A Longitudinal Study on the Development of Law Students' Learning Strategies in Problem-Based Learning and the Relation with Assessment and Academic Performance

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ABSTRACT

Self-regulated learning and deep processing are desirable learning strategies in higher education. Student-centered educational methods like problem-based learning (PBL) aim to foster these strategies. The present study investigated the development of Dutch law students' learning strategies in a three-year PBL program with a longitudinal design. Second, the relation between learning strategies and academic achievement and study progress was studied, taking the type of assessment into account. Results showed that deep processing stayed stable over time and self-regulation did not increase. Analysis of assessment showed more focus on surface than on deep learning in the exams of the academic program under study. Further, concrete processing (i.e., relating learned knowledge to real-life experiences) increased over the course of the three-year PBL program and lack of regulation decreased. Lack of regulation was negatively associated with academic performance and study progress. The assessments used in the curriculum help explain the use of learning strategies in a PBL curriculum.

INTRODUCTION

How students learn and approach their learning tasks has been a topic of research for decades. The distinction between deep and surface learning (Biggs, 1987; Marton & Säljö, 1976; Newble & Entwistle, 1986) as well as the concept of self-regulation (Boekaerts, 1997; Zimmerman, 1989) received a lot of attention in educational research in the preceding century. There is general consensus that deep processing of information (i.e., relating concepts, structuring, creating deeper understanding of material; Newble & Entwistle, 1986) and self-regulation (i.e., self-initiated information seeking, planning, organizing, and goal-setting; Zimmerman, 1989) are effective learning strategies, as both are positively related to academic outcomes (e.g., GPA; Richardson, Abraham, & Bond, 2012). Hence, self-regulation and deep learning are desirable outcomes in education.

Previous studies demonstrated that the learning environment plays an important role in the development of students' learning strategies (Donche, Coertjens, & Van Petegem, 2010; Donche & Van Petegem, 2009; Vermetten, Lodewijks, & Vermunt, 1999). Vermunt (2007) discussed that self-regulation can be encouraged by learning environments that aim to *activate* students (e.g., working with assignments or problems or cooperation among students). This is in line with the constructivist perspective on education. Constructivism stresses an active role for students, as learners construct and build knowledge structures by themselves (O'Donnell, 2012). Problem-based learning (PBL) is an educational application of a constructivist learning theory (O'Donnell, 2012). The present study investigates whether learning strategies such as deep processing and self-regulation, are indeed fostered in a constructivist, PBL environment.

Learning Strategies

In the Netherlands, Vermunt conducted a lot of research on students' learning approaches in higher education (Vermunt, 1998; Vermunt & Vermetten, 2004). He differentiated several aspects of learning with the Inventory Learning Styles (ILS; Vermunt & Van Rijswijk, 1988): learning strategies (i.e., learning activities), conceptions of learning and teaching, and learning orientations (i.e., motives for studying). These aspects together can be united into four learning patterns (before learning styles; see Vermunt, 1998). However, the current study focused on learning strategies only, because previous studies demonstrated that these are subject to change by the learning environment (e.g., Donche & Van Petegem, 2009; Vermetten et al., 1999).

Learning strategies are divided into cognitive processing strategies and metacognitive regulatory strategies. Cognitive processing strategies refer to thinking strategies that are used to process course material. These strategies affect learning outcomes directly (e.g., these strategies directly lead to knowledge acquisition). Processing strategies are divided into three types. First, deep processing refers to students relating study concepts together, bringing structure in study material, being critical, and creating a deeper understanding (Newble & Entwistle, 1986; Vermunt & Vermetten, 2004). A second processing strategy is stepwise processing or surface learning, meaning that information is rehearsed till it is memorized (Newble & Entwistle, 1986). Finally, concrete processing holds that students connect acquired knowledge to real-life situations and prior experiences (Vermunt, 1998).

Metacognitive regulatory strategies are used to control or regulate the cognitive processing strategies and hence influence learning outcomes indirectly (Vermunt, 1998). Regulation strategies refer to goal-setting in the learning process, planning study time, monitoring the learning tasks, and evaluating the learning process. Similar to processing strategies, three kinds of regulation strategies are differentiated by Vermunt. Self-regulation is the first, which implies that students steer the learning process by themselves, take initiative, and are self-able to set goals, plan, monitor, and evaluate their learning process (Boekaerts, 1997; Vermunt, 1998; Vermunt & Vermetten, 2004). Second is external regulation, in which students let external factors, such as teachers, control their learning process (Boekaerts, 1997; Vermunt, 1998). Third is lack of regulation, which indicates that students have trouble to regulate the learning process, either by themselves or by an external source (Vermunt & Vermetten, 2004).

Learning Strategies and Academic Performance

Research shows that deep processing positively relates to academic outcomes (i.e., GPA; Boyle, Duffy, & Dunleavy, 2003; Lindblom-Ylänne & Lonka, 1999; Richardson et al., 2012; Zeegers, 2001), while stepwise processing is often found to be negatively related to academic performances (i.e., GPA; Lindblom-Ylänne & Lonka, 1999; Richardson et al., 2012; Zeegers, 2001). Positive relations between self-regulation activities and academic outcomes (i.e., GPA; Boyle et al., 2003; Richardson et al., 2012) are often found and negative relations between lack of regulation and academic outcomes (Lindblom-Ylänne & Lonka, 1999; Vermunt, 2005). Regarding concrete processing and external regulation on the one hand and performance on the other hand, the research literature shows inconsistent results. In sum, deep processing and self-regulation are considered good learning strategies with regards to academic achievement, while stepwise processing and lack of regulation are detrimental for learning.

