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Overige leden:	Prof.dr. H.A.P. Pols Prof.dr. H.G. Schmidt Prof.dr.ir. A.P.N. Themmen

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1 Introduction to student achievement in medical school

Introduction

In the Netherlands, it is assumed that students who have fulfilled successfully their pre-university education are capable to complete a study at the university. Not every student is allowed to enroll for each study at the university, as for some studies it is required to have studied successfully certain subjects during pre-university education. For example, to apply for medical school required subjects are Mathematics, Physics, Chemistry and Biology and at least three other ones. Despite abovementioned positive expectations and pre-requisites, still a considerable amount of students does not complete their studies. For example, in the behavioural and technology sciences 50-60% of the students fails (Van den Berg & Hofman, 2005). In that regard, medical students are a positive exception (Parkhouse, 1996; McManus, 1996), which is supported by retrospective data over the past 15 years in our medical school. The data shows that an average of about 13 percent does not complete their study within 10 years after the start (unpublished observation).

Student achievement is the resultant of a very complex interaction between a range of student-related factors such as ability, motivation, ambition, study skills, learning styles, personality traits, and time spent on study-related activities, curriculum-related factors such as teaching methods, examination methods and ways of supporting students, and social environment related factors such as time students spend hanging out with peers (Walberg, 1981). Insufficient achievement is due to a mismatch between the student and the learning environment. The causes of a mismatch are probably multiple and diverse. For example, it is possible that students' cognition is still too low for a specific study and / or students' motivation is insufficient and / or the interaction between the student and the learning environment is not optimal.

In order to give any student a fair chance to complete a study successfully at a proper level and in a proper time we should be able to predict correctly how students will achieve in distinctive study phases in medical school. It is in particular important to identify early and reliably which students will fail to complete their study and why. Such an early identification may create the possibility to refer those students to another study or to offer them corrective measures to solve their mismatch with the learning environment. Moreover,

it is important to investigate why the achievement of some students improves at the transition of study phases and that of others gets worse leading to retardation. More insight into causes of changes in performance may create the opportunity for selecting students on rational ground and adapting the learning environment selectively.

Factors related to student achievement for entire cohorts or groups

So far, many studies have been conducted to investigate the impact of factors related to the student, the curriculum and the social environment on student achievement. It has been shown that some of the student-related factors such as learning styles and time spent on study-related activities have a limited or equivocal relationship with student achievement (Ferguson, James & Madely, 2002; Leiden, Crosby & Follmer, 1990; Lynch, Woelfl, Steele & Hanssen, 1998; Bussato, Prins, Elshout & Hamaker, 2000; van der Hurk, Wolfhagen, Dolmans & van der Vleuten, 1998; Schuman, Walsh, Olson & Etheridge, 1985). The impact of other student-related factors such as motivation, ambition, ability and some of the personality traits seems to be larger (Sobral, 2004; Nonis & Wright, 2003; McManus, Powis, Wakeford, Ferguson, James & Richards, 2005; Lievens, Coetsier, de Fruyt & de Maeseneer, 2002; Ferguson, James, O'Hehir & Sanders, 2003; Shen & Comrey, 1997). With respect to curriculum-related factors, the direct relationship with teaching methods seems to be limited (Albanese & Mitchell, 1993), whereas some social environment factors such as the time students spend hanging out with peers seem to have a negative relationship (Jordan & Nettles, 2000).

To date, it has been shown that previously attained Grade Point Average scores (GPAs) are the best predictors for subsequent achievement (Salvatori, 2001; Norman, 2004; Gottheil & Michael, 1957; Kulatunga-Moruzi & Norman, 2002). Maybe, this is not very surprising, as those GPAs also represent the outcome of an interaction between the student, the learning environment and the social environment. Therefore, pu-GPA, students' Grade Point Average for the final examination of pre-university education, is the strongest predictor for student achievement in medical school (Salvatori, 2001; Norman, 2004; Gottheil & Michael, 1957; Kulatunga-Moruzi & Norman, 2002; Cohen-Schotanus, Muijtjens, Reinders, Agsteribbe, Van Rossum & Van der Vleuten, 2006). In most studies, pu-GPA seems to explain sixteen to twenty-five percent of the variance in students' achievement during the pre-clinical years (Salvatori, 2001). Although the relationship between pu-GPA and achievement in the earlier years of medical school seems to be rather strong (Mitchell, 1990; Peat, Woodbury & Donner, 1982), the relationship between pu-GPA and clinical performance seems to be much weaker. For example, in

the study of Peat et al. (1982) only nine percent of clinical performance could be explained by pu-GPA. This decrease in the predictive value of pu-GPA is probably caused by an accumulation of changes in student achievement due to consecutive changes in the learning environment. Students undergo three important study phase transitions, i.e. from pre-university education to the first year in medical school, from the first year to pre-clinical years 2-4, and from pre-clinical years 2-4 to clinical years 5-6. The former transition can be stressful, as many students are leaving home for the first time, and academic work is often more difficult and more voluminous than during pre-university education (Baker & Siryk, 1986; Pratt, Hunsberger, Pancer, Alisat, Bowers, Mackey, Ostaniewics, Rog, Terzian & Thomas, 2000; Levitz & Noel, 1989). In addition, in university classes tend to be big and impersonal, students have to organize their own learning and have to establish and maintain new social relationships. The transition from the first year to the remaining three pre-clinical years seems to be easier, as the focus in both parts is on the acquisition of integrated basic and clinical knowledge and as teaching methods are more or less the same. And, the transition from the pre-clinical years 2-4 to the clinical phase may again be more difficult, since students may have problems in bridging the gap between the theoretical and practical phase of the curriculum (Prince, van de Wiel, Scherpbier, Van der Vleuten & Boshuizen, 2000).

Are prognostic factors valid for entire cohorts or groups?

In most studies conducted so far, relationships between predictive factors on one side and student achievement on the other were sought for entire cohorts or groups of students with common characteristics. However, it has been shown that the predictive value of some of the abovementioned factors for achievement in medical school may be very different for subgroups of students.

For example, Van den Hurk, Wolfhagen, Dolmans and Van der Vleuten (1998) did not find a clear relationship between time spent on individual study and academic achievement for an entire group of students. This may be due to the heterogeneous composition of the entire group. It is very well possible that within the group of high performing students those who need less time for individual study obtain the same or even higher grades than those who work very hard. It is also possible that within the group of low performing students those who work hard obtain higher grades than those who put little effort into their study. Due to this diversity, the relationship between time spent on individual study and achievement may be absent for an entire

group of students. However, it may still be present for certain subgroups of students.

Also in other studies it was demonstrated that relationships, which were found for entire groups or cohorts, could be different for subgroups. For example, Koenig, Sireci and Wiley (1998) and Lynch and Schneider (2000) demonstrated that the predictive value of pu-GPA for subsequent achievement may be different for students from an ethnic minority group. Chan-Ob and Boonyanaruthee (1999) demonstrated that the same might be true for students who used English as a second language. And also in the admission policy of medical schools in the Netherlands, the diversity of the student population is taken into account. Students with a pu-GPU of 8 or higher on a scale ranging from 5.5 to 10.0 are directly admitted to medical school, as it has been shown that those students had only a very small chance of failing to complete their study (Commissie Toelating Numerus Fixusopleidingen, 1997). Students with a pu-GPA between 5.5 and 8.0 are enrolled into a weighted lottery system, in which the chance of selection rises along with the pu-GPA. There are four different lottery categories defined as: $7.5 \leq$ pu-GPA < 8.0; $7.0 \leq$ pu-GPA < 7.5; $6.5 \leq$ pu-GPA < 7.0; and $5.5 \leq$ pu-GPA < 6.5. The ratio by category for admission is, respectively, 9:6:4:3 (Urlings-Strop, Stijnen, Themmen & Splinter, 2009). The lottery system is based on the observation that the size of pu-GPA between 5.5 and 8.0 is moderately correlated with pre-clinical achievement in medical school (Commissie Toelating Numerus Fixusopleidingen, 1997). This indicates that after a transition from one study phase to the other there is a large variation in students' achievements and that some high performers become low performers after a transition and/or vice versa.

Hypothesis

Based on abovementioned studies it is obvious that from pre-university education till graduation the achievement of students may be constant or change in time. The interaction between the student, the learning environment and the social environment may provoke superior achievement or seriously inhibit superior capabilities. It is hypothesized that the more heterogeneous the population of students and / or the environments are, the larger the differences between students' achievements, varying from very positive to very negative. Heterogeneity has a profound negative effect on the predictive value of any characteristic. To obtain insight into factors, which lead to improvement or worsening of students' achievements, the outcomes of the interactions between more homogeneous groups of students and better-defined learning environments are needed.

Objectives

The goal of the studies in this thesis is to find factors to predict more reliably which subgroups of students will encounter what kind of problems in which study phase. To that purpose, the relationship between factors related to the student, the curriculum and the social environment on one side and student achievement on the other is investigated for both distinctive study phases and for more homogeneous subgroups of students.

It is well-known that worldwide the output of medical education is much better than that of other branches of study (Van den Berg & Hofman, 2005; McManus, 1996). Thus, there is no urgent need at the managerial level to improve it. The fact that the high output is a widespread phenomenon, seeming independent of race, culture and learning environment indicates that medical students form a rather homogeneous population. Therefore, they probably are a more useful population to investigate factors, which influence achievement, than other students. The outcome of the studies in this thesis should be applied to other branches of study, which are more in need of improvement of output.

Present studies

In Chapter 2 of this thesis, it is reported whether the size of the relationship between GPAs of different study phases is dependent on the nature of the study phase transition and / or students' level of achievement before a transition. The relationships between pu-GPA, pre-clinical year 1 GPA, pre-clinical years 2-4 GPA and the GPA of the clinical phase are investigated for both an entire group of 327 students who have completed medical school and also for two subgroups of these students, which are distinguished by their GPA level below or above the mean in the preceding study phase.

It is shown that the size of the relationship between GPAs of distinctive study phases is inversely related to the size of the change in the learning environment. Moreover, it is demonstrated that significant differences in the relationship between GPAs of different study phases exist between students with a GPA below the mean in the preceding study phase and those with a GPA above it.

Since it is shown in Chapter 2 that the pu-GPA below the mean has no predictive value at all for the achievement in the first year in medical school, other factors are sought. In Chapters 3 and 4, the development of a model is described to predict at an early stage and in a reliable way whether students will fail to pass the first-year curriculum within two years of study. Such an early

and reliable prediction is meant to create the possibility of a short remedial support programme or referral to another study.

In Chapter 3, a model is reported for the early and reliable prediction of those who will fail to pass the first-year curriculum within two years of study. Data on pre- and post-admission variables are collected from 1819 students of 5 consecutive cohorts (2001-2005). By logistic regression analyses, predictions for failing to pass the first-year curriculum are made at 0, 4, 6, 8, 10 and 12 months in the first year.

It is shown that pre-admission variables such as pu-GPA and gender do not contribute significantly to both the predictive model for the 5 cohorts together and to that for each cohort separately. Furthermore it is shown that students who pass all exams at 4 or 6 or 8 months in medical school (so-called optimals) have a chance of 99% of passing the first-year curriculum within two years of study. Within the group of non-optimals, at 6 months, failure to pass the first-year curriculum can be predicted with a specificity of 66.7% and a sensitivity of 84.5% by using the variable 'passing no exams between 4 and 6 months'. Specificity increases from the start until 6 months and remains constant afterwards.

In the study described in Chapter 4 it is explored whether other factors can help to improve the model that is described in Chapter 3. A questionnaire measuring student participation in study-related activities, aspects of learning competence, intrinsic motivation, integration, discipline and time management, satisfaction with elements of the learning environment and personal circumstances is administered to 129 students of cohort 2006 who suffered from serious study delay at 4 months in medical school. By logistic regression analysis it is shown that a lack of student participation in the optional plenary lectures during the first four months may help to improve slightly the prediction at 6 months of those who will fail to pass the first year.

In summary, it seems that the risk of failure during the first year of study can mainly be predicted by student achievement during the first 6 months in medical school and slightly by students' attendance at the optional plenary lectures during the first 4 months.

Chapters 5 through 7 are part of a broad exploratory study, in which we want to find indications for pre-clinical year 1, the subsequent pre-clinical years 2-4 and the clinical phase, which factors in addition to students' previously attained GPAs are related to the achievement of students with a GPA below or above the mean in the preceding study phase.

A questionnaire is administered to 107 students who have completed medical school. They are asked to look back on the three distinctive study phases

(year 1, pre-clinical years 2-4, clinical phase) and to respond for each study phase to 22 closed-ended items measuring aspects of their adaptation to the learning environment, intrinsic and extrinsic motivation, satisfaction with elements of the learning environment, time spent on study-related activities, and aspects of the social environment. Moreover, in an open-ended item, students are challenged to report other factors, which in their opinion may have affected positively or negatively their GPA in each of the distinctive study phases in comparison with the preceding study phase. Step-wise multiple linear regression analyses are used to investigate the additional value of the factors in order to explain the variance of students' GPAs in the three distinctive study phases.

In the study described in Chapter 5, data from Chapter 2 is confirmed that for students with a GPA below the mean during pre-university education pu-GPA has no predictive value at all for their achievement in the first year. For this group, aspects of intrinsic motivation (37%), membership of a students' social club (6%) and aspects of extrinsic motivation (6%) explain 49% of the variance in year 1 GPA. In contrast, for students with a pu-GPA above the mean, pu-GPA is strongly related to year 1 GPA (44% explained variance) and aspects of extrinsic motivation help to raise the explained variance with another 10%.

In Chapter 6, it is reported that for students with a year 1 GPA below the mean, year 1 GPA (21%), aspects of students' adaptation to the learning environment (15%) and membership of a students' social club (6%) together explain 42% of the variance in year 2-4 GPA. For students with a year 1 GPA above the mean, year 1 GPA is a very strong predictor for year 2-4 GPA (60% explained variance) and students' satisfaction with elements of the learning environment adds another 6% to the explained variance.

In Chapter 7, it is shown that for students with a year 2-4 GPA below the mean, year 2-4 GPA is moderately related to the GPA of the clinical phase (explained variance of 19%). None of the other factors helps to raise the explained variance. For students with a year 2-4 GPA above the mean, 20% of the variance in the GPA of the clinical phase can be explained: 15% by aspects of students' adaptation to the clinical learning environment and only 5% by year 2-4 GPA.

In summary, it is shown in Chapters 5 through 7 that factors related to student achievement vary a lot between both distinctive study phases and subgroups of students. Such data indicates that care is needed in the interpretation of predictive factors for heterogeneous groups of students under heterogeneous circumstances.

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2 Relationship between Grade Point Average scores of different study phases as a function of the nature of a study phase transition and students' level of achievement before a transition

Gerard J.A. Baars[1], Paul F. Wimmers[2], Theo Stijnen[3] & Ted A.W. Splinter[4]

Abstract

Background In has shown that previously obtained Grade Point Average scores (GPAs) are the best predictors for subsequent achievement in medical school. However, the relationship between GPAs of subsequent study phases may be dependent on the size of changes in the learning environment and may differ between subgroups of students.

Objective To investigate whether the size of the relationship between Grade Point Average scores (GPAs) of different study phases is dependent on the nature of a study phase transition and /or students' level of achievement before a transition.

Methods For 327 students, GPAs of four subsequent study phases, i.e. pre-university education, year 1 in medical school, pre-clinical years 2-4 and clinical phase, were collected. By conducting bivariate linear regression analyses, the relationship between GPAs of subsequent study phases was investigated for both the entire group and for subgroups with a level of achievement below or above the mean in the preceding study phase.

Results The relationship between the GPAs of pre-university education and year 1 was .58 for the entire group, .67 for those with a pre-university education GPA above the mean, but a non-significant .22 for those with a pu-GPA below it. Similarly, the relationship between the GPAs of year 1 and

1 Erasmus University Rotterdam, Risbo; Erasmus MC, Department of Medical Education and Research, the Netherlands
2 School of Medicine, University of California, Los Angeles (UCLA), USA
3 Leiden University Medical Center, Department of Medical Statistics and Bioinformatics, the Netherlands
4 Erasmus MC, Department of Internal Medicine, the Netherlands

pre-clinical years 2-4 was .75 for the entire group, .96 for those with a year 1 GPA above the mean, but only .34 for those with a year 1 GPA below it. However, the relationship between GPAs of the pre-clinical years 2-4 and the clinical phase was .45 for the entire group and .55 and .53 for those with a year 2-4 GPA below and above the mean, respectively.

Conclusions The size of the relationship between GPAs of different study phases seems to be dependent on both the nature of a study phase transition and students' preceding GPA-level. Therefore, investigation of factors that may influence student achievement at the transition of study phases should take both factors into account.

Introduction

Student achievement is the resultant of a very complex interaction between a range of student-related factors such as ability, motivation, ambition, study skills, learning styles, personality traits, and time spent on study-related activities, and external factors such as elements of the learning environment and aspects of the social environment. Some of these factors such as learning styles (Ferguson, James & Madely, 2002) and teaching methods (Albanese & Mitchell, 1993) seem to have a limited or equivocal relationship with student achievement, whereas others such as motivation, and ambition seem to be stronger related (Sobral, 2004; Nonis & Wright, 2003).

Since students' Grade Point Average for the final examination of pre-university education (pu-GPA) is the resultant of such an interaction before medical school, it is not surprising that it has the strongest relationship with student achievement in medical school (Salvatori, 2001; Norman, 2004; Gottheil & Michael, 1957; Kulatunga-Moruzi & Norman, 2002; Cohen-Schotanus, Muijtjens, Reinders, Agsteribbe, Van Rossum & Van der Vleuten, 2006). In most studies, pu-GPA explains sixteen to twenty-five percent of the variance in achievement during the pre-clinical years (Salvatori, 2001). Although the relationship between pu-GPA and achievement in the earlier years of medical school seems to be rather strong (Mitchell, 1990; Peat, Woodbury & Donner, 1982), the relationship between pu-GPA and clinical performance seems to be much weaker. For example, in the study of Peat et al. (1982) only nine percent of clinical performance could be explained by pu-GPA.

The decrease in the size of the relationship between pu-GPA and the GPAs of subsequent study phases in medical school is probably caused by an accumulation of changes in student achievement due to changes in the learning environment. Students undergo three important study phase transitions, i.e. from pre-university education to the first year in medical school, from the first year to pre-clinical years 2-4, and from pre-clinical years 2-4 to

the clinical phase (years 5-6 in medical school). The former transition can be stressful, as many students are leaving home for the first time, and academic work is often more difficult and more voluminous than during pre-university education (Baker & Siryk, 1986; Pratt, Hunsberger, Pancer, Alisat, Bowers, Mackey, Ostaniewics, Rog, Terzian & Thomas, 2000; Levitz & Noel, 1989). In addition, in university classes are big and impersonal, students have to organize their own learning and have to establish and maintain new social relationships. The transition from the first year to the remaining three pre-clinical years seems to be easier, as the focus in both parts is on the acquisition of integrated basic and clinical knowledge and as teaching methods are more or less the same. And, the transition from the pre-clinical years 2-4 to the clinical phase may again be more difficult, since students may have problems in bridging the gap between the theoretical and practical phase of the curriculum (Prince, Van de Wiel, Scherpbier, Van der Vleuten & Boshuizen, 2000).

In abovementioned studies, correlations were sought for entire cohorts or groups of students with common characteristics. However, it has been shown that the predictive value of pu-GPA may be different for subgroups of students such as those of ethnic minority groups (Koenig, Sireci & Wiley, 1998; Lynch & Schneider, 2000) and those who used English as a second language (Chan-Ob & Boonyanaruthee, 1999). In the Netherlands, students are admitted to medical school by a weighted lottery system, in which the chance of selection rises along with the pu-GPA. There are four different lottery categories defined as: $7.5 \leq$ pu-GPA < 8.0; $7.0 \leq$ pu-GPA < 7.5; $6.5 \leq$ pu-GPA < 7.0; and $5.5 \leq$ pu-GPA < 6.5. The ratio by category for admission is, respectively, 9:6:4:3 (Urlings-Strop, Stijnen, Themmen & Splinter, 2009). The lottery system is based on the observation that the size of pu-GPA is moderately correlated with the preclinical achievement in medical school, indicating a large variation in students' achievements after transition from one study phase to the other (Commissie Toelating Numerus Fixusopleidingen, 1997).

It is our hypothesis that the larger the difference is between subsequent study phases, the lower the relationship between achievements in each of these phases. Moreover, decrease of the relationship indicates that some high performers become low performers and / or vice versa.

Therefore, the goal of this study is to investigate whether the size of the relationship between GPAs of different study phases is dependent on the nature of a study phase transition and / or students' level of achievement before a transition. To that end, by conducting linear regression analyses, we determined the relationships between pu-GPA, year 1 GPA, pre-clinical years 2-4 GPA and the GPA of the clinical phase for both an entire group of 327 medical students and for two subgroups with a GPA-level below or above the mean, respectively, in the preceding study phase.

Methods

Setting

This study was conducted at Erasmus medical school in Rotterdam, the Netherlands. Its curriculum consisted of four pre-clinical years and two clinical years. The pre-clinical years were aimed at providing students integrated basic and clinical knowledge. In the clinical years, the focus was on the acquisition of problem-solving and practical clinical skills.

From pre-university education through medical school, students underwent three important study phase transitions, i.e. the transition from pre-university education to the first year in medical school, from the first year to the remaining three years of the pre-clinical phase, and from the pre-clinical years 2-4 to the clinical phase (years 5 and 6).

The first year of the pre-clinical phase fulfilled a special function and was also meant for orientation and selection. During this year, seventeen courses were offered, such as anatomy, biochemistry, and molecular biology. Teaching methods included plenary lectures, practicals, patient demonstrations, and practical clinical skills training. Students who did not complete successfully the entire first-year programme within two years after registration were not allowed to continue their study. Teaching methods in the remaining three pre-clinical years, which comprised 31 courses, resembled very much those of the first year, although more and more clinical themes such as patient demonstrations and case discussions were included. The clinical phase was composed of ten successive clerkships, starting with internal medicine, followed by surgery, paediatrics, psychiatry, neurology, gynaecology, dermatology, otorhinolaryngology, ophthalmology, family medicine and public health, followed by 15 weeks of electives. The duration of the 10 clerkships was 8, 8, 3, 5, 5, 6, 3, 3, 3 and 4 weeks, respectively. The aim of the clerkships was to learn the students the competencies of history taking, physical examination, differential diagnosis, additional diagnostic procedures and therapy plan (Splinter & Verwoerd, 2000).

Participants

Participants in this study were a sample of 327 students who had completed successfully their study in the early 2000s. This group comprised 144 men (44%) and 183 women (56%). Their mean age at the start of medical school was 19.51 years, with a range from 17.74 to 36.11 years.

To check if this sample was representative, data concerning age, gender, and GPAs obtained before and during medical school was compared with other population data. Using T-tests, no significant differences were found.

Variables

Pre-university education GPA (pu-GPA)

Of all students, the GPA before admission to medical school was determined by the mean grade for the final examination of pre-university education and called pre-university education GPA (pu-GPA). Fifty percent of this GPA was determined by a national examination, the other half by a school examination. Pu-GPA had a value between 5.5 and 10 and was transformed into a z-score.

GPAs in medical school

For each study phase in medical school, i.e. year 1, pre-clinical years 2-4, and the clinical phase, the GPA was determined by the mean grade of the first attempt at all examinations. The GPA of the first year (year 1 GPA) was based on 17 grades and the GPA of the pre-clinical years 2-4 (year 2-4 GPA) on 31 grades. In both study phases, students were assessed by written examinations, which contained multiple-choice questions, open-answer questions, essay questions, and cases. The GPA in the clinical phase (year 5-6 GPA) was calculated by the mean grade on ten clerkships. All clerkships were assessed by a combination of a patient related and oral examination and rewarded with a grade between 5 (poor) and 10 (excellent). All GPAs were measured on a 10-point scale and transformed into z-scores. Cronbach's alpha reliability coefficients of all GPAs were above .70, indicating that the reliability was sufficient.

Data Analysis

Analyses were conducted using SPSS Version 15 for Windows.

Firstly, the relationship between pu-GPA and the GPA of year 1, year 2-4 and year 5-6 was determined by performing bivariate linear regression analyses. This was done for both the entire group of 327 students and for the subgroups with a pu-GPA below and above the mean. Differences between the subgroups were tested by multiple regression analyses. Trends in the strength of the relationship between pu-GPA and GPAs in later study phases were analysed using the linear mixed model.

Secondly, in a similar way, the relationship between the GPAs of other subsequent study phases was investigated. Again, analyses were done for both the entire group of students and for subgroups with a preceding GPA level below and above the mean.

In all regression analyses, the unstandardized regression coefficient *B*, representing the slope of the regression line, was used. A higher value of *B* corresponded with a stronger relationship between GPAs. The residual vari-

ance σ_{res} was used to measure the accuracy of the relationship between GPAs as made by the regression line.

Results

Relationship between pu-GPA and GPAs in medical school

As shown in Table 2.1, for the entire group of 327 students, the relationship between pu-GPA and year 1 GPA was moderate to strong ($B = .58$; $p < .001$); that between pu-GPA and year 2-4 GPA moderate ($B = .46$; $p < .001$); and that between pu-GPA and year 5-6 GPA weak ($B = .24$; $p < .001$). In conclusion, the size of the relationship decreased as the interval between pre-university education and study phases in medical school increased. By conducting a mixed model analysis this decrease was found to be significant at $p < .001$.

