.* Boston, MA: Houghton Mifflin.

Sierens, E., Soenens, B., Vansteenkiste, M., Goossens, L., & Dochy, F. (2006). De authoritatieve leerkrachtstijl: Een model voor de studie van leerkrachtstijlen [The authoritative teaching style: A model for the study of teaching styles]. *Pedagogische Studiën*, *83*, 419-431.

Sierens, E., Vansteenkiste, M., Goossens, L., Soenens, B., & Dochy, F. (2009). The synergistic relationship of perceived autonomy support and structure in the prediction of self-regulated learning. *British Journal of Educational Psychology*, *79*, 57-68. doi:10.1348/000709908X304398

Skinner, E. A. (1996). A guide to constructs of control. *Journal of Personality and Social Psychology,* 71, 549-570. doi:10.1037/0022-3514.71.3.549

Skinner, E. A., Kindermann, T. A., & Furrer, C. J. (2009). A motivational perspective on engagement and disaffection: Conceptualization and assessment of children's behavioral participation in academic activities in the classroom. *Educational and Psychological Measurement*, *69*, 493-525. doi:10.1177/0013164408323233

Skinner, E. A., Wellborn, J. G., & Connell, J. P. (1990). What it takes to do well in school and whether I've got it: A process model of perceived control and children's engagement and achievement in school. *Journal of Educational Psychology*, *83*, 22-32. doi:10.1037/0022-0663.82.1.22

Slavin, R. E. (1996). Research on cooperative learning and achievement: What we know, what we need to know. *Contemporary Educational Psychology*, *21*, 43-69. doi:10.1006/ceps.1996.0004

Slavin, R. E. (2006). *Educational psychology. Theory and practice.* Needham Heights, MA: Allyn and Bacon.

Smith, A. E., Jussim, L., & Eccles, J. (1999). Do self-fulfilling prophecies accumulate, dissipate, or remain stable over time? *Journal of Personality and Social Psychology*, *77*, 548-565. doi:10.1037/0022-3514.77.3.548

Soenens, B., Sierens, E., Vansteenkiste, M., Dochy, F., & Goossens, L. (2012). Psychologically controlling teaching: Examining outcomes, antecedents, and mediators. *Journal of Educational Psychology*, *104*, 108-120. doi:10.1037/a0025742

Soenens, B., & Vansteenkiste M. (2010). A theoretical upgrade on the concept of parental psychological control: Proposing new insights on the basis of self-determination theory. *Developmental Review*, *30*, 74-99. doi:10.1016/j.dr.2009.11.001

Steiger, J. H. (1990). Structural model evaluation and modification: An interval estimation approach. *Multivariate Behavioral Research*, *25*, 173-180. doi:10.1207/s15327906mbr2502_4

Stevens, J. P. (2002). *Applied multivariate statistics for the social sciences.* Hillsdale, NJ: Erlbaum.

Strømsø, H. I., Bråten, I., & Samuelstuen, M. S. (2008). Dimensions of topic-specific epistemological beliefs as predictors of multiple text understanding. *Learning and Instruction*, *18*, 513-527. doi:10.1016/j.learninstruc.2007.11.001

Südkamp, A., Kaiser, J., & Möller, J. (2012). Accuracy of teachers' judgments of students' academic achievement: A meta-analysis. *Journal of Educational Psychology*, *104*, 743-762. doi:10.1037/a0027627

Sungur, S., & Tekkaya, C. (2006). Effects of problem-based learning and traditional instruction on self-regulated learning. *The Journal of Educational Research*, *99*, 307-317. doi:10.3200/JOER.99.5.307-320

Sweller, J. (2010). Element interactivity and intrinsic, extraneous, and germane cognitive load. *Educational Psychology Review*, *22*, 123-138. doi:10.1007/s10648-010-9128-5

Sweller, J., & Cooper, G. A. (1985). The use of worked examples as a substitute for problem solving in learning algebra. *Cognition and Instruction*, *2*, 59-89. doi:10.1207/s1532690xci0201_3

Sweller, J., Kirschner, P. A., & Clark, R. E. (2007). Why minimally guided teaching techniques do not work: A reply to commentaries. *Educational Psychologist*, *42*, 115-121. doi:10.1080/00461520701263426

T

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics.* Boston, MA: Pearson Education.

Tans, R. W., Schmidt, H. G., Schade-Hoogeveen, B. E. J., & Gijselaers, W. H. (1986). Sturing van het onderwijsleerproces door middel van problemen: Een veldexperiment [Directing the learning process by means of problems: A field experiment]. *Tijdschrift voor Onderwijsresearch*, *11*, 35-46.

