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Counselling in the introductory phase of studies

Abstract

The University of Applied Sciences RheinMain has a heterogenic field of beginners, which leads to a high dropout rate after the first semester. We ran a project to change the engineering department's introductory phase based on motor learning's feedback concept. The beginners could choose to have one exam at the end of the semester or having three shorter exams instead during the semester. Failing one of the shorter exams made it mandatory to get individual counselling. The data from that project shows the effects of that counselling which helps the students to be successful in later exams. Students, who assume early support offers, are proven to perform better.

Keywords

counselling, introductory phase, augmented feedback

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1 Introduction

As previous studies showed, missing mathematical knowledge caused a high dropout rate in the context of STEM studies (cf. MÜLLER, FLECK & WEBER, 2018; FRETTLÖH & HATTERMANN, 2016; FARIDHAN, 2014; HEUBLEIN, EBERT, HUTZSCH, ISLEIB, KÖNIG, RICHTER & WOISCH, 2017). These failure rates described above exist worldwide, and there are many data on this. However, only a few studies recommend interventions for better support. LAROSE et al. (2011) noted the lack of theoretical embedding, representative samples, control groups and empirical evaluation. At the RheinMain University of Applied Sciences, Department of Engineering, the dropout rate in electrical engineering was also very high after the first semester. From 2014 to 2016, 419 students subscribed for electrical or media engineering, but only 141 took the math exam at the end of the first semester of which 56 did successfully. The dropout was 87% of all beginners, 66% did not even try the exam. These numbers failed all expectations, and the department of engineering had to react to these results. For this purpose, the department implemented and evaluated a project for three years: “Studienerfolg” funded by the Hessen State Ministry for Higher Education, Research and the Arts.

Previous studies examine various support services to determine their success. As a result, many universities have implemented bridge courses without a consistent scientific basis for effectiveness (MERKT et al., 2017). The following considerations arose for higher education intervention with the initial situation described above. The idea at RheinMain University of Applied Sciences was to change the first semester of selected studies. Instead of having one long exam, the students can choose three shorter exams during the semester. This way, the department tries to reduce the inhibition to take an exam. The results of the three exams adding up, one could get 20, 30 and 50 points, so 100 points in total and half of it were enough to pass the lecture. To face the problems with passing the exams, students were obliged to attend individual counselling if they had less than half of the first two exams scores. This counselling focused on the learning process. To be successful, students have to enhance their self-efficacy through the experience of competence, social integration and self-determination and promote continuous learning (BLÖMEKE, 2016; DERBOVEN & WINKLER, 2010; DEHLING, GLASMACHERS, GRIESE, HÄRTERICH & KALLWEIT, 2014). One advantage of the setting with three exams and the counselling came from (motor learning) psychology. Instead of *knowledge of result* at the end of the semester, the students get the *knowledge of performance* during the semester, which is better for the learning process, especially for beginners (MAGILL & ANDERSON, 2007).

Our present study's main objective was to evaluate the effects of counselling in combination with partial exams.