Table 2.1 Relationship between GPAs of subsequent study phases for an entire group and for subgroups of students, which are distinguished by their preceding level of achievement

				Pu-GPA subgroups			
Independent variable	Dependent variable	Entire group (N=327)		Below the mean (n=183)		Above the mean (n=144)	
		B	σ_{res}	*B*	σ_{res}	*B*	σ_{res}
Pu-GPA	Year 1 GPA	.58***	.82	.22	.86	.67***	.75
Pu-GPA	Year 2-4 GPA	.46***	.89	.19	.84	.56***	.95
Pu-GPA	Year 5-6 GPA	.24***	.97	.08	.97	.24*	.98

				Year 1 GPA subgroups			
		Entire group (N=327)		Below the mean (n=168)		Above the mean (n=159)	
		B	σ_{res}	*B*	σ_{res}	*B*	σ_{res}
Year 1 GPA	Year 2-4 GPA	.75***	.66	.34***	.60	.96***	.66
Year 1 GPA	Year 5-6 GPA	.32***	.95	.20	.93	.55***	.96

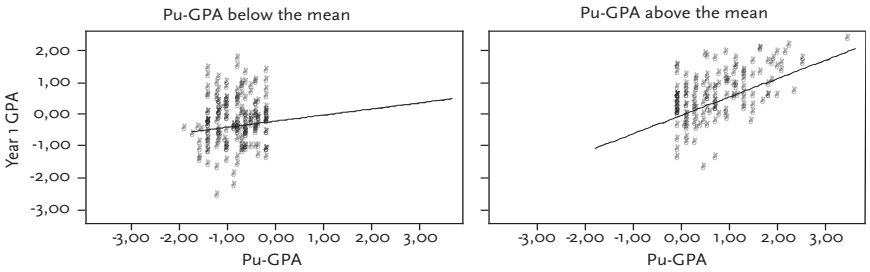
				Year 2-4 GPA subgroups			
		Entire group (N=327)		Below the mean (n=179)		Above the mean (n=148)	
		B	σ_{res}	*B*	σ_{res}	*B*	σ_{res}
Year 2-4 GPA	Year 5-6 GPA	.45***	.90	.55***	.91	.53***	.88

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

Note: *B* represents *unstandardized regression coefficient* σ_{res} represents *residual variance*

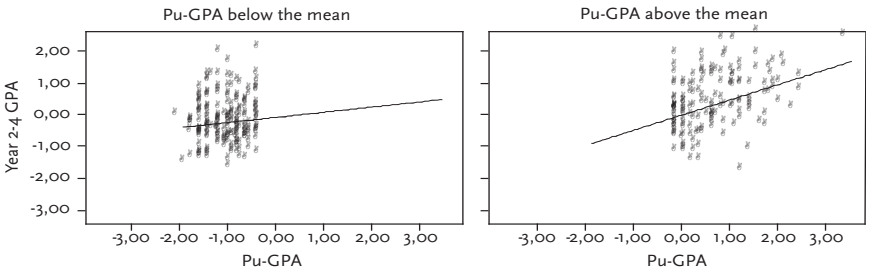
Similar analyses were done for students with a pu-GPA below the mean and those with a pu-GPA above it. The former group comprised 183 students (82 men, 101 women), the latter 144 (62 men, 82 women). For those two subgroups, the relationship between pu-GPA and the GPAs of the different study phases is shown in Figure 2.1a through 2.1c.

Figure 2.1a Relationship pu-GPA and year 1 GPA



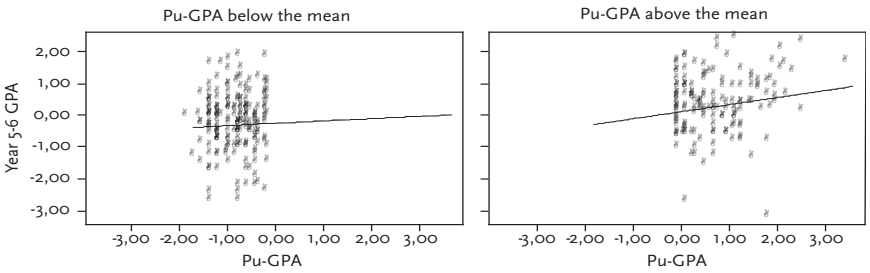
B =.22, σ_{res}=.86 *B* =.67***, σ_{res}=.75

Figure 2.1b Relationship pu-GPA and year 2-4 GPA



B =.19, σ_{res}=.84 *B* =.56***, σ_{res}=.95

Figure 2.1c Relationship pu-GPA and year 5-6 GPA



B =.08, σ_{res}=.97 *B* =.24*, σ_{res}=.98

For those with a pu-GPA below the mean, the relationships of pu-GPA with year 1 GPA, with year 2-4 GPA and with year 5-6 GPA were non-significant. In contrast, for students with a pu-GPA above the mean, the relationships between pu-GPA and the GPAs of the three subsequent study phases were .67 ($p < .001$), .56 ($p < .001$) and .24 ($p < .05$), respectively. For this latter group, a mixed model analysis revealed that the decrease in the size of the relationship was significant at $p < .01$.

Multiple regression analyses revealed that the relationship of pu-GPA with both year 1 GPA and with year 2-4 GPA was significantly stronger (at $p < .05$ level) for those with a pu-GPA above the mean than for those with a GPA below it. In contrast, between the groups no significant difference in the relationship between pu-GPA and year 5-6 GPA was found.

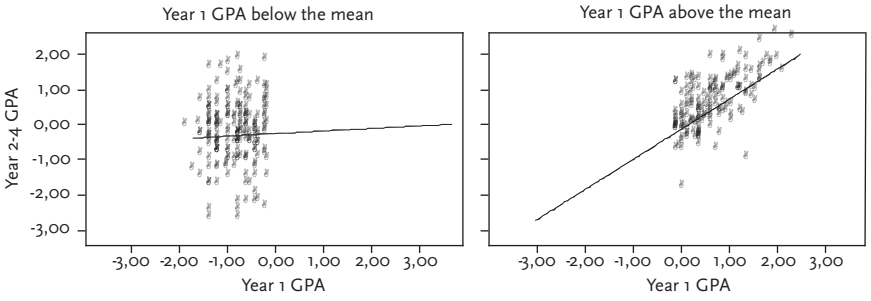
Relationship between year 1 GPA and year 2-4 GPA

As presented in Table 2.1, the relationship between year 1 GPA and year 2-4 GPA was very strong for the entire group of students ($B = .75$; $p < .001$). In Figure 2.1d, this relationship is displayed for students with a year 1 GPA below the mean and those with a GPA above it. For the former subgroup, consisting of 168 students, the relationship was weak to moderate ($B = .34$, $p < .001$); for the latter group, comprising 159 students, it was very strong ($B = .96$, $p < .001$). Between the two groups, the difference in the relationship was significant at $p < .001$.

Relationship between year 2-4 GPA and year 5-6 GPA

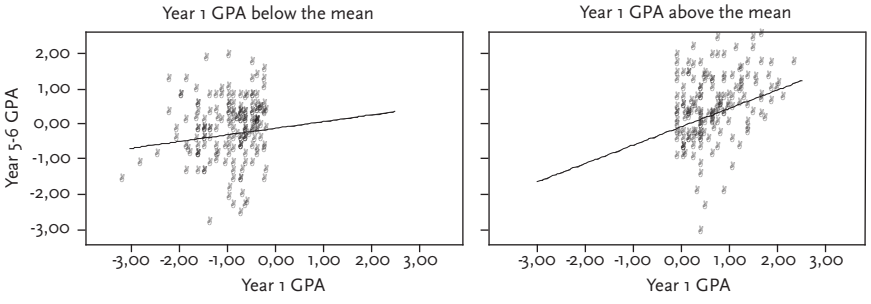
As shown in Table 2.1 and Figure 2.1f, the relationship between the GPAs of the pre-clinical years 2-4 and the clinical phase was moderate for the entire group ($B = .45$; $p < 0.001$) and equal for the subgroups with a year 2-4 GPA below and above the mean (respectively $B = .55$ and $B = .53$, with $p < .001$). Consequently, between the year 2-4 GPA subgroups no significant difference in the relationship between the GPAs was found.

Figure 2.1d Relationship year 1 GPA and year 2-4 GPA



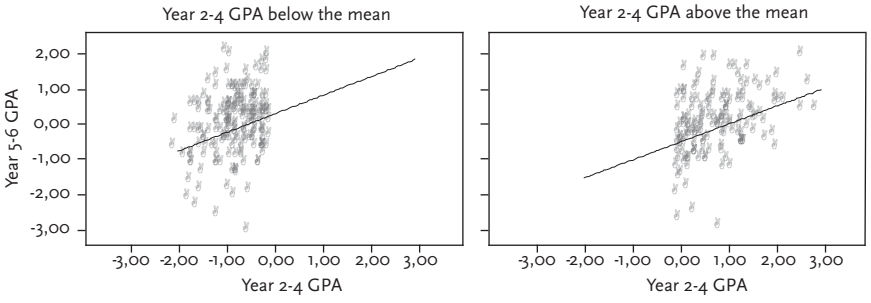
B =.34***, σ_{res}=.60 *B* =.96***, σ_{res}=.66

Figure 2.1e Relationship year 1 GPA and year 5-6 GPA



B =.20, σ_{res}=.93 *B* =.55***, σ_{res}=.96

Figure 2.1f Relationship year 2-4 GPA and year 5-6 GPA



B =.55***, σ_{res}=.91 *B* =.53***, σ_{res}=.88

Discussion

In the Netherlands, students are admitted to medical school by a weighted lottery system, in which the chance of selection rises along with the pu-GPA (Urlings-Strop, Stijnen, Themmen & Splinter, 2009). The lottery system is based on the observation that the size of pu-GPA is moderately correlated with pre-clinical achievement in medical school, indicating a large variation in students' achievements after transition from one study phase to the other (Commissie Toelating Numerus Fixusopleidingen, 1997). It is our hypothesis that the larger the difference is between study phases, the lower the relationship between their GPAs. Moreover, decrease of the relationship indicates that some high achievers become low achievers and / or vice versa. Therefore, the goal of this study was to investigate whether the size of the relationship between GPAs of different study phases was dependent on the nature of a study phase transition and / or students' level of achievement before a transition. To that end, by conducting linear regression analyses, we determined the relationships between pu-GPA, year 1 GPA, pre-clinical years 2-4 GPA and the GPA of the clinical phase for both an entire group of 327 medical students and for two subgroups with a GPA-level below or above the mean, respectively, in the preceding study phase.

It was shown that for the entire group of 327 students, the "weakest" relationships between GPAs were found between pre-university education and the first year in medical school, and between the pre-clinical years 2-4 and the clinical phase. In contrast, a very strong relationship between the GPAs of the first year and the remaining three pre-clinical years was found. The transition from pre-university education to the first year in medical school is considered to be big, as students need to adjust to life in university and need to cope with an extended amount of learning content (Levitz & Noel, 1989). Moreover, some students move away from home and are separated from family and friends (Rice, 1992). The transition from the first year to the remaining three pre-clinical years seems to be much smaller. In both study phases the emphasis is on the acquisition of integrated basic and clinical knowledge, and teaching and examination methods are very similar. The transition from the pre-clinical to the clinical phase seems to be big again, as the learning and examination approaches of both phases are quite different. Where the emphasis in the former phase is on the acquisition and assessment of basic and clinical knowledge, the focus in the clinical phase is on the application of the theoretical knowledge in a practical oriented learning environment. Moreover, during the clerkships, students are assessed by a supervisor once or twice by global performance ratings (GPR), covering students' performance on a number of clinically relevant competencies over a certain period of time (Daelmans, Van

der Hem-Stokroos, Hoogenboom, Scherpbier, Stehouwer & Van der Vleuten, 2005). Recently, it was shown that those grades were mainly determined by knowledge, quality of the patient file and problem solving abilities (Wimmers, Kanter, Splinter & Schmidt, 2008). Abovementioned results seem to imply that the size of the relationship between GPAs was inversely related to the size of change in the learning environment.

A second finding was that the relationship between GPAs differed for subgroups of students, which were distinguished by their preceding GPA-level. For students with a pu-GPA above the mean, the relationship between pu-GPA and year 1 GPA was strong. The same pattern was found for students with a year 1 GPA above the mean. These results suggest that students who achieved well during pre-university education or in the first year of medical school were consistent performers in the subsequent study phase. Apparently, those students were not sensitive to the first two study phase transitions. Probably, they already possessed some learning and other skills that they were able to re-use, as teaching and examination methods in the study phases were more or less comparable. In contrast, for students with a pu-GPA below the mean, their pu-GPA had no significant relationship with year 1 GPA. The same was more or less true for those with a year 1 GPA below the mean. This result suggests that in this group the achievement of some students remained at the same low level in the subsequent study phase, whereas that of others improved a lot. Interestingly, for the year 2-4 GPA subgroups below and above the mean, the relationship between the GPAs of the pre-clinical and clinical phase was comparable and at a moderate level. This indicates that for both groups, the transition from the preclinical to the clinical phase is large.

This study had some limitations. Due to the fact that only students who had successfully completed medical school were included, the first limitation was the lack of data on those who failed. Figures from the 1987 to 2004 period at our medical school have shown that the mean percentage of failing students in the first two years was 13% with a range from 8% to 19%. Approximately eighty percent of the failing students belonged to those with a pu-GPA lay below the mean. Where this "below the mean" group comprised approximately 56% of all students, the failing students were overrepresented in this group. A second limitation might be that only GPAs were used as measure of student achievement and for example not the number of years that students had needed to complete the three distinctive study phases in medical school. However, beforehand we investigated the relationship between those two variables and it was found to be very strong. A third weakness might be related to the validity of pu-GPA. However, it can be reported that those were quite comparable between institutions, since pu-GPA in the Netherlands was composed for fifty percent by a national examination. A final possible limitation

was related to restriction of range. However, compared to other countries, our lottery system to select students for admission to Dutch medical schools ensured that both students with low and high GPAs enrolled. Therefore, the effect of restriction of range was limited. Finally, attention should be paid to the fact that the GPAs of students included in this study were established by the interaction with our curriculum that consisted of four pre-clinical years and two clinical years. In curricula with an other composition, it is very well possible that deviant relationships between GPAs will be found both for the entire group of students and for subgroups with a preceding GPA-level below and above the mean.

In conclusion, the size of the relationship between GPAs is dependent on both the nature of the study phase transition and students' level of achievement before the transition. Our study indicates that investigation of factors that may influence student achievement should take into account both the nature of a study phase transition and the level of achievement before the transition. In future studies, other factors than GPAs are needed to improve the prediction of achievement in each study phase of those with a preceding GPA-level below and above the mean.

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3 A model to predict student failure in the first-year medical curriculum

Gerard J.A. Baars[1], Karen M. Stegers-Jager[2], Theo Stijnen[3] & Ted A.W. Splinter[4]

Abstract

Background In our Erasmus medical school, students who fail to pass the first-year curriculum within two years of study are forced to withdraw. An early and reliable identification of those students may create the possibility of remediation or referral to another study.

Objective To develop a model for early and reliable prediction of those who fail to pass the first-year curriculum within two years of study.

Methods 1819 medical students of five consecutive cohorts were included. By logistic regression analyses, predictions for failure in the first-year curriculum were made at 0, 4, 6, 8, 10 and 12 months. Predictive variables included pre-admission variables such as age, gender, pre-university education GPA, the way students were selected, and post-admission variables such as number of credits obtained, degree of participation in exams, and exam success rate. Variables were only included if they contributed significantly to the model both for the five cohorts together and for each cohort separately. Students who had voluntarily withdrawn before a predictive moment were not included in the analyses.

Results Students who had passed all exams at 4 or 6 or 8 months (so-called "optimals") had a chance of 99% of passing the first-year curriculum. Within the group of non-optimals, at 6 months, failure to pass the first-year curriculum could be predicted with a specificity of 66.7% and a sensitivity of 84.5% by using the variable 'passing 0 exams between 4 and 6 months'. Specificity increased from the start till 6 months and remained constant afterwards.

1 Erasmus University Rotterdam, Risbo; Erasmus MC, Department of Medical Education and Research, the Netherlands
2 Erasmus MC, Department of Medical Education and Research, the Netherlands
3 Leiden University Medical Center, Department of Medical Statistics and Bioinformatics, the Netherlands
4 Erasmus MC, Department of Internal Medicine, the Netherlands

Conclusions The earliest moment with the highest specificity to predict student failure in the first-year curriculum seems to be at 6 months. However, additional factors are needed to improve this prediction or to bring forward the predictive moment.

Introduction

Worldwide, universities are under pressure to reduce the number of students who fail to complete their study. The major motives are a waste of money and talent. Student failure is the resultant of a 'mismatch' between student-related factors on one side and curriculum-related and/or social environment related factors on the other. Examples of student-related factors are the inability to adapt oneself to the academic environment, allocating insufficient time to studying, lack of discipline, and lack of motivation (Agar & Knopfmacher, 1995; Hurtado, Carter & Spuler, 1996; Lowe & Cook, 2003; Moelaert, Verwijnen, Rikers & Scherpbier, 2004; Powis, Neame, Bristow & Murphy, 1988; Thomas, Bol & Warkentin, 1991). Examples of curriculum related factors are unsatisfactory teaching methods and styles, difficulty of exams, and absence of remedial support (Arulampalam, Naylor & Smith, 2004a; Thomas, Bol & Warkentin, 1991; Webb, Sedlacek, Cohen, et al., 1997). And examples of social environment related factors are membership of a students' social club, having a job, and students' lack of involvement with their peers and faculty staff inside and outside the university (Smith & Naylor, 2001; Tinto, 1975; 1987).

Considerable differences in the percentage of students who fail to complete their study within an acceptable period of time are observed between various fields of study. For example, the percentage of failing students in the behavioural and technology sciences is approximately 50-60% (van den Berg & Hofman, 2005). In this regard, medical students are a positive exception (Parkhouse, 1996; McManus, 1996). In our medical school, retrospective data over the past 15 years has shown that an average of 'only' about 13 percent fails to complete their study within 10 years of study (unpublished observation).

It is well-known that the majority of students who are not successful fails to perform well during the first year in university (e.g. Cope & Hannah, 1975; Arulampalam, Naylor & Smith, 2004a; Arulampalam, Naylor & Smith, 2004b; Murtaugh, Burns & Schuster, 1999). This is also true for our medical school, in which approximately 80% of all failing students does not complete the first-year curriculum (unpublished observation). Our students are obliged to pass this curriculum part within two years after the start of their study. Students who fail are forced to withdraw, unless they had suffered from temporary, but serious personal circumstances such as decease of close relatives or illness.

Our challenge is to identify as soon as possible after the start and as reliable as possible students who will fail to pass the first-year curriculum within two years of study. Such an early and reliable identification would have the potential advantage of intervention by a short remedial support programme for a well-defined subgroup of motivated students in order to help them to overcome their initial problems or referral to another study for the subgroup that is not willing to remediate.

Concerning the prediction of those who will fail, it was demonstrated by others that there seems to be a relationship between student achievement in the first months in university and subsequent achievement (Horn & Carroll, 1998; Mallette & Cabrera, 1991; Murtaugh, Burns & Schuster, 1999). How. ever, looking at abovementioned studies, two major problems arise. First, they do not indicate exactly which specific students will fail. And secondly, they do not give any insight into the best moment to predict whether students will fail or not.

Therefore, the goal of the current study was to develop a model for early and reliable prediction of those who fail to pass the first-year curriculum within two years of study. To that end, data on pre- and post-admission variables was collected from 1819 students of five consecutive cohorts. By logistic regression analyses, predictions for failing to pass the first-year curriculum were made at 0, 4, 6, 8, 10 and 12 months.

Methods

First-year curriculum of Erasmus medical school

This study was conducted at Erasmus medical school. Its curriculum, which was entirely integrated and theme-oriented, was implemented in 2001 and consisted of four pre-clinical years and two clinical years. The pre-clinical years were aimed at providing students a theoretical basis and clinical knowledge in order to prepare them for the clinical years. In the clinical years, the focus was on the acquisition of problem-solving and practical clinical skills.

The composition of the first-year curriculum is shown in Table 3.1. The first year of the pre-clinical phase comprised four themes, i.e. "An introductory course", "Disorders of the milieu interieur", "Abnormal cell growth", and an "Integration exam". The second and third theme were divided into four subthemes. In all themes, teaching and learning methods included plenary lectures, symposia, tutorials, and home study assignments. Clinical elements were realised by patient demonstrations and practical clinical skills training. Each (sub)theme was finished with a written examination comprising open-ended and multiple-choice questions.

Table 3.1 Composition of the first-year curriculum

Time	N exams	Obtainable credits (during period)	Number of credits (cumulative)	Theme(s)
Between 0 and 4 months	3	19.0 credits	19.0 credits	Introductory course Disorders in the milieu interieur (part 1&2)
Between 4 and 6 months	2	13.0 credits	32.0 credits	Disorders in the milieu interieur (part 3&4)
Between 6 and 8 months	2	11.5 credits	43.5 credits	Abnormal cell growth (part 1&2)
Between 8 and 10 months	3	16.5 credits	60.0 credits	Abnormal cell growth (part 3&4) Integration exam
Between 10 and 12 months	10 re-exams	60.0 credits	60.0 credits	All 4 (sub)themes

Participants

Five consecutive cohorts of students (2001-2005) of Erasmus medical school were included in this study. These cohorts comprised 272, 332, 405, 403 and 407 students, respectively.

Variables

The dependent variable was 'failing to pass the first-year curriculum within two years of study'. This data was obtained from the student administration system of Erasmus medical school.

For the predicting variables, a distinction was made between pre- and post-admission variables. Also this data was obtained from the student administration system. Table 3.2a provides an overview of the pre-admission variables.

Table 3.2a Independent pre-admission variables

Pre-admission variables	Definition	N	% or M (SD)
Age at start medical school	Continuous, 16.55 – 40.98 years	1819	19.56 (2.11)
Gender	1 = Male	702	38.6%
	2 = Female	1117	61.4%
Pre-admission selection group	1 = Directly admitted (pre-admission GPA>=8)	106	5.8%
	2 = Selected by a local procedure at Erasmus medical school	532	29.2%
	3 = Selected by national weighted lottery	1181	64.9%
Pre-university education GPA subgroups	1 = Below the mean	925	50.9%
	2 = Above the mean	802	44.1%
	3 = Unknown	92	5.1%
Western preparatory education certificate	1 = No	30	1.6%
	2 = Yes	1789	98.4%

As shown in Table 3.2a, the entire group of 1819 students comprised 702 males (38.6%) and 1117 females (61.4%). Their mean age at the start of medical school was 19.56 years (SD = 2.11), with a range from 16.55 to 40.98 years. Of 1727 students, their Dutch pre-university education Grade Point Average (pu-GPA) was available, which represented students' mean grade on all subjects obtained during the final year of pre-university education. Final grades were based half on school examinations and half on the state examination. For 925 of these students, pu-GPA was at a level below the mean (<6.94 on a ten-point scale), whereas for 802 others it was above it (≥ 6.94) (see Chapter 2). For 92 students, pu-GPA was not available; 44 of them entered with another Dutch preparatory programme and 48 entered with a foreign certificate, either from Western countries such as Germany or Non-Western countries like Surinam. All students were admitted according to Dutch regulations: 106 were directly admitted as their pu-GPA was 8.0 or higher on a ten-point scale, 532 were selected by a local procedure at Erasmus medical school and the remaining 1181 were selected by the national weighted lottery (Urlings-Strop, Stijnen, Themmen & Splinter, 2009).

Post-admission predicting variables are presented in Table 3.2b.

Table 3.2b Independent post-admission variables

Post-admission variables	Definition	N	% or M (SD)
Predictive variables, available at 4 months (t = 4)			
Voluntarily withdrawn during first 4 months	1 = No	1810	99.5%
	2 = Yes	9	.5%
Cumulative number of credits at 4 months	Continuous, 0.0 - 19.0	1810	13.36 (6.62)
Passing 0 exams or at least 1 during first 4 months	1 = Passed 0 exams	214	11.8%
	2 = Passed 1 or more exams	1596	88.2%
Passing all exams during first 4 months	1 = No ("non-optimal")	930	51.4%
	2 = Yes ("optimal")	880	48.6%
Number of exams taken during first 4 months	0	10	.6%
	1	19	1.0%
	2	86	4.8%
	3	1695	93.6%
Exam success rate at 4 months (number of exams successfully completed/ number of exams taken)	Continuous, 0.00 – 1.00	1810	.71 (.35)
Predictive variables, available at 6 months (t=6)			
Voluntarily withdrawn during first 6 months (cumulative)	1 = No	1795	98.7%
	2 = Yes	24	1.3%

Table 3.2b Independent post-admission variables (continued)

Post-admission variables	Definition	N	% or M (SD)
Cumulative number of credits at 6 months	Continuous, 0.0 – 32.0	1795	23.75 (10.27)
Passing all exams during first 6 months	1 = No ("non-optimal")	921	51.3%
	2 = Yes ("optimal")	874	48.7%
Number of credits between 4 and 6 months	Continuous, 0.0 – 13.0	1795	9.97 (4.79)
Passing 0 exams between 4 and 6 months	1 = Passed 0 exams	262	14.6%
	2 = Passed 1 or more exams	1533	85.4%
Number of exams taken between 4 and 6 months	0	35	1.9%
	1	44	2.5%
	2	1716	95.6%
Exam success rate between 4 and 6 months	Continuous, 0.00 – 1.00	1795	.77 (.37)
Predictive variables, available at 8 months (t = 8)			
Voluntarily withdrawn during first 8 months (cumulative)	1 = No	1793	98.6%
	2 = Yes	26	1.4%
Cumulative Number of credits at 8 months	Continuous, 0.0 – 43.5	1793	32.40 (13.19)
Passing all exams during first 8 months	1 = No ("non-optimal")	1046	58.3%
	2 = Yes ("optimal")	747	41.7%
Number of credits between 6 and 8 months	Continuous, 0.0 – 10.0	1793	7.14 (3.86)
Passing 0 exams between 6 and 8 months	1 = Passed 0 exams	316	17.6%
	2 = Passed 1 or more exams	1477	82.4%
Number of exams taken between 6 and 8 months	0	36	2.0%
	1	54	3.0%
	2	1703	95.0%
Exam success rate between 6 and 8 months	Continuous, 0.00 – 1.00	1793	.71 (.39)
Predictive variables, available at 10 months (t = 10)			
Voluntarily withdrawn during first 10 months (cumulative)	1 = No	1791	98.5%
	2 = Yes	28	1.5%
Cumulative number of credits at 10 months	Continuous, 0.0 - 60.0	1791	46.13 (16.73)
Passing all exams during first 10 months	1 = No ("non-optimal")	1095	61.1%
	2 = Yes ("optimal")	696	38.9%
Number of credits between 8 and 10 months	Continuous, 0.0 – 12.0	1791	9.11 (4.29)
Passing 0 exams between 8 and 10 months	1 = Passed 0 exams	156	8.7%
	2 = Passed 1 or more exams	1635	91.3%
Number of exams taken between 8 and 10 months	0	65	3.6%
	1	13	.7%
	2	51	2.8%
	3	1662	92.8%
Exam success rate between 8 and 10 months	Continuous, 0.00 – 1.00	1791	.79 (.32)

Table 3.2b Independent post-admission variables (continued)

Post-admission variables	Definition	N	% or M (SD)
Predictive variables, available at 12 months (t = 12)			
Voluntarily withdrawn during first 12 months (cumulative)	1 = No 2 = Yes	1747 72	96.0% 4.0%
Cumulative number of credits at 12 months	Continuous, 0.0 - 60.0	1747	52.95 (13.23)
Passing all exams during first 12 months	1 = No ("non-optimal") 2 = Yes ("optimal")	653 1094	37.4% 62.6%
Number of credits on re-exams (only students with less than 60 credits at t = 10 included)	Continuous, 0.0 – 43.0	1051	9.43 (7.92)
Number of re-exams taken (only students with less than 60 credits at t = 10 included)	Scale, 0 – 10	1051	2.92 (2.20)
Exam success rate at re-exams (only students with less than 60 credits at t = 10 included)	Continuous, 0.00 – 1.00	1051	.59 (.39)

At each of the predictive moments in medical school, i.e. at 4, 6, 8, 10 and 12 months, data was collected on (a) whether students had already voluntarily withdrawn, (b) the number of credits students had obtained so far (cumulative), (c) the number of credits students had obtained in the preceding period, (d) whether students had passed all exams so far (cumulative), (e) whether students had passed no exams or at least one in the preceding period, (f) the number of exams students had taken in the preceding period, and (g) the exam success rate, which was calculated by dividing the number of exams successfully completed by the exams taken.