Taylor, H. G., Anselmo, M., Foreman, A. L., Schatschneider, C., & Angelopoulos, J. (2000). Utility of kindergarten teacher judgments in identifying early learning problems. *Journal of Learning Disabilities*, *33*, 200-210. doi:10.1177/002221940003300208

Te Winkel, W., Rikers, R., Loyens, S., & Schmidt, H. (2006). Influence of learning resources on study time and achievement scores in a problem-based curriculum. *Advances in Health Sciences Education*, *11*, 381-389. doi:10.1007/s104559-006-9016-4

Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. *Review of Educational Research, 45*, 89-125. doi:10.3102/00346543045001089

Tinto, V. (1988). Stages of student departure: Reflections on the longitudinal character of student leaving. *The Journal of Higher Education, 59*, 438-455. doi:10.2307/1981920

Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition* (2nd ed.). Chicago, IL: The University of Chicago Press.

Tinto, V. (1997). Classrooms as communities: Exploring the educational character of student persistence. *The Journal of Higher Education*, *68*, 599-623. doi:10.2307/2959965

Tinto, V. (1998). Colleges as communities: Taking research on student persistence seriously. *The Review of Higher Education*, *21*, 167-177.

Tobias, S., & Duffy, T. M. (2009). *Constructivist instruction: Success or failure?* New York, NY: Routledge.

Trouilloud, D., Sarrazin, P., Bressoux, P., & Bois, J. (2006). Relation between teachers' early expectations and student' later perceived competence in physical education classes: Autonomy-supportive climate as a moderator. *Journal of Educational Psychology*, *98*, 75-86. doi:10.1037/0022-0663.98.1.75

Trouilloud, D. O., Sarrazin, P. G., Martinek, T. J., & Guillet, E. (2002). The influence of teacher expectations on student achievement in physical education classes: Pygmalion revisited. *European Journal of Social Psychology*, *32*, 591-607. doi:10.1002/ejsp.109

Tsai, Y.-M., Kunter, M., Lüdtke, O., Trautwein, U., & Ryan, R. M. (2008). What makes lessons interesting? The role of situational and individual factors in three school subjects. *Journal of Educational Psychology*, *100*, 460-472. doi:10.1037/0022-0663.100.2.460

Tucker, L. R., & Lewis, C. (1973). A reliability coefficient for maximum likelihood factor analysis. *Psychometrica*, *38*, 1-10. doi:10.1007/BF02291170

V

Vallerand, R. J. (1997). Toward a hierarchical model of intrinsic and extrinsic motivation. *Advances in Experimental Social Psychology*, *29*, 271-360. doi:10.1016/S0065-2601(08)60019-2

Vallerand, R. J., & Bissonnette, R. (1992). Intrinsic, extrinsic, and amotivational styles as predictors of behavior: A prospective study. *Journal of Personality, 60*, 599-620. doi:10.1111/j.1467-6494.1992.tb00922.x

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Briere, N. M., Senecal, C., & Vallieres, E. F. (1992). The Academic Motivation Scale: A measure of intrinsic, extrinsic, and amotivation in education. *Educational and Psychological Measurement*, *52*, 1003-1017. doi:10.1177/0013164492052004025

Van Berkel, H. J. M. (1990). Assessment in a problem-based medical curriculum. *Higher Education*, *19*, 123-146. doi:10.1007/BF00137104

Van Berkel, H. J. M., & Schmidt, H. G. (2000). Motivation to commit oneself as a determinant of achievement in problem-based learning. *Higher Education*, *40*, 231-242. doi:10.1023/A:1004022116365

Van Berkel, H. J. M., & Dolmans, D. H. J. M. (2006). The influence of tutoring competencies on problems, group functioning and student achievement in problem-based learning. *Medical Education*, *40*, 730-736. doi:10.1111/j.1365-2929.2006.02530.x

Van Blankenstein, F. M., Dolmans, D. H. J. M., Van der Vleuten, C. P. M., & Schmidt, H. G. (2011). Which cognitive processes support learning during small-group discussion? The role of providing explanations and listening to others. *Instructional Science*, *39*, 189-204. doi:10.1007/s11251-009-9124-7

Van Blankenstein, F. M., Dolmans, D. H. J. M., Van der Vleuten, C. P. M., & Schmidt, H. G. (2013). Relevant prior knowledge moderates the effect of elaboration during small group discussion on academic achievement. *Instructional Science*, *41*, 729-744. doi:10.1007/s11251-012-9252-3

Van den Berg, M. N., & Hofman, W. H. A. (2005). Student success in university education: A multi-measurement study of impact of student and faculty factors on study progress. *Higher Education*, *50*, 413-446. doi:10.1007/s10734-004-6361-1

Van de Watering, G. A., & Claessens, S. (2003). Verschillen tussen de perceptie van tutoren op de leerprestatie en de toetsprestatie van hun studenten [Differences between tutors' perceptions of performance and students' actual achievement]. *Tijdschrift voor Hoger Onderwijs*, *21*, 199-214.