Learning Strategies over Time

Not only are deep processing and self-regulation desirable in terms of achievement, but also because these strategies are useful in life after university. Students then need to have acquired a coherent understanding of the acquired knowledge during study and be able to educate themselves throughout their professional lives. Therefore, deep processing and self-regulation should improve over the course of higher education. The best way to investigate whether this change actually takes place is to use a longitudinal design. Although longitudinal studies on the progress of learning strategies are scarce, a number of studies have been conducted over the years. Results are, however, inconclusive.

An increase in deep processing in higher education was found in some longitudinal studies (Busato, Prins, Elshout, & Hamaker, 1998; Donche et al., 2010; Donche & Van Petegem, 2009; Severiens, Ten Dam, & Van Hout Wolters, 2001; Vermetten et al., 1999), while other studies found no differences of deep processing over time (Rodriguez & Cano, 2007; Severiens et al., 2001; Zeegers, 2001). The results for self-regulation are similar: an increase of self-regulation activities was found in a number of studies (Busato et al., 1998; Donche & Van Petegem, 2009; Severiens et al., 2001; Vermetten et al., 1999), whereas others found no change over time (Endedijk, Vermunt, Meijer, & Brekelmans, 2014; Severiens et al., 2001). Likewise, results on more inefficient learning strategies over time are mixed. For example, some studies show a decrease in stepwise processing or surface learning (Rodriguez & Cano, 2007; Severiens et al., 2001) while others indicate that stepwise processing stays constant over time (Donche & Van Petegem, 2009; Vermetten et al., 1999; Zeegers, 2001). Severiens et al. (2001) showed a decline in external regulation, though in the study of Vermetten et al. (1999), a stable pattern of external regulation was found. A decrease in lack of regulation over time was found by Vermetten et al. (1999), Donche et al. (2010) and Donche and Van Petegem (2009).

These mixed findings on the development of learning strategies leave us with a challenging question: How can effective learning strategies be fostered in a sustainable way? A learning environment that promotes an *active* role of students and hence promotes deep processing and self-regulation, might offer a solution (Mattick & Knight, 2007; Vermunt, 2007). PBL could be seen as such a learning environment.

Problem-Based Learning

PBL is a student-centered instructional method (Barrows, 1996; Hmelo-Silver, 2004) that consists of three phases. It starts with the initial discussion, in which students work collaboratively on a realistic, ill-defined problem. This is usually a description of a real-life situation, which has no clear-cut explanation or solution and hence elicits discussion in the group. Students discuss the problem and by doing so, they activate prior knowledge, based on experiences and common sense. Since prior knowledge is limited, students end the initial discussion by formulating questions (i.e., learning issues) about the problem. Learning issues guide students during a period of self-study, the second phase, in which they individually select and study literature resources (e.g., book chapters, articles). In the third phase of PBL, the reporting phase, students return to the group after a few days of self-study and formulate a complete answer on the learning issues together. During the group meetings, a tutor is present who stimulates the group discussions by asking open-ended questions. In between meetings students have ample time for self-study (Hmelo-Silver, 2004; Loyens, Kirschner, & Paas, 2012; Schmidt, 1983).

PBL is believed to foster deep processing in several ways (Mattick & Knight, 2007; Newble & Entwistle, 1986). Students are encouraged to connect their existing knowledge to new to-be-learned knowledge. This happens as prior knowledge is activated in the initial discussion. The process of elaboration (i.e., connecting existing knowledge to new learned knowledge; Schmidt, 1983) is then stimulated, which results in better knowledge retention (Dochy, Segers, Van den Bossche, & Gijbels, 2003). Furthermore, during self-study and discussions in the reporting phase, students need to connect different literature sources and different concepts together in order to create a complete answer to the learning issues. A tutor stimulates the use of deep processing by asking in-depth questions, making sure elaboration takes place. Moreover, concrete processing is also encouraged in PBL as information is learned in the context of an authentic situation (i.e., the problem) that fosters application of knowledge in real-life situations.

Further, stimulation of different aspects of self-regulation takes place in PBL. Self-regulation models assume that learners are able to monitor, control, and regulate their own learning process (Boekaerts, 1997). PBL is expected to stimulate these aspects of self-regulation. In PBL, students themselves formulate the learning issues, collaboratively decide what they need to study after the initial discussion, select different literature sources themselves during self-study, and evaluate whether they have sufficiently studied to answer learning issues during the reporting phase (Schmidt, 2000). Preparation is required for each tutorial meeting and hence students need to monitor and carefully plan their self-study time. In short, PBL is assumed to stimulate effective learning strategies like deep processing and self-regulation.

Assessment

Besides the learning environment, another important factor to take into account when investigating learning strategies is assessment. Assessment affects the learning strategies that are applied by students (Baeten, Kyndt, Struyven, & Dochy, 2010; Gijbels, Van de Watering, Dochy, & Van den Bossche, 2005). One could argue that if deep processing is desired in students, assessment used in higher education should stimulate this type of learning (e.g., more focus on *application* of knowledge in examination than on memorizing information). Moreover, the meta-analysis of Gijbels, Dochy, Van den Bossche, and Segers, (2005) shows that in PBL, students perform better on assessments that focus on complex levels of knowledge structures (e.g., understanding the link between concepts and application of knowledge). The authors explain that PBL's goals are more in line with complex level knowledge structures. Given the crucial role of assessment in students' learning processes, the present study will take assessments used in the PBL curriculum under study into account.