Data analysis

Analyses were conducted using SPSS 15 for Windows.

For all 5 cohorts together and also for each cohort separately, the number and percentage of students who failed to pass the first-year curriculum was determined.

By logistic regression analysis, method forward likelihood ratio, the first prediction for student failure in the first-year curriculum was made at the start of medical school. For this prediction, only pre-admission variables were used (see Table 3.2a).

Subsequent predictions were made at 4, 6, 8, 10 and 12 months in the first year. For those predictions, both pre- and post-admission variables were used. Students who had already voluntarily withdrawn before a predictive moment, were not included. In the predictions at 10 and 12 months, also those who had already passed the first-year curriculum were excluded.

Table 3.3

Statistics of the predictions at 0, 4, 6, 8, 10 and 12 months for student failure in the first-year curriculum (n=1819)

Time	Voluntarily withdrawn*	Optimals**	Non-optimals***	Logistic regression equation****	TN	FP	FN	TP	Specificity	Sensitivity
t = 0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
t = 4	9	880	930	Log(Odds) = .398 - 1.990 * (passed at least one exam during first 4 months)	128	121	86	595	51.4%	87.4%
t = 6	24	961	834	Log(Odds) = .517 - 2.389 * (passed at least one exam between 4 and 6 months)	156	78	93	507	66.7%	84.5%
t = 8	26	961	832	Log(Odds) = 1.841 - .157 * (cumulative number of credits at 8 months)	147	85	52	548	63.4%	91.3%
t = 10	28	961	830	Log(Odds) = 2.175 - .114 * (cumulative number of credits at 8 months) - .196 * (number of credits obtained between 8 and 10 months)	164	66	47	553	71.3%	92.2%
t = 12	72	1185	562	Log(Odds) = 3.185 - .103 * (cumulative number of credits at 12 months)	114	74	36	338	60.6%	90.4%

NA Not applicable

* Students who had voluntarily withdrawn before the predictive moment. Those were not included in the regression analysis.

** Students who had passed all exams at a predictive moment or at any of the preceding predictive moments. Those were not included, as it was shown that they had a chance of 99% of successfully completing the first-year curriculum within two years of study.

*** Students who had not passed all exams at a predictive moment or at any of the preceding predictive moments. Only those were included in the logistic regression analysis. Please note that the number of non-optimals at 6 months was lower than at 4 months due to a "compensation regulation", which implied that high grades obtained between 4 and 6 months could be used to compensate for insufficient grades during the first 4 months. The number of non-optimals at 12 months was lower than at 10 months due to the re-exams scheduled between 10 and 12 months.

**** Dependent variable: failing to pass the first-year curriculum within two years of study (0 = no, 1 = yes); cut value is .500.

In all prognostic models, only variables that contributed significantly to the explanation of the odds of the dependent variable and also improved the predictive value of the model were included. Moreover, variables needed to contribute significantly to the model for both the five cohorts together and for each cohort separately. The latter was done to ensure that predictive factors could also be applied to coming cohorts. A cut value of .50 was used indicating that students who had a chance of 50% or more to fail to pass the first-year curriculum were predicted to fail, whereas those with a chance of less than 50% were predicted to be successful. This cut value was chosen, as it was demonstrated that at each of the predictive moments it led to the highest accuracy scores of the model, i.e. to the highest fraction of students for whom success or failure in the first-year curriculum could be correctly predicted.

For each prediction, the number of True Negatives (TN; students who were predicted to fail and actually failed), False Positives (FP; students who were predicted to be successful, but actually failed), False Negatives (FN; students who were predicted to fail, but actually were successful) and True Positives (TP; students who were predicted to be successful and actually were successful) was determined. Moreover, the specificity (TN / (TN + FP); proportion of failing students who were correctly identified) and the sensitivity (TP / (TP + FN); proportion of successful students who were correctly identified) were calculated.

Results

Of the 1819 students, 267 failed to pass the first-year curriculum within two years of study (14.7%). The percentage of failing students ranged from 11.4% in cohort 2002 to 20.6% in cohort 2001.

Prediction at the start of medical school (t=0)

The first prediction for student failure was made at the start of medical school (t=0). Although almost all the pre-admission variables such as pre-university education GPA subgroup below or above the mean, pre-admission selection group, age and gender did contribute significantly to the predictive model for one or more of the cohorts, none of them contributed significantly to the model for both the five cohorts together and to that for each cohort separately. Thus, according to our strict criteria pre-admission variables could not be used as predictors for student failure in our medical school.

Predictions in medical school (t=4, t=6, t=8, t=10, t=12)

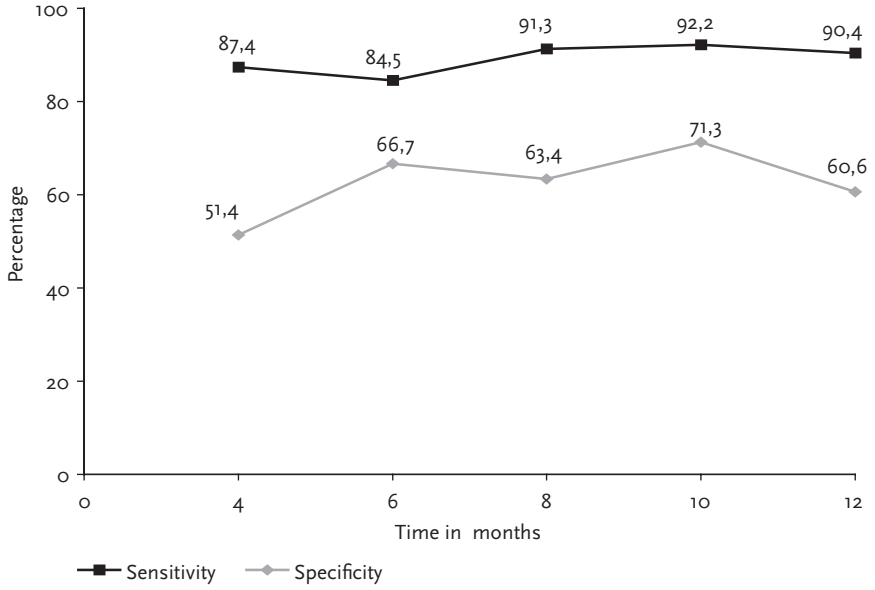
Subsequent predictions for student failure were made at 4, 6, 8, 10 and 12 months in the first year. At those predictions, students who had already

voluntarily withdrawn were excluded. As shown in Table 3.3, the number of voluntarily withdrawals at the five consecutive predictive moments was 9, 24, 26, 28 and 72, respectively.

Due to the fact that we wanted to identify students who would fail to pass the first-year curriculum, also students who had passed all exams at a certain predictive moment ("optimals") were not included in the analyses. It was shown that this group contained only a very small number of failing students. At 4, 6 and 8 months (n=880, n=961, n=961, respectively[5]) this number was 9, 9, and 9, respectively. Thus, at each of the predictive moments the optimals had a minimal chance of 99% of passing the first-year curriculum.

As shown in Figure 3.1, for the group of non-optimals, the prediction with the highest specificity at the earliest stage was at 6 months in medical school.

Figure 3.1 Specificity and sensitivity of the predictions at 0, 4, 6, 8, 10 and 12 months for student failure in the first-year curriculum



5 The number of optimals at 6 months was higher than at 4 months due to a "compensation regulation", which implied that high grades obtained between 4 and 6 months could be used to compensate for insufficient grades during the first 4 months. Optimals at 10 or 12 months had completed successfully the entire first-year curriculum.

At that moment the specificity was 66.7% and the sensitivity 84.5%. The specificity was lower in the predictions before 6 months and did not increase substantially in the predictions after 6 months. As shown in Table 3.3, in the prediction at 6 months, the regression equation comprised only one predictive (binary) factor, i.e. "passed no exam between 4 and 6 months". Using this variable, the number of True Negatives, False Negatives, False Positives and True Positives was 156, 93, 78 and 507, respectively.

Usefulness of the predictive model at t=6

Our challenge was to identify as soon as possible and as reliable as possible failing students in the first-year curriculum in order to select them or to offer them a short remedial support programme. But could our model be used for those purposes?

To find an answer to that question, in Table 3.4 the statistics of the prediction at 6 months are presented for the cohorts 2001-2005 separately. As shown in Table 3.4, at 6 months the application of the model would lead to a selection of 33 to 62 failing students per cohort (= TN + FN). However, between 13 and 25 of them would be unjustly selected (= FN) and between 12 and 24 others would be missed (= FP). This data indicates that for each of the cohorts application of the model would lead to the selection of a manageable group of students for a short remedial support programme. However, the current model did not seem to be strong enough yet in order to force students to withdraw. Therefore, still more prognostic factors are needed.

Discussion

In line with other institutes worldwide, most students who are not successful in our medical school fail to perform well in the first year. An early and reliable identification of those students may create the possibility of remediation or referral to another study. The goal of this study was to develop a model for early and reliable prediction of those who fail to pass the first-year curriculum within two years of study. To that end, data on pre- and post-admission variables was collected from 1819 students of five consecutive cohorts. By logistic regression analyses, predictions for failing to pass the first-year curriculum were made at 0, 4, 6, 8, 10 and 12 months. Predicting variables were only included if they contributed significantly to the predictive model for both the five cohorts together and for each cohort separately. This was done to ensure that the predictive variables could also be applied to coming cohorts of students.

It was shown that pre-admission variables, such as pre-university education GPA, the way students were selected, age and gender, could not be used

Table 3.4 Statistics of the prediction at 6 months for student failure in the cohorts 2001-2005

Cohort	N	Voluntarily withdrawn*	Optimals**	Non-optimals***	Logistic regression equation****	TN	FP	FN	TP	Specificity	Sensitivity
2001	272	8	159	105	Log(Odds) = .795 - 1.985 * (passed at least 1 exam between 4 and 6 months)	31	14	14	46	68.9%	76.7%
2002	332	3	198	131	Log(Odds) = .431 - 2.142 * (passed at least 1 exam between 4 and 6 months)	20	15	13	83	57.1%	86.5%
2003	405	5	202	198	Log(Odds) = .75 - 2.368 * (passed at least 1 exam between 4 and 6 months)	36	24	17	121	60.0%	87.7%
2004	403	2	200	201	Log(Odds) = .46 - 2.731 * (passed at least 1 exam between 4 and 6 months)	38	13	24	126	74.5%	84.0%
2005	407	6	202	199	Log(Odds) = .215 - 2.605 * (passed at least 1 exam between 4 and 6 months)	31	12	25	131	72.1%	84.0%
2001 - 2005	1819	24	961	834	Log(Odds) = .517 - 2.389 * (passed at least 1 exam between 4 and 6 months)	156	78	93	507	66.7%	84.5%

* Students who had voluntarily withdrawn during the first 6 months in medical school. Those were not included in the regression analysis.

** Students who had passed all exams at 4 or 6 months in medical school. Those were not included, as it was shown that they had a chance of more than 99% of successfully completing the first-year curriculum within two years of study.

*** Students who had not passed all exams at 4 or 6 months were included in the logistic regression analysis.

**** Dependent variable: failing to pass the first-year curriculum within two years of study (0 = no, 1 = yes); cut value is .500.

as constant prognostic factors to predict whether students would fail to pass the first-year curriculum within two years of study. Although some of the variables, such as pre-university education GPA and gender, did contribute significantly to the predictive model for one or more of our cohorts, none of them contributed significantly to the model for both the five cohorts together and for each cohort separately. This finding might be caused by the fact that only non-optimal students were included in our prognostic models. The variation in the predictive value of pre-admission variables indicates that – due to the variation between cohorts - it is very necessary to study several (consecutive) cohorts if you want to develop a prognostic model for student failure.

In the predictions at 4, 6 and 8 months, it was shown that the group of optimals, i.e. those who had passed all exams, comprised only a very small number of students who would not pass the entire first-year curriculum. In fact, this finding was not very surprising to us, as those students apparently possessed the required learning and motivational skills from the start in medical school and could continue to use those strategies in the remaining part of the first-year curriculum, where similar teaching and examination methods were used. Within the group of non-optimals, at 6 months, failure to pass the first-year curriculum could be predicted with a specificity of 66.7% and a sensitivity of 84.5% by using the variable 'passing no exams between 4 and 6 months'. The specificity was lower in the prediction at 4 months and did not increase much at 8, 10 or 12 months. This finding indicates that it does not seem to be fruitful to wait longer than 6 months before making a prediction whether students will fail to pass the first-year curriculum. But why does the specificity stabilize from 6 months onwards? Apparently, the success rate of not optimally performing students during the first 4 months, who also fail between 4 and 6 months, does not change after this period in contrast to those who do not fail. Such data suggests that unsuccessful achievement in the first 4 months is reversible for some students and not for others. The interaction of the latter students with the learning environment remains problematic without remediation from outside.

Our goal was to identify as early and reliable as possible students who fail to pass the first-year curriculum in order to remediate them or refer them to another study. In order to select students for a short remedial support programme the model seems to be very appropriate. Per cohort, it would lead to a selection of between 33 and 62 students. Those numbers seem to be manageable. However, of course, this group would still contain some students who would pass the first-year curriculum also without support (between 13 and 25 per cohort) and some others would be missed (between 12 and 24). Due to those latter faults, yet the model is less useful to purely select students and force them to withdraw.

In order to improve the specificity of the prediction at 6 months or to bring forward the predictive moment, other prognostic factors are needed. Perhaps the most promising factor is students' (lack of) ability to adapt themselves to the academic environment, such as adjusting to the level of difficulty, the other way of learning, the amount of work, the way of preparing and taking exams, allocating sufficient time to studying, and managing study time (Hurtado, Carter & Spuler, 1996; Lowe & Cook, 2003; Agar & Knopfmacher, 1995; Thomas, Bol & Warkentin, 1991). A second possible additional prognostic factor is students' (lack of) motivation for medical school, such as their interest in the study and the willingness to work hard (Agar & Knopfmacher, 1995; Moelaert, Verwijnen, Rikers & Scherpbier, 2004). And a third possible prognostic factor may be students' (lack of) involvement with their peers and faculty staff (Astin, 1999), both inside and outside the classroom, which was earlier reported to be positively related to the quality of student effort and in turn to both learning and persistence (Tinto, 1975; 1987).

It should be mentioned that the results of this study were based on the interaction of our students with our curriculum. It seemed that already from the start in medical school our exams did help to discriminate between students. However, probably, different models are needed for different curricula.

The model designed in this study seems to be very powerful, since the predicting variables are applicable to both five cohorts together and to each cohort separately. It is therefore assumed that it can be applied to future cohorts in our medical school. Moreover, also others support our results (e.g. Horn & Carroll, 1998; Mallette & Cabrera, 1991; Murtaugh, Burns & Schuster, 1999).

In conclusion, it was shown in this study that the earliest moment with the highest specificity to predict student failure in the first-year curriculum seems to be at 6 months in medical school. At that moment, manageable groups of students for investigating a remedial support programme could be identified. However, additional factors are needed to improve the predictive power and/or bring forward the predictive moment.

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4 Exploratory study to improve a model to predict student failure in the first-year medical curriculum

Gerard J.A. Baars[1], Karen M. Stegers-Jager[2], Theo Stijnen[3] & Ted A.W. Splinter[4]

Abstract

Background Recently, a model was developed for early and reliable prediction of those who would fail to pass the first-year curriculum within two years of study. Optimal students, i.e. those who had passed all exams at 4 or 6 or 8 months, had a chance of 99% of passing the first year. For non-optimals at 6 months failure in the first year could be predicted with a specificity of 66.7% and a sensitivity of 84.5% by using the variable 'passed no exams between 4 and 6 months'. Specificity was lower at 4 months and did not increase much from 6 months onwards.

Objective To explore whether other factors could help to improve the prediction at 6 months of those who would fail to pass the first-year curriculum within two years of study.

Methods Of cohort 2006 (n=402), 129 students who failed to pass more than 1 out of 3 exams at 4 months were included. They received a questionnaire measuring participation in study-related activities, aspects of learning competence, intrinsic motivation, integration, discipline and time management, satisfaction with the learning environment, and personal circumstances. By logistic regression analysis it was explored whether those factors could help to improve our existing predictive model at 6 months.

Results 71 students responded. Between respondents and non-respondents, no difference was found in the number of credits at 4 months. However, the group of non-respondents comprised significantly more students

1 Erasmus University Rotterdam, Risbo; Erasmus MC, Department of Medical Education and Research, the Netherlands
2 Erasmus MC, Department of Medical Education and Research, the Netherlands
3 Leiden University Medical Center, Department of Medical Statistics and Bioinformatics, the Netherlands
4 Erasmus MC, Department of Internal Medicine, the Netherlands

who would fail to pass the first year. Student participation in plenary lectures contributed significantly to the predictive model at 6 months, which led to a specificity of 72.2% and a sensitivity of 79.2%.

Conclusion Students' lack of participation in plenary lectures during the first 4 months might help to improve the prediction at 6 months of those who would fail to pass the first year.

Introduction

In line with other institutes worldwide, our Erasmus medical school strives to reduce the number of students who fail to complete their study. The major motive is to avoid a waste of money and talent. Student failure is the resultant of a 'mismatch' between student-related factors on one side and curriculum-related and/or social environment related factors on the other. Examples of student-related factors are the inability to adapt oneself to the academic environment, allocating insufficient time to studying, lack of discipline, and lack of motivation (Agar & Knopfmacher, 1995; Hurtado, Carter & Spuler, 1996; Lowe & Cook, 2003; Moelaert, Verwijnen, Rikers & Scherpbier, 2004; Powis, Neame, Bristow & Murphy, 1988; Thomas, Bol & Warkentin, 1991). Examples of curriculum-related factors are unsatisfactory teaching methods and styles, difficulty of exams, and absence of remedial support (Arulampalam, Naylor & Smith, 2004a; Thomas, Bol & Warkentin, 1991; Webb, Sedlacek, Cohen, et al., 1997). And examples of social environment related factors are membership of a students' social club, having a job, and students' lack of involvement with their peers and faculty staff inside and outside the university (Smith & Naylor, 2001; Astin, 1999; Tinto, 1975; 1987).

Retrospective data over the past 15 years in our medical school has shown that an average of about 13 percent fails to complete their study within 10 years after the start (unpublished observation). This percentage is comparable to that of other medical schools (Parkhouse, 1996; McManus, 1996), but much lower than that of other disciplines (Van den Berg & Hofman, 2005). It is well-known that the majority of students who are not successful fails to perform well during the first year in university (e.g. Cope & Hannah, 1975; Arulampalam, Naylor & Smith, 2004a; Arulampalam, Naylor & Smith, 2004b; Murtaugh, Burns & Schuster, 1999). This is also true for our medical school, in which approximately 80% of all failing students does not complete the first-year curriculum (unpublished observation).

In line with many other institutes for higher education in the Netherlands, our students are obliged to pass the first-year curriculum within two years after the start of their study. Students who fail are forced to withdraw, unless they had suffered from temporary, but serious personal circumstances

such as decease of close relatives or illness. Our challenge is to identify in a reliable way at the earliest stage students who will fail to pass the first-year curriculum. Such an early and reliable identification would have the potential advantage of intervention by a short remedial support programme for a well-defined subgroup of motivated students in order to help them to overcome their initial problems or referral to another study for the subgroup that is not willing to remediate.

In a preceding study, we developed a model to predict whether students would fail to pass the first-year curriculum within two years of study (see Chapter 3). Predicting variables included pre-admission variables such as age, gender, pre-university education Grade Point Average (GPA), the way students were selected, and post-admission variables such as number of credits obtained and the degree of participation in exams. Predictions were made at 0, 4, 6, 8, 10 and 12 months in the first year. Students who had voluntarily withdrawn before a predictive moment were not included in the analyses. It was shown that pre-admission variables such as pre-university education GPA and gender could not be used as constant factors to predict student failure in the first-year curriculum. Furthermore, it was shown that students who had passed all exams at 4 or 6 or 8 months (so-called "optimals") had a chance of 99% of passing the entire first year. Due to the fact that we wanted to identify students who would fail those optimals were not included in further analyses. For the non-optimals at 6 months failure to pass the first year could be predicted with a specificity of 66.7% and a sensitivity of 84.5% by using the variable 'passed no exams between 4 and 6 months'. Specificity was lower in the prediction at 4 months (51.4%) and did not increase from 6 months onwards. This data was very strong as it was based on the analysis of five consecutive cohorts of students (cohorts 2001-2005). Thereby, the predictive variable was not only applicable to the predictive model for the five cohorts together, but also to that for each cohort separately. This was done to ensure that predictive variables could also be applied to coming cohorts of students. The predictive model at 6 months seemed to be very useful in order to select students for a short remedial support programme. Per cohort, application of the model would lead to a selection of between 33 and 62 students. Those numbers seemed to be manageable. However, the selected group would still contain students who would also pass the first-year curriculum without support (number of False Negatives per cohort was between 13 and 25) and some others who would be missed (number of False Positives per cohort was between 12 and 24).

Although the results of our preceding study seemed to be very useful, still additional factors are needed in order to improve the prediction at 6 months. Therefore, the goal of the current study was to explore whether other factors

could help to improve the prediction at 6 months of those who would fail to pass the first-year curriculum within two years of study. To that end, a questionnaire measuring student participation in study-related activities, aspects of learning competence, intrinsic motivation, integration, discipline and time management, satisfaction with elements of the learning environment, and personal circumstances was sent to 129 students of cohort 2006 who suffered from serious study delay at 4 months in medical school. By logistic regression analysis, it was investigated whether those factors could help to improve the existing predictive model at 6 months.

Methods

First-year curriculum of Erasmus medical school

This study was conducted at Erasmus medical school. Its curriculum, which was entirely integrated and theme-oriented, was implemented in 2001 and consisted of four pre-clinical years and two clinical years. The pre-clinical years were aimed at providing students a theoretical basis and clinical knowledge in order to prepare them for the clinical years. In the clinical years, the focus was on the acquisition of problem-solving and practical clinical skills.

The composition of the first-year curriculum is shown in Table 4.1.

Table 4.1 Composition of the first-year curriculum

Time	N exams	Obtainable credits (during period)	Number of credits (cumulative)	Theme(s)
Between 0 and 4 months	3	19.0 credits	19.0 credits	Introductory course Disorders in the milieu interieur (part 1&2)
Between 4 and 6 months	2	13.0 credits	32.0 credits	Disorders in the milieu interieur (part 3&4)
Between 6 and 8 months	2	11.5 credits	43.5 credits	Abnormal cell growth (part 1&2)
Between 8 and 10 months	3	16.5 credits	60.0 credits	Abnormal cell growth (part 3&4) Integration exam
Between 10 and 12 months	10 re-exams	60.0 credits	60.0 credits	All 4 (sub)themes

The first year of the pre-clinical phase comprised four themes, i.e. "An introductory course", "Disorders of the milieu interieur", "Abnormal cell growth", and an "Integration exam". The second and third theme were divided into four subthemes. In all themes teaching and learning methods included plenary lectures, symposia, tutorials, and home study assignments. Clinical elements were realised by patient demonstrations and practical clinical skills training. Each (sub)theme was completed with a written examination of open-ended and multiple-choice questions.

Participants

Participants in this study were 129 students of cohort 2006 who suffered from serious study delay at 4 months in medical school. Serious study delay was defined as 'failed to pass more than 1 out of 3 exams'. This specific group was selected, as it was demonstrated earlier on basis of data of the cohorts 2001-2005 (n=1819), that there was a strong relationship between 'failed to pass more than 1 out of 3 exams during the first 4 months' and 'not passing the first-year curriculum within two years of study' ($\chi^2 = 428.34$; $p < .000001$) (unpublished observation). The 129 students were invited for a voluntary encounter with the study counsellor in order to discuss their delay. Beforehand, they were requested to fill in a questionnaire.

Instrument

The questionnaire was made through a review of literature on factors relating to student failure (see Introduction). Furthermore, it was based on the results of a pilot study that was conducted in 2005. In this latter study, 136 students of cohort 2005 who failed to pass more than 1 out of 3 exams during the first 4 months were requested to report in a written questionnaire factors that according to them had caused their early study delay.

As shown in Table 4.2, the final version of the questionnaire aimed at measuring 7 factors:

1. Student participation in study-related activities;
2. Aspects of learning competence;
3. Aspects of discipline and time management;
4. Aspects of intrinsic motivation;
5. Aspects of integration;
6. Satisfaction with elements of the learning environment;
7. Personal circumstances.