2 Theoretical framework

The change from school to university is an upheaval. For example, the learning patterns that worked at school often cannot be successfully transferred (GRIESE, 2017). Problems with converting to intensive, independent and efficient working methods result. Students realize too late that they cannot pass the exam at the end of the semesters (CLARK & SCHROTH, 2010). While in school, the students had exams spread over the year and thus had continuous feedback on their learning progress. This crisis leads to an increased number of students dropping out because the change is too challenging (ZUMBACH & ASTLEITNER, 2016; CLARK & SCHROTH, 2010; ENGELBRECHT & HARDING, 2016; BLÖMEKE, 2016). The first semester experiences at university are described as “traumatic” (ENGELBRECHT, 2010) and “stressful, demanding, life-changing experience” (CLARK & LOVRIC, 2008). There is an urgent need for ideas to help students of STEM subjects with mathematics problems. In particular, mathematical subjects lead to a high dropout rate at the beginning of studies. In Germany and the USA, around 48% of engineering students fail in their first semesters at university (HEUBLEIN, RICHTER, SCHMELZER, & SOMMER, 2012; KNIGHT, CARLSON & SULLIVAN, 2007). According to the Education Report 2012, the mathematics-related courses of study have the highest dropout rate of all courses of study, with 55% of beginners in a Bachelor's course of study (for comparison: the average dropout rate of all Bachelor's programs at the university is 35%) (AUTORENGRUPPE BILDUNGSBERICHTERSTATTUNG, 2012). A higher level of abstraction and complexity and less practical relevance characterized Mathematics at university. Books or seminars like learning to learn are no help for students in mathematical subjects. Because the needed skill "pattern recognition" cannot be found in these books (DERBOVEN & WINKER, 2010). Many students believe that they would have stayed if they had studied more often and more intensively. Therefore, universities must promote continuous learning, by finding ways to shift from the "mass production" with big lectures to cooperative teaching and learning methods (DERBOVEN & WINKER, 2010; MÜLLER, FLECK & WEBER, 2018; FRETTLÖH & HATTERMANN, 2016; FARIDHAN, 2014; HEUBLEIN, EBERT, HUTZSCH, ISLEIB, KÖNIG, RICHTER & WOISCH, 2017; GRIESE, 2017; HILGERT, 2016). The classification scheme for learning psychology of FRIEDEWOLD et al. (2015) shows that learning does not only mean taking in information at the subject level (level 1). Learning is always a process, and in this respect, questions of learning strategy also play a decisive role for success: How do I learn? (Level 2) Equally powerful are the emotions and motivation that accompany learning: What is going on inside me? (level 3) Concerning how to design teaching and learning support, the present concept suggests a combination of counselling and divided exams. Any action in teaching and guidance should aim at creating favourable conditions for all three levels of learning.

In summary, critical factors for students' academic success are motivation, active learning, help-seeking, student effort and workload. Offers like a bridge course, focus on "at-risk" students, online homework, online quizzes and a tutor system reveal a better pass rate than without these offerings (ENGELBRECHT & HARDING, 2015).

At the University of Bochum, experience shows a bigger group of students who have sufficient professional competence and interest in the subject, but who have major problems with their work organization and the university's necessary learning techniques (GRIESE, 2017).

Against the backdrop of high dropout rates, the Technical University of Illmenau has investigated three engineering science bachelor's degree programs. The first phase's core result was that students devote little time to their self-study. As a result, they developed teaching interventions to promote continuously and sustained learning: Block structure in terms of content and time, examinations during the semester, teaching in networked contexts with practical relevance, concrete assignments with feedback for self-study (SCHULZ et al., 2011). The block structure and the precisely coordinated didactic of the courses can lead to an improvement in teaching. SCHULZ et al. (2011) did not discuss the possibility to include small examinations during the semester.

In Germany, there were 30 advisory programmes across all universities in 2012. The purpose is to improve the study satisfaction and reduce dropout rates (HARTUNG, 2012). The RWTH Aachen has introduced an advisory program for students who are either in their third attempt at an exam and all STEM first semester students. Most students came for counselling because of learning difficulties and failed exams. For this reason, the university promotes courses on learning and self-management, time management, exam anxiety and related topics in the introductory phase (WESTERHOLT et al., 2018). Students experience how their self-efficacy increases through competence, social integration and self-determination and experience continuous learning. For example, three exams spread over the semester, instead of one at the end of the semester, allow for earlier feedback on what the student can already do.

On the other hand, an exam at the end of the semester leads to a lack of feedback and causes unnecessary stress for students (NITKO, 1995). Studies show how continuous testing promotes self-regulated learning (COMBRINCK & HATCH, 2012). It increases the certainty and experience of competence. Self-regulated learning includes three crucial aspects: the ability to learn; the ability to know how to learn; and the ability of students to know that they have learned. The goals can be divided and broken down into sub-goals. Counselling supports the student in achieving them (BLÖMEKE, 2016; DERBOVEN & WINKLER, 2010; DEHLING et al., 2014; COMBRINCK & HATCH, 2012). Mainly concerning learning strategies, these services help avoid dropout risk (ZUMBACH & ASTLEITNER, 2016). Furthermore, the counselling's systematic documentation and evaluation can detect and eliminate students' general needs, current challenges, and last but not least structural weaknesses in the system (WESTERHOLT, LENZ, STEHLING & ISENHARDT, 2018).

In this context, it is essential to distinguish between counselling as support in learning strategies, feedback on exam results and counselling with a psychological background. This article does not aim at psychological counselling.