Van Gog, T., Kirschner, F., Kester, L., & Paas, F. (2012). Timing and frequency of mental effort measurement: Evidence in favour of repeated measures. *Applied Cognitive Psychology*, *26*, 833-839. doi:10.1002/acp.2883

Van Gog, T., & Paas, F. (2008). Instructional efficiency: Revisiting the original construct in educational research. *Educational Psychologist*, *43*, 16-26. doi:10.1080/00461520701756248

Van Gog, T. & Rummel, N. (2010). Example-based learning: Integrating cognitive and social-cognitive research perspectives. *Educational Psychology Review*, *22*, 155-174, doi:10.1007/s10648-010-9134-7

Vanheste, T., Lens, W., & Vandenberghe, R. (2001). *Motivatie en leerstijlen bij eerstejaarsstudenten aan de universiteit [Motivation and learning styles in college-freshmen].* Leuven: Department of Psychology.

Vansteenkiste, M., Lens, W., & Deci, E. L. (2006). Intrinsic versus extrinsic goal contents in self-determination theory: Another look at the quality of academic motivation. *Educational Psychologist*, *41*, 19-31. doi:10.1207/s15326985ep4101_4

Vansteenkiste, M., Sierens, E., Goossens, L., Soenens, Dochy, F., Mouratidis, A., … Beyers, W. (2012). Identifying configurations of perceived teacher autonomy support and structure: Associations with self-regulated learning, motivation and problem behavior. *Learning and Instruction*, *22*, 431-439. doi:10.1016/j.learninstruc.2012.04.002

Vansteenkiste, M., Sierens, E., Soenens, B., Luyckx, K., & Lens, W. (2009). Motivational profiles from a self-determination perspective: The quality of motivation matters. *Journal of Educational Psychology*, *101*, 671-688. doi:10.1037/a0015083

Vansteenkiste, M., Simons, J., Lens, W., Sheldon, K. M., & Deci, E. L. (2004). Motivating learning, performance, and persistence: The synergistic effects of intrinsic goal contents and autonomy-supportive contexts. *Journal of Personality and Social Psychology*, *87*, 246-260. doi:10.1037/0022-3514.87.2.246

Vansteenkiste, M., Simons, J., Lens, W., & Soenens, B. (2004). De kwaliteit van motivatie telt: Over het promoten van intrinsieke doelen op een autonomieondersteunende wijze [The quality of motivation matters: Promoting intrinsic goals in an autonomy-supportive way]. *Nederlands Tijdschrift voor de Psychologie*, *59*, 119-131.

Vansteenkiste, M., Simons, J., Lens, W., Soenens, B., & Matos, L. (2005). Examining the motivational impact of intrinsic versus extrinsic goal framing and autonomy-supportive versus internally controlling communication style on early adolescents' academic achievement. *Child Development*, *76*, 483-501. doi:10.1111/j.1467-8624.2005.00858.x

Veerman, A. & Veldhuis-Diermanse, E. (2001). Collaborative learning through computer-mediated communication in academic education. In P. Dillenbourg, A. Eurlings, & K. Hakkarainen (Eds.), *European perspectives on computer-supported collaborative learning. Proceedings of the first European conference on CSCL*. Maastricht, Netherlands: McLuhan Institute, University of Maastricht.