Table 4.2 Mean scores and standard deviations on factors and underlying items of the questionnaire

Factors and underlying items	M	SD	M < 4	M ≥4
1. Participation in study-related activities				
Part of optional plenary lectures attended	4.65	.64	5.6%	94.4%
Part of optional self -study assignments completed	3.85	1.22	33.8%	66.2%
Part of obligatory skills training sessions attended	4.11	.95	22.5%	77.5%
Part of recommended literature studied	2.34	1.10	85.9%	14.1%
2. Learning competence (cronbach's α = .69)	3.35	.52	90.1%	9.9%
Studying was easy for me	2.94	.86	77.5%	22.5%
I could manage the large amount of learning content	3.06	.83	69.0%	31.0%
I had confidence in successfully completing the first-year curriculum in time	3.81	.87	34.3%	65.7%
The learning content was easy for me	3.18	.76	66.2%	33.8%
The language, which was used in education, was easy for me	3.65	.74	36.6%	63.4%
I was able to solve study-related problems	3.47	.85	45.7%	54.3%
3. Discipline and time management (cronbach's α = .86)	3.10	.76	87.3%	12.7%
I had the right study discipline	3.34	1.08	53.5%	46.5%
I spent enough time on study-related activities	3.07	1.03	62.0%	38.0%
I had no difficulties with setting myself to do self-study activities	3.20	1.08	54.9%	45.1%
I spend little time on study-unrelated activities	2.90	1.03	73.2%	26.8%
I did not postpone learning for the exams until the latest moment	3.30	1.15	52.1%	47.9%
Planning study-related activities was easy for me	2.82	.87	80.3%	19.7%
I had often enough energy for studying	3.07	.90	64.8%	35.2%
4. Intrinsic motivation (cronbach's α = .81)	4.17	.54	25.4%	74.6%
My motivation to learn was high	4.01	.82	22.5%	77.5%
The learning content was interesting to me	4.27	.64	7.1%	92.9%
I was challenged to learn more about the content of the courses	3.72	.74	33.8%	66.2%
I enjoyed my study	4.32	.67	8.5%	91.5%
I made the right study choice	4.51	.72	12.7%	87.3%
5. Integration (cronbach's α = .70)	3.95	.69	39.4%	60.6%
I was in sufficient contact with fellow students	4.04	.73	16.9%	83.1%
I felt at ease at the university	3.93	.91	22.9%	77.1%
I felt at ease in Rotterdam	3.89	.96	35.2%	64.8%
6. Satisfaction with elements of the learning environment (cronbach's α = .77)	3.74	.54	64.8%	35.2%
Education was stimulating to me	3.63	.76	38.0%	62.0%
I was satisfied with the teaching activities such as plenary lectures and practical sessions	3.82	.68	28.2%	71.8%
I appreciated the ratio between theory and practice	3.66	.74	32.4%	67.6%

Table 4.2 Mean scores and standard deviations on factors and underlying items of the questionnaire (continued)

Education in the first year was more appealing to me than that during pre-university education	4.00	.91	25.4%	74.6%
Examinations corresponded well with the learning objectives and teaching methods	3.56	.63	39.4%	60.6%
7. Personal circumstances	3.51	1.35	39.7%	60.3%
My study delay was not due to personal circumstances	3.51	1.35	39.7%	60.3%

Items concerning factor 1, which were constructed by us, were measured on a 5-point scale, ranging from 1 = "0-20%", 2 = "30-40%", 3 = "50-60%", 4 = "70-80%" and 5 = "90-100%". Items of factors 2 through 7 were all measured on a 5-point Likert scale, ranging from 1 = "Strongly disagree" to 5 = "Strongly agree". Most items of factor 2 were selected from Kleijn, Van der Ploeg and Topman (1994) and Schouwenburg and Stevens (1996); some were constructed by ourselves; Most items of factors 3 and 5 were selected from Schouwenburg and Stevens (1996) and some others were added by us; Items of factor 4 were derived from Pintrich, Smith, Garcia and McKeachie (1993) and Vallerand, Pelletier, Blais, Brière, Senécal and Vallières (1992); those of factors 6 and 7 were constructed by ourselves.

Other variables

Besides the factors and items of the questionnaire, two other variables were included in this study:

- Whether students passed no exams out of 2 between 4 and 6 months (independent variable);
- Whether students failed to pass the first-year curriculum within two years of study (dependent variable).

This data was obtained from the student administration system.

Data analysis

Analyses were conducted using SPSS 15 for Windows. Students' ID was used to link the responses on the questionnaire to the other variables. In this process, anonymity of the students was guaranteed.

In the analyses, all single items of factors 1 and 7 of the questionnaire were used. Besides, students' mean scores on the factors 2 through 6 were included, which is called the method of item parcelling (Elliot, Kratochwill, Littlefield & Travers, 1996). As shown in Table 4.2, Cronbach's alpha reliability coefficients of the factors were sufficient to good.

The analysis comprised four parts:

1. By logistic regression analysis, method forward likelihood ratio, it was investigated whether the existing predictive model at 6 months would also fit for the data of the entire group of 129 students included in this study (see Chapter 3). This was also done for the data of only the group of respondents.
2. For the respondents, descriptive statistics such as mean scores and standard deviations on the factors and items of the questionnaire were calculated. Besides, the percentage of those with low (< 4 on a 5-point Likert scale) and high scores (≥ 4) on the factors and items was determined. It was assumed that a score ≥ 4 indicated that the factor was probably not a main cause for students' study delay at 4 months.
3. By using chi-square statistics, the relationship between the dichotomized scores on the factors (subgroups with score < 4 or ≥ 4) and failure to pass the first-year curriculum was investigated.
4. By logistic regression analysis, method forward likelihood ratio, it was investigated whether the factors of the questionnaire in addition to the variable 'passed no exams between 4 and 6 months' could help to improve the specificity of the prediction at 6 months. A cut value of .50 was used, indicating that students who had a chance of 50% or more to fail to pass the first-year curriculum were predicted to fail, whereas those with a chance of less than 50% were predicted to be successful. For the prediction, the number of True Negatives (TN; students who were predicted to fail and actually failed to pass the first year), False Positives (FP; students who were predicted to be successful, but actually failed), False Negatives (FN; students who were predicted to fail, but actually were successful), True Positives (TP; students who were predicted to be successful and actually were successful) was determined. Moreover, the specificity (TN / (TN + FP); proportion of failing students who were correctly identified) and sensitivity (TP / (TP + FN); proportion of successful students who were correctly identified) were calculated.

Results

Did the existing predictive model at 6 months also fit for the data of the entire group of 129 students at risk?

The already existing predictive model at 6 months fitted for the data of the entire group of 129 students. It was shown that the use of the variable 'passed no exams between 4 and 6 months' led to a considerable percentage of students for whom failure could be predicted. The resulting regression equation was: Log(Odds) = -1.72 + 2.125 * (passed no exams between 4 and 6 months). The

specificity of the prediction was 71.4% and the sensitivity 77.0%. The number of TN, FN, FP and TP was 30, 20, 12 and 67, respectively.

Respondents

Of the 129 students who were requested to fill in the questionnaire, 71 actually responded. It was shown that respondents and non-respondents did not differ significantly in their number of credits at 4 months (t = -.73; df = 127; p > .10). However, the group of non-respondents comprised significantly more students who failed to pass the first-year curriculum than the group of respondents (χ^2 = 3.73; df = 1; p < .05).

Did the existing predictive model at 6 months fit for the data of only the group of respondents?

The existing predictive model at 6 months also fitted for the data of only the group of respondents. The resulting regression equation was: Log(Odds) = -1.815 + 1.911 * (passed no exams between 4 and 6 months). This led to a specificity of the prediction of 61.1% and a sensitivity of 81.1% (TN=11, FN=10, TP=43 and FP=7). In comparison with the statistics of the entire group of 129 students, the specificity of the prediction was lower in the group of respondents. This could be caused by the fact that the group of non-respondents, which was of course included in the entire group, comprised most students who would fail to complete the first-year curriculum.

Profile of the respondents

For the respondents, descriptive statistics of the factors and items of the questionnaire are presented in Table 4.2. Despite their study delay, 94% of the respondents attended more than 70% of the optional plenary lectures, 78% attended more than 70% of the obligatory skills training sessions, and 66% completed more than 70% of the optional self-study assignments. However, only a very small minority of 14% studied more than 70% of the recommended literature.

Only about 10% of the respondents obtained a score ≥ 4 on the factors 'discipline and time management' and 'learning competence'. In contrast, a large majority obtained a score ≥ 4 on the factors 'intrinsic motivation', 'integration' and 'my study delay was not due to personal circumstances'. Finally, about 35% of the respondents had a score ≥ 4 on the factor 'satisfaction with elements of the learning environment'. Those results indicate that at 4 months a lot of respondents experienced problems concerning their 'discipline and time management' and 'learning competence', whereas most did not seem to have motivational or integration problems.

Relationship between factors and failure in the first-year curriculum

Using chi-square statistics, the relationship between the factors (subgroups with score <4 or ≥4) and student failure in the first-year curriculum was investigated. As shown in Table 4.3, failing students had significantly more frequently a score < 4 on the following factors: part of optional plenary lectures attended ($\chi^2 = 5.52$, $p < .05$), part of recommended literature studied ($\chi^2 = 3.95$, $p < .05$), 'integration' ($\chi^2 = 4.74$, $p < .05$), 'satisfaction with elements of the learning environment' ($\chi^2 = 6.14$, $p < .01$) and 'personal circumstances' ($\chi^2 = 4.69$, $p < .05$).

Table 4.3 Relationship between dichotomized scores < 4 or ≥ 4 on factors and failing to pass the first-year curriculum within two years

Factors		χ^2	*P*-value
1a.	Part of optional plenary lectures attended	5.52	.02*
1b.	Part of optional self-study assignments completed	1.22	.27
1c.	Part of obligatory skills training sessions attended	1.61	.20
1d.	Part of recommended literature studied	3.95	.05*
2.	Learning competence	.04	.84
3.	Discipline and time management	1.10	.29
4.	Intrinsic motivation	.08	.78
5.	Integration	4.74	.03*
6.	Satisfaction with elements of the learning environment	6.14	.01**
7.	Personal circumstances	4.69	.03*

Please note that:

1) Chi-square analyses were conducted to test the relationship between dichotomized scores on factors (subgroups M<4 or ≥4) and failing to pass the first-year curriculum within two years of study
2) * Significant relationship at $p < .05$; ** Significant relationship at $p < .01$

Which factors did add significantly to the predictive model at 6 months?

Logistic regression analysis showed that of abovementioned factors only the factor 'student attendance at the optional plenary lectures' contributed significantly to the predictive model at 6 months ($p < .05$). The resulting regression equation was: Log(Odds) = -2.14 + 2.15 * (passed no exams between 4 and 6 months) + 2.91 * (attended less than 70% of the plenary lectures during the first 4 months). The number of TN, FN, FP and TP was 13, 11, 5 and 42, respectively. Addition of the new predictive variable improved the specificity of the prediction at 6 months from 61.1% to 72.2%. The sensitivity decreased from 81.1% to 79.2%.

Discussion

Our challenge was to develop a model for early and reliable prediction of students who would fail to pass the first-year curriculum within two years of study. Such an early and reliable prediction would have the potential advantage of intervention by a short remedial support programme for a well-defined subgroup of motivated students in order to help them to overcome their initial problems or referral to another study for the subgroup that was not willing to remediate.

In a preceding study, it was demonstrated that optimal students, i.e. those who passed all exams at 4 or 6 or 8 months in our medical school, had a chance of 99% of passing the entire first-year curriculum within two years of study (see Chapter 3). For the non-optimals, at 6 months failure to pass the first year could be predicted with a specificity of 66.7% and a sensitivity of 84.5% by using the variable 'passed no exams between 4 and 6 months'. The specificity was lower at 4 months (51.4%) and did not increase much from 6 months onwards. The goal of the current study was to explore whether other factors could help to improve the prediction at 6 months of those who would fail to pass the first-year curriculum within two years of study. To that end, a questionnaire measuring student participation in study-related activities, aspects of learning competence, intrinsic motivation, integration, discipline and time management, satisfaction with elements of the learning environment, and personal circumstances was sent to 129 students of cohort 2006 who suffered from serious study delay at 4 months in medical school.

Of all factors, only 'student attendance at the optional plenary lectures' helped to improve our existing predictive model at 6 months. In the group of respondents, 'attending less than 70% of the optional plenary lectures' together with the variable 'passed no exams between 4 and 6 months' led to a specificity of the prediction of 72.2% and a sensitivity of 79.2%. The number of TN, FN, FP and TP was 13, 11, 5 and 42, respectively. To compare, if we had included only the variable 'passed no exams between 4 and 6 months' this would have led to a specificity of 61.1% and a sensitivity of 81.1%. It was shown in this study that only 6% of the respondents attended less than 70% of the optional plenary lectures. Thus, not attending the majority of those lectures seemed to be a symptom of deviant behaviour. Maybe, those students were not challenged by the content of the lectures or were not motivated themselves. Due to the fact that in those lectures important issues concerning the exams were discussed, the relationship between non-attendance and failing seems to be explainable. As the nature of the plenary lectures did not change in the remaining part of the first year, it seems conceivable that students who did not participate in the beginning period also lacked participation after-

wards. However, it is still very well possible that the same students would participate in other types of teaching activities, which would be more adapted to their preferred way of learning.

This study was limited by the fact that the results were based on the data of a subgroup of students from only one cohort (see Chapter 3). Thereby, the group of respondents in this study was a biased group, since this group contained significantly fewer students who would fail to pass the first year than the group of non-respondents. Therefore, caution is required in drawing too strong conclusions. In fact, it is very well possible that the scores on the factors of the non-respondents could be different from those of the respondents. For example, maybe the group of non-respondents comprised much more students who were not motivated or badly integrated. This finding stresses the importance of having the highest possible response rate and also the importance of conducting research in the group of non-respondents. A lack of information about the latter group might lead to statements for the entire population, which are untrue. A second limitation was that we did not use validated questionnaires. This was not done, as the nature of this study was exploratory and it was not feasible to use extensive questionnaires. Instead, we used a selection of items from existing questionnaires in combination with some items, which were developed by ourselves on basis of students' responses to an earlier conducted pilot study. This led to factors, which had sufficient to good reliability coefficients. However, still the results of this study need to be confirmed in the future by using existing questionnaires, which are validated.

In conclusion, students' lack of participation in optional plenary lectures may help to improve the prediction at 6 months for student failure in the first-year curriculum. However, still this finding need to be confirmed in a larger study, in which a number of consecutive cohorts is included and validated questionnaires are used.

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5 Exploratory study on factors related to student achievement in the first year of medical school

Gerard J.A. Baars[1], Theo Stijnen[2] & Ted A.W. Splinter[3]

Abstract

Background Pre-university education Grade Point Average (pu-GPA), i.e. the mean grade of students obtained during the final year of pre-university education, is moderately related to the GPA of year 1 in medical school for all students. However, this relationship is higher for students with a pu-GPA above the mean and absent for those with a pu-GPA below it.

Objective The goal of this study was to explore for each of these pu-GPA subgroups, which other factors than pu-GPA are related to year 1 GPA.

Methods A questionnaire was sent to 107 students who had completed medical school. They were requested to complete 22 closed-ended items with respect to the first year, measuring aspects of students' adaptation to the learning environment, intrinsic and extrinsic motivation, satisfaction with elements of the learning environment, time spent on study-related activities, and aspects of the social environment. Besides, in 1 open-ended item, students were asked to report other factors, which in their opinion might have affected positively or negatively their grades in the first year. All this data was linked to pu-GPA, year 1 GPA, age and gender.

Results The response rate was 65.4%. For students with a pu-GPA below the mean, the absence of a significant relationship between pu-GPA and year 1 GPA was confirmed. Step-wise multiple regression analysis revealed that aspects of intrinsic motivation explained 37% of the variance in year 1 GPA, membership of a students' social club another 6% and aspects of extrinsic motivation an additional 6%. For students with a pu-GPA above the

1 Erasmus University Rotterdam, Risbo; Erasmus MC, Department of Medical Education and Research, the Netherlands
2 Leiden University Medical Center, Department of Medical Statistics and Bioinformatics, the Netherlands
3 Erasmus MC, Department of Internal Medicine, the Netherlands

mean, pu-GPA explained 44% of the variance and aspects of extrinsic motivation another 10%.

Conclusions Pu-GPA, aspects of intrinsic and extrinsic motivation, and membership of a students' social club seemed to be related to student achievement in the first year. The degree of importance was different for those with a pu-GPA below or above the mean.

Introduction

In the transition from pre-university education to the first year in medical school the achievement of some students remains constant, while that of others improves significantly or gets worse and may even lead to dropping out. If such achievements can be correctly predicted, opportunities may be created for selecting students on rational grounds and adapting the learning environment selectively, so that all medical students get a fair chance to complete their studies at a proper level and in a proper time.

Academic achievement is the resultant of a very complex interaction between a range of student-related factors such as ability, motivation, ambition, study skills, learning styles, personality traits, time spent on study-related activities, and external factors such as learning environments, teaching methods, and social environments. Some of the student-related factors such as learning styles and time spent on study-related activities seem to have a limited or equivocal relationship with student achievement (Ferguson, James & Madely, 2002; Leiden, Crosby & Follmer, 1990; van den Hurk, Wolfhagen, Dolmans & van der Vleuten, 1998). Others such as ability, motivation, ambition, and some of the personality traits seem to be stronger related (McManus, Powis, Wakeford, Ferguson, James & Richards, 2005; Sobral, 2004; Nonis & Wright, 2003; Lievens, Coetsier, de Fruyt & de Maeseneer, 2002; Ferguson, James, O'Hehir & Sanders, 2003; Shen & Comrey, 1997). With respect to the external factors, the direct relationship with teaching methods seems to be limited (Albanese & Mitchell, 1993; Gijbels, Dochy, Van den Bossche & Segers, 2005), whereas some social environment factors such as the time students spend hanging out with peers seem to have a negative relationship (Jordan & Nettles, 2000).

To date, pre-university education Grade Point Average (pu-GPA), i.e. the mean grade that students obtain during the final year of pre-university education, seems to be the best and most consistent single variable for predicting success in medical school (Gottheil & Michael, 1957; Salvatori, 2001). In particular, the relationship between pu-GPA and achievement in the pre-clinical phase seems to be moderate to strong (Salvatori, 2001). Our own data support these observations. However, for students with a pu-GPA below the mean,

the relationship between pu-GPA and the GPA in the first year in medical school (year 1 GPA) was found to be non-existent. In contrast, for those with a pu-GPA above the mean, the relationship between the GPAs was higher (see Chapter 2).

This study is part of a broader exploratory study, in which we want to find indications for year 1, the subsequent pre-clinical years 2-4 and the clinical phase, which factors are related to the achievement of subgroups of students with a GPA below or above the mean in the preceding study phase. To that end, a questionnaire was sent to 107 students who had completed medical school. They were asked to look back on the three distinctive curriculum parts and to respond for each part to 22 closed-ended items measuring aspects of adaptation to the learning environment, intrinsic and extrinsic motivation, satisfaction with elements of the learning environment, time spent on study-related activities, and aspects of the social environment. In an open-ended item students were challenged to report factors, which in their opinion might have affected positively or negatively their GPA.

In the current study, only students' responses on the items concerning the first year were used. The goal was to explore for both students with a pu-GPA below the mean and those with a pu-GPA above it, which other factors than pu-GPA were related to year 1 GPA.

Methods

Setting

This study was conducted at Erasmus medical school in Rotterdam, the Netherlands. Its curriculum consisted of four pre-clinical years and two clinical years. The pre-clinical years were aimed at providing students integrated basic and clinical knowledge. In the clinical years, the focus was on the acquisition of problem-solving and practical clinical skills.

The first year in medical school was also meant for orientation and selection. During this year, seventeen courses were offered, such as anatomy, biochemistry, and molecular biology. Teaching methods included plenary lectures, practicals, patient demonstrations, and practical clinical skills training. Each course was completed by a written examination that contained multiple-choice questions, open-answer questions, essay questions, and clinical cases. Students who did not successfully complete the entire first-year curriculum within two years after registration were not allowed to continue their study.

Instrument

A questionnaire was constructed, aimed at exploring which factors had affected the achievement of students in three distinctive curriculum parts, i.e. the first year, pre-clinical years 2-4, and the clinical phase.

The first draft of the questionnaire was made through a review of literature on factors relating to student achievement in medical school. It comprised for each of the three curriculum parts a selection of 9 closed-ended items concerning aspects of students' adaptation to the learning environment and their appreciation of the curriculum. Besides, in 1 open-ended item, students were requested to report factors that according to them had affected positively or negatively their achievement. The draft version was sent to 97 students who had completed medical school between February and May 2004. Based on the responses of 63 of them, the questionnaire was adjusted and extended. This led to a final version of the questionnaire, which comprised for each of the three curriculum parts a selection of 22 closed-ended items and 1 open-ended item. Closed-ended items are presented in Table 5.1.

As shown in Table 5.1, closed-ended items were aimed at measuring 6 factors:

1. Aspects of students' adaptation to the learning environment;
2. Aspects of intrinsic motivation;
3. Aspects of extrinsic motivation;
4. Satisfaction with elements of the learning environment;
5. Time spent on study-related activities;
6. Aspects of the social environment.

Items concerning factors 1 through 4 were measured on a 5-point Likert scale, ranging from 1 = "Strongly disagree" to 5 = "Strongly agree". Items of factor 1 were selected from Kleijn, Van der Ploeg and Topman (1994), and Schouwenburg and Stevens (1996); those of factors 2 and 3 from Pintrich, Smith, Garcia and McKeachie (1993), and Vallerand, Pelletier, Blais, Brière, Senécal and Vallières (1992); and those of factor 4 were constructed by ourselves. The item concerning factor 5, in which students were requested to report in a free text field the number of hours they had spent on study-related activities, was derived from Van den Hurk, Wolfhagen, Dolmans and Van der Vleuten (1998). Items concerning factor 6 were measured on a 2-point scale (1 = "Yes", 2 = "No") and constructed by us.

In the open-ended item, students were asked to report for each curriculum part factors that according to them had affected positively or negatively their GPA. Those answers were used to find support for the outcomes of the quantitative data and to catch sight of other factors, which might have influenced student achievement in the first year.

Table 5.1 Descriptives of 22 closed-ended items concerning the first year in medical school (n=70)

Factors		Items	Mean	SD	Alpha reliability
1.	Aspects of adaptation to the learning environment	Studying was easy for me	3.64	0.89	.70
		Planning study activities was easy for me	3.64	1.08	
		I felt at ease at the university	3.61	0.84	
2.	Aspects of intrinsic motivation	My motivation to learn was high	3.90	0.95	.73
		I liked my study	3.81	3.81	
		I was interested in the content of the courses	3.49	0.85	
		I felt challenged to learn more about the content of the courses	3.11	0.91	
3.	Aspects of extrinsic motivation	I wanted to prove myself that I could succeed at medical school	3.33	1.29	.66
		I studied to obtain high grades	3.43	1.08	
		My peers and/or parents stimulated to obtain high grades	3.34	0.96	
4.	Satisfaction with elements of the learning environment	I was stimulated by the instruction/ the courses	3.09	0.86	.74
		I was satisfied with the teaching methods such as plenary lectures and practical training sessions	3.40	0.95	
		I appreciated the examination methods	2.90	1.02	
		I appreciated the ratio between theory and practice	2.66	1.13	
		The examinations corresponded well with the instruction/ education	3.40	0.88	
		Education in the first year appealed more to me than that of pre-university education	3.40	1.06	
5.	Time spent on study-related activities	How many hours did you spend on study-related activities per week?	38.92	11.52	NA
6.	Aspects of the social environment	Did you live at your parents' home? (1 = Yes, 2 = No)	1.57	.50	NA
		Were you member of a study union? (1 = Yes, 2 = No)	1.11	.32	
		Were you member of a students' social club? (1 = Yes, 2 = No)	1.73	.45	
		Were you member of a sports club? (1 = Yes, 2 = No)	1.51	.50	
		Did you have a job besides the study? (1 = Yes, 2 = No)	1.37	.49	

Note: SD, Standard Deviation; NA, Not Applicable

Participants and procedure

The final questionnaire was sent to 107 students who had completed their study between May and October 2004. Participation was voluntary. After one month, a reminder was sent.

In the current study, only students' responses with respect to the first year in medical school were used.

Other independent variables

Besides students' responses to the questionnaire, three other independent variables were included in this study, i.e. pu-GPA, age and gender. This data was obtained from the student administration system.

Pu-GPA was determined by students' mean grade on all subjects of the final examination of pre-university education. The final grade for each subject was based partly on school examinations (50%) and partly on a state examination (50%). Since all students in this study were selected through a national lottery procedure, pu-GPA scores ranged from 5.5 to 10.0 (Urlings-Strop, Stijnen, Themmen & Splinter, 2009). Those were transformed into z-scores.

Dependent variable

The dependent variable was students' year 1 GPA, i.e. students' mean grade on the first attempt at all 17 exams in the first year. Grades, which were given on a 10-point scale (1 = very poor; 10 = outstanding), were derived from the student administration system. Year 1 GPA scores were also transformed into z-scores.

Data analysis

Analyses were conducted using SPSS Version 15 for Windows. Using students' identification number, responses to the items of the questionnaire concerning the first year were linked to pu-GPA, year 1 GPA, age and gender. As the investigators could not link the identification numbers to students' names, anonymity was guaranteed.

In the analyses, students' mean scores on the factors 1 through 4 of the questionnaire were used, which is called the method of item parcelling (Elliot, Kratochwill, Littlefield & Travers, 1996). As shown in Table 5.1, Cronbach's alpha reliability coefficients of these factors were sufficient. Besides, all single items of factors 5 and 6 were included.

All respondents were divided into one of the pu-GPA subgroups, i.e. those with a pu-GPA below the mean ($z < 0$; mean grade ≥ 5.5 and < 6.98; $n = 38$) or those with a pu-GPA above it ($z \geq 0$; mean grade ≥ 6.98 and ≤ 10; $n = 32$). For each of these subgroups, the analysis comprised three main parts:

1. The relationship between pu-GPA and year 1 GPA was determined by performing bivariate regression analyses;
2. A step-wise multiple linear regression analysis was conducted to test which of the independent variables, i.e. pu-GPA, aspects of students' adaptation to the learning environment, aspects of intrinsic motivation, aspects of extrinsic motivation, satisfaction with elements of the learning environment, time spent on study-related activities, aspects of the social environment, age and gender, were related to year 1 GPA;
3. Students' answers to the open-ended question, in which they were requested to report factors that according to them had affected positively or negatively their year 1 GPA, were used to find support for the outcomes of the quantitative analysis and to catch sight of factors, which were not included in the quantitative part of the questionnaire.

Results

Respondents

Of the 107 students, 70 students completed the entire questionnaire, which represented a response rate of 65.4%. The group of respondents consisted of 36% men and 64% women. Their mean age at the start in medical school was 19.47 years (SD = 1.52), ranging from 17.89 to 27.44. Other descriptive statistics for the respondents are presented in Table 5.1.