LUNSFORD, CRISP, DOLAN and WUETHERICK (2017) could show that students, who accept offers of support, perform better. Also, students have an increase in cognitive and social-emotional skills (such as learning to learn or feeling belonging).

According to CRISP and CRUZ (2009), counselling can consist of four components:

- Psychological and emotional support: listening, identifying problems
- Advice on goal setting and career planning: identifying subject-relevant strengths and weaknesses and using this knowledge to select study options
- Competence promotion and personality development: Promotion of the development of subject-specific and social competencies that are important for studies and work
- Being a role model: student perceives the teacher as a role model who can handle challenging tasks

So far, counselling is rarely used in Germany (ZUMBACH & ASTLEITNER, 2016). RUSHTON (2005) found that students who took several exams performed better than students with fewer exams.

Exams can summarise students' performance to provide some form of certification (summative assessment) and provide feedback to students to support learning (formative assessment). Observed effects of formative assessments are rare so far. The introduction of several individual exams during the semester is a formative assessment. The study by WEURLANDER, SÖDERBERG, SCHEJA, HULT and WEMERSON (2012) states that formative examinations motivate students more to learn and make them more aware of what they should learn more. Formative assessments encourage reflection on one's learning and weaknesses concerning the exam tasks.

Traditional assessment practices generally do not provide counselling and support, therefore not improving the students' performance (BROWN, 1999). Moreover, formative examinations are preferable in terms of advice and support. With advice and support, knowledge of the process can become effective.

The following section briefly summarises the findings on feedback from sports science relevant to the article and refers to MAGILL and ANDERSON (2007).

In sports science, there is the term "Augmented Feedback". Athletes can usually see the sporting results they have achieved, for example, how far they have thrown. However, only a coach who comments on these results makes it possible to generate added value from these results (Augmented Feedback), which allows the athletes to achieve better results. There are two basic forms: *knowledge of result* and *knowledge of process*. The knowledge of result helps trained athletes because they have experience in their field and have already acquired techniques to classify results and adjust their training. Inexperienced athletes often have little use for the result. They need to know what they can change in their technique, which they need to practice to achieve better results. In sports science, coaches should not give feedback too often. If they comment on every attempt, they overstrain the learner, and the learning process will slow down. Such learners perform worse than before the training because they became dependent on the coach's help. Therefore, the coach should use feedback selectively. There are three approaches to this: Feedback only if specific goals are not met or exceeded, feedback only on request, summarising feedback after several attempts.

The project "Studienerfolg" followed the rules for Augmented Feedback. First-year students are precisely that: beginners who do not yet have the experience and the methodological repertoire of a Master's student. They need more feedback than students from higher semesters. They receive feedback once on the result at the end of the semester via the final exam and then try again next semester. By dividing the exam into three parts, a balance is created to receive feedback more often but not too often (knowledge of result). Simultaneously, we choose the feedback approach for falling short of a goal for the counselling (50% of the tasks are solved correctly). The counselling refers to the process, which learning strategies were followed, which strategies were used when solving the exam (knowledge of performance). Of course, the findings from sports science cannot be transferred one-to-one. The types of feedback will not be the same in mathematics. However, the authors believe that the underlying mechanisms of learning are similar enough that the project's structure could theoretically support first-year students' learning. Based on these considerations, we pose the following research questions:

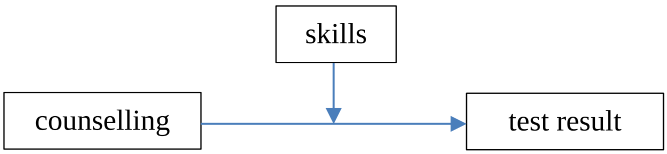
3 Research question

What effects does the project “Studienerfolg” have on first-year students? Do weaker students manage to pass their examinations due to counselling?

4 Method

The present data (Success rate of all tests, participation or non-participation in the counselling session) of the project participants were recorded entirely during the first semester. We used SAS to evaluate the data. It is not a control and treatment group design. At the beginning of the lecture, students wrote a basic test on math, so that based on this test achievement groups were formed. Mathematical knowledge is the most crucial factor influencing mathematical performance in later settings (SCHRADER & HELMKE, 2008; AUSUBEL, 1978; DÖRMANN, MORDEL & MENDZHERITSKAYA, 2019; FLEISCHER, LEUTNER, BRAND, FISCHER, LANG, SCHMIEMAN & SUMFLETH 2019; LEDERMÜLLER & FALLMANN, 2017). Also, group formation will be based on counselling participation, as this is the core element of the project.