Verkoeijen, P. P. J. L., Rikers, R. M. J. P., Te Winkel, W. W. R., & Van den Hurk, M. M. (2006). Do student-defined learning issues increase quality and quantity of individual study? *Advances in Health Sciences Education*, *11*, 337-347. doi:10.1007/s10459-006-9013-7

Vermunt, J. D., & Verloop, N. (1999). Congruence and friction between learning and teaching. *Learning and Instruction*, *9*, 257-280. doi:10.1016/S0959-4752(98)00028-0

W

Waaler, R., Halvari, H., Skjesol, K., & Bagøien, T. E. (2013). Autonomy support and intrinsic goal progress expectancy and its links to longitudinal study effort and subjective wellbeing: The differential mediating effect of intrinsic and identified regulations and the moderator effects of effort and intrinsic goals. *Scandinavian Journal of Educational Research*, *57*, 325-341. doi:10.1080/00313831.2012.656284

Wang, Z., Hu, X. Y., & Guo, Y. Y. (2012). Goal content and goal contexts: Experiments with Chinese students. *The Journal of Experimental Education*, *81*, 105-122. doi:10.1080/00220973.2012.678407

Watson, D. (1988). The vicissitudes of mood measurement: Effects of varying descriptors, time frames, and response formats on measures of positive and negative affect. *Journal of Personality and Social Psychology*, *55*, 128-141. doi:10.1037/0022-3514.55.1.128

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*, 1063-1070. doi:10.1037/0022-3514.54.6.1063

Weinstein, C. E. (1987). *LASSI user's manual*. Clearwater, FL: H & H Publishing Company.

Weinstein, C. E., & Palmer, D. R. (2002). *LASSI user's manual*. Clearwater, FL: H & H Publishing Company.

Wentzel, K. R. (1999). Social-motivational processes and interpersonal relationships: Implications for understanding motivation at school. *Journal of Educational Psychology, 91*, 76-97. doi:10.1037/0022-0663.91.1.76

Wentzel, K. R. (2000). What is it that I'm trying to achieve? Classroom goals from a content perspective. *Contemporary Educational Psychology, 25*, 105-115. doi:10.1006/ceps.1999.1021

White, B. Y., & Frederiksen, J. R. (1998). Inquiry, modeling, and metacognition: Making science accessible to all students. *Cognition and Instruction*, *16*, 3-118. doi:10.1207/s1532690xci1601_2

White, C. B. (2008). Smoothing out transitions: How pedagogy influences medical students' achievement of self-regulated learning goals. *Advances in Health Sciences Education*, *12*, 279-297. doi:10.1007/s10459-006-9000-z

White, R. W. (1959). Motivation reconsidered: The concept of competence. *Psychological Review*, *66*, 297-333. doi:10.1037/h0040934

Whitfield, C. F., & Xie, S. X. (2002). Correlation of problem-based learning facilitators' scores with student performance on written exams. *Advances in Health Sciences Education*, *7*, 41-51. doi:10.1023/A:1014522513526

Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology*, *25*, 68-81. doi:10.1006/ceps.1999.1015

Wijnia, L., Loyens, S. M. M., & Derous, E. (2011). Investigating effects of problem-based versus lecture-based learning environments on student motivation. *Contemporary Educational Psychology*, *36*, 101-113. doi:10.1016/j.cedpsych.2010.11.003

Wijnia, L., Loyens, S. M. M., Derous, E., Koendjie, N. S., & Schmidt, H. G. (2014). Predicting educational success and attrition in problem-based learning: Do first impressions count. *Studies in Higher Education*, *39*, 967-982. doi:10.1085/03075079.2012.754856

Williams, G. C., & Deci, E. L. (1996). Internalization of biopsychological values by medical students: A test of self-determination theory. *Journal of Personality and Social Psychology, 70*, 767-779. doi:10.1037/0022-3514.70.4.767

Wosnitza, M., & Volet, S. (2014). Trajectories of change in university students' general views of group work following one single group assignment: Significance of instructional context and multidimensional aspects of experience. *European Journal of Psychology of Education*, *29*, 101-115. doi:10.1007/s10212-013-0189-y

Z

Zimmerman, B. J., & Campillo, M. (2003). Motivating self-regulated problem solvers. In J. E. Davidson & R. J. Sternberg (Eds.), *The psychology of problem solving* (pp. 233-262). New York: Cambridge University Press.

Appendices

APPENDIX A

Problem Description "Robbers Cave" – In Dutch (Chapters 3 To 5)

Op 19 juni 1954 kwam een groep 11- tot 12-jarige jongens aan op het zomerkamp Robbers Cave. Ze zouden daar drie weken vakantie hebben in een bosrijk gebied. In de eerste week leerden de jongens elkaar goed kennen, ze deden spelletjes met elkaar en gingen zwemmen. Ook bedachten ze een naam voor hun groep: De "Eagles".

Na een week, zagen ze ineens dat er nog een andere groep op het kamp was, de "Rattlers". Deze groep jongens was op dezelfde dag aangekomen als de andere groep, maar dan aan de andere kant van het zomerkamp. Beide groepen wisten niets van elkaars bestaan af en dachten dat ze alleen op dat kamp waren!