The Present Study

The present study investigates the development of learning strategies in a PBL program and, in addition, the relation between learning strategies and academic performance. Three research questions are addressed. The first research question is: 'How do law students' learning strategies develop over a three-year PBL Bachelor's program?' In order to answer this question, learning strategies (i.e., processing and regulation strategies) are measured six times with the ILS (Vermunt & Van Rijswijk, 1988), over the course of the three-year PBL Bachelor's program at the Erasmus School of Law (i.e., from the start of the first academic year throughout the end of the third and final year of the Bachelor's program). PBL aims to stimulate the use of deep processing and self-regulation (e.g., Mattick & Knight, 2007) and as students get familiar with PBL over the course of the Bachelor's program, it is expected that students' learning activities become more effective in terms of more use of deep processing, concrete processing, and self-regulation over time. Furthermore, it was hypothesized that the use of stepwise processing, external regulation, and lack of regulation would decrease throughout the Bachelor's program, as these strategies are less effective for learning.

The second and third research questions focus on the relation between learning strategies and academic success. With the second research question, 'How do learning strategies relate to academic performance?' we attempt to replicate previous findings. It is hypothesized that deep processing and self-regulation are positively related to academic performance, while stepwise processing and lack of regulation are hypothesized to be negatively related to academic performance (e.g., Richardson et al., 2012; Boyle et al., 2003; Lindblom-Ylänne & Lonka, 1999; Zeegers, 2001). The third research question is: 'What differences in applied learning strategies exist between students who drop out after the first academic year and students who continue the academic program?' It is expected that, in line with the second research question, students who drop out use less deep and concrete processing and more stepwise processing. Further, dropouts are expected to be less self-regulated, more externally regulated and have more lack of regulation, compared to students who continued the program because of the negative relations with academic achievement (e.g., Richardson et al., 2012; Boyle et al., 2003; Lindblom-Ylänne & Lonka, 1999; Zeegers, 2001). However, as mentioned before, assessment used in the curriculum might influence this. Therefore, assessment was taken into account in the present study. We examined the depth of knowledge tested in a selection of exams from the three-year Bachelor's program under study.

The current study will add to findings of previous longitudinal studies on learning strategies in several ways. First, the progress of learning strategies will be studied in a PBL program, which is an interesting addition considering the expected influence on student learning. Second, previous longitudinal research often studied a relative short-time period (e.g., one year; Busato et al., 1998; Vermetten et al., 1999) or contained only a few measurement moments over time (e.g., two measurements; Busato et al., 1998; Donche & Van Petegem, 2009; Rodriguez & Cano, 2007). This makes it hard to draw conclusions on the development of learning strategies over the course of higher education. The present study attempts to overcome these shortcomings (e.g., few measurement moments) by studying the development over three years with a total of six measurement moments.

METHOD

Learning Environment

Students at the Erasmus School of Law enroll in one of the three study programs: Dutch law, tax law or criminology. All programs consist of a three-year Bachelor's program and a one-year Master program. In the Bachelor's program, a total of 180 study point credits (i.e., European Credit Transfer System (ECTS), 60 ECs per year) can be obtained. A total of 16 courses of five weeks are offered in the first and second academic year (eight each year). The third year starts with a minor course (i.e., ten weeks), followed by five courses and a five week period for writing a Bachelor's thesis. Courses are offered in succession and all end with a written examination (i.e., course test). Each course equals 7.5 ECTS, which are earned when a sufficient grade on the exam is obtained (i.e., a score of 5.5 on a ten point scale or higher). When all courses are completed successfully, students acquire a total of 60 credit points at the end of each academic year. It is required at the university under study to earn all 60 credits in the first year in order to be allowed to the second year (Vermeulen et al., 2012). Insufficient grades can, however, be compensated with higher grades on other courses during the first year (e.g., a 5.0 score for a specific course can be compensated with a 7.0 score for another course), as long as a GPA of 5.5 at the end of the year is reached and the obtained grade is not below a 4.0. The number of retakes is restricted to two each academic year. Courses in the first academic year are mainly introductory courses, in which students get familiar with all areas of the law (e.g., Introduction to criminal law). The majority of the courses in the second and third academic year build upon these introductory courses. However, some courses contain new subjects within Dutch law and do not build upon previous courses (e.g., Philosophy of law).

The Bachelor's program at the Erasmus School of Law is entirely problem-based. Small tutorial meetings (of 2.5 hours each) are a key element in the PBL curriculum. Twice a week, students come together in groups of approximately ten to twelve students and a tutor. At the start of each course, the group composition changes. Eight PBL problems are discussed in each course. Students participate in the initial discussion (i.e., pre-discussion about the problem) and the reporting phase (i.e., discussing literature sources and answering learning issues). In between meetings, two to three days of self-study are available. Other activities in the curriculum are practical courses that help students learn how to apply the learned knowledge (e.g., practice court) and lectures that address the topics in a broader sense (i.e., two or three a week).

Participants

Students who enrolled in September 2013 in the first year of one of the study programs (i.e., Dutch law, tax law, and criminology) at the Erasmus School of Law participated in this study. Over three years, students' learning strategies were measured twice a year with a six-month interval, resulting in six trials in total. Students, who filled out the questionnaire five or six times out of the six measurements, were included in the analyses. This resulted in a total of 244 students (35.2% male). Mean age at the first trial was 19.33 year (*SD* = 1.58). Of these participants, 167 students were Dutch law students (68.4%), 29 tax law students (11.9%), and 48 studied criminology (19.7%). This distribution, as well as the male-female distribution, are common at the Erasmus School of Law.