Since counselling and test results depend to some extent on the participant's mathematical skills – i.e. "good" students are less likely to visit the counselling – we apply a moderated regression analysis (see, e.g. HAYES, 2018). So, we regress "counselling" moderated by mathematical "skills" on the observed final "test results". The following figure illustrates our model:



The moderator "skills" consists of three different mathematical skill levels ("low", "average", "high") which were derived from the results of the previously conducted basic test. We use SAS PROC GENMOD to estimate the corresponding Generalized Linear Model (GLM). To better understand the combined effect of counselling and mathematical skills on the final test result, we also calculated least-square means and -differences based on the GLM results (see, e.g. GOODNIGHT & HARVEY, 1976).

5 Results

In total, data are available from 326 students who participated in the project "Studienerfolg". However, only for 188 students, all data is available: the basic test, the three exams and the overall score in the end. The correlation coefficient r is 0.62 for the basic test and the three exams' overall score, confirming that previous mathematical knowledge significantly influences the later study result. So the basic test is suitable for classifying performance groups. We define the low achievers (group 1) by those who have up to 50% score in the basic test, 58 students in total. The middle group (group 2) is between 50% and 80% in the basic test, 65 students in total. The high achievers (group 3) have scored more than 80% in the basic test, another 65 students.

After that, we separated the groups again for the times of counselling. No counselling is zero, one-time counselling is one and being counselled twice is two. Table 1 shows the different combinations and the number of students in each group.

Table 1: Overview of the different groups. The first number is the performance (1 = low, 2 = middle, 3 = high); the second number is the number of counselling that had happened.

Group	1.0	1.1	1.2	2.0	2.1	2.2	3.0	3.1	3.2
N	13	25	20	46	14	5	60	4	1

Now we look at those groups' performance during the third exam. No counselling happened before the first exam, and some get counselling after the second exam. The effects of counselling can be best observed in the third exam. The overall score is influenced by 50% by the first two exams. Regarding the research question, the results of the third exam fit best.

Figure 1 shows the 95% confident intervals and means of the different groups in the third exam. Group 3.2 (high performer with two times counselling) is not displayed since it has only one member.

Looking into the performance groups reveals that our assumption holds: the need for counselling is connected to the exams' performance. For example, 1.0 is better than 1.1, which is better than 1.2. Looking closer, the difference between 1.0 and 1.1 is not so big as the difference between 2.0 and 2.1 or 3.0 and 3.1. Furthermore, even the difference between 1.0 and 1.2 is smaller than between 2.0 and 2.2.

The second thing that can be observed here is that looking at 1.0, 2.0 and 3.0 (the students without counselling), the performance determines the third exam result. The middle and high performing groups 2.0 and 3.0 are significantly better than the low performing group 1.0. On the other hand, the groups with one-time counselling

1.1, 2.1 and 3.1 are not significantly different, although group 3.1 performs a bit better than 2.1, which again performs a bit better than 1.1.

The data shows that counselling aligns the scores between the performance groups. However, counselling itself does not equalize everything. There is still a group where counselling does not affect. This group gets second counselling, which does not help them connect to the other groups' performance. Also, counselling does help the low performers a lot, but none of the counselled groups gets connected to the students without counselling.