De kampleiding organiseerde een competitie waarbij de twee groepen tegen elkaar gingen strijden in spelletjes zoals touwtrekken. Alleen de winnende groep zou de nieuwe zakmessen krijgen die beide groepen zo graag wilden hebben. Al snel waren de twee groepen in hevige competitie met elkaar en was er veel vijandigheid over en weer. Toen de "Rattlers" de touwtrekcompetitie wonnen, besloten de "Eagles" de vlag van de "Rattlers" in brand te steken…

English Translation

On June 19th in 1954 a group of 11- to 12-year old boys arrived at the summer camp Robbers Cave. They would be on holiday for three weeks in the densely wooded area of the park. During the first week, the boys got to know each other very well; they played games together and went swimming. They gave themselves a group name: the "Eagles."

After a week they discovered another group was present at the camp, the "Rattlers." This group of boys had arrived on the same day as the Eagles, but on the other side of the summer camp. Both groups were initially unaware of the presence of the other group and believed they were alone at the summer camp!

The camp leaders organized a competition in which both groups competed in games such as tug-of-war. Only the winning group would receive the desirable prize: new pocket knives. Almost overnight, both groups were fiercely competing and turned into hostile antagonists. After the "Rattlers" won the tug-of-war, the "Eagles" decided to burn the flag of the "Rattlers"…

APPENDIX B

Examples of Discussion Input (Chapter 3)

Type of contribution	Example
No contribution	"I have nothing new to contribute."
Borrowed information: The participant directly repeated or paraphrased information presented earlier in the discussion.	"I think first a group-feeling was created because they indeed connected with one another by playing games" ("I think they see themselves as two separate groups and feel more similar within one group […] the first week they played games with each other" was mentioned in the simulated discussion.)
Elaboration: The participant elaborated or fine-tuned ideas that were mentioned earlier during the discussion.	"When they play games, they need to feel a connection with their group and this promotes friction between the two groups." ("Playing games promoted intergroup conflict" was mentioned in the simulated discussion. The participant further elaborated on this idea by mentioning "friction.")
New idea: The participant presented new information in the context of the discussion.	"I think de-individuation occurs and therefore participants do not see themselves as an individual any more but more as one with the group." (De-individuation was a new theoretical idea.)
Evaluation: The participant gave a critical discussion of ideas presented earlier that went further than a simple confirmation or rejection of ideas.	"They wondered whether the reward matters. I do not think it matters. I think a consolation prize will make things even worse. Because by accepting a consolation prize, you will only admit that you have lost." (In the simulated discussion it was stated that a consolation prize would reduce intergroup conflicts.)

APPENDIX C

Example of an Integrated Model Answer (Chapter 4)

Learning Issue 2: How can intergroup conflicts be resolved?[5]

This question can be answered by looking at phase 3 of the Robbers Cave experiment: "intergroup cooperation". This third phase, which will be explained below, showed that intergroup conflicts could be resolved, but that several attempts and joint/positive activities were necessary to resolve the conflict and reduce hostility.

There was a third phase of the Robbers Cave experiment, called intergroup cooperation, in which the experiment leaders tried to resolve the conflict between the "Rattlers" and the "Eagles". While creating conflict through competition was easy, resolving the conflict proved to be more difficult. The experiment leaders tried several things to resolve the conflict, but none of them seemed to work:
- Telling nice things about the other group.
- Sharing a fun activity, such as watching a movie together.
- Introducing a third group as a common enemy.

There was only one solution that did seem to work: introducing **superordinate goals.** Superordinate goals are common goals that can only be achieved when both groups work together. For example, a truck that was supposed to bring their lunch or a film was stuck in the mud. Both groups were needed to pull the truck out of the mud. In this manner **positive interdependence** can be created: the ingroup goals can only be achieved when the outgroup achieves its goal.

These findings seem highly relevant for naturalistic settings where competition over scarce and valued resources, such as water, food, and oil often occur and lead to depletion or destruction of the resource. The benefits of reducing the focus on competition by activating superordinate goals can sometimes be observed around the world after natural disasters such as earthquakes. Greece-Turkey relationships were fraught with conflict and mistrust for generations; however the relationship improved during the aftermath of serious earthquakes that affected both countries. Both countries, for instance, had to work together to rescue survivors out of the rubble.

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5. The integrated model answer was based on social psychology textbooks by Brehm, Kassin, and Fein (2002); Feldman (2001); Hewstone, Stroebe, and Klaus (2007); and Hogg and Vaughan (2002).