To check if the sample taken was representative, data concerning age, gender, pu-GPA and year 1 GPA was compared with data of the 97 students who had participated in the preceding pilot study. Using T-tests, no significant differences were found.

Pu-GPA subgroup below the mean (n = 38)

Relationship between pu-GPA and year 1 GPA

For students with a pu-GPA below the mean, firstly, the relationship between pu-GPA and year 1 GPA was investigated. This relationship was found to be very low and non-significant ($F1_{,36} = 2.35$; $p > .10$).

Relationship between other factors and year 1 GPA

By conducting a step-wise multiple regression analysis, it was explored whether the other variables, which were included in this study (see Table 5.2), were related to year 1 GPA.

Table 5.2 Descriptive statistics of study variables for subgroups with a pu-GPA below or above the mean

	Pu-GPA below the mean (n=38)		Pu-GPA above the mean (n=32)	
Variables	Mean	SD	Mean	SD
Aspects of adaptation to the learning environment	3.50	0.76	3.79	0.70
Aspects of intrinsic motivation	3.46	0.65	3.72	0.67
Aspects of extrinsic motivation	3.25	0.89	3.51	0.83
Satisfaction with elements of learning environment	3.11	0.62	3.17	0.68
Time spent on study-related activities (in hours per week)	37.20	11.87	40.93	10.94
Living at parents' home (1 = Yes, 2 = No)	1.68*	0.47	1.44*	0.50
Member of study union (1 = Yes, 2 = No)	1.08	0.27	1.16	0.37
Member of students' social club (1 = Yes, 2 = No)	1.66	0.48	1.81	0.40
Member of sports club (1 = Yes, 2 = No)	1.53	0.51	1.50	0.51
Having a job (1 = Yes, 2 = No)	1.26*	0.45	1.50*	0.51
Age at start medical school (in years)	19.98**	1.74	18.86**	0.91
Gender (1 = Female; 2 = Male)	1.34	0.48	1.38	0.49
Z-score pu-GPA	-0.66***	0.45	0.87***	0.76
Z-score year 1 GPA	-0.53***	0.78	0.71***	0.82

Note: SD, Standard Deviation
Note: *** Significant differences between subgroups at p<.001, ** at p < .01; * at p < .05

It was shown that higher scores on aspects of intrinsic and extrinsic motivation together with not being a member of a students' social club were related to higher year 1 GPA scores. Those factors together explained 49% of the variance in year 1 GPA: intrinsic motivation explained 37% ($F1_{,36} = 22.49$; $p < .01$), membership of a students' social club an additional 6% ($F1_{,35} = 4.92$; $p < .05$), and extrinsic motivation again another 6% ($F1_{,34} = 4.89$; $p < .05$).

Self-reported factors affecting the study results of year 1

In the open-ended question, the results of the quantitative analysis were confirmed. Some students explicitly stated that their motivation had affected positively their achievement. Examples: "I was very motivated to study medicine" and "My motivation certainly contributed to obtain good results". Furthermore, some students reported that being member of a students' social club had affected negatively their achievement.

However, responses to the open-ended item did not provide insight into new factors, which were not covered by the quantitative part of the questionnaire.

Pu-GPA subgroup above the mean (n = 32)

Relationship between pu-GPA and year 1 GPA

Similar analyses were conducted for students with a pu-GPA above the mean. Also for this group, the relationship between pu-GPA and year 1 GPA was investigated. This relationship was found to be very strong (explained variance of 44%; $F1_{,30} = 25.15$; $p < .0001$).

Additional factors in relation to year 1 GPA

By conducting a stepwise multiple regression analysis, it was investigated whether - in addition to pu-GPA - other variables were related to year 1 GPA. It was shown that aspects of extrinsic motivation added another 10% to the explained variance in year 1 GPA ($F1_{,29} = 7.84$; $p < .01$). Thus, pu-GPA plus aspects of extrinsic motivation together explained 54% of the variance in year 1 GPA. Higher scores on the two factors were related with higher year 1 GPA scores.

Self-reported factors affecting the study results of year 1

The strong relationship between pu-GPA and year 1 GPA suggested that students with a pu-GPA above the mean were not very sensitive to the transition from pre-university education to the first year in medical school. This was supported by students' answers to the open-ended question. Some reported: "During my entire life I was used to pay a lot of attention to study-related activities and to obtain high grades" and "I have never encountered problems in putting myself to learn, even not if the activity was very dull".

However, the qualitative data did not give insight into factors, which were not included in the quantitative part of the questionnaire.

Discussion

It has been shown that pu-GPA is the best and most consistent predictor for student achievement in the first year in medical school for entire cohorts of students (see Chapter 2; Salvatori, 2001). For students with a pu-GPA below the mean this relationship seems to be absent and for those with a pu-GPA above it, it is strong (see Chapter 2). The goal of the current study was to explore for each of the pu-GPA subgroups, which other factors than pu-GPA are related to year 1 GPA. Factors included in this study were aspects of students' adaptation to the learning environment, intrinsic and extrinsic motivation, satisfaction with elements of the learning environment, time spent on study-related activities, aspects of the social environment, age and gender.

For students with a pu-GPA below the mean (≥ 5.5 and < 6.98 on a 10-point scale), achievement at the examinations during the final year of pre-university education had no predictive value for year 1 GPA. Instead, higher scores on aspects of intrinsic motivation plus higher scores on aspects of extrinsic motivation plus not being member of a students' social club were related to higher year 1 GPAs. Those factors together explained 49% of the variance in year 1 GPA. Results were confirmed by students' responses to the open-ended question.

For students with a pu-GPA above the mean (≥ 6.98 and ≤ 10), both pu-GPA and aspects of extrinsic motivation were related to the GPA of the first year. Achievement during the final year of pre-university education explained 44% of the variance and aspects of extrinsic motivation an additional 10%. These results indicated that students who achieved well during pre-university education went on to do so. For these students, the interaction between the student and the learning environment in the first year seemed to be more or less the same in comparison with pre-university education. This might be explained by the fact that, although there were some differences between the two study phases, both phases were theory-oriented. Furthermore, teaching and examination methods were more or less similar. As a consequence, those students could probably continue to use some learning and other skills, which had proven to be effective during pre-university education. For these high performing students, aspects of extrinsic motivation, such as studying to obtain high grades, determined whether the GPA of the students changed in the first year or not.

This study has some limitations. First, as a retrospective study, students' knowledge of their grades might have influenced the attribution of causal factors. It is conceivable that students whose GPA improved to a higher level in medical school, assigned causality to factors within themselves such as to aspects of their intrinsic motivation. Also the opposite may be true: students whose GPA dropped to a lower level might have assigned causality to an outside force such as being member of a students' social club. In relation to this, by retrospectively questioning students also their recollections could well have been coloured by the intervening period. A second limitation is that we did not use validated questionnaires. As mentioned earlier, this study was part of a larger exploratory study, in which we wanted to find indications not only for year 1, but also for pre-clinical years 2-4 and the clinical phase, which factors had affected the achievement of those whose GPA in the preceding study phase was at a level below or above the mean. Due to this exploratory character and the fact that it was not feasible to use extensive questionnaires a selection of items from existing questionnaires was used. As a consequence, results of this study need to be confirmed by using validated questionnaires.

A third limitation is that results were based on small samples, which might have introduced sampling variability and have limited the generalisability. However, based on the high explained variances, which were found in both pu-GPA subgroups, we think that at least some of the factors, which emerged in this study, are likely to be confirmed in future studies. A fourth limitation is that we lacked data of the non-respondents. Inclusion of this latter group could have led to some differences in the outcomes of this study. Fifthly, one other important group was not included in this study, i.e. those who failed. Data from 15 year-cohorts between 1987 and 2002 in our medical school have shown that the mean percentage of failing students is 13% with a range from 8% to 19%. Of these students, approximately eighty percent failed during the first year (unpublished observation). Finally, attention should be paid to the fact that the outcomes of this study were established by the interaction between our students and our curriculum. In other curricula, it is very well possible that deviant relationships between factors in relation to student achievement will be found. Despite these limitations, our findings with respect to the impact of motivation and the social environment on study results are in line with those of Sobral (2004), McKenzie, Gow and Schweitzer (2004), Nonis and Wright (2003), and Jordan and Nettles (2000).

The results of this study do give additional support to the finding that investigation of the relationship between student-related factors and/or external factors on one side and student achievement on the other should be directed at subgroups and not only at entire cohorts (see also Chapter 2). Such data raises the question on how to interpret relationships between predictive factors and student achievement in a heterogeneous population of students.

In conclusion, pu-GPA, aspects of intrinsic and extrinsic motivation and membership of a students' social club seem to be important factors in relation to student achievement in the first year of medical school. The degree of importance was different for students with a pu-GPA above the mean and those with a pu-GPA below it. More in-depth prospective investigation into the impact of these aspects by using validated instruments is needed to confirm these results. Such data may be useful to identify students for selection and/or early adaptation of the learning environment.

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6 Exploratory study on factors related to student achievement in pre-clinical years 2-4

Gerard J.A. Baars[1], Theo Stijnen[2] & Ted A.W. Splinter[3]

Abstract

Background Year 1 Grade Point Average (year 1 GPA) is strongly related to the GPA in the pre-clinical years 2-4 for all students. For students with a year 1 GPA below the mean, this relationship is moderate, whereas it is very strong for those with a year 1 GPA above it.

Objective The goal of this study is to explore for each of these year 1 GPA subgroups, which factors in addition to year 1 GPA are related to year 2-4 GPA.

Methods A questionnaire was sent to 107 students who had completed medical school. They were asked to complete 22 closed-ended items with respect to pre-clinical years 2-4, measuring aspects of students' adaptation to the learning environment, intrinsic and extrinsic motivation, satisfaction with elements of the learning environment, time spent on study-related activities, and aspects of the social environment. Besides, in 1 open-ended item, students were asked to report other factors, which in their opinion had affected positively or negatively their grades. This data was linked to year 1 GPA, years 2-4 GPA, age and gender.

Results The response rate was 65.4%. Step-wise multiple regression analysis revealed that for students with a year 1 GPA below the mean, aspects of adaptation to the learning environment, year 1 GPA, and membership of a students' social club explained 42% of the variance in year 2-4 GPA. For those with a year 1 GPA above the mean, year 1 GPA plus appreciation of elements of the learning environment led to an explained variance of 66%.

Conclusions Student achievement in the first year, aspects of adaptation to the learning environment, membership of a students' social club and appreciation of elements of the learning environment seemed to be related to

1 Erasmus University Rotterdam, Risbo; Erasmus MC, Department of Medical Education and Research, the Netherlands
2 Leiden University Medical Center, Department of Medical Statistics and Bioinformatics, the Netherlands
3 Erasmus MC, Department of Internal Medicine, the Netherlands

student achievement in pre-clinical years 2-4. The degree of importance was different for those with a year 1 GPA below or above the mean.

Introduction

Student achievement is the resultant of a very complex interaction between a range of student-related factors such as ability, motivation, ambition, study skills, learning styles, personality traits, and time spent on study-related activities, and external factors such as elements of the learning environment and aspects of the social environment. Some of the student-related characteristics such as achievement striving, motivation (Moelaert, Verwijnen, Rikers & Scherpbier, 2004; see also Chapter 5) and personality traits (Ferguson, James & Madely, 2002; Ferguson, James, O'Hehir & Sanders, 2003; Hoschl & Kozeny, 1997; Lievens, Coetsier, De Fruyt & De Maeseneer, 2002) seem to be moderately to strongly associated with achievement in medical school. In contrast, the direct influence of external factors seems to be much smaller or even not existing (Colliver, 2000).

At the transition of study phases, the achievement of some students remains unaffected, whereas that of others changes either to a lower or higher level. In general, it seems logical to assume that the number of students whose achievement changes and the size of the change is related to the size of change in the learning and/or social environment (see Chapter 2). Reversely, strong relationships between achievements in different study phases are expected as same abilities are reflected, and teaching and examinations methods are similar (Case & Swanson, 1993). In line with this way of reasoning, in a previous study we reported moderate relationships between the Grade Point Average scores (GPAs) obtained during the final year of pre-university education and the first year in medical school (unstandardized regression coefficient B = .58, σ_{res}=.82, with p < .001), and between those of the pre-clinical and clinical phase (B = .45, σ_{res}=.90, with p < .001) (see Chapter 2). In contrast, a very strong relationship of .75 (σ_{res}=.66), with p < .001, was found between the GPAs of the two parts of the four-year pre-clinical phase, i.e. year 1 and the subsequent pre-clinical years 2-4.

Although the latter relationship seems to be very strong, we reported remarkable differences between subgroups of students, which were distinguished by their preceding level of achievement below or above the mean (see Chapter 2). More specifically, for students with a year 1 GPA below the mean, the relationship between the GPAs of the first year and the remaining three pre-clinical years was found to be weak to moderate (B = .34, σ_{res}=.60, with p < .001). This indicates that for this subgroup year 1 GPA, i.e. the resultant of factors determining student achievement in the first year, had only little

value for predicting achievement in the remaining three pre-clinical years. In contrast, for those with a year 1 GPA above the mean, the relationship between the GPAs of year 1 and pre-clinical years 2-4 was very strong ($B = .96$, $\sigma_{res}=.66$, with $p < .001$), indicating that year 1 GPA was a very good predictor for achievement during the remaining part of the pre-clinical phase.

This study is part of a broader exploratory study, in which we want to find indications for year 1, the subsequent pre-clinical years 2-4 and the clinical phase, which factors are related to the achievement of subgroups of students with a GPA below or above the mean in the preceding study phase. To that end, a questionnaire was sent to 107 students who had completed medical school. They were asked to look back on the three distinctive curriculum parts and to respond for each part to 22 closed-ended items measuring aspects of adaptation to the learning environment, intrinsic and extrinsic motivation, satisfaction with elements of the learning environment, time spent on study-related activities, and aspects of the social environment. In an open-ended item students were challenged to report other factors, which in their opinion had affected positively or negatively their GPA.

In the current study, only students' responses concerning pre-clinical years 2 through 4 were used. The goal was to explore for both students with a year 1 GPA below the mean and those with a year 1 GPA above it, which factors in addition to year 1 were related to pre-clinical year 2-4 GPA. Furthermore, outcomes of the current study were compared with those of a preceding study, in which factors in relation to year 1 GPA were investigated for GPA-subgroups of students (see Chapter 5).

Methods

Setting

This study was conducted at Erasmus medical school in Rotterdam, the Netherlands. Its curriculum consisted of four pre-clinical years and two clinical years. The pre-clinical years were aimed at providing students integrated basic and clinical knowledge. In the clinical years, the focus was on the acquisition of problem-solving and practical clinical skills.

The first year of the pre-clinical phase, also called the propaedeutic phase, was also meant for orientation and selection. During this year, seventeen courses were offered, such as anatomy, biochemistry, and molecular biology. Teaching methods included plenary lectures, practicals, patient demonstrations, and practical clinical skills training. Each course was completed by a written examination that contained multiple-choice questions, open-answer questions, essay questions, and clinical cases. Students who did not successfully complete the entire first-year curriculum within two years after registra-

tion were not allowed to continue their study, unless they had suffered from temporary, but serious personal circumstances such as decease of close relatives or illness.

In the subsequent three pre-clinical years, thirty-one courses were offered. Teaching and examinations methods resembled very much those of the first year. However, more and more clinical themes such as patient demonstrations and case discussions were included.

Instrument

A questionnaire was constructed, aimed at exploring which factors had affected the achievement of students in three distinctive curriculum parts, i.e. year 1, the subsequent pre-clinical years 2-4, and the clinical phase.

The first draft of the questionnaire was made through a review of literature on factors relating to student achievement in medical school. It comprised for each of the three curriculum parts a selection of 9 closed-ended items with respect to aspects of students' adaptation to the learning environment and their appreciation of the curriculum. Besides, in 1 open-ended item, students were requested to report factors, which according to them had affected positively or negatively their achievement. This draft version was sent to 97 students who had completed their study between February and May 2004. Based on the responses of 63 of them, the draft version of the questionnaire was adjusted and extended.

This led to a final version of the questionnaire, which comprised for each of the three curriculum parts a selection of 22 closed-ended items and 1 open-ended item.

Closed-ended items are presented in Table 6.1. As shown in Table 6.1, closed-ended items were aimed at measuring 6 factors:

1. Aspects of students' adaptation to the learning environment;
2. Aspects of intrinsic motivation;
3. Aspects of extrinsic motivation;
4. Satisfaction with elements of the learning environment;
5. Time spent on study-related activities;
6. Aspects of the social environment.

Items concerning factors 1 through 4 were measured on a 5-point Likert scale, ranging from 1 = "Strongly disagree" to 5 = "Strongly agree". Items of factor 1 were selected from Kleijn, van der Ploeg and Topman (1994), and Schouwenburg and Stevens (1996); those of factors 2 and 3 from Pintrich, Smith, Garcia and McKeachie (1993), and Vallerand, Pelletier, Blais, Brière, Senécal and Vallières (1992); and those of factor 4 were constructed by ourselves. The item concerning factor 5, in which students were requested to report in a free text

field the number of hours they had spent on study-related activities, was derived from Van den Hurk, Wolfhagen, Dolmans and Van der Vleuten (1998). Items concerning factors 6 were measured on a 2-point scale (1 = "Yes", 2 = "No") and constructed by us.

Table 6.1 Descriptives of 22 closed-ended items concerning pre-clinical years 2-4 in medical school (n=70)

Factors		Items	Mean	SD	Alpha reliability
1.	Aspects of adaptation to the learning environment	Studying was easy for me	3.73	.85	.74
		Planning study activities was easy for me	3.67	.85	
		I felt at ease at the university	3.96	.65	
2.	Aspects of intrinsic motivation	My motivation to learn was high	3.76	.73	.79
		I liked my study	3.96	.71	
		I was interested in the content of the courses	4.07	.55	
		I felt challenged to learn more about the content of the courses	3.49	.94	
3.	Aspects of extrinsic motivation	I wanted to prove myself that I could succeed at medical school	3.14	1.09	.70
		I studied to obtain high grades	3.37	1.01	
		My peers and/or parents stimulated to obtain high grades	3.47	.86	
4.	Satisfaction with elements of the learning environment	I was stimulated by the instruction/ the courses	3.51	.86	.79
		I was satisfied with the teaching methods such as plenary lectures and practical training sessions	3.29	.90	
		I appreciated the examination methods	2.76	1.00	
		I appreciated the ratio between theory and practice	2.77	1.07	
		The examinations corresponded well with the instruction/ education	3.34	.87	
		Education in pre-clinical years 2-4 appealed more to me than during year 1	4.03	.74	
5.	Time spent on study-related activities	How many hours did you spend on study-related activities per week?	35.24	9.24	NA
6.	Aspects of the social environment	Did you live at your parents' home? (1 = Yes, 2 = No)	1.80	.40	NA
		Were you member of a study union? (1 = Yes, 2 = No)	1.10	.30	
		Were you member of a students' social club? (1 = Yes, 2 = No)	1.63	.49	
		Were you member of a sports club? (1 = Yes, 2 = No)	1.41	.50	
		Did you have a job? (1 = Yes, 2 = No)	1.10	.30	

Note: SD, Standard Deviation; NA, Not Applicable

In the open-ended item, students were asked to report for each study phase factors that according to them had affected positively or negatively their GPA. Those answers were used to find support for the quantitative data and to catch sight of other factors, which might have influenced students' achievement in the pre-clinical years 2-4.

Participants and procedure

The final questionnaire was sent to 107 students who had completed their study between May and October 2004. Participation was voluntary. After one month, a reminder was sent.

In the current study, only students' responses to the items concerning pre-clinical years 2-4 were used.

Other independent variables

Besides students' responses to the questionnaire, three other independent variables were used in this study, i.e. year 1 GPA, age and gender. This data was obtained from the student administration system. Year 1 GPA was determined by calculating students' mean grade of the first attempt at 17 examinations during the first year in medical school. Those GPAs were transformed into z-scores.

Dependent variable

The dependent variable was students' year 2-4 GPA, i.e. students' mean grade on the first attempt at 31 exams in the pre-clinical years 2-4. Grades, which were given on a 10-point scale (1 = very poor; 10 = outstanding), were derived from the student administration system. Again, GPAs were transformed into z-scores.

Data analysis

Analyses were conducted using SPSS Version 15 for Windows. Using students' identification number, responses to the items of the questionnaire concerning pre-clinical years 2-4 were linked to students' year 1 GPA, year 2-4 GPA, age and gender. As the investigators could not link the identification numbers to students' names, anonymity was guaranteed.

In the analyses, students' mean scores on the factors 1 through 4 of the questionnaire were used, which is called the method of item parcelling (Elliot, Kratochwill, Littlefield & Travers, 1996). As shown in Table 6.1, Cronbach's alpha reliability coefficients of these factors were sufficient. Besides, all single items of factors 5 and 6 were included in the analyses.

All respondents were divided into one of the two year 1 GPA subgroups, i.e. those with a year 1 GPA below the mean ($z < 0$; mean grade ≥ 4.00 and

< 6.93; n = 38) or those with a year 1 GPA above it (z ≥ 0; mean grade ≥ 6.93 and ≤ 8.88; n = 32). For each of these subgroups, the analysis comprised three main parts:

1. The relationship between year 1 GPA and year 2-4 GPA was determined by performing bivariate regression analyses;
2. A step-wise multiple linear regression analysis was conducted to test which of the independent variables in this study, i.e. aspects of students' adaptation to the learning environment, intrinsic motivation, extrinsic motivation, satisfaction with elements of the learning environment, time spent on study-related activities, aspects of the social environment, age and gender in addition to year 1 GPA were related to year 2-4 GPA;
3. Students' answers to the open-ended question, in which they were requested to report additional factors that according to them had affected positively or negatively their year 2-4 GPA were used to find support for the outcomes of the quantitative analysis and to catch sight of factors, which were not included in the quantitative part of the questionnaire.

Results

Respondents

Of the 107 students, 70 students completed the entire questionnaire, which represented a response rate of 65.4%. The group of respondents consisted of 36% men and 64% women. Their mean age at the start in medical school was 19.47 years (SD = 1.52), ranging from 17.89 to 27.44. Other descriptive statistics for the respondents are presented in Table 6.1.

To check if the sample taken was representative, data concerning age, gender, and GPAs obtained during the first year and the remaining three pre-clinical years was compared with data of the 97 students who had participated in the preceding pilot study. Using T-tests, no significant differences were found.

Year 1 GPA subgroup below the mean (n = 38)

Relationship between year 1 GPA and year 2-4 GPA

For students with a year 1 GPA below the mean, the relationship between year 1 GPA and year 2-4 GPA was investigated. For this group, year 1 GPA explained 7% of the variance in year 2-4 GPA ($F_{1,36} = 3.57$; $p < .10$).

Relationship between other variables and year 2-4 GPA

By conducting a step-wise multiple regression analysis, it was explored whether the other variables, which were included in this study (see Table 6.2), were related to year 2-4 GPA.

Table 6.2 Descriptive statistics of study variables for subgroups with a year 1 GPA below or above the mean

	Year 1 GPA below the mean (n=38)		Year 1 GPA above the mean (n=32)	
Variables	Mean	SD	Mean	SD
Aspects of adaptation to the learning environment	3.67	.71	3.93	.52
Aspects of intrinsic motivation	3.84	.61	3.79	.56
Aspects of extrinsic motivation	3.32	.86	3.34	.71
Satisfaction with elements of learning environment	3.30	.73	3.26	.52
Time spent on study-related activities (in hours per week)	34.73	9.50	35.87	9.04
Living at parents' home (1 = Yes, 2 = No)	1.84	.37	1.75	.44
Member of study union (1 = Yes, 2 = No)	1.13	.34	1.06	.25
Member of students' social club (1 = Yes, 2 = No)	1.53*	.51	1.75*	.44
Member of sports club (1 = Yes, 2 = No)	1.47	.51	1.34	.48
Having a job (1 = Yes, 2 = No)	1.08	.27	1.13	.34
Age at start medical school (in years)	20.00***	1.73	18.84***	.90
Gender (1 = Female; 2 = Male)	1.29	.46	1.44	.50
Z-score year 1 GPA	-.72***	.62	.93***	.53
Z-score year 2-4 GPA	-.54***	.63	.86***	.73

Note: SD, Standard Deviation
Note: *** Significant differences between subgroups at p<.001, ** at p < .01; * at p < .05

It was shown that higher scores on aspects of adaptation to the learning environment together with higher scores on year 1 GPA and not being a member of a students' social club were related to higher year 2-4 GPA scores. Those factors together explained 42% of the variance in year 2-4 GPA: aspects of the adaptation to the learning environment explained 15% ($F1_{,36} = 7.66$; $p < .01$), year 1 GPA an additional 21% ($F1_{,35} = 12.59$; $p < .001$), and membership of a students' social club again another 6% ($F1_{,34} = 4.40$; $p < .05$).

Self-reported factors affecting achievement in pre-clinical years 2-4

The outcomes of the quantitative analysis were confirmed by students´ answers to the open-ended question. Some students reported that aspects of their adaptation to the learning environment had affected positively their

achievement in pre-clinical years 2-4. Examples were: "I had developed my own method of learning and planning, through which I was more convinced that my capacities were sufficient" and "I was much more able to identify important issues for the examinations". Some others reported that being member of a students' social club had affected negatively their grades. An example: "I was more involved into study-unrelated activities such as being member of a students' social club".

In students' answers, no factors could be identified, which were not covered by the closed-ended items.

Year 1 GPA subgroup above the mean (n = 32)

Relationship between year 1 GPA and year 2-4 GPA

Similar analyses were conducted for students with a year 1 GPA above the mean. Also for this group, the relationship between year 1 GPA and year 2-4 GPA was investigated. This relationship was found to be very strong (explained variance of 60%; $F1_{,30} = 46.52$; $p < .000001$).

Additional factors in relation to year 2-4 GPA

By conducting a stepwise multiple regression analysis, it was investigated whether – in addition to year 1 GPA – other variables were related to year 2-4 GPA. It was shown that satisfaction with elements of the learning environment explained another 6% of the explained variance in year 2-4 GPA ($F1_{,29} = 7.04$; $p < .01$). Thus, year 1 GPA plus satisfaction with elements of the learning environment together explained 66% of the variance in year 2-4 GPA. Higher scores on year 1 GPA and higher scores on satisfaction with elements of the learning environment were related with higher scores on year 2-4 GPA.