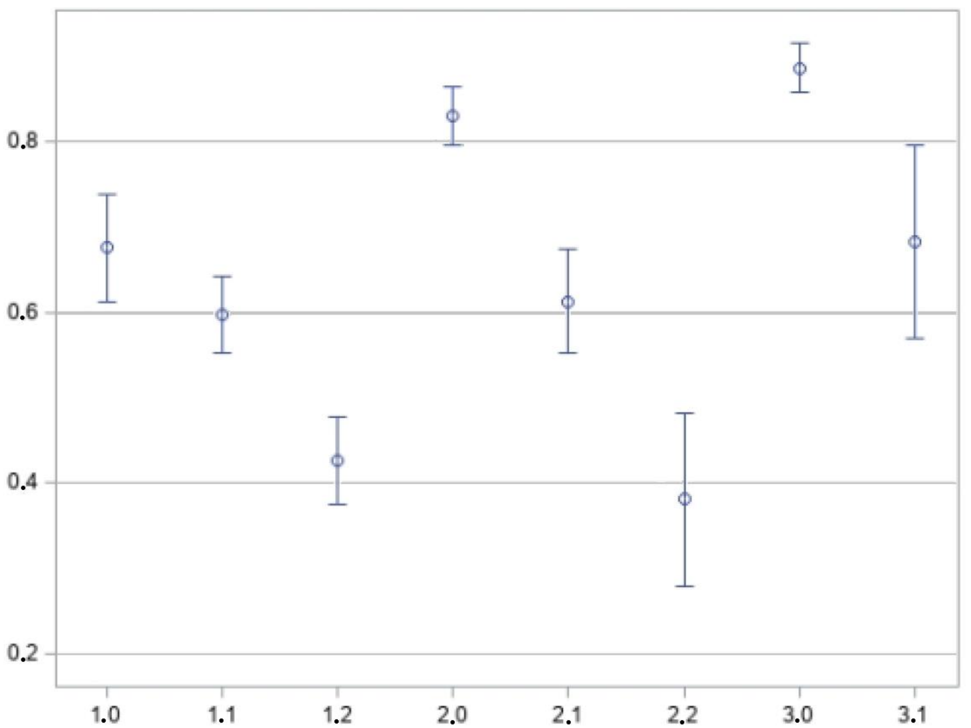


Figure 1: Results of the third exam by performance in the basic test and the number of counselling.

6 Discussion

Previous research shows that support services such as bridge courses or tutorials can impact advancing math skills. This paper presented a combination of counselling and partial exams to encourage and retain students in STEM subjects. The research and considerations described above indicate that such a design can help these students deal with mathematics. The combination of counselling and the division into three exams addresses all three levels of Friedewold et al. (2015). The counselling can refer specifically to levels 2 and 3, while the exams focus on level 1. Therefore, the "how" of learning is just as important as the "what". SADLER (1989) identified three conditions necessary for students to benefit from feedback on assignments. He states that students must know:

- what good performance is, i.e. the student should have a concept of the objective or standard to be achieved
- what is the relationship between current performance and good performance, i.e. the student must be able to compare current and good performance
- how to behave to close the gap between current and good performance.

It is precisely the third point that counselling in the present study started when students failed the exam. The counsellor asked Students to reflect on their learning and consider ways to close the gap between current and desired performance.

The first counselling session led most students to better performance after a low exam result. The reflection on their knowledge and their learning behaviour was partly successful. A second counselling session, however, did not bring any added value. If the first counselling does not help, doing the same thing will not help.

Counselling can address deficient skills such as self-organization, self-assessment, or motivation (LAROSE, 2011). The question is entirely open about whether another form of counselling, another counselling centre (e.g. general study guidance) or a completely different control instrument should be used if, despite the counselling, the second exam is again poor after the first exam. Also, the systematic documentation and evaluation of counselling sessions can reveal and address general student needs, current challenges, and, not least, structural weaknesses in the system (WESTERHOLT et al., 2018).

Given the strong correlation between the basic test and the semester results, one consideration is to start the first compulsory counselling session after the basic test. A further recommendation is to extend the counselling limit, in the sense that the criterion of 50% of the possible points is not used for the first obligatory counselling. Instead, it is recommended to use up to 60% of the possible points. In this way, “wobbly candidates” reaching just a bit over 50% and risk their success in the second exam, can be considered.

In conclusion, we can state that the project fulfilled the department’s goals. The exam acceptance rate has increased from 33% to 76%, and the dropout rate has fallen from 87% to 42%. Our findings show that counselling and multiple small exams during the semester play a role in academic success because the students had studied more often and more intensively. This broadens the view for a more comprehensive design of subject-specific offerings in mathematics. The authors highly recommend implementing a combination of early exam and mandatory counselling for feedback during the first semester when thinking about lowering the dropout rates.

LAROSE et al. (2011) noted the lack of theoretical embedding, representative samples, control groups and empirical evaluation. Therefore, further studies with representative participant groups and control groups are needed to deepen our understanding of the process.

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Acknowledgements

The authors would like to thank the reviewers for their excellent feedback on the article, which helped sharpen the arguments, improve the language, and lead to a better analysis of the data.

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