However, in real settings it is not always possible to create superordinate goals and other measures are necessary to resolve intergroup conflict. Intergroup conflict can be perceived as a social dilemma in which self-interest and ingroup favoritism is pitted against the collective good. Structural solutions often have to be imposed that cause the dilemma to disappear. Structural solutions include: limiting the number of people accessing the resource (via permits), limiting the amount of resources that people can take (via quota), handing over management of the resource to a leader, facilitating free communication among those accessing the resource, and shifting the pay-off to ensure cooperation is favored over competition. However, these structural solutions can only be achieved when an enlightened and powerful authority implements these measures, manages bureaucracy, and polices violations. One way a leader can enhance group cooperation is to facilitate group identification among people who access the collective resource and thus help make those people act responsibly towards the resource.

Summary:

In summary, intergroup conflicts can be resolved in two different ways. First, through superordinate goals, i.e., common goals that can only be achieved when the ingroup and outgroup work together. These goals change the relationship between the two groups; the groups become positively dependent on one another and need each other to fulfill their goals. Second, an enlightened or powerful authority may be appointed to manage the resource and to control access to the source.

APPENDIX D

Overview of the Open-Ended Questions and Coding Scheme (Chapters 4 and 5)

Question 1:	Give two theoretical explanations that could account for the conflict between the Rattlers and the Eagles. *2 Points* for naming realistic conflict theory (1 point) and providing a correct description stating that intergroup conflict is the result of direct competition (0.5 point) of two groups over a scarce but desirable resource/prize (0.5 point). *2 Points* for naming social identity theory (1 point) and providing a correct description explaining that belonging to a group can lead to conflict (0.5 point) and that people favor in-groups over out-groups in order to enhance their self-esteem (0.5 point)
Question 2:	Describe two solutions to solve intergroup conflict. *2 Points* for naming superordinate goals (1 point) and providing a correct description: Goals that can only be achieved when the two groups work together (1 point). *2 Points* for naming (1 point) and correctly describing (1 point) a structural solution imposed by a powerful authority. Structural solutions could include: limiting the number of people accessing the resource (via permits), limiting the amount of resources that people can take (via quotas), handing over management of the resource to a leader, facilitating free communication among those accessing the resource, and shifting the pay-off to ensure cooperation is favored over competition.
Question 3:	The Robbers Cave experiment is based on realistic conflict theory. Do you believe the results of this experiment can be explained by this theory? Describe both weak and strong elements of this theory in your answer. *2 Points* when participants mentioned that elements of realistic conflict theory were in line with some of the observations in the experiment. Possible answers could include: (a) explaining that Sherif and colleagues ruled out other explanations; (b) explaining that in-group solidarity, in-group identification, and negative out-group attitudes increased during the competition, or (c) explaining that both the winning and losing teams developed negative/hostile attitudes towards the other group. *2 Points* when participants mentioned that not all observations in the experiment could be explained by the theory. Possible correct answers could include: (a) The experimenters observed some signs of negative attitudes towards the other group even before the competition took place: The boys asked for competitive games when they noticed there was another group at the summer camp. (b) Simply being assigned to a group could promote conflict. (c) A realistic competition for resources might not always be necessary. Sometimes a perception or imagination of a competition is sufficient. Therefore, a "real" competition may not be necessary for intergroup conflict to arise. (d) It is not always necessary that a resource be scarce; sometimes the perception or experience that one is deprived of something relative to others is sufficient. In other words, a sense of relative deprivation may also lead to conflict.
Question 4:	If you were to design an experiment to examine intergroup conflict, what would you do the same as in the Robbers Cave experiment and what would you do differently? *2 Points* for mentioning what elements they would keep the same and why (e.g., controlling for other explanations, such as dominant personality, or certain phases of the experiment such as the group formation phase, because this is relevant from both a realistic conflict or social identity perspective). *2 Points* for mentioning what they would change and why (e.g., explaining that not all observations were explained by social identity theory and that the role of direct competition or the role of scarce resources could be examined). Other possible answers could include tests of generalization, role of gender, role of a consolation prize, role of the appointment of an objective leader.