In answering the second (i.e., relation learning strategies and academic performances) and third research question (i.e., dropouts comparing to non-dropouts) also students who dropped out of the academic program were included. Dropouts are defined as students who filled out the questionnaire at *both* the first and second trial and quit the program at the end of the first academic year. This resulted in a total of 52 dropouts (48.1% male). Mean age at trial one of these students was 19.85 (*SD* = 1.66). Thirty-nine dropouts were Dutch law students (75.0%), six were tax law students (11.5%), and seven students studied criminology (13.5%).

Materials

Learning Strategies

Learning strategies were measured with the ILS. The ILS, a self-report questionnaire developed for students in higher education, was used to measure learning strategies (Vermunt, 1998; Vermunt & Van Rijswijk, 1998). Only the first part of the ILS was used and students' conceptions and motives were not included as our focus was on learning strategies. Processing and regulatory strategies are divided into three subscales each. Processing strategies are categorized in: A) Deep processing (11 items), which contain relating, structuring, and critical processing, B) Stepwise processing (11 items), in which the use of memorization, rehearsal, and analyzing is measured, and C) Concrete processing (5 items), which measures whether the learning material is concretized and personalized by the student.

Regulatory processes are divided into D) Self-regulation (11 items), which measures to what degree students control their own learning process, E) External regulation (11 items), which measures to what degree students depend on external resources (e.g., a teacher) for steering and controlling their learning process, and F) Lack of regulation (6 items), which measures whether students experience difficulty in regulating their learning process. In total, the questionnaire contains 55 items. Each item represents a statement of which students need to indicate to what extent each statement fits them. This is measured on a scale of 1 ("I never or hardly do this") to 5 ("I (almost) always do this"). An overview of the subscales including an example item is shown in Table 5.1.

Table 5.1. Example Items of ILS

Learning strategy	Subscale	Example item
Processing Strategies	Deep processing	'I try to combine separately discussed concepts to a whole'
	Stepwise processing	'I rehearse important topics of the learning material till I memorize them'
	Concrete processing	'I use what I learn on a course in my activities outside the study'
Regulation Strategies	Self-regulation	'When I'm having difficulties with parts of the course material, I try to analyze why it is hard for me'
	External regulation	'I study according to the instructions provided by course materials or teacher'
	Lack of regulation	'I admit that I find it difficult to determine whether or not I sufficiently mastered the course material'

Academic performance

Students' grades (i.e., a score between 1.0 and 10.0) for all course tests of the Bachelor's program were retrieved from the university administration. For each student, six mean grades were calculated and included in the analysis: a mean grade was calculated for the courses that were finished by the time the questionnaire was administered. Mean grade 1 is the mean grade of the first and second course of the first year; mean grade 2 is the mean grade of the third till seventh course of the first year; mean grade 3 is the mean grade of the eight course of the first year and the first and second course of the second year; mean grade 4 is the mean grade of the third till seventh course of the second year; mean grade 5 is the mean grade of the eight course of the second year and the minor course (i.e., a course of choice which has the duration of two courses) of the third year; mean grade six is the mean grade of the third till seventh course of the third year. An overview of when the mean grades were calculated is given in Table 5.2.

Procedure

Students filled out the ILS twice each year of the three-year Bachelor's program. In total, they hence received the questionnaire six times. The first measurement moment each academic year was at the first day of the third course (i.e., November). At the start of the eighth and final course of the academic year (i.e., June), the questionnaire was distributed again. Table 5.2 provides an overview of these measurement moments throughout the Bachelor's program. Questionnaires were administered by the tutors during the first tutorial meeting of the course that was given at the time. It took students about 15 minutes to fill out the ILS. Participation was voluntary.

Table 5.2. Overview measurement moments learning strategies and mean grades

	Measurements			
	Learning strategies		Mean grade	
Academic year 1 (Sep 2013 – Jul 2014)	T1	November (2013)	G1	Courses 1.1 - 1.2
	T2	June (2015)	G2	Courses 1.3 – 1.7
Academic year 2 (Sep 2014 – Jul 2015)	T3	November (2014)	G3	Courses 1.8 – 2.2
	T4	June (2015)	G4	Courses 2.3 – 2.7
Academic year 3 (Sep 2015 – Jul 2016)	T5	November (2015)	G5	Courses 2.8, minor
	T6	June (2016)	G6	Courses 3.3 – 3.8

Assessment

Half of the exams that were administered in the three-year Dutch law Bachelor's program were analyzed in the current study. This concerned exams of the first, second, and third year. Exam questions were either multiple-choice (MC) or open-ended. Exams in the first year mostly contained MC questions, while in the third year, exam questions were exclusively open-ended. Exam questions were coded on the level of knowledge that was tested, based on Sugrue's (1993) coding scheme for problem-solving. Sugrue distinguished three levels of problem solving assessment that are linked to different cognitive levels used in problem solving: the understanding of concepts (i.e., knowledge of what a certain concept is), the understanding of principles (i.e., knowledge of the relationship between concepts), and the linking of concepts and principles to conditions and procedures for application. The latter is in line with the highest cognitive level of knowledge structures (Sugrue, 1993). Sugrue's coding scheme was chosen for categorizing the exam questions, because this model is based on problem solving skills. Working with problems and problem solving/understanding play a central role in PBL.