Self-reported factors affecting the study results of year 2-4

Students' answers to the open-ended question were supportive for the results of the quantitative analysis. Some reported that positive elements of the learning environment had affected positively their achievement. Examples: "Courses included more clinical elements and were less theoretical", and "Pre-clinical years 2-4 were more patient-oriented, real diseases of real patients were discussed". Some others reported that negative aspects of the learning environment had affected negatively their grades. Examples: "Examination methods were not challenging", and "Clinical courses were less interesting for me". The qualitative data did not give sight of factors, which were not included in the quantitative part of the questionnaire.

Discussion

For all students there seems to be a strong relationship between the Grade Point Average scores (GPAs) of the first year in medical school and the remaining three pre-clinical years. For students with a year 1 GPA below the mean, this relationship is weak to moderate and for those with a year 1 GPA above the mean very strong (see Chapter 2). The goal of the current study was to explore for both students with a year 1 GPA below the mean and those with a year 1 GPA above it, which factors in addition to year 1 GPA were related to the achievement of students in pre-clinical years 2-4. Included factors in this study were aspects of students' adaptation to the learning environment, intrinsic and extrinsic motivation, satisfaction with elements of the learning environment, time spent on study-related activities, aspects of the social environment, age and gender. Outcomes of the current study were compared with those of a preceding study, in which factors in relation to achievement in the first year were investigated for subgroups of students with a pre-university education GPA below or above the mean (see Chapter 5).

For students with a year 1 GPA below the mean (≥ 4.00 and < 6.93 on a 10-point scale), higher scores on aspects of adaptation to the learning environment, year 1 GPA and not being member of a students' social club were related to higher grades in the pre-clinical years 2-4 and vice versa. Those results indicated that for many students in this group, an improved achievement in the pre-clinical years 2-4 in comparison with their GPA in the first year was caused by an increased adaptation to the academic environment, which represented appropriate study skills and a sense of well-being, as well as not being member of a students' social club. These findings were supported by students' own explanations for improvement or worsening of their achievement in the pre-clinical years 2-4.

For students with a year 1 GPA above the mean (≥ 6.93 and < 8.88), higher scores on year 1 GPA plus higher scores on students' satisfaction with elements of the learning environment were related to higher year 2-4 GPA scores and vice versa. Those two factors together explained 66% of the variance in year 2-4 GPA. Since year 1 GPA explained most of the variance (60%), it seems that for this group factors determining their achievement during the first year played a comparable important role in their achievement during the remaining three pre-clinical years. Probably, high performing students in the first year could continue to use some learning and other skills, which had proven to be effective, in the remaining pre-clinical years, in which teaching and examination methods were more or less similar. In addition, students' dissatisfaction or satisfaction with elements of the learning environment determined whether the GPA of the students deteriorated or improved, respectively.

This study had limitations. First, as a retrospective study, students' knowledge of their grades might have influenced their attribution of causal factors. A second limitation is that we purposely did not use validated questionnaires. As mentioned earlier, this study was part of a larger exploratory study, in which we wanted to find indications not only for the pre-clinical years 2-4, but also for year 1 and the clinical phase, which factors had affected student achievement. Due to this exploratory character and the fact that it was not feasible to use extensive questionnaires a selection of items from existing questionnaires was used. Of course, consequently, results of this study need to be confirmed in the future by using validated questionnaires. A third plausible limitation is that the results were based on small samples, which might have introduced sampling variability and might have limited the generalisability of our findings. However, based on the high explained variances, which were found in both year 1 subgroups, we think that at least some factors, which emerged in this study, are likely to be confirmed in future studies. A fourth limitation is that we lacked data of the non-respondents. Inclusion of this group could have led to some differences in the outcomes of this study. Fifthly, only students who had successfully completed their study were included in this study. This means that those who failed were excluded. Figures from 15 year-cohorts between 1987 and 2002 in our medical school have shown that the mean percentage of failing students is 13% with a range from 8% to 19%. Of these students, approximately five percent failed during the pre-clinical years 2-4 (unpublished observation). Finally, attention should be paid to the fact that the outcomes of this study were established by the interaction between our students and our curriculum. In other curricula, it is very well possible that deviant relationships between factors in relation to student achievement will be found. Despite abovementioned limitations, most relationships found in this study were in line with those of others. For example, in 2004, Moelaert, Verwijnen, Rikers and Scherpbier reported a positive and significant relationship between study and planning skills on one side and achievement on the other. Other results such as the impact of social environment also seem to be in line with others (Jordan & Nettles, 2000). This is also true for the relationship between learning activities that are not challenging or relevant enough and student motivation to achieve (Csikszentmihalyi & Schneider, 2000).

In a preceding exploratory study we investigated which factors were related to student achievement in the first year (see Chapter 5). It was shown that for students with a pre-university education GPA (pu-GPA) below the mean, there was no relationship between pu-GPA and year 1 GPA. For this group, aspects of intrinsic motivation (37%), membership of a students' social club (6%) and aspects of extrinsic motivation (6%) explained 49% of the variance in year 1 GPA. In contrast, for students with a pu-GPA above the mean, pu-GPA

was strongly related to year 1 GPA (44% explained variance) and aspects of extrinsic motivation helped to raise the explained variance with another 10% to a total of 54%. Comparison of these results with those of the current study shows that the transitions from pre-university education to the first year in medical school and from the first year to the subsequent pre-clinical years do seem to have a small effect on the achievement of high performing students and a larger effect on the low performing ones. Furthermore, factors in relation to student achievement seem to differ a lot between year 1 and the subsequent pre-clinical years 2-4. All these results do give additional support to the hypothesis that investigation into the relationship between student-related and/ or external factors on one side and student achievement on the other should be directed at both distinctive study phases and subgroups of students (see also Chapters 2 and 5).

In conclusion, students' year 1 GPA, aspects of students' adaptation to the learning environment, membership of a students' social club and appreciation of elements of the learning environment seemed to be related to student achievement in pre-clinical years 2-4. The degree of importance was different for students with a year 1 GPA below the mean and those with a GPA above it. More in-depth prospective investigation into the impact of these aspects by using validated instruments is needed to confirm these results. Such data may be useful to identify students for selection and/ or selective adaptation of the learning environment.

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7 Exploratory study on factors related to student achievement in the clinical phase

Gerard J.A. Baars[1], Theo Stijnen[2] & Ted A.W. Splinter[3]

Abstract

Background Grade Point Average scores (GPAs) obtained during pre-clinical years 2-4 are moderately related to the GPA in the clinical years for all students. Recently, no difference in this relationship was found between students with a year 2-4 GPA below and above the mean.

Objective The goal of this study was to explore for each of these year 2-4 GPA subgroups, which factors in addition to year 2-4 GPA were related to the GPA in the clinical phase.

Methods A questionnaire was sent to 107 students who had completed medical school. They were requested to complete 22 closed-ended items with respect to the clinical phase, measuring aspects of adaptation to the learning environment, intrinsic and extrinsic motivation, satisfaction with elements of the learning environment, time spent on study-related activities, and aspects of the social environment. Besides, in 1 open-ended item, students could report other factors, which had affected positively or negatively their grades. This data was linked to year 2-4 GPA, the GPA of the clinical phase, age and gender.

Results The response rate was 65.4%. Step-wise multiple regression analysis revealed that for students with a year 2-4 GPA below the mean, only year 2-4 GPA was related to the GPA in the clinical phase (explained variance of 19%). For those with a year 2-4 GPA above the mean, year 2-4 GPA plus aspects of students' adaptation to the clinical learning environment explained 20% of the variance.

Conclusions For students with a year 2-4 GPA below the mean, no additional factors in relation to the GPA in the clinical phase were found. For students with a year 2-4 GPA above it, in addition to year 2-4 GPA, aspects

1 Erasmus University Rotterdam, Risbo; Erasmus MC, Department of Medical Education and Research, the Netherlands
2 Leiden University Medical Center, Department of Medical Statistics and Bioinformatics, the Netherlands
3 Erasmus MC, Department of Internal Medicine, the Netherlands

of students' adaptation to the clinical learning environment were related to achievement in the clinical phase.

Introduction

Student achievement is the resultant of a very complex interaction between a range of student-related factors such as ability, motivation, ambition, study skills, learning styles, personality traits, time spent on study-related activities, and external factors such as elements of the learning environment and aspects of the social environment.

Concerning the student-related aspects, the influence of most factors on student achievement in the clinical phase seems to be very small or non-existing. For example, the relationship between learning style and clinical performance seems to be negligible (Lynch, Woelfl, Steele & Hanssen, 1998), although some relationship seems to exist between the knowledge acquired by clinical students and their learning style (McManus, Richards, Winder & Sproston, 1998; Martin, Stark & Jolly, 2000). Interpersonal qualities such as empathy also seem to be associated to a certain extent with student performance during the clinical phase (Hojat, Gonnella, Mangione, Nasca, Veloski, Erdmann, Callahan & Magee, 2002), although this relationship seems only to be true for ratings of clinical competence as given by faculty members and not for objective examinations (Hojat et al., 2002).

Also with respect to the learning environment most aspects seem to have only a small effect on student achievement in the clinical phase. For example, the direct effect of good teaching on students' achievement seems to be modest (Stern, Williams, Gill et al., 2000; Irby & Papadakis, 2001; Roop & Pangaro, 2001). Not surprisingly, the resident seems to have the greatest effect on students' cognitive growth, as the resident is present with the student and creates the climate for learning on the wards (Roop & Pangaro, 2001).

A lot of studies have investigated the relationship between academic achievement and clinical achievement. The outcomes are inconsistent. Some studies reported a rather strong relationship between pre-clerkship Grade Point Average (GPA) and clinical achievement (Roop & Pangaro, 2001; Tan, Meredith & McKenna, 2004), whereas others found a much more modest relationship (see Chapter 2; Blackman & Darmawan, 2004; Briceland & Hamilton, 1997; Ferguson, James & Madely, 2002; Salvatori, 2001). Again others did not find any significant relationship at all (Reede, 1999; Gough & Hall, 1975). A more sophisticated distinction was made by Willoughby, Gammon and Jonas (1979), who reported a significant relationship between some aspects of clinical performance pertaining to information, concepts, skills, ingenuity and conscientiousness on the one hand and academic

achievement on the other. They did not find such a relationship for other aspects pertaining to attitude, peer relations, maturity, patient report, and integrity. The latter study illustrates that the unclear relationship between academic achievement and clinical achievement may be caused by differences in the way clinical performance is assessed and/or differences in examination methods between the pre-clinical and clinical phase.

The low to moderate correlations between pre-clinical and clinical achievement implies that for medical students the transition from the pre-clinical to the clinical phase seems to be major (see also Case & Swanson, 1993). Indeed, several studies seem to indicate that for some students this transition to an entirely new learning environment may cause problems. For example, adapting to the new environment may require considerable effort (Radcliffe & Lester, 2003), not only mentally but also physically because of the long hours students have to work (Prince et al., 2000; Prince, Boshuizen, Van der Vleuten & Scherpbier, 2005). Students may also perceive difficulties in applying theoretical knowledge in clinical practice (Prince et al., 2000; Prince et al., 2005). Moreover, they may experience insufficient knowledge and skills (Prince et al., 2005; Radcliffe & Lester, 2003), as a result of which they may feel useless, unable to contribute to patient care (Radcliffe & Lester, 2003; Moss & McManus, 1992.). It is also possible that students feel insecure because they do not know what is expected from them (Prince et al., 2000; Prince, Boshuizen, Van der Vleuten & Scherpbier, 2005; Radcliffe & Lester, 2003). Or that students have to get used to work with senior staff members, which in the beginning may be stress-inducing (Prince et al., 2000; Moss & McManus, 1992; Alexander & Haldane, 1979). Another reason may be that students have to change their learning strategies, because learning changes from passive acquisition of knowledge to more active learning (Prince et al., 2000; Prince, Boshuizen, Van der Vleuten & Scherpbier, 2005). Also students' social life may change dramatically as a result of the clerkship (Prince et al., 2000). However, for some students the transition from the pre-clinical to the clinical phase may also have positive effects. For example, real patient contacts may increase student motivation to learn and promote the acquisition of knowledge (Prince, Boshuizen, Van der Vleuten & Scherpbier, 2005; Prince et al., 2000). In conclusion, all abovementioned studies illustrate that clinical achievement may indeed be the resultant of a very complex interaction between student-related and environment-related factors. To date no unequivocal factors with strong predictive value for clinical achievement have been distinguished.

This study is part of a broader exploratory study, in which we want to find indications for year 1, the subsequent pre-clinical years 2-4 and the clinical phase, which factors are related to the achievement of subgroups of students

with a GPA below or above the mean in the preceding study phase. To that end, a questionnaire was sent to 107 students who had completed medical school. They were asked to look back on the three distinctive curriculum parts and to respond for each part to 22 closed-ended items measuring aspects of adaptation to the learning environment, intrinsic and extrinsic motivation, satisfaction with elements of the learning environment, time spent on study-related activities, and aspects of the social environment. In open-ended items students were challenged to report other factors, which in their opinion had affected positively or negatively their GPA in each of the three study phases.

In the current study, only students' responses concerning the clinical phase were used. The goal was to explore for both students with a pre-clinical year 2-4 GPA below the mean and those with a year 2-4 GPA above it, which factors in addition to years 2-4 GPA were related to achievement in the clinical phase. Furthermore, outcomes of the current study were compared with those of two preceding studies, in which factors in relation to year 1 GPA and pre-clinical years 2-4 GPA were investigated for subgroups of students with a preceding GPA-level below or above the mean (see Chapters 5 and 6).

Methods

Setting

This study was conducted at Erasmus medical school in Rotterdam, the Netherlands. Its curriculum consisted of four pre-clinical years and two clinical years. The pre-clinical years were aimed at providing students integrated basic and clinical knowledge. Teaching methods included plenary lectures, practicals, patient demonstrations, case discussions and practical clinical skills training. In the clinical years, the focus was on the acquisition of problem-solving and practical clinical skills. Ten successive clerkships were offered, starting with internal medicine, followed by surgery, paediatrics, psychiatry, neurology, gynaecology, dermatology, otorhinolaryngology, ophthalmology, family medicine and public health, followed by 15 weeks of electives. The duration of the clerkships was 8, 8, 3, 5, 5, 6, 3, 3, 3 and 4 weeks, respectively. The aim of the clerkships was to learn the students the competencies of history taking, physical examination, differential diagnosis, additional diagnostic procedures and therapy plan (Splinter & Verwoerd, 2000).

Instrument

A questionnaire was constructed, aimed at exploring which factors had affected the achievement of students in three distinctive curriculum parts, i.e. year 1, pre-clinical years 2-4, and the clinical phase.

The first draft of the questionnaire was made through a review of literature on factors relating to student achievement in medical school. It comprised for each of the three curriculum parts a selection of 9 closed-ended items, which were related to aspects of students' adaptation to the learning environment and students' appreciation of the curriculum. Besides, in 1 open-ended item, students were asked to report factors, which according to them had affected positively or negatively their achievement. This draft version was sent to 97 students who had completed their study between February and May 2004. Based on the responses of 63 of them, the questionnaire was adjusted and extended.

This led to a final version of the questionnaire, which comprised for each of the three curriculum parts a selection of 22 closed-ended items and 1 open-ended item.

Closed-ended items are presented in Table 7.1. As shown in Table 7.1, these items were aimed at measuring 6 factors:

1. Aspects of students' adaptation to the clinical environment;
2. Aspects of intrinsic motivation;
3. Aspects of extrinsic motivation;
4. Satisfaction with elements of the clinical environment;
5. Time spent on study-related activities;
6. Aspects of the social environment.

Items concerning factors 1 through 4 were measured on a 5-point Likert scale, ranging from 1 = "Strongly disagree" to 5 = "Strongly agree". Items of factor 1 were selected from Kleijn, Van der Ploeg and Topman (1994), and Schouwenburg and Stevens (1996); those of factors 2 and 3 from Pintrich, Smith, Garcia and McKeachie (1993), and Vallerand, Pelletier, Blais, Brière, Senécal and Vallières (1992); and those of factor 4 were constructed by ourselves. The item concerning factor 5, in which students were requested to report in a free text field the number of hours they had spent on study-related activities, was derived from Van den Hurk, Wolfhagen, Dolmans and Van der Vleuten (1998). Items concerning factors 6 were measured on a 2-point scale (1 = "Yes", 2 = "No") and constructed by us.

In the open-ended item, students were asked to report factors that in their opinion had affected positively or negatively their GPA in the clinical phase. Those factors were used to find support for the outcomes of the quantitative analysis and to catch sight of new factors, which might have influenced student achievement in the clinical phase.

Table 7.1 Descriptives of 22 closed-ended items concerning the clinical phase in medical school (n=70)

Factors		Items	Mean	SD	Alpha reliability
1.	Aspects of adaptation to the clinical environment	Learning was easy for me	3.51	.97	.71
		Planning study activities was easy for me	3.30	.95	
		I felt at ease in the clinical environment	3.93	.89	
2.	Aspects of intrinsic motivation	My motivation to learn was high	4.06	.88	.81
		I like my study	4.14	.80	
		I was interested in the content of the clerkships	4.13	.57	
		I felt challenged to learn more about the content of the clerkships	3.96	.82	
3.	Aspects of extrinsic motivation	I wanted to prove myself that I was a good doctor	4.27	.68	.69
		It was important to me to obtain high grades	4.20	.71	
		My peers and/or parents stimulated me to obtain high grades	3.56	.74	
4.	Satisfaction with elements of the clinical learning environment	I was stimulated by the supervision	3.11	1.03	.80
		I was satisfied with the teaching methods	3.13	.96	
		I appreciated the examination methods	2.88	1.15	
		I appreciated the ratio between theory and practice	3.59	.86	
		The examinations corresponded well with the instruction/ education	3.11	.94	
		Learning during the clerkships (learning in practice with real patients; solving real problems) appealed more to me than education of the pre-clinical years 2-4	4.21	.90	
5.	Time spent on study-related activities	How many hours did you spend on study-related activities besides the clerkships	7.51	4.05	NA
6.	Aspects of the social environment	Did you live at your parents' home? (1 = Yes, 2 = No)	1.80	.40	NA
		Were you member of a study union? (1 = Yes, 2 = No)	1.26	.44	
		Were you member of a students' social club? (1 = Yes, 2 = No)	1.83	.38	
		Were you member of a sports club? (1 = Yes, 2 = No)	1.44	.50	
		Did you have a job? (1 = Yes, 2 = No)	1.77	.42	

Note: SD, Standard Deviation; NA, Not Applicable

Participants and procedure

The final questionnaire was sent to 107 students who had completed their study between May and October 2004. Participation was voluntary. After one month, a reminder was sent.

In the current study, only students' responses concerning the clinical phase were used.

Other independent variables

Besides these responses, three more independent variables were included in this study, i.e. pre-clinical year 2-4 GPA, age and gender. This data was obtained from the student administration system. Year 2-4 GPA was determined by students' mean grade of the first attempt at 31 examinations during the pre-clinical years 2-4. Students were assessed by written examinations, which contained multiple-choice questions, open-answer questions, essay questions, and cases. All grades were given on a 10-point scale, ranging from 1 = "Very Poor" to 10 = "Excellent". Mean grades were transformed into z-scores.

Dependent variable

The dependent variable was students' GPA in the clinical phase. This GPA was calculated by taking the mean grade on ten clerkships. All clerkships were assessed by a combination of a patient related and oral examination and were rewarded with a grade between 5 (poor) and 10 (excellent). This data was obtained from the student administration system. The GPAs in the clinical phase were transformed into z-scores. Cronbach´s alpha reliability coefficient of the grades was .70.

Data analysis

Analyses were conducted using SPSS Version 15 for Windows. Using students' identification number, responses to the items of the questionnaire concerning the clinical phase were linked to students' year 2-4 GPA, the GPA in the clinical phase, age and gender. As the investigators could not link the identification numbers to students' names, anonymity was guaranteed.

In the analyses, students' mean scores on the factors 1 through 4 of the questionnaire were used, which is called the method of item parcelling (Elliot, Kratochwill, Littlefield & Travers, 1996). As shown in Table 7.1, Cronbach's alpha reliability coefficients of these factors were sufficient. Besides, all single items of factors 5 and 6 were included

All respondents were divided into one of the two year 2-4 GPA subgroups, i.e. those with a year 2-4 GPA below the mean ($z < 0$; mean grade ≥ 5.31 and < 6.74; $n = 33$) or those with a year 1 GPA above the mean ($z \geq 0$; mean grade ≥ 6.74 and ≤ 8.54; $n = 37$). For each of these subgroups, the analysis comprised three main parts:

1. The relationship between year 2-4 GPA and the GPA in the clinical phase was determined by performing bivariate regression analyses;
2. A step-wise multiple linear regression analysis was conducted to test which of the independent variables in this study, i.e. aspects of students' adaptation to the clinical environment, intrinsic motiva-

tion, satisfaction with elements of the clinical learning environment, time spent on study-related activities besides the clerkships, aspects of the social environment, age and gender in addition to year 2-4 GPA were related to the GPA in the clinical phase;

3. Students' answers to the open-ended question, in which they were requested to report additional factors that according to them had affected positively or negatively their GPA in the clinical phase were used to find support for the outcomes of the quantitative analysis and to catch sight of factors, which were not included in the quantitative part of the questionnaire.

Results

Respondents

Of the 107 students, 70 students completed the entire questionnaire, which represented a response rate of 65.4%. The group of respondents consisted of 36% men and 64% women. Their mean age at the start in medical school was 19.47 years (SD = 1.52), ranging from 17.89 to 27.44. Other descriptive statistics for the respondents are presented in Table 7.1.

To check if the sample taken was representative, data concerning age, gender, and GPAs obtained during the pre-clinical years 2-4 and the clinical phase was compared with data of the 97 students who participated in the preceding pilot study. Using T-tests, no significant differences were found.

Year 2-4 GPA subgroup below the mean (n = 33)

Relationship between year 2-4 GPA and the GPA in the clinical phase

For students with a year 2-4 GPA below the mean, firstly, the relationship between year 2-4 GPA and the GPA in the clinical phase was investigated. Year 2-4 GPA explained 19% of the variance in the GPA of the clinical phase ($F1_{,31} = 8.66$; $p < .01$).

Relationship between other variables and the GPA in the clinical phase

By conducting a step-wise multiple regression analysis, it was explored whether – in addition to year 2-4 GPA – other variables, as included in this study (see Table 7.2), were related to the GPA of the clinical phase.

Table 7.2 Descriptive statistics of study variables for subgroups with a year 2-4 GPA below or above the mean

	Year 2-4 GPA below the mean (n=33)		Year 2-4 GPA above the mean (n=37)	
Variables	Mean	SD	Mean	SD
Aspects of adaptation to the clinical environment	3.92***	.74	3.28***	.62
Aspects of intrinsic motivation	4.25*	.59	3.91*	.61
Aspects of extrinsic motivation	4.14	.62	3.89	.47
Satisfaction with elements of clinical learning environment	3.63***	.66	3.09***	.61
Time spent on study-related activities (in hours, besides the clerkships)	7.98	4.44	7.12	3.73
Living at parents' home (1 = Yes, 2 = No)	1.82	.39	1.78	.42
Member of study union (1 = Yes, 2 = No)	1.36	.49	1.16	.37
Member of students' social club (1 = Yes, 2 = No)	1.79	.42	1.86	.35
Member of sports club (1 = Yes, 2 = No)	1.45	.51	1.43	.50
Having a job (1 = Yes, 2 = No)	1.79	.42	1.76	.44
Age at start medical school (in years)	19.68	1.25	19.27	1.72
Gender (1 = Female; 2 = Male)	1.39	.50	1.32	.48
Z-score year 2-4 GPA	-.70***	.52	.82***	.66
Z-score GPA in the clinical phase	-.19*	.98	.34*	.82

Note: SD, Standard Deviation
Note: *** Significant differences between subgroups at p<.001, ** at p < .01; * at p < .05

As shown in Table 7.2 , students' mean scores on those additional variables ranged from rather high to very high. Students' mean score on the factor "satisfaction with elements of the clinical learning environment" was rather high: 3.63. Their mean scores on the factors "aspects of adaptation to the clinical learning environment", "intrinsic motivation" and "extrinsic motivation" were even high to very high: 3.92, 4.25 and 4.14, respectively. This latter finding suggests that most students felt well-integrated and well-motivated in the clinical learning environment. Perhaps due to these high mean scores, none of the factors could help to raise the explained variance in the GPA of the clinical phase. Thus, for students with a year 2-4 GPA below the mean, 81% of the explained variance remained unexplained.

Self-reported factors affecting achievement in the clinical phase

Students' self-reported answers were in line with abovementioned results. A lot of students reported to be very motivated in the clinical learning environment. Examples: "I was not in doubt anymore whether this was the right study for me" and "I wanted to prove myself that I could be a good doctor". A lot of others reported to be well-adapted to the clinical learning environ-

ment: "For me, in practice it was much easier to learn" and "I am a practical person: Learning from practice comes very easy to me". Also the rather positive appreciation of the learning environment was confirmed by a lot of students: "In the clinical environment, theory was put into life, which made learning much more challenging", "The hospital, the contact with real patients, and working with specialists was very stimulating", and "In the practical environment I was challenged to really learn and understand things". However, with respect to the environment, also some negative comments were made, which had probably affected students' appreciation of the clinical learning environment. Most of those negative comments were related to the way students were assessed and supervised. Examples: "Between the examiners there was a huge difference in the quality of assessing students", "The method of assessment was very subjective; sometimes the assessment was entirely unfounded" and "There was a lack of supervision." However, as mentioned before, all those factors could not be used to explain more of the variance in the GPA of the clinical phase. Furthermore, students' answers did not give insight into new factors, which were not covered by the quantitative part of the questionnaire.

Year 2-4 GPA subgroup above the mean (n = 37)

Relationship between year 2-4 GPA and the GPA in the clinical phase
Similar analyses were conducted for students with a year 2-4 GPA above the mean. Also for this group, the relationship between year 2-4 GPA and the GPA in the clinical phase was investigated. Year 2-4 GPA explained 5% of the variance in the GPA of the clinical phase ($F1_{,35} = 2.98$; $p < .10$).