APPENDIX E

Overview of the Coding Scheme and Examples (Chapter 8)

Student Characteristic	Valence	Examples
Demographic characteristics	Positive	-
	Negative	"too young"; "(-) a bit young"
	Neutral	"an older student"
Intellectual factors		
B.1. General cognitive ability	Positive	"intelligent"; "smart"; "understands the subject matter"
	Negative	"Does not understand the subject matter"; "seems to find it difficult"
	Neutral	"I find it difficult to determine whether she understands everything"
B.2. Verbal ability	Positive	"Passed the language test at once"; "I have read a paper written by this student and she possess good writing skills"
	Negative	"Makes spelling errors"; Dutch language skills are poor"
	Neutral	-
B.3. Prior educational experiences	Positive	"Was enrolled in bilingual secondary education (English and Dutch) which is very beneficial when compared to other students"; "Has prior experiences with meetings and discussions"
	Negative	"Already tried to pass this course 3 years ago but did not pass it"; "Is enrolled in the first year for the second time"
	Neutral	"Has finished vocational training, wants to do university"
Non-intellectual factors		
C.1. Personality – not specified	Positive	"personality is okay"
	Negative	-
	Neutral	-
C.2. Extraversion – Introversion	Positive	"Takes initiative"; "social"; "oriented to others"
	Negative	"Shy"; "timid"; "introvert"; "does not make contact with other students"
	Neutral	-
C.3. Conscientiousness	Positive	"Determined"; "Disciplined"; "Well-organized"
	Negative	"Lazy attitude"; "No discipline"
	Neutral	-
C.4. Collaboration readiness	Positive	"has interest in collaboration with other student"; "seeks help of other students"
	Negative	"Does not listen to other students"
	Neutral	-
C.5. (In)stability	Positive	"self-confident"; "calm"; "sure of himself"
	Negative	"Insecure"; "seeks confirmation"; "was so nervous during presentation, that she wanted to quit before it was finished"
	Neutral	-
C.6. Study priority	Positive	-
	Negative	"Busy social life which led to shortage in time"; "undertakes many activities besides studying"
	Neutral	"Has moved to Rotterdam and has joined a fraternity [and is committed to both leaving home and finishing his studies]"

C.7. Motivation and interest	Positive	"interested"; "motivated"; "enthusiastic"; "wants to learn"
	Negative	"Does not seem motivated"; "Does not show enthusiasm"
	Neutral	"[Student had difficulty understanding concepts] it is unclear whether this is caused by lack of motivation"
C.8. Preparation and participation	Positive	"well prepared"; actively contributes to discussions"; "can explain concepts in own words"; "asks critical questions" "can make connections"; "reads multiple resources"
	Negative	"always comes a few minutes late"; "not prepared"; "doubt whether she has the right study skills"
	Neutral	"is a good chair, but sometimes takes over this role from others"
C.9. Other non-intellectual factors	Positive	"mediation (+)"; "acceptation (+)" [both examples mentioned in the context of a psychological disorder]
	Negative	"is naïve"; "has personal circumstances that can trouble study progress"
	Neutral	"lives at home"; "has worked a couple of years before starting this course"

Curriculum Vitae and publications

CURRICULUM VITAE

Lisette Wijnia was born on November 24, 1984 in Zwolle, the Netherlands. She completed her secondary education (VWO) in 2003 at Develsteincollege in Zwijndrecht. Hereafter, she started studying psychology at Erasmus University Rotterdam. In December 2007, she received her Master's degree in educational and developmental psychology at Erasmus University Rotterdam (cum laude). Her master thesis on motivation in problem-based learning was awarded with the Unilever Research Prize in 2008. From September 2006 till April 2009 she was employed at the Regionaal Expertise Centrum Zuid-Holland Zuid De Nachtegaal, as an assistant case evaluator of special education applications for children with a physical/mental disability or chronic illness. In May 2009, Lisette started as a PhD candidate at the Institute of Psychology at Erasmus University Rotterdam, studying motivation and teacher judgments in problem-based learning. The results of this PhD project are reported in the present dissertation. As a PhD student, she taught a number of psychology courses and supervized several bachelor theses. As of September 2014, she is employed as a part-time post-doctoral researcher at the Department of Human Resource Studies of Tilburg University and as a tutor at Erasmus University College.

