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Drop Out and Attendance in Online Pre-Study Preparatory Physics Courses

Dominik Giel

Offenburg University of Applied Sciences, Germany

Abstract

Offenburg university of Applied Sciences offers pre-study extracurricular preparatory courses for future engineering students in mathematics and physics. Due to pandemic restrictions, the two-week preparatory physics course preceeding winter term 2020/21 was presented as an online-only course. Students enrolled to the course attended eight online lectures of approximately 90 minutes duration followed by a group assignment. Both lectures and tutoring to the group assignment used a videoconference system with group sizes of 120 (lecture) and 6 (peer instruction and group assignments). The eight lectures focused on the high school physics curriculum of mechanics, electricity, thermodynamics and optics. Each lecture included four "peer instruction" questions to improve student activation. Student responses were collected using an audience response online tool. The "peer instruction" questions were discussed by the students in online groups of six students. These groups also received written group assignments consisting of common textbook exercises and additional problems with incomplete information. To solve these problems, groups were encouraged to discuss possible solutions. The on-line course attendance was monitored and showed a characteristic exponential "decay" curve with a half-life of approximately 18 lectures which is comparable to conventional courses: Around 73% of the students enrolled in the preparatory course attended all eight lectures. In addition to the attendance, the progress of the participants was monitored by two online tests: A pre-course online test the first course day and a post-course online test on the last day. The completion of both tests was highly recommended, but not a formal requirement for the students. The fraction of students completing the pre-course, but not the post-course test was used as an estimate for the drop-out rate of (34±3)%.

Keywords: *Engineering education, STEM preparatory course, peer instruction*

1. Introduction

Preparatory courses are offered by many universities before the start of the first semester to reduce the heterogeneity in introductory classes. Offenburg University offers two-week preparatory courses in mathematics, physics and informatics to all STEM-field students. Participation in the complimentary courses is voluntary, but highly recommended. The preparatory courses in mathematic focus on the repetition of pre-calculus middle-school subjects like arithmetic operations, fractions and basic algebra. The preparatory physics course focuses on an introduction to mechanics, electricity, thermodynamics and optics defined in the requirements catalogue for STEM-field subjects at universities of applied sciences in Baden-Württemberg state [1]. In this paper, we describe the online version of the physics preparatory course (section 1.2) which was introduced due to the pandemic situation, in particular the included blended learning elements (section 2) and the effects of the online course on enrolment and participation (section 3).

1.1 Conventional physics preparatory course

To monitor the progress during the conventional preparatory course for both participants and teachers, the first and the last unit of the preparatory course consists of a 45 min pre- and post-course test with comparable difficulty. For a number of reasons, the post-test yields higher average scores: In addition to improvements in the physics skills, the drop-out probability is correlated to the pre-test score so that the students remaining in the course achieve a higher post-test score. The ratio of average post-test to average pre-test score is not a direct measure for the quality of a course. However, the ratio can be used to compare courses if they have comparable drop-out ratios and use the same test questions. In the conventional preparatory courses, (57±5) % of the enrolled students who took the pre-test also took the the post-test (uncertainty derived from a four-year average, fig. 1)