Relationship between other variables and the GPA in the clinical phase
By conducting a step-wise multiple regression analysis, it was explored which factors in addition to students' year 2-4 GPA were related to the GPA in the clinical phase. Descriptives of the additional factors are presented in Table 7.2. As shown in this table, students with a level of achievement above the mean in the pre-clinical phase felt much less adapted to the clinical learning environment than students with a preceding GPA-level below the mean. The former group was also much less satisfied with elements of the learning environment than the latter group.

For students with a year 2-4 GPA above the mean, it was shown that in addition to year 2-4 GPA the factor "aspects of adaptation to the clinical learning environment" was related to the GPA of the clinical phase. Higher scores on those two factors were related to higher GPAs in the clinical phase. By the two fac-

tors, 20% of the variance in the GPA of the clinical phase could be explained: 15% by the factor "aspects of adaptation to the clinical learning environment" ($F1_{,34} = 7.19$; $p < .01$) and only 5% by year 2-4 GPA ($F1_{,35} = 2.98$; $p < .10$).

Also for this subgroup, still 80% of the variance remained unexplained.

Self-reported factors affecting achievement in the clinical phase

The main result of the quantitative analysis was supported by students' responses to the open-ended question. Some reported that being well-adapted to the clinical learning environment led to better achievements in the clinical phase. For example: "In practice, it was much easier for me to learn". In the open-ended answers, also factors were mentioned, which were not covered by the closed-ended items of the questionnaire. Firstly, some students reported that there was a lack of exercise in clinical reasoning skills. And some others reported that they lacked time for studying besides the clerkships. Examples of comments: "There was not enough time to study for the exams" and "Due to the long and tiring working hours in hospital, there was only little time to study".

Discussion

For entire cohorts or groups of students, there seems to be a low to moderate relationship between the GPAs of the pre-clinical and clinical phase (see Chapter 2; Salvatori, 2001). No significant difference in this relationship was found between students with a year 2-4 GPA below the mean and those with a year 2-4 GPA above it (see Chapter 2). The goal of the current study was to explore for each of the two year 2-4 GPA subgroups, which factors in addition to pre-clinical years 2-4 GPA were related to the GPA in the clinical phase. Factors included were aspects of students' adaptation to the clinical learning environment, intrinsic and extrinsic motivation, satisfaction with elements of the clinical learning environment, time spent on study-related activities besides the clerkships, aspects of the social environment, age and gender.

For students with a pre-clinical year 2-4 GPA below the mean (≥ 5.31 and < 6.74 on a 10-point scale), only pre-clinical year 2-4 GPA was related to the achievement in the clinical phase. This factor explained 19% of the variance. Addition of the factors students' adaptation to the clinical environment, intrinsic and extrinsic motivation, appreciation of elements of the clinical learning environment, and social environment related aspects did not help to raise the explained variance. This was probably due to the fact that the mean scores on those factors ranged from rather high to very high. Also students' answers to the open-ended question did not provide a clear mindset to track down other factors, which might be related to the GPA in the clinical phase

for this group. Thus, still more than eighty percent of the variance in the GPA of the clinical phase remained unexplained.

For students with a pre-clinical year 2-4 GPA above the mean (≥ 6.74 and ≤ 8.54), higher scores on year 2-4 GPA plus higher scores on aspects of their adaptation to the clinical learning environment were related to higher scores on the GPA in the clinical phase. By these two factors 20% of the variance could be explained: 15% by aspects of students' adaptation to the clinical learning environment and only 5% by year 2-4 GPA. This result suggests that for students with a year 2-4 GPA above the mean, the transition from the pre-clinical phase to the clinical phase is big. If students succeeded in adapting themselves to the new environment, this seemed to lead to a high or even higher GPA in the clinical phase in comparison with the GPA in the pre-clinical years 2-4. If students did not succeed, this seemed to lead to a lower GPA in the clerkships. This outcome was supported by students' answers to the open-ended question.

This study has some limitations. One limitation is that students' knowledge of their GPA in the clinical phase might have influenced their causation attribution. For example, it is conceivable that students whose achievement deteriorated during the clerkships assigned this to negative evaluations of curriculum-related aspects. A second limitation is that we purposely did not use validated questionnaires. As mentioned earlier, this study was part of a larger exploratory study, in which we wanted to find indications not only for the clinical phase, but also for the two parts of the pre-clinical phase, which factors had affected student achievement. Due to this exploratory character and the fact that it was not feasible to use extensive questionnaires a selection of items from existing questionnaires was used. Of course, consequently, results of this study need to be confirmed in the future by using validated questionnaires. Another limitation of this study is that our results were based on small samples, which might introduce sampling variability and limit the generalisability of our findings. A fourth limitation is that we lacked data of the non-respondents. Inclusion of this group could have led to some differences in the outcomes of this study. Fifthly, only students who had completed our medical school were included in this study. This means that those who failed were excluded. However, figures from 15 year-cohorts between 1987 and 2002 in our medical school have shown that a negligible number of students failed during the clinical phase (unpublished observation). Finally, attention should be paid to the fact that the outcomes of this study were established by the interaction between our students and our curriculum. In other curricula, it is very well possible that deviant relationships between factors in relation to student achievement will be found. Despite these limitations, most of our results seemed to be in accordance with those of others. Firstly, the size of

the relationship between the GPAs of the pre-clinical and clinical phase observed in our data was comparable to that reported by others (e.g. Salvatori, 2001; Briceland & Hamilton, 1997). And secondly, students' own reported positive and negative factors strongly resembled those reported by others: many students in our study indicated that learning in practice during the clerkships was more motivating and easier than learning in theory. Besides, a substantial group of students reported insufficient time for studying during the clerkships. Both these aspects were in line with those earlier reported by Prince et al. (2005). Moreover, a considerable group of our students reported negative aspects concerning the clinical learning environment, also in relation to the supervision. This seems to be in line with the study of Remmen et al. (2000), who reported that students frequently indicated that coaching, feedback and supervision during the clerkships were suboptimal. Finally, a lot of our respondents reported negative aspects concerning the assessment methods during the clerkships, mainly relating to the reliability and validity of the assessments. This aspect was earlier discussed by McManus et al. (1998), Van der Vleuten, Scherpbier, Dolmans, Schuwirth, Verwijnen and Wolfhagen (2000), and Streiner (1995). However, it was shown in the current study that Cronbach's alpha reliability coefficient of the GPA of the clinical phase was .70. Thus, concerning the reliability there did not seem to be a problem.

An interesting finding emerges by comparing the outcomes of the current study with those of two preceding studies (see Chapters 5 and 6), in which factors relating to students' GPA in the first year and the subsequent three preclinical years were investigated. In Chapter 5, it was shown that for students with a GPA below the mean during pre-university education, pre-university education GPA (pu-GPA) had no predictive value at all for achievement in the first year of medical school. For this group, aspects of intrinsic motivation (37%), membership of a students' social club (6%) and aspects of extrinsic motivation (6%) explained 49% of the variance in year 1 GPA. In contrast, for students with a pu-GPA above the mean, pu-GPA was strongly related to year 1 GPA (44% explained variance). Aspects of extrinsic motivation helped to raise the explained variance with another 10% to a total of 54%. In Chapter 6, it was reported that for students with a year 1 GPA below the mean, year 1 GPA (21%), aspects of students' adaptation to the learning environment (15%) and membership of a students' social club (6%) together explained 42% of the variance in year 2-4 GPA. For students with a year 1 GPA above the mean, year 1 GPA was a very strong predictor for year 2-4 GPA (60% explained variance) and students' satisfaction with elements of the learning environment added another 6% to the explained variance. The results of the studies in Chapter 5 and 6 seemed to indicate that the transitions from pre-university education

to the first year in medical school and from the first year to the remaining three pre-clinical years did have small effect on the achievements of high performing students and a larger effect on the achievements of low performing ones. Moreover, for the latter students the change of factors related to achievement in year 1 to those in years 2-4 suggested that they might need more and other support than high performing students. In the current study, an entirely different pattern was found. For both the year 2-4 GPA subgroup below and above the mean, the relationship between the GPAs of the pre-clinical and clinical phase was comparable and at a moderate level. These findings indicated that for both groups, the transition from the pre-clinical to the clinical phase was large. For students with a preceding GPA-level below the mean, this was not very surprising, as it was shown also in the preceding studies that at each study phase transition the achievement of many of them changed. For those with a pre-clinical year 2-4 GPA above the mean, it was much more remarkable. However, for the latter group the lower relationship between the GPAs of the pre-clinical and clinical phase could be explained by the fact that they could not simply go on with their way of learning that had proven to be effective during the pre-clinical phase. During the clerkships other skills were required as the learning environment with inclusion of the ways of assessing students was very different from that of the pre-clinical phase. From now on, students were required to apply theoretical knowledge in clinical practice (Prince et al., 2005), to carry out practical procedures, to communicate with patients, to reformulate differential diagnoses, to order tests, to evaluate their results, to decide on management (McManus et al., 1998), and to possess clinical reasoning skills (Pulito, Donnelly, Plymale & Mentzer, 2006). Also aspects of professionalism such as work ethic, motivation and participation in patient care activities (Pulito, Donnelly, Plymale & Mentzer, 2006; Stern, Frohna & Gruppen, 2005) were important. Apparently, some students were able to acquire these skills at the same high level as before, whereas others failed. As a consequence, for all students with a pre-clinical year 2-4 GPA above the mean, year 2-4 GPA was not very predictive for the GPA in the clinical phase.

It may be questioned which other factors could help to improve the prediction of the GPA in the clinical phase for both subgroups. In general, it seems logical that factors that do predict student achievement do reflect the abilities, which are being assessed (Case & Swanson, 1993). In line with this way of reasoning, factors with high predictive value for student achievement in the clinical phase are assumed to be related to aspects that are being assessed during the clerkships such as knowledge, quality of the patient file and problem solving abilities (Wimmers, Kanter, Splinter & Schmidt, 2008). The integration of such aspects in the pre-clinical learning environment may lead

to a much smaller transition from the pre-clinical to the clinical phase. As a consequence, it is very well possible that the relationship between the GPAs of the pre-clinical and clinical phase will become stronger.

The results of both the current and the preceding studies support the assumption that factors in relation to student achievement might vary a lot between specific study phases and subgroups of students, which are distinguished by their preceding GPA-level below and above the mean. Therefore, investigation of the relationship of student-related and / or external factors on one side and student achievement on the other should be directed at specific study phases and specific subgroups.

In conclusion, in this study it was shown that year 2-4 GPA and aspects of students' adaptation to the clinical learning environment seemed to be important factors in relation to the GPA of the clinical phase. The degree of importance was different for students with a year 2-4 GPA below and those with a year 2-4 GPA above the mean. For both groups, other factors are needed in order to be able to predict better their achievement in the clinical phase. The integration of more clinical elements such as problem solving skills in the pre-clinical phase might help to make smaller the transition from the pre-clinical to the clinical phase.

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8 General discussion: summary, conclusions and recommendations

Background

From pre-university education till graduation the achievement of students may be constant or may change in time. The interaction between the student, the learning environment and the social environment may provoke superior achievement or seriously inhibit superior capabilities. In order to give any student a fair chance to complete a study successfully at a proper level and in a proper time we should be able to predict correctly how students will achieve in distinctive study phases in medical school. In particular it is important to identify as early and reliably as possible which students will fail to complete their study and why. Such an early identification may create the possibility to refer those students to another study or to offer them corrective measures to solve their mismatch with the learning environment. In addition, it is important to investigate why the achievement of some students improves in some study phases while that of others gets worse, leading to study delay.

It was hypothesized that the more heterogeneous the population of students and / or the environments are, the larger the differences between individual students' achievements, varying from very positive to very negative. Heterogeneity has a profound negative effect on the predictive value of any characteristic. Therefore, insight into factors, which lead to improvement or worsening of students' achievements, can be only obtained by investigation of the outcomes of the interactions between more homogeneous groups of students and better-defined learning environments.

The goal of the studies in this thesis was to find factors to predict more reliably which subgroup of students will encounter what kind of problems in which study phase. To that purpose, the relationship between factors related to the student, the curriculum and the social environment on one side and student achievement on the other was investigated for both distinctive study phases and for more homogeneous subgroups of students.

Summary and conclusions

To date, students' Grade Point Average obtained during pre-university education (pu-GPA) has been shown to be the best predictor for student achieve-

ment in medical school (Salvatori, 2001; Norman, 2004; Gottheil & Michael, 1957; Kulatunga-Moruzi & Norman, 2002; Cohen-Schotanus, Muijtjens, Reinders, Agsteribbe, van Rossum & van der Vleuten, 2006). In particular the predictive value of pu-GPA for pre-clinical achievement has been found to be rather strong (Mitchell, 1990; Peat, Woodbury & Donner, 1982). However, the predictive value of pu-GPA for performance during the clerkships has been shown to be much weaker (Peat et al., 1982). The decrease in the size of the relationship between pu-GPA and the GPAs of subsequent study phases in medical school is probably caused by an accumulation of changes in student achievement due to changes in the learning environment after the transition from one study phase to another. Moreover, decrease of the relationship indicates that some high performers become low performers and / or vice versa.

It has been shown that also in other branches of study, pu-GPA has only moderate predictive value for achievement in university (Deckro & Woudenberg, 1977; Sobol, 1984; Turnbull, 1980; Hedlund, Wilt, Nebel, Ashford & Sternberg, 2006; Federici & Schuerger, 1974; Chissom & Lanier, 1975).

We investigated whether the relationship between students' GPAs of subsequent study phases was dependent on the nature of a study phase transition and their level of achievement below or above the mean before a transition (Chapter 2). It was shown that for an entire group of 327 medical students the relationship between the GPAs of pre-university education and the first year was strong. For the same group, the relationship between the GPAs obtained in the two parts of our theory-oriented pre-clinical phase, i.e. the first year and subsequent three years, was very strong and the relationship between the GPAs of the pre-clinical and clinical phase moderate. Those findings indicated that the relationship between the GPAs of subsequent study phases was inversely related to the size of change in the learning environment at the transition of study phases. Concerning above-mentioned relationships major differences were found between grade subgroups of students.

For students with a GPA above the mean in the preceding study phase the relationships between the GPAs were slightly stronger than those reported for the entire group. For this group the relationship between the GPAs of pre-university education and the first year was strong and that between the GPAs of the two parts of the pre-clinical phase very strong. This data indicated that students with a preceding GPA-level *above the mean* did not seem to be very sensitive to the transition from pre-university education to the first year in medical school and from the first year to the subsequent three pre-clinical years. Probably, in the preceding study phase they had already mastered some learning and other skills that were also sufficient to achieve well in the subsequent part of the pre-clinical phase.

For students with a GPA *below the mean* in the preceding study phase entirely different relationships between GPAs were found. Their pu-GPA had no relationship at all with the GPA in the first year and the relationship between the GPAs of the first year and subsequent three pre-clinical years was only weak. Those findings indicated that for this subgroup of students previously attained grades did not or only limitedly predict their achievement in the pre-clinical phase. This suggests that these students were very sensitive to each study phase transition in the pre-clinical phase. Apparently the grades of some improved substantially whereas those of others remained at the same low level or even got worse leading to study delay.

Interestingly, the relationship between the GPAs of the pre-clinical and clinical phase was similar for the two subgroups. Thus, both the group of students with a preceding GPA-level below and above the mean seemed to be equally sensitive to the transition from the theory-oriented pre-clinical phase to the practical-oriented clinical phase. Apparently all students had to adapt themselves to the "new" clinical learning environment where other skills were required to perform well.

The consequences of the limited predictive value of GPA for student achievement due to the dependency on study phases and levels of preceding achievement are that additional or substitutional predictive factors should be sought. In our medical school GPA has limited predictive value (1) for students who fail to complete the first-year curriculum; (2) for students who perform below the mean in the pre-clinical phase and are at risk of study delay; (3) and for all students who enter the clinical phase.

Concerning the first group, it was shown that eighty percent of our students who fail to complete the first-year curriculum had a pu-GPA below the mean (unpublished observation). Since such a pu-GPA had no predictive value at all for the achievement in the first year, we tried to develop a model for early and reliable prediction of those who fail to pass the first-year curriculum within two years of study (Chapter 3). Predictive variables included pre-admission variables and the results of the first examinations in medical school. It was shown that students who passed all examinations from the start had a risk of less than 1% to fail to pass the first-year curriculum. Within the group of "non-optimal" students, i.e. those who did not pass all examinations, 66.7% of the students who would fail to pass the first year could be identified after the first 5 examinations at 6 months. The predictive specificity was lower before 6 months and did not increase substantially afterwards. The predictive sensitivity was 84.5%.

The purpose of the development of a model was twofold: (1) to select students for a short remedial support programme or (2) to dismiss and refer them to another study. For the latter purpose, the model was not specific enough. Both at 6 and at 12 months, too many students would be dismissed on non-rational grounds by using their number of credits obtained as selection criterion. It is interesting to realize that in several institutes for higher education in the Netherlands with inclusion of the Erasmus University in Rotterdam a Binding Study Advice is given at the end of the first year of study, based on the number of credits obtained. Based on our data, the Binding Study Advice in our medical school has been adapted. In order to select students for a remedial programme, our model at 6 months seemed to be very appropriate. By applying the model, per cohort comprising approximately 400 starting students between 33 and 62 students would be selected. Those numbers seem to be manageable. However, of course, this group would still contain some students who would pass the first-year curriculum also without support (false negatives; between 13 and 25 per cohort) and some others would be missed (false positives; between 12 and 24). For a remedial support programme more insight is needed into the causes why students do not succeed in passing exams in our medical school and more information is needed about students' problems in the first few months and why they are not able to overcome them without support from outside. If answers to those questions are multiple and diverse, which is not inconceivable, the intervention programme should be very tailor-made, aimed at the solution of the problems of individual or subgroups of students.

We explored whether other factors such as student participation in study-related activities, aspects of learning competence, aspects of discipline and time management, aspects of intrinsic motivation, aspects of integration, satisfaction with elements of the learning environment and personal circumstances could help to improve our model (Chapter 4). It was shown that only 'student attendance at the optional plenary lectures' made a slight contribution. This indicates that entirely different factors should be sought in order to improve the model substantially. Perhaps the predictive specificity of the model may increase and become more useful earlier in the first year of study by making exams in the first 3-4 months more discriminating. The guideline of 3-4 months is not only important for early remedial support but also because in this period students in the Netherlands are allowed to change to another study while retaining their grants.

It is unnecessary to emphasize that the optimal model should be able to predict the outcome of the interaction between the student and the learning environment before the start of the study.

The second subgroup of students for whom additional predictive factors for student achievement are needed is the one that performs below the mean in the pre-clinical phase and is at risk of study delay. Analysis of the study rate from 1987 has shown that approximately 35% of our medical students needed 5-7 years to complete the 4-year pre-clinical phase (unpublished observation). We performed an exploratory investigation of possible reasons why student achievement in the pre-clinical phase improved or got worse (Chapters 5 and 6). To that purpose, 107 students who had completed medical school were requested to fill in a survey with questions concerning aspects of their adaptation to the learning environment, motivation, satisfaction with elements of the learning environment, time spent on study-related activities and aspects of the social environment. It was shown that for the group of students who performed below the mean during pre-university education a high level of motivation led to an improved achievement in the first year (Chapter 5). In addition, adaptation to the learning environment seemed to be an important determinant of student achievement in the pre-clinical years (Chapter 6).

Since universities and governments are particularly interested in students who will fail to complete their study, to date little has been known about reasons for study delay. In the interest of students who are at risk of unwanted study delay, but have shown that they can complete their study, it is important to investigate in-depth the mismatch between the student and the learning environment in specific study phases.

Finally, the third group for whom additional predictive factors for student achievement are needed comprises all students who enter the clinical phase. It was shown in Chapter 2 that the predictive value of the GPA of pre-clinical years 2-4 for clinical achievement was moderate for both the "above the mean" and "below the mean" group. In Chapter 7, using the same exploratory investigation as used for the pre-clinical phase, it was shown that for students with a GPA above the mean in pre-clinical years 2-4 aspects of their adaptation to the clinical learning environment was an important factor for their clinical achievement. For students with a GPA below the mean in the pre-clinical phase no additional factors were found to explain their GPA of the clinical phase.

The data of the studies as described in Chapters 2 and 7 indicates that the transition from the pre-clinical phase to the clinical phase is large for all students. And indeed, between the pre-clinical and clinical phase major differences can be found in the learning environment and the way of assessing students. Since the GPA of the clinical phase is high, almost any student will complete it in the optimal time of 2 years, independent of their level of pre-clinical achievement. This is surprising and worrying and therefore an

urgent reason for investigation of the lack of connection between pre-clinical and clinical achievement.

In conclusion, the drive behind the studies in this thesis is the view that on principle any student who has successfully completed pre-university education should be able to complete a matching study at the university at a proper level and in a proper time. However, in reality not many students fulfil this view. Fortunately, medical students are a positive exception (Van den Berg & Hofman, 2005; Parkhouse, 1996; McManus, 1996).

Student achievement is the resultant of a complex interaction between student-related factors and factors related to the learning and social environment. Insufficient achievement is due to a mismatch between the student and the learning environment. In order to improve student achievement knowledge is required about the reasons for the mismatch. There are large differences between students and between learning environments. The studies in this thesis were based on the hypothesis that the more heterogeneous the population of students and / or the environments are, the larger the differences between students' achievements, varying from very positive to very negative. Heterogeneity has a profound negative effect on the predictive value of any characteristic. To obtain insight into factors, which lead to improvement or worsening of students' achievements, the outcomes of the interactions between more homogeneous groups of students and better-defined learning environments are needed. It was indeed shown that investigation of factors in relation to student achievement should be focussed on specific subgroups of students in specific study phases. Measures to improve student achievement should therefore be adapted to the causes of the mismatch between students of specific subgroups and specific learning environments.

Limitations

Studies in this thesis were subject to some limitations. The first is that only medical students were included. It is well-known that in contrast with many other branches of study medical students are a positive exception in terms of percentage of students who fail to complete their study (Van den Berg & Hofman, 2005; Parkhouse, 1996; McManus, 1996). In addition, medical students do seem to form a rather homogeneous population since in medical schools all over the world their success rate is high, independent of for example race, culture and learning environment. Consequently, our results may not be found to the same extent in other branches of study.

The second limitation is that results of the studies in this thesis were based on the outcome of the interaction of our students with our curriculum. It is

very well possible that for other curricula with another composition other relationships between factors related to the student, learning environment and social environment on one side and student achievement on the other will be found. For example, the strength of our model to predict early and reliably student failure in the first-year curriculum may be determined by the discriminating character of the exams in the first months.

Finally, some limitations were related to the exploratory studies as described in Chapters 4 through 7, in which questionnaires were used to find additional factors in relation to student achievement. Results of these studies were based on small samples. This might have introduced sampling variability and have limited the generalisability of our results. In addition, we lacked specific information about the non-respondents. It was shown in Chapter 4 that this group might be an entirely different group with other characteristics than the group of respondents. A lack of information about the non-respondents might have led to incorrect statements for the entire population. And finally, the nature of the exploratory studies was retrospective. As a consequence, students' knowledge of their achievement might have influenced the attribution of causal factors. It is conceivable that students with a superior achievement assigned causality to factors within themselves such as their own abilities or opposite; students with inferior achievement might have assigned causality to an outside force such as the learning environment.

Recommendations

The outcomes of the studies in this thesis lead to a number of general and study-related recommendations.

Any branch of study should develop a predictive model for student achievement, based on objective and reliable pre-admission variables such as pu-GPA, command of specific abilities and extra-curricular activities, and post-admission variables such as early student achievement. Such a model should be aimed at distinguishing subgroups of students, which are much less heterogeneous than the original cohort where they belong to. The minimal requirement is the reliable recognition of three types of students. The student, who is at risk of failure should be detected early and should be distinguished as true negative or false negative with the aid of additional data. Early recognition of truly failing students gives them a chance to change to another study while retaining their study grants and is a relief for the teachers and managers. Moreover, the model should form the rational base for any faculty to implement a Binding Study Advice separately for their own students.

Secondly, it is important to recognize at an early stage students, who are not at all at risk of failure and who may be able and willing to do more than just completing their study. These students should be actively challenged to do more by offering additional possibilities to develop their talent. For this group it is important to prevent boredom. It is worrying that the level of achievement, especially of students who start at a level above the mean, decreases in the four years of the pre-clinical phase (unpublished observation).

The remaining type are the students, who will complete the study hopefully at a proper level but certainly not in a proper time because of a multitude of reasons. It is a challenge for any institution to investigate the reasons of the suboptimal match between the student and the learning environment and to apply adapted intervention programmes as possible remediation.

In order to develop a predictive model to fit these purposes any branch of study should establish an own database as the backbone of quality control, in which all items concerning the achievement of the individual student are stored together with additional information obtained by e.g. enquiries. Such a database is at the same time the tool to check the outcome of often expensive and equivocal changes in the learning environment.

Specific recommendations for the Erasmus MC medical school, based on our model, concern two items. It seems worthwhile to investigate whether a curriculum for the first 3-4 months can be developed, which is relevant and provides strong prognostic factors for student achievement in the remaining part of the curriculum.

The large transition from the pre-clinical phase to the clinical phase for all students and the GPA of the ten different clerkship of almost 8 (on a scale of 5-10; unpublished observation) in contrast with the GPA of the pre-clinical examinations of 6.5 (Urlings-Strop, Stijnen, Themmen & Splinter, 2009) is surprising and worrying. An investigation of the lack of the connection between both phases is very much needed as a check of important quality aspects of the pre-clinical and clinical curriculum.

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9 Algemene discussie: samenvatting, conclusies en aanbevelingen

Achtergrond

Studieprestaties van studenten kunnen, van het vwo tot aan de diploma-uitreiking, constant blijven of veranderen. De interactie tussen de student, de leeromgeving en de sociale omgeving kan leiden tot goede of slechte studieprestaties. Om alle studenten een eerlijke kans te geven om een studie op het juiste niveau en binnen een acceptabele tijd af te ronden, is het van belang goed te kunnen voorspellen hoe studenten zullen presteren in verschillende fasen van de opleiding geneeskunde. Het is vooral belangrijk om zo vroeg en zo betrouwbaar mogelijk te achterhalen welke studenten hun studie niet zullen afronden en waarom niet. Zo'n vroege identificatie kan ertoe leiden dat studenten op rationele gronden moeten stoppen met hun studie of dat ze remediërende maatregelen krijgen aangeboden waardoor de 'mismatch' met de leeromgeving kan worden opgelost. Verder is het belangrijk om te onderzoeken waarom de studieprestaties van sommige studenten juist beter worden in bepaalde fasen, terwijl die van anderen verslechteren met als gevolg dat ze studievertraging oplopen.