PUBLICATIONS

Wijnia, L., Loyens, S. M. M., Derous, E., & Schmidt, H. G. (in press). Do students' topic interest and tutors' instructional style matter in problem-based learning? *Journal of Educational Psychology.* doi:10.1037/a0037119

Wijnia, L., Loyens, S. M. M., Derous, E., & Schmidt, H. G. (in press). How important are student-selected versus instructor-selected literature resources for students' learning and motivation in problem-based learning? *Instructional Science.* doi:10.1007/s11251-014-9325-6

Wijnia, L., Loyens, S. M. M., Derous, E., Koendjie, N. S., & Schmidt, H. G. (2014). Predicting educational success and attrition in problem-based learning: Do first impressions count? *Studies in Higher Education*, *39*, 967-982. doi:10.1080/03075079.2012.754856

Wijnia, L., Loyens, S. M. M., Van Gog, T., Derous, E., & Schmidt, H. G. (2014). Is there a role for direct instruction in problem-based learning? Comparing student-constructed versus integrated model answers. *Learning and Instruction*, *34*, 22-31. doi:10.1016/j.learninstruc.2014.07.006

Wijnia, L., Loyens, S. M. M., & Derous, E. (2011). Investigating effects of problem-based vs. lecture-based learning environments on student motivation. *Contemporary Educational Psychology, 36*, 101-113. doi:10.1016/j.cedpsych.2010.11.003

PRESENTATIONS

Wijnia, L., Noordzij, G., Loyens, S. M. M., & Derous, E. (2014, June). *Motivation and engagement in student-centered learning: The role of autonomy support and structure.* Paper presented at the International Conference on Motivation, Helsinki, Finland.

Noordzij, G., & Wijnia, L. (2013, June). *Stability and change in motivation and achievement goal orientation*. Paper presented at the Self-Determination Theory Conference, Rochester, New York.

Wijnia, L., & Noordzij, G. (2013, June). *Motivation in student-centered learning: The role of affect and participation in group meetings*. Poster session presented at the Self-Determination Theory Conference, Rochester, New York.

Wijnia, L., Loyens, S. M. M., Derous, E., & Schmidt, H. G. (2012, November). *Student motivation in problem-based learning: Do topic interest and tutor communication style matter?* Paper presented at the ICO International Fall School, Gerona, Spain.

Wijnia, L., Loyens, S. M. M., Derous, E., & Schmidt, H. G. (2012, August). *Student motivation in student-centered learning: The influence of topic interest and tutor instructions.* Paper presented at the International Conference on Motivation, Frankfurt am Main, Germany.

Wijnia, L., Loyens, S. M. M., Derous. E., & Schmidt, H. G. (2012, July). *Literature recommendations in problem-based learning: The effects of autonomy.* Paper presented at the meeting of Junior Researchers of the European Association for Research on Learning and Instruction, Regensburg, Germany.

Wijnia, L., Loyens, S. M. M., Derous, E., & Schmidt, H. G. (2012, April). *The influence of tutor communication on motivation: Controlling versus noncontrolling language.* In D. H. J. M. Dolmans (Chair), Does feedback in problem-based learning enhance student learning? Symposium conducted at the meeting of American Educational Research Association, Vancouver, Canada.

Wijnia, L., Loyens, S. M. M., Koendjie, N. S., & Schmidt, H. G. (2011, September). *Tutor predictions of students' study success.* In S. M. M. Loyens (Chair). Factors influencing students' achievement in problem-based learning. Symposium conducted at the meeting of European Association for Research on Learning and Instruction, Exeter, United Kingdom.

Wijnia, L., Loyens, S. M. M., Derous, E., & Schmidt, H. G. (2011, August). *The influence of tutor autonomy-support on student motivation and performance in problem-based learning.* Poster session presented at the meeting of Junior Researchers of the European Association for Research on Learning and Instruction, Exeter, United Kingdom.

Wijnia, L., Loyens, S. M. M., & Derous, E. (2010, November). *Student motivation in problem-based learning: A comparison with lecture-based learning.* Paper presented at the ICO Toogdag, Amsterdam.

Wijnia, L., Loyens, S. M. M., Koendjie, N. S., & Schmidt, H. G. (2010, July). *The accuracy of tutor expectations of student achievement in a problem-based learning environment.* Poster session presented at the meeting of Junior Researchers of the European Association for Research on Learning and Instruction, Frankfurt am Main, Germany.

Wijnia, L., Loyens, S. M. M., & Derous, E. (2010, May). *Effects of student-centered vs. lecture-based learning environments on student motivation.* Poster session presented at the Self-Determination Theory Conference, Gent, Belgium.

Wijnia, L., Loyens, S. M. M., & Derous, E. (2010, May). *The influence of student-centered and lecture-based learning environments on student motivation: A self-determination perspective.* Poster session presented at the meeting of American Educational Research Association, Denver, Colorado.

Wijnia, L., Loyens, S. M. M., & Derous, E. (2008, October). *The effect of problem-based learning on student motivation.* Unilever R&D, Vlaardingen.

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