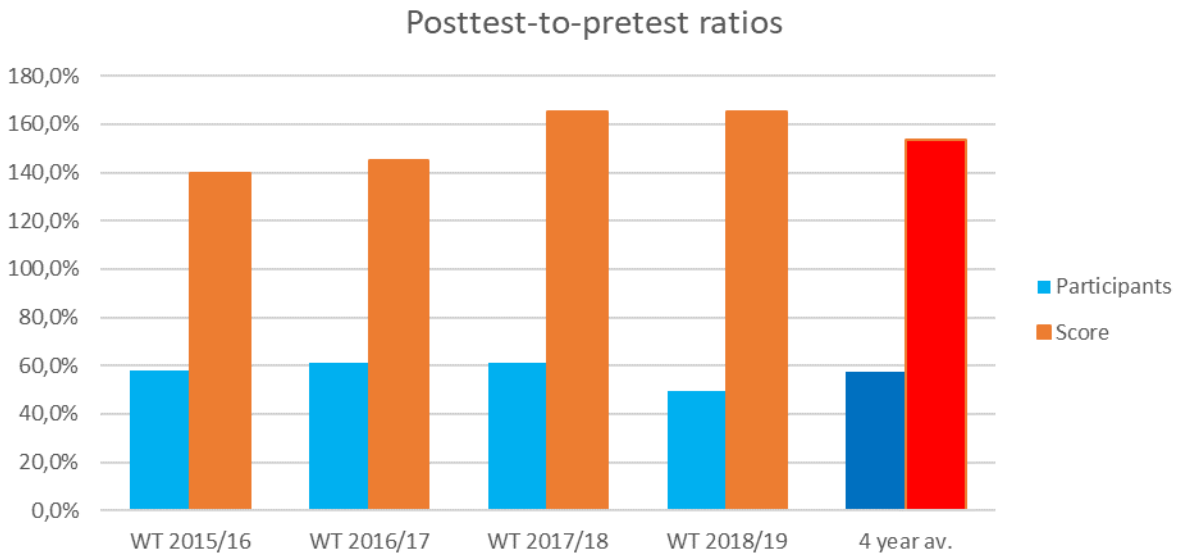

Fig.1. Ratio of participants and average test score (post-test to pre-test) in conventional preparatory courses. Numbers below 100% indicate a loss of participants, numbers over 100% an improved average score in the post-test

1.2 Online physics preparatory course

Due to the constraints of the Covid-19 pandemic, the preparatory physics course preceeding winter term 2020/21 had to be hold on-line without any physical presence of the first year students. Instead of the conventional combination of exercises and lectures (180 min duration) held in classes of approximately 40 students, the online lectures were presented through the zoom online platform (www.zoom.us) with 120 students in each class. Each online lecture had a duration of 90 minutes followed by half an hour break, an exercise phase of 80 minutes and a debriefing lecture of 10 minutes.

Each course days focused on a topic of the high school physics curriculum: one day focussed on units and mathematical formulas, three days on mechanics, two on electricity, and one day on thermodynamics and optics, respectively. Pre- and post-test were presented a on the moodle learning management system (LMS). The LMS also was used to distribute an electronic booklet with exercise questions and a daily letter describing the exercise phase. To maximize student activation, a number of blended learning elements was introduced into the online course.

2. Blended learning elements

Interaction from student to teacher and among students is significantly reduced in online courses as compared to conventional courses. To increase student-student interaction, we formed groups of 5-7 students with similar subject, place of residence and previous education for the mathematics and physics preparatory courses. Each group was assigned to a separate virtual classroom (“breakout room” in terms of the zoom platform) during online-lectures, especially peer instruction (section 2.1) and group assignments of the exercise phase (section 2.3).

2.1 Peer instruction lecture

In order to get a feedback on the students’ understanding of the presentation, each lecture contained questions in the peer-instruction [2] format. Peer instruction requires the students to answer a single-choice question, subsequently group discussion and in a finally a re-answer of the question. If questions are well-posed, the discussion among the participants leads to an activation of the students. The monitoring of the single-choice answers also indicates the average learning level of the students. The recommendation is that questions should receive two-third correct answers in the first voting for optimum progress.

For the on-line preparatory physics course, each day used four peer-instruction questions and modified textbook [3] exercise modified for online voting. Audience responses were collected using the “peer instruction for very large groups” (pingo) web service [4]. This audience response system uses common web-browser without further client or server installation. After a first vote, participants were

placed in a separate “breakout room” to discuss their choices. In the “breakout rooms”, participants used video and audio to communicate in their group. After a discussion period of 5 minutes, the audience response voting was repeated. The outcome of the second vote was commented by the lecturer to correct residual ill-conceptions, if necessary.

2.2 TeachMatics App

After 90 minutes of peer instruction lecture, the groups were told to solve an exercise sheet with two types of exercises: Common textbook problems were presented for individual work and a group assignment which required additional discussion. Solution to the common textbook problems was provided through a smartphone app (TeachMatics App) [5] which has been used in the preparatory courses since 2014. The smartphone app supports students with help texts on different mathematical skills needed to solve a given textbook exercise.