De hypothese is dat hoe heterogener de studentenpopulatie en/of de leeromgevingen zijn, hoe groter de verschillen tussen de studieprestaties van individuele studenten, variërend van heel positief tot heel negatief. Heterogeniteit heeft een diepgaand negatief effect op de voorspellende waarde van welk kenmerk dan ook. Inzicht in factoren die leiden tot verbetering of verslechtering van studieprestaties, kan daarom alleen worden verkregen door de uitkomsten van de interactie tussen meer homogene groepen studenten en beter gedefinieerde leeromgevingen te onderzoeken.

Het doel van de studies in dit proefschrift is om factoren te vinden die beter kunnen voorspellen welke subgroepen van studenten welke problemen zullen tegenkomen in welke studiefase. Met dat doel is de relatie tussen student-gebonden factoren, het curriculum en de sociale omgeving aan de ene kant en de studieprestaties aan de andere kant onderzocht voor specifieke studiefasen en meer homogene subgroepen van studenten.

Samenvatting en conclusies

Tot nu toe is het gemiddelde cijfer van studenten op het eindexamen vwo de beste voorspeller voor studieprestaties in de opleiding geneeskunde (Salvatori 2001; Norman, 2004; Gottheil & Michael, 1957; Kulatunga-Moruzi & Norman, 2002; Cohen-Schotanus, Muijtjens, Reinders, Agsteribbe, van Rossum & van der Vleuten, 2006). Vooral de voorspellende waarde voor prestaties in de pre-klinische fase is groot (Mitchell, 1990; Peat, Woodbury & Donner, 1982). Echter, de voorspellende waarde van het gemiddeld eindexamencijfer vwo voor prestaties tijdens de co-schappen is klein (Peat et al., 1982). De afname van de voorspellende waarde van het eindexamen vwo voor prestaties in de opleiding geneeskunde wordt waarschijnlijk veroorzaakt door een stapeling van veranderingen in studieprestaties die toegeschreven kunnen worden aan veranderingen in de leeromgeving tijdens de overgang van de ene naar de andere studiefase. Bovendien is de afname van de relatie een aanwijzing voor het feit dat sommige studenten, die eerst goed presteren, slechter gaan presteren en vice versa.

De matig voorspellende waarde van het eindexamen vwo voor studieprestaties op de universiteit is identiek voor andere studierichtingen (Deckro & Woudenberg, 1977; Sobol, 1984; Turnbull, 1980; Hedlund, Wilt, Nebel, Ashford & Sternberg, 2006; Federici & Schuerger, 1974; Chissom & Lanier, 1975).

We onderzochten of de relatie tussen de gemiddelde cijfers van studenten in opeenvolgende studiefasen afhankelijk was van de aard van de studiefase-overgang en/of het niveau van presteren boven of onder het gemiddelde van studenten in de voorafgaande studiefase (hoofdstuk 2). In deze studie werd aangetoond dat voor een groep van 327 studenten een sterk verband bestaat tussen het gemiddeld eindexamencijfer vwo en het gemiddeld cijfer in het eerste jaar. Voor dezelfde groep studenten was het verband tussen de gemiddelde cijfers behaald in de twee delen van de theoretische pre-klinische fase, dat wil zeggen het eerste jaar en de daaropvolgende drie jaar, zeer sterk en de relatie tussen de gemiddelde cijfers van de pre-klinische fase en de klinische fase matig. Deze bevindingen laten zien dat de relatie tussen de gemiddelde cijfers van opeenvolgende studiefasen omgekeerd gerelateerd is aan de grootte van verandering in de leeromgeving tijdens de overgang van de ene naar de andere studiefase. Met betrekking tot bovenstaande relaties, vonden we grote verschillen tussen studenten met een ondergemiddeld cijfer in de voorafgaande studiefase en studenten met een bovengemiddeld cijfer.

Voor studenten met een *bovengemiddeld cijfer* in de voorafgaande studiefase, waren de relaties tussen de gemiddelde cijfers iets groter dan die van

de gehele groep van 327 studenten. Voor deze groep was de relatie tussen het gemiddeld eindexamencijfer vwo en het gemiddeld cijfer in het eerste jaar sterk en de relatie tussen de gemiddelde cijfers behaald in de twee delen van de pre-klinische fase zeer sterk. Deze gegevens tonen aan dat studenten met een bovengemiddeld cijfer in de voorafgaande studiefase niet erg gevoelig lijken te zijn voor de overgang van het vwo naar het eerst jaar van de opleiding geneeskunde en van het eerste jaar naar de volgende drie pre-klinische jaren. Waarschijnlijk hebben deze studenten zich in de voorafgaande studiefase al bepaalde studie- en andere vaardigheden eigengemaakt die nodig zijn voor het welslagen in het daaropvolgende deel van de pre-klinische fase.

Voor studenten met een *ondergemiddeld cijfer* in de voorgaande studiefase vonden we compleet andere relaties tussen gemiddelde cijfers. Hun gemiddeld eindexamen vwo had helemaal geen relatie met het gemiddelde cijfer in het eerste jaar en de relatie tussen de gemiddelde cijfers van het eerste jaar en de daaropvolgende drie pre-klinische jaren was zwak. Deze bevindingen laten zien dat eerder verkregen cijfers voor deze subgroep van studenten geen of slechts een beperkte voorspellende waarde hebben voor studieresultaten in de pre-klinische fase. Dit duidt erop dat deze studenten erg gevoelig zijn voor elke studiefaseovergang in de pre-klinische fase. Blijkbaar verbeteren de cijfers van sommige studenten in deze subgroep aanmerkelijk terwijl die van anderen op hetzelfde lage niveau blijven of zelfs nog slechter worden met als gevolg dat ze studievertraging oplopen.

Interessant is dat de relatie tussen de gemiddelde cijfers van de pre-klinische en de klinische fase gelijk is voor de twee subgroepen. Zowel studenten met een ondergemiddeld als bovengemiddeld cijfer in de pre-klinische fase lijken dus even gevoelig voor de overgang van de theoretische pre-klinische fase naar de praktijkgerichte klinische fase. Blijkbaar moeten alle studenten wennen aan de 'nieuwe' klinische leeromgeving waar andere vaardigheden zijn vereist om goed te kunnen functioneren.

De gevolgen van de beperkte voorspellende waarde van eerder behaalde cijfers voor toekomstige prestaties zijn dat er naar aanvullende of vervangende voorspellende factoren gezocht moet worden. Voor onze opleiding geneeskunde hebben eerder behaalde gemiddelde cijfers beperkte voorspellende waarde (1) voor studenten die het eerstejaars curriculum niet succesvol afronden; (2) voor studenten die onder het gemiddelde scoren tijdens het eindexamen vwo en/of in de pre-klinische fase met als gevolg dat ze studievertraging kunnen oplopen; (3) en voor alle studenten die aan de klinische fase beginnen.

Wat betreft de eerste groep is gebleken dat 80% van onze studenten die het eerstejaars curriculum niet succesvol afronden een ondergemiddeld cijfer

heeft op het eindexamen wvo (ongepubliceerde observatie). Aangezien een dergelijk vwo-cijfer helemaal geen voorspellende waarde heeft voor studieprestaties in het eerste jaar, hebben we geprobeerd een model te ontwikkelen om vroegtijdig en betrouwbaar te kunnen voorspellen of studenten de propedeuse niet succesvol zullen afronden binnen twee jaar na aanvang van de studie (hoofdstuk 3). In het model gebruikten we voorspellende variabelen die vóór de toelating bekend waren, zoals leeftijd, geslacht, de manier waarop studenten geselecteerd waren, en de resultaten van studenten op de eerste tentamens tijdens de opleiding geneeskunde. Uit de resultaten van deze studie bleek dat studenten die vanaf het begin alle examens haalden, minder dan 1% kans hadden om het propedeutisch jaar niet succesvol af te ronden binnen 2 jaar nadat ze met de studie waren gestart. In de groep met 'niet-optimale' studenten, dat wil zeggen studenten die in de eerste maanden niet alle tentamens haalden, konden we 66.7% van de studenten, die het eerste jaar niet zouden halen, na 6 maanden herkennen op basis van hun prestaties op de eerste vijf tentamens. De specificiteit van de voorspelling was lager na 4 maanden en nam naderhand niet aanmerkelijk toe. De sensitiviteit van de voorspelling was 84.5%.

Het doel van de ontwikkeling van een model was tweeledig: (1) om studenten te selecteren voor een kort, remediërend programma of (2) om ze op rationele gronden te laten stoppen met de studie en ze te verwijzen naar een andere studie. Voor het laatste doel was het ontwikkelde model niet specifiek genoeg. Als we alleen het aantal behaalde studiepunten als selectiecriterium zouden gebruiken zouden we na zowel 6 als na 12 maanden teveel studenten onterecht afwijzen. Het is interessant om te beseffen dat op verschillende universiteiten in Nederland, inclusief de Erasmus Universiteit in Rotterdam, een Bindend Studieadvies (BSA) wordt gegeven aan het eind van het eerste studiejaar, gebaseerd op het aantal behaalde studiepunten. Op basis van onze eigen gegevens is het Bindend Studieadvies voor onze opleiding aangepast. Hoewel ons model nog niet geschikt is om studenten af te wijzen, lijkt het wel geschikt om studenten te selecteren voor een kort remediërend programma. Met behulp van het model zouden we na 6 maanden per cohort, bestaande uit ongeveer 400 startende studenten, tussen de 33 en 62 studenten voor een dergelijk programma kunnen selecteren. Deze aantallen lijken hanteerbaar. Wel moet worden opgemerkt dat de geselecteerde groep nog studenten zou bevatten die ook zonder hulp de propedeuse na twee jaar succesvol zouden afronden ('false negatives'; tussen de 13 en 25 per cohort) en dat een aantal andere studenten ten onrechte niet zou worden geselecteerd voor het remediërend programma ('false positives'; tussen de 12 en 24 per cohort). Voordat er daadwerkelijk een remediërend programma kan worden opgezet, is meer informatie nodig. Allereerst is meer inzicht nodig in de redenen waarom stu-

denten er niet in slagen tentamens van de opleiding geneeskunde te halen. Op de tweede plaats is er meer informatie nodig over de problemen die studenten hebben in de eerste paar maanden van de studie en over de redenen waarom ze die problemen niet kunnen overwinnen zonder hulp van buitenaf. Als het antwoordpatroon op bovenstaande vragen divers is, wat niet ondenkbaar is, zal het interventieprogramma 'op maat' moeten worden ingericht. Dat betekent dat de oplossing van de problemen van individuele of subgroepen van studenten centraal zal moeten komen te staan.

We hebben onderzocht of factoren als deelname aan studiegerelateerde activiteiten, leercompetentie van studenten, discipline en 'time management', intrinsieke motivatie, integratie, tevredenheid met elementen van de leeromgeving en persoonlijke omstandigheden zouden kunnen bijdragen om ons model na 6 maanden te verbeteren (hoofdstuk 4). Gebleken is dat alleen de niet-verplichte aanwezigheid van studenten op de hoorcolleges een kleine bijdrage zou kunnen leveren. Dit duidt erop dat compleet andere factoren gezocht moeten worden om het model aanzienlijk te kunnen verbeteren. Misschien dat de specificiteit van het model verhoogd kan worden en dat eerder in het eerste jaar een betrouwbare voorspelling gemaakt kan worden, als tentamens in de eerste drie-vier maanden meer discriminerend worden gemaakt. De richtlijn van drie-vier maanden is niet alleen belangrijk om studenten zo snel mogelijk remediërende hulp te kunnen bieden, maar ook omdat studenten in Nederland gedurende deze periode nog van studie mogen wisselen, zonder dat dit consequenties voor hun studiefinanciering heeft.

Het is onnodig om te benadrukken dat het optimale model de uitkomst van de interactie tussen de student en de leeromgeving al kan voorspellen vóór aanvang van de studie.

De tweede subgroep van studenten, voor wie aanvullende voorspellende factoren voor studieprestaties nodig zijn, is de groep studenten die tijdens het VWO of gedurende de pre-klinische fase ondergemiddelde cijfers halen en die het risico lopen om studievertraging op te lopen. Op basis van analyse van gegevens vanaf 1987 in onze geneeskunde opleiding is aangetoond dat ongeveer 35% van onze studenten 5 tot 7 jaar nodig heeft om de vierjarige pre-klinische fase succesvol te doorlopen (ongepubliceerde observatie). Wij voerden een verkennend onderzoek uit naar mogelijke redenen waarom studieprestaties van studenten in de pre-klinische fase beter werden of juist verslechterden (hoofdstuk 5 en 6). Voor dat doel vroegen we 107 studenten die de opleiding geneeskunde hadden afgerond om een lijst in te vullen met vragen over hun aanpassing aan de leeromgeving, motivatie, tevredenheid over elementen van de leeromgeving, de tijd die ze hadden besteed aan hun studie en aspecten van de sociale omgeving. Voor de groep van studenten

met een ondergemiddeld vwo-eindcijfer bleek dat een hoge motivatie bijdroeg aan verbeterde studieresultaten in het eerste studiejaar (hoofdstuk 5). Voor studenten met een ondergemiddeld cijfer in het eerste jaar bleek aanpassing aan de leeromgeving een belangrijke determinant voor hun prestaties in de resterende jaren van de pre-klinische fase (hoofdstuk 6).

Aangezien universiteiten and regeringen in het bijzonder geïnteresseerd zijn in studenten die de opleiding niet succesvol zullen afronden is er tot op heden weinig bekend over redenen van studievertraging. In het belang van studenten die een grote kans lopen op ongewilde studievertraging, maar die ook hebben bewezen dat ze de studie succesvol kunnen afronden is het belangrijk om een diepgaand onderzoek in te stellen naar de 'mismatch' tussen de student en de leeromgeving in specifieke studiefasen.

Tenslotte, de derde groep, voor wie aanvullende voorspellende factoren voor studieprestaties nodig zijn, bevat alle studenten die starten met de co-schappen. Uit de resultaten, beschreven in hoofdstuk 2, bleek dat de voorspellende waarde van het gemiddelde cijfer tijdens de pre-klinische fase matig gecorreleerd was met de cijfers in de co-schappen. Dit gold zowel voor studenten met een ondergemiddeld cijfer als voor studenten met een bovengemiddeld cijfer in de pre-klinische fase. Uit de resultaten, beschreven in hoofdstuk 7, waarin gebruik was gemaakt van hetzelfde verkennende onderzoek als voor de pre-klinische fase, bleek dat voor studenten met een bovengemiddeld cijfer in de pre-klinische fase aanpassing aan de klinische leeromgeving belangrijk was voor de cijfers die ze behaalden tijdens de co-schappen. Voor studenten met een ondergemiddeld cijfer in de pre-klinische fase werden geen aanvullende factoren gevonden die hun prestaties tijdens de co-schappen konden verklaren.

De gegevens, beschreven in hoofdstuk 2 en 7, geven aan dat de overgang van de pre-klinische fase naar de co-schappen groot is voor alle studenten. En inderdaad, er zijn grote verschillen in de leeromgeving en de manier van tentamineren tussen de twee fasen. Aangezien het gemiddeld cijfer van studenten in de klinische fase hoog is zal bijna elke student de co-schappen binnen de optimale termijn van 2 jaar afronden, onafhankelijk of ze in de pre-klinische fase goed of slecht scoorden. Dit is verrassend en verontrustend en daarom een belangrijke reden voor onderzoek naar de gebrekkige relatie tussen de studieprestaties van studenten in de pre-klinische fase en die in de klinische fase.

Tot besluit, de drijfveer achter de studies in dit proefschrift is de opvatting dat in principe elke student die succesvol het vwo heeft doorlopen in staat zou moeten zijn om een passende studie op de universiteit op het juiste ni-

veau en binnen een acceptabele tijd af te ronden. In de praktijk voldoen niet veel studenten aan deze opvatting. Gelukkig zijn geneeskunde-studenten een positieve uitzondering (Van den Berg & Hofman, 2005; Parkhouse, 1996; McManus, 1996).

Studieprestaties zijn de resultante van een complexe interactie tussen studentgebonden factoren en factoren die gerelateerd zijn aan de leeromgeving en de sociale omgeving. Onvoldoende prestaties zijn het gevolg van een 'mismatch' tussen de student en de leeromgeving. Om studieprestaties te kunnen verbeteren is kennis nodig over de oorzaken van de 'mismatch'. Er zijn grote verschillen tussen studenten en leeromgevingen. De studies in dit proefschrift waren gebaseerd op de hypothese dat hoe heterogener de populatie studenten en/of de omgevingen zijn, hoe groter de verschillen tussen de prestaties van studenten, variërend van heel positief tot heel negatief. Heterogeniteit heeft een diepgaand negatief effect op de voorspellende waarde van welk kenmerk dan ook. Inzicht in factoren die leiden tot verbetering of verslechtering van studieprestaties, kan daarom alleen worden verkregen door de uitkomsten van de interactie tussen meer homogene groepen studenten en beter gedefinieerde leeromgevingen te onderzoeken. Uit de studies in dit proefschrift bleek inderdaad dat onderzoek naar factoren in relatie tot studieprestaties gericht moet zijn op specifieke subgroepen van studenten in specifieke studiefasen. Maatregelen om studieprestaties te verbeteren moeten daarom worden aangepast aan de oorzaken van de 'mismatch' tussen studenten van specifieke subgroepen en specifieke leeromgevingen.

Beperkingen van de studies

De studies in dit proefschrift hebben een aantal beperkingen. Ten eerste bevat de onderzoeksgroep alleen studenten geneeskunde. Het is algemeen bekend dat in vergelijking met andere studierichtingen geneeskunde-studenten een positieve uitzondering vormen als het gaat om studierendement (Van den Berg & Hofman, 2005; Parkhouse, 1996; McManus, 1996). Bovendien lijkt de populatie geneeskunde-studenten zeer homogeen, aangezien wereldwijd hun rendement hoog is, onafhankelijk van bijvoorbeeld afkomst, cultuur en leeromgeving. Daarom zou het kunnen zijn dat onze resultaten niet in gelijke mate worden gevonden bij andere studierichtingen.

Een tweede belangrijke beperking is dat de resultaten van de studies in dit proefschrift gebaseerd zijn op de uitkomst van de interactie van onze studenten met ons curriculum. Het is goed mogelijk dat voor curricula met een andere opbouw andere relaties worden gevonden tussen factoren gerelateerd aan de student, het curriculum en de sociale omgeving aan een kant en studieprestaties aan de andere kant. Bijvoorbeeld, de sterkte van ons model om

vroegtijdig en betrouwbaar het falen van de student in het eerstejaars curriculum te voorspellen zou elders kunnen afwijken omdat de tentamens meer of minder discriminerend zijn.

Tenslotte hebben de verkennende studies, die beschreven staan in hoofdstuk 4 tot en met 7 en waarin vragenlijsten werden gebruikt om additionele factoren in relatie tot studieprestaties te vinden, een aantal beperkingen. De resultaten van deze studies zijn gebaseerd op kleine aantallen studenten. Daarnaast ontbreekt specifieke informatie over de non-respondenten. Zoals blijkt uit de studie, die beschreven is in hoofdstuk 4, kan deze groep andere kenmerken hebben dan de groep van respondenten. Dit ontbreken van informatie over de non-respondenten kan hebben geleid tot beweringen voor de hele populatie die niet op waarheid berusten. Tenslotte zijn de verkennende studies retrospectief. Als gevolg daarvan kan de kennis van studenten over hun prestaties de toekenning van oorzakelijke factoren hebben beïnvloed. Het is denkbaar dat studenten met betere studieprestaties de oorzaken hiervan hebben toegewezen aan zichzelf zoals aan hun vermogen om goed te leren en dat studenten met slechtere prestaties externe factoren als oorzaak hebben aangewezen zoals negatieve aspecten van de leeromgeving. In verband hiermee is het ook mogelijk dat door studenten retrospectief te bevragen hun geheugen gekleurd is door de tussenliggende periode.

Aanbevelingen

De uitkomsten van de studies in dit proefschrift leiden tot de volgende algemene en studiegebonden aanbevelingen.

Elke faculteit zou een model moeten ontwikkelen om studieprestaties te kunnen voorspellen. Zo'n model zou gebaseerd moeten zijn op objectieve en betrouwbare factoren die vóór aanvang van de opleiding bekend zijn, zoals het eindexamencijfer vwo, beheersing van specifieke vaardigheden, en activiteiten die studenten naast het vwo-curriculum hebben uitgevoerd, en factoren die na de start kunnen worden verzameld zoals de prestaties die studenten vroeg in de opleiding behalen. Met het model zouden subgroepen van studenten moeten kunnen worden onderscheiden die minder heterogeen zijn dan het oorspronkelijke cohort waartoe ze behoren. De minimale vereiste is dat 3 typen studenten op een betrouwbare manier kunnen worden herkend. De student die het risico loopt om uit te vallen moet vroegtijdig worden geïdentificeerd en moet worden onderscheiden als 'true negative' of 'false negative' met behulp van aanvullende factoren. Vroegtijdige herkenning van studenten die zeker gaan uitvallen geeft hen de mogelijkheid om zonder verlies van hun studiefinanciering van studie te veranderen. Daarbij moet het model

voor elke faculteit de rationele basis vormen om een Bindend Studieadvies (BSA) in te voeren speciaal voor haar eigen studenten.

Ten tweede is het belangrijk om vroegtijdig de studenten te herkennen die helemaal geen risico lopen om uit te vallen en die meer kunnen en willen doen dan alleen de reguliere studie-activiteiten. Deze studenten moeten actief worden uitgedaagd om meer te doen door ze additionele verdiepende of verrijkende activiteiten aan te bieden, zodat ze hun talent verder kunnen ontwikkelen. Het moet voorkomen worden dat deze groep studenten zich gaat vervelen. Het is verontrustend dat het prestatieniveau van vooral studenten met een bovengemiddeld cijfer afneemt gedurende de vier pre-klinische jaren (ongepubliceerde observatie).

De resterende groep van studenten die moet kunnen worden geïdentificeerd zijn de studenten die hun studie zullen afronden, hopelijk op het juiste niveau, maar zeker niet binnen een redelijke termijn. Aan het laatste kunnen diverse factoren ten grondslag liggen. Het is een uitdaging voor elke instelling om te onderzoeken waardoor de suboptimale 'match' tussen de student en de leeromgeving veroorzaakt wordt en of deze gerepareerd kan worden met een kort remediërend interventieprogramma.

Ten einde een voorspellend model te kunnen ontwikkelen om bovenstaande doelstellingen te bereiken zou elke faculteit een eigen database als ruggengraat van het kwaliteitszorgsysteem moeten opbouwen. In de database moeten alle gegevens met betrekking tot de prestaties van de individuele student worden opgeslagen als ook aanvullende informatie die verkregen wordt door bijvoorbeeld vragenlijsten. Zo'n database is de tool om de uitkomst van vaak dure en twijfelachtige veranderingen in de leeromgeving te onderzoeken.

Gebaseerd op ons model kunnen de volgende specifieke aanbevelingen worden gedaan voor de geneeskunde opleiding van Erasmus MC. Ten eerste lijkt het de moeite waard om te onderzoeken of een curriculum voor de eerste 3 tot 4 maanden ontwikkeld kan worden, dat relevant is en sterke factoren bevat om de prestaties van studenten in de rest van het curriculum te voorspellen.

Ten tweede is het feit dat de overgang van de pre-klinische naar de klinische fase voor alle studenten groot is en dat het gemiddeld cijfer op de co-schappen bijna een 8 is (op een schaal van 5-10; ongepubliceerde observatie) in tegenstelling tot het gemiddelde cijfer van 6.5 tijdens de pre-klinische fase (Urlings-Strop, Stijnen, Themmen & Splinter, 2009) verrassend en verontrustend. Een onderzoek naar de gebrekkige aansluiting van de twee fasen is erg noodzakelijk als een controle van belangrijke kwaliteitsaspecten van het pre-klinisch en klinisch curriculum.

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Gerard Baars
Rotterdam, oktober 2009

Curriculum Vitae

Gerard Baars was born in Nederhorst den Berg on March 10, 1971. After his high school at the Municipal Grammar School in Hilversum, he studied Applied Educational Sciences at the University of Twente from 1989 to 1995. From 1993 to 1995, he also studied at the Teacher Training Institute for Primary Education at the Hogeschool Enschede. From both studies, he graduated in 1995. After his graduations, Gerard worked as a teacher and educational consultant in several jobs. Since August 2000, he works as a senior educational consultant at Risbo, Erasmus University Rotterdam. His main expertise area is the pedagogical use of ict tools in education. Gerard is project manager of the website www.digitaledidactiek.nl, which contains approximately 200 practical instruments for teachers in higher education on how to use ict tools in education. Moreover, the last three years he wrote two first-author books on this area: Leren (en) doceren met digitale leermiddelen in het hoger onderwijs [Learning and teaching with digital learning tools in higher education] and Digitale Didactiek: Praktische stappenplannen voor het gebruik van ICT in het hoger onderwijs [Digital Didactics: Practical step-by-step plans to use ICT in higher education]. From March 2004 he combined abovementioned activities with his Ph.D. research on factors related to student achievement in medical school.

In order to give every student a fair chance to complete an academic study at a proper level and in a proper time institutes should be able to predict correctly how students will achieve in distinctive study phases. In particular it is important to identify early and reliably which students will fail to complete their study and why. Such an early identification may create the possibility to refer those students to another study or to offer them corrective measures to solve their mismatch with the learning environment.

The goal of the studies in this thesis is to find factors to predict more reliably which subgroups of students will encounter what kind of problems in which study phase. To that purpose, the relationship between factors related to the student, the curriculum and the social environment on one side and student achievement on the other is investigated for both distinctive study phases and subgroups of students.

One of the main outcomes of this thesis is a very useful model for the early and reliable prediction of students who will fail to pass the first-year curriculum within two years of study. By using this model we are able to identify at 6 months from the start a manageable group of students for a short remedial support programme. It is also shown that too many of our students would be dismissed on non-rational grounds at the end of the first year of study, if we would only use their number of credits obtained as selection criterion. Based on this latter finding the Binding Study Advice regulation in our medical school has been adapted.

LEMMA

Gerard J.A. Baars studied Applied Educational Sciences at the University of Twente. Since August 2000, he works as a senior educational consultant at Risbo, Erasmus University Rotterdam.

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