Exam questions of eleven course exams (i.e., four exams of the first year, four exams of the second year, and three exams of the third year) were investigated. In total, 283 exam questions were assessed on the level of knowledge that was tested. One of the authors and a second, independent rater, who graduated in Dutch law, coded three exams based on Sugrue's scheme. Interrater reliability turned out to be rather low, Cohen's kappa = .55. Differences were solved through discussion. Due to the insufficient interrater reliability, both raters assessed again three exams, which resulted in a Cohen's kappa of .70. The remaining exam questions (151 items) were then coded by the first rater only.

Table 5.3. Classification of Knowledge Structure Level of Exam Questions

	Exams		
	First year	Second year	Third year
Number of exam questions	N_{total} = 161 n_{MC} = 120 (74.5%) n_{open} = 41 (25.5%)	N_{total} = 82 n_{MC} = 46 (56.1%) n_{open} = 36 (44.9%)	N_{total} = 40 n_{MC} = 0 (0.0%) n_{open} = 40 (100.0%)
Level of knowledge assessed			
Concepts	n = 108 (67.1%)	n = 40 (48.8%)	n = 13 (32.5%)
Principles	n = 47 (29.2%)	n = 33 (40.2%)	n = 19 (47.5%)
Linking concepts and principles	n = 6 (3.7%)	n = 9 (11.0%)	n = 8 (20.0%)

Table 5.3 shows an overview of the levels of knowledge tested in exam questions each year. In the first year, the focus lies on concepts in the exam questions (i.e., 67.1 %), referring to the lowest level of knowledge. In the second academic year, still about half of the exam questions focus on understanding concepts. In the final year of the Bachelor's program, understanding concepts is the main focus in a third of the exam questions. Questions regarding principles and application of concepts and principles increase over the Bachelor's program. These types of questions require a higher level of knowledge structure. Understanding of principles (i.e., second level) receives most attention in the third year exams. The number of questions regarding application of concepts and principles increases over the years. Still, only about 20.0% of these question types are included in the final year, which is not an excessive increase over the years.

Statistical analyses

Three analyses are conducted in order to answer the three research questions. Regarding the first research question, the development of learning strategies, six Repeated Measures Analysis of Variances (RM-ANOVA's) were applied. Moment of testing (i.e., six levels) served as the within-subject factor and the six subscales of the ILS (i.e., three processing and three regulation strategies) served as dependent variables. To reduce the chance of Type I error, Bonferroni-corrections were applied and results were only considered statistically significant when an alpha level of .008 was reached (.05/6).

To answer the second research question, namely the relationship between learning strategies and academic performance, correlations were calculated between the ILS scores and mean grades at every moment of measuring.

To compare dropouts after the first academic year with students who continued the program (i.e., the third research question) six separate Analysis of Variances (ANOVA's) were conducted with type of student (dropout vs. non-dropout) as between-subject factor and ILS scores as dependent variables. These students were compared at the end of the first academic year and therefore, scores on the second measurement moment were used in the analysis. In order to reduce the chance of Type I error, Bonferroni-corrections were applied and results were only considered statistically significant when an alpha level of .008 was reached (.05/6).

RESULTS

Development of Learning Strategies in PBL

Table 5.4 provides mean item scores of the subscales of the ILS at all trials. In order to visualize the development of PBL students' learning strategies, Figure 5.1 depicts this in a graph. Processing strategies scores will be discussed first, followed by results on regulatory strategies.

Table 5.4. Mean item scores of learning strategies each measurement moments (Standard Deviation in Parentheses)

		T1	T2	T3	T4	T5	T6
Processing strategies	Deep	3.21 (.59)	3.14 (.61)	3.15 (.59)	3.14 (.61)	3.17 (.58)	3.16 (.63)
	Stepwise	3.09 (.60)	3.02 (.59)	3.07 (.54)	3.07 (.58)	3.15 (.61)	3.05 (.62)
	Concrete	2.98 (.66)	3.07 (.68)	3.07 (.66)	3.18 (.65)	3.20 (.65)	3.20 (.61)
Regulatory strategies	Self	2.83 (.62)	2.74 (.64)	2.70 (.61)	2.73 (.62)	2.91 (.57)	2.77 (.65)
	External	3.22 (.51)	3.23 (.50)	3.12 (.50)	3.14 (.48)	3.24 (.43)	3.12 (.46)
	Lack	2.60 (.71)	2.45 (.72)	2.42 (.67)	2.54 (.67)	2.50 (.63)	2.52 (.69)

Note. $N = 241$
Range: 1 – 5

No effect of time on deep processing was present, $F(5,1200) = 1.04$, $p = .391$. A small statistically significant effect of time was found for stepwise processing, $F(5,1200) = 3.23$, $p = .007$, partial $\eta^2 = .01$. Bonferroni's post-hoc tests showed that stepwise processing at T5 was significant higher than scores at T2 ($t(240)= 3.82$, $p = .002$, $r = .24$), and scores at T6 ($t(240) = 2.97$, $p = .049$, $r = .19$). A small effect of time was also present for concrete processing, $F(5,1200) = 9.53$, $p < .001$, partial $\eta^2 = .04$. Post-hoc tests indicated that scores on concrete processing at T1 were significantly lower than at T4 ($t(240) = -4.56$, $p < .001$, $r = .28$), T5 ($t(240) = -4.68$, $p < .001$, $r = .29$), and T6 ($t(240)= -4.80$, $p < .001$, $r = .30$). Concrete processing scores at T2 were also significant lower compared to T5, $t(240) = -3.05$, $p = .035$, $r = .19$. Further, concrete processing scores at T3 were lower than scores on T5 ($t(240) = -3.21$, $p < .001$, $r = .20$), and T6 ($t(240) = -3.22$, $p < .001$, $r = .20$). In short, these results show no change in deep processing over time, a small increase in stepwise processing, followed by a small decrease at the end of the program, and an increase in concrete processing over the course of higher education.

With regards to regulatory strategies, a small effect of time on self-regulation was found, $F(5,1200) = 8.79$, $p < .001$, partial $\eta^2 = .04$. Post-hoc tests showed a decrease of self-regulation from T1 to T3, ($t(240) = 3.42$, $p = .011$, $r = .22$). Further, scores of self-regulation were higher on T5 compared to T2 ($t(240) = 4.70$, $p < .001$, $r = .29$), T3 ($t(240) = 5.68$, $p < .001$, $r = .34$), T4 ($t(240) = 5.51$, $p < .001$, $r = .34$), and T6 ($t(240) = 4.15$, $p = .003$, $r = .26$). Also for external regulation a small effect of time was found, $F(5,1200) = 6.61$, $p < .001$, partial $\eta^2 = .03$. Bonferroni's post-hoc tests showed that external regulation scores at T1 were higher than T3 ($t(240) = 3.29$, $p = .015$, r = .21) and T6 ($t(240) = 3.00$, $p = .044$, $r = .19$). Scores at T2 were higher than scores of external regulation at T3 ($t(240) = 3.58$, $p = .006$, r = .23), T4 ($t(240) = 3.00$, $p = .046$, $r = .19$), and T6 ($t(240) = 3.26$, $p = .020$, $r = .21$). Also, external regulation appeared higher at T5 compared to T4 ($t(240) = 3.28$, $p = .018$, $r = .21$) and T6 ($t(240) = 3.87$, $p = .002$, $r = .24$). A statistically significant effect of time was also found for lack of regulation, $F(5,1200) = 4.28$, $p = .001$, partial $\eta^2 = .02$. Post-hoc tests pointed out that lack of regulation scores were higher at T1 compared to T2 ($t(240) = 3.20$, $p = .025$, $r = .20$) and T3 ($t(240) = 3.85$, $p = .002$, $r = .24$).

In sum, the development of regulatory strategies demonstrate the following pattern: a decrease in self-regulation, followed by a small increase later in the Bachelor's program and again a small drop at the end of the third year. External regulation shows a similar pattern: a decrease in external regulation, followed by an increase, and a decrease again at the end of the Bachelor's program. Lack of regulation demonstrated a drop at the beginning of the Bachelor's program and this remains till the end of the program.

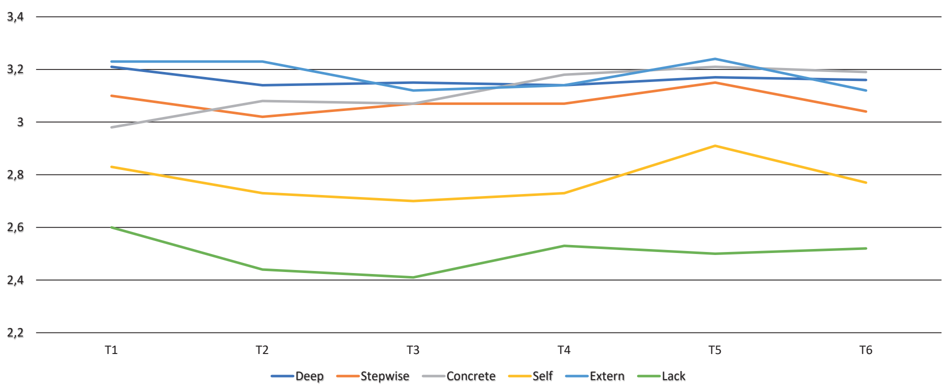

Figure 5.1. Development of Learning Strategies in PBL

Relationship Learning Strategies and Academic Performance

Table 5.5 provides the correlations between learning strategies and mean grades at each measurement moment. The majority of the learning strategies appeared unrelated to academic performances. The only statistically significant correlations for processing strategies were found between stepwise processing and mean grade at T2 and T3 (respectively, $r = -.12$, $p = .046$; $r = -.14$, $p = .032$). Both correlations are negative, meaning that a higher score on stepwise processing is related to a lower mean grade. However, these correlations should be considered as small.

Regarding regulation strategies, significant correlations with mean grades and lack of regulation showed up at almost all measurement moments (T1: $r = -.18$, $p = .002$; T2: $r = -.21$, $p < .001$; T3: $r = -.17$, $p = .007$; T4: $r = -.18$, $p = .006$; T6: $r = -.20$, $p = .002$). These correlations can be considered small and negative, meaning that high scores on lack of regulation are linked to low academic performance. The other regulatory strategies did not have statistically significant correlations with academic performance.

Table 5.5. Pearson Correlations between Learning Strategies and Mean Grade at each Measurement Moment

		T1 (*N*=296)	T2 (*N*=296)	T3 (*N*=244)	T4 (*N*=244)	T5 (*N*=244)	T6 (*N*=244)
		Mean grade					
Processing strategies	Deep processing	.01	.10	.09	.03	-.02	.06
	Stepwise processing	-.09	-.12*	-.14*	-.06	-.05	-.02
	Concrete processing	-.04	.00	-.11	-.11	-.01	.06
Regulation strategies	Self-regulation	-.05	.04	.02	.01	-.01	.07
	External regulation	-.04	-.00	-.01	.00	-.03	.01
	Lack of regulation	-.18*	-.21**	-.17*	-.18*	-.04	-.20*

Note. ** $p < .001$; * $p < .05$

Drop-out Analysis

Mean scores on the subscales of the ILS for students who continued the academic program and students who dropped out after the first academic year are displayed in Table 5.6. These are the scores of the second trial (T2), measured at the end of the first year. Separate ANOVA's only showed a statistically significant effect of dropout on the scale lack of regulation, $F(1,294) = 12.77$, $p < .001$, partial $\eta^2 = .04$. There was no effect present on any of the processing strategies (deep processing: $F(1,294) = .06$, $p = .806$; stepwise processing: $F(1,294) = .48$, $p = .490$; concrete processing: $F(1,294) = .06$, $p = .808$), nor on self-regulation and external regulation (respectively $F(1,294) = 1.01$, $p = .315$, $F(1,294) = 1.02$, $p = .313$).

Table 5.6. Mean item scores on the subscales of learning strategies for drop-outs and students who continue on the second measurement (T2) (Standard Deviation in parentheses)

Learning strategy	Subscale	Non-Dropouts (*N*=244)	Dropouts (*N*=52)
Processing strategies	Deep processing	3.14 (.61)	3.16 (.60)
	Stepwise processing	3.02 (.59)	3.08 (.54)
	Concrete processing	3.08 (.68)	3.10 (.60)
Regulation strategies	Self-regulation	2.73 (.64)	2.83 (.67)
	External regulation	3.23 (.49)	3.16 (.47)
	Lack of regulation	2.44 (.71)	2.84 (.77)

DISCUSSION

Deep processing and self-regulation are desirable learning strategies in higher education. PBL is a student-centered instructional method that is assumed to stimulate these strategies. The present study investigated the development of law students' learning strategies over the course of a three-year PBL program at the Erasmus School of Law. In addition, the association between learning strategies and academic performance was studied, as well as the differences in learning strategies between students who dropped out after the first academic year and those who continued the academic program. Results are discussed below.

Development of Learning Strategies

Processing Strategies.

Regarding the development of processing strategies, deep processing showed no change over time and stepwise processing increased slightly at first and decreased slightly at the end of the Bachelor's program. No change of deep processing is in line with some previously conducted longitudinal studies (Rodriguez & Cano, 2007; Severiens et al., 2001; Zeegers, 2001). Moreover, the review of Asikainen and Gijbels (2017) shows that the pattern of development of deep learning in higher education is still inconclusive. However, it was expected that deep processing would increase and stepwise processing would decrease in a PBL program. A possible explanation might lie in the exams used in the curriculum under study, which could influence the use of students' learning strategies (Baeten et al., 2010; Gijbels, Van de Watering, et al., 2005).

After analyzing a selection of exams from the Bachelor's program, the number of questions focusing on simple level knowledge structures (e.g., concepts) appeared rather high. In the first year, the majority of exam questions focused on understanding of concepts. In the third year this was still the case for about a third of the exam questions. One could argue that considering the high number of these types of exam questions, stepwise processing is still a useful learning strategy in a later phase of the Bachelor's program. This might explain why there is no large decline in the use of stepwise processing. Moreover, questions regarding the application of concepts and principles (i.e., highest level of Sugrue's model) showed a small increase over the course of the Bachelor program's, but these types of questions remain underrepresented in the curriculum under study. Hence, deep learning is not always required, which could provide an explanation why deep processing is not improving over the three academic years. It should be noted that a lack of change in deep processing could also be ascribed to the already high scores on deep processing from the start of the program. Still, there is room for improvement of deep processing.

The area of study or academic discipline could also offer an explanation here (Baeten et al., 2010). Vermunt (2005) found that Dutch law students reported more use of stepwise processing and external regulation than students in other disciplines (e.g., Psychology, Arts, and Economics). This could indicate that the course materials in Dutch law do not always require deep processing, but can also be managed with stepwise processing. Moreover, this would further explain why the exams in all three academic years contain many questions with a focus on concepts (i.e., low level of knowledge in Sugrue's model).

Finally, a small increase over time in the use of concrete processing was shown, meaning that students apply learned knowledge more often to practice as they progress in their academic program. An increase of concrete processing is in line with the goals of PBL. In PBL, students work with authentic, ill-defined problems. These problems relate to real-life situations that students can encounter later in their professional life. PBL claims that when students learn in a realistic context during their academic program, they will be better able to apply the knowledge in a similar situation (Schmidt, 1983).

Regulatory Strategies.

Self-regulation was expected to increase in the three years of the PBL program under study, because in PBL, students need to plan their own study time, select their own literature, and evaluate what they have learned (Schmidt, 2000). However, results of the present study showed a different pattern: self-regulation decreased over the first two years, then increased at the beginning of the third year, and decreased again at the end of the program. Although this specific pattern is hard to explain, it shows that there is no steady increase of self-regulation, as was expected. One explanation is that the PBL aspects, which are assumed to stimulate self-regulation in theory, are not always present in practice or that external factors to rely on are more often present than they should (e.g., a tutor who provides too many instructions during meetings). An encountered issue in PBL practice is that some students appear to be actively involved, while in reality students do not always learn optimal from it (e.g., when students read the literature, but do not understand it and are not able to connect concepts; Dolmans, Wolfhagen, Van der Vleuten, & Wijnen, 2001; Dolmans, De Grave, Wolfhagen, & Van der Vleuten, 2005).

As a consequence, the tutors in PBL might be frustrated and instead of asking more in-depth questions, they provide students with more guidance than is actually intended to in PBL (e.g., give learning issues or lectures in tutorial groups; Dolmans et al., 2001; Dolmans et al., 2005). Self-regulation activities are not stimulated this way while external regulation is. In short, how PBL is implemented and executed could play a major role in how students act in their learning process.

The high scores on external regulation among Dutch law students found in this study are in line with previous research findings (Vermunt, 2005; Wijnen, Loyens, Smeets, Kroeze, & Van der Molen, 2017). Furthermore, Liddle (1999) showed that after following a course in PBL, law students still preferred clear directions, guidance, and teachers explaining information in the learning environment. Despite the high rates of external regulation, external regulation seems to decline a bit over the years (with exception of the beginning of the third year).

Lack of regulation reduced over the program. This indicates that over the course of a three-year PBL program, students experience less difficulty in steering and controlling the learning process, either by themselves or by depending on external factors. Other longitudinal studies found a similar decrease of lack of regulation over time in higher education (Donche et al., 2010; Donche & Van Petegem, 2009; Vermetten et al., 1999). This indicates that when students gain experience with studying, they get clearer ideas about how to manage the learning process. A decrease in lack of regulation is positive in terms of learning outcomes, as was shown in this study and on which we will elaborate below.

Striking are the scores of both processing and regulatory strategies on the fifth trial (i.e., start of the third year). Stepwise processing, self-regulation, and external regulation are relatively high compared to scores on the other trials. A possible explanation for this is the course students followed right before filling out the questionnaire. Students participated in a so called minor, which is an elective course that can either be more in-depth of an area within legal education, or broader in nature, such as a course in another discipline. Only a limited number of minors are offered in a PBL format. The majority of minors contained different educational formats (e.g., lectures and large work groups). The sudden change in instruction style right before the fifth trial might explain the changes in learning strategies.

Relationship between Learning Strategies and Academic Performance

The current study only showed a few statistically significant correlations between learning strategies and academic achievement. Concerning processing strategies, only stepwise processing was small and negatively related to mean grades on the second and third trial. This means that a higher score on stepwise processing is related to a lower grade at the end of first and the beginning of the second academic year. This result is in line with previous studies (Lindblom-Ylänne & Lonka, 1999; Richardson et al., 2012; Zeegers, 2001). However, it was expected that deep processing would be related to academic performance, based on prior studies (Boyle et al., 2003; Lindblom-Ylänne & Lonka, 1999; Richardson et al., 2012; Zeegers, 2001). Again, assessments used in the curriculum could provide an explanation here. As was demonstrated, deep processing is not so much required in exams as is the case for concrete processing. Mainly questions at the conceptual level were present in exams.

Self-regulation and external regulation were not related to academic performance, which contradicts earlier studies demonstrating positive associations between self-regulation and performance (Boyle et al., 2003; Richardson et al., 2012). It is, however, demonstrated that when students have difficulties with regulation at all (i.e., lack of regulation), this is related to achievement. Students with a high lack of regulation are clueless in what they need to do during studying, which is connected to lower achievement. In short, it shows that if students are able to regulate their learning, either by themselves or by external factors, it is not related to how they perform. However, when students have difficulty in regulating their study activities, a relationship with academic performance can be expected.

Drop-out

In line with the correlations found between academic performance and learning strategies, lack of regulation was the only strategy associated with dropping out. Students who dropped out of the academic program after the first year showed higher scores on lack of regulation. Again, whether regulation depends on oneself or on external factors does not seem to matter for performing and academic success, but the presence of regulation itself is crucial. If one has difficulties with regulation of processing strategies, it is detrimental for one's study progress.

LIMITATIONS

A limitation of the present study is that measurements of learning strategies were based on self-report. A disadvantage here is that not actual learning strategies were measured, but how students *think* they learn. In addition, students can answer in a socially desirable way, however instructions indicated that there are no correct or incorrect answers. Still, since learning is an internal process, self-reports seem to be the best way of investigating this. Despite this limitation, we believe that the longitudinal character of this study (i.e., over the course of a complete three-year Bachelor's program with six measurement moments) is a strength.

Even though the findings showed that deep processing and self-regulation were not associated with academic performance and study progress, these strategies are still desirable in higher education and these strategies should be stimulated. Whether or not the use of these strategies are reflected in grades, educational institutions aim to create deep instead of surface understanding in students. This because, after university, students need to be able to apply their knowledge in practice and regulate their own learning processes, as learning continues in the professional life.

CONCLUSIONS

The present study showed that deep processing and self-regulation did not increase over the course of a three-year PBL program. Assessments, as well as the presence of other external factors (e.g., tutor who provides too much instructions) could provide an explanation for the present findings. Further, it was shown that students relate more knowledge they have learned to practical cases (i.e., concrete processing) in the course of their program. Working with authentic problems seems to help in relating material to real-life situations. Additionally, lack of regulation decreases over the years, meaning that students tend to experience less difficulties with regulating their learning process. This appeared to be beneficial for academic performance and study progress.