2.3 Group assignments

In addition to the smartphone app, the exercise phase consisted of a daily group assignment which was not solvable alone with the information given in the exercise sheet. Instead, groups were told to discuss what additional assumptions were needed to solve the problem, to research missing data (for example, the density of air at 20°) and to sketch a possible solution to the problem relying on the assumption. Groups were told to hand in their solution. Instead of an individual feed-back on each submission, the three extraordinary submissions were presented to the semester on the next day to encourage further submissions.

3. Results

257 students enrolled in the pre-test of the physics online course, 235 of them completed the (voluntary) online pre-test. The students were divided into two groups of approximately 120 students for two online classes and the attendance in the classes was recorded through zooms server logs. The courses were given on-line by one lecturer and one student tutor to address questions from participants on the assignments and peer instruction.

3.3 Drop out

On the last course day, 163 students started the post-test and only 144 completed it. In comparison, all students attending the last course day of the conventional preparatory course complete the post-test. The ratio derived from completed post-to-pre-tests is 144 to 235 (63%) well within the standard deviation in the conventional preparatory physics courses with a four-year average of (57±5) %. Taking into account the 19 students who started, but did not complete the post-test, the drop-out ratio is between (34±3) % where the uncertainty of 3% stems from whether participants with incomplete tests are considered or not. The drop-out rate is comparable to conventional courses (43±5) % calculated on from the four-year average.

The average test score of the students in the online post-test was 391% of the average score of the online pre-test. This number should be taken with a piece of salt due to the difference in online and written tests: It can be assumed that the students need to accustom to the online test environment whereas they already know written exams on the first course day. The online preparatory course yields a significant higher score improvement than the conventional preparatory course with a four-year average of (154±12) % even though the drop-out rate in the online course is slightly lower in the online courses.

3.3 Attendance

In addition to the drop-out rate calculated from the ratio of completed online tests, the zoom platform logs the individual attendance of the participants with a temporal resolution of minutes. For analysis, we counted all enrolled students who attended more than 50% of the duration of the online course (Fig. 2). A least-square-fit of an exponential decay indicates that 246 students attended the first day. The decay curve has a half-time of around 18 days. On day 8, 181 students attended class, although only 163 started (and 144 completed) the post-test.

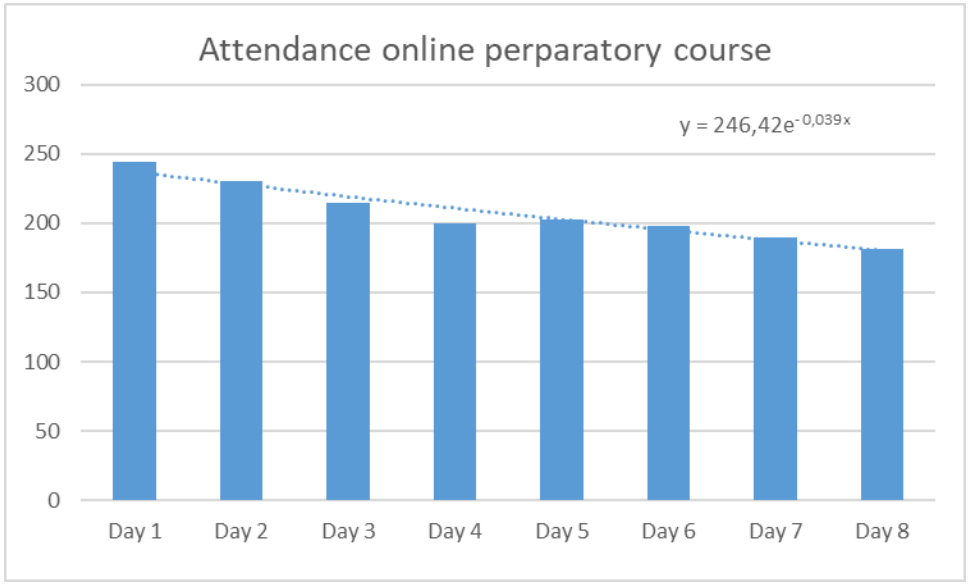

Fig.2. Number of students attending more of 50% of the duration of the online preparatory physics course as recorded through the zoom platform logs

From the server logs, a finer analysis of the participation is in principle possible. One could, for instance, identify the fraction of students attending only in particular course activities like peer instruction lectures or group assignments. However, it is difficult to discriminate against external effects. For instance, the attendance in afternoon sessions seems to be lower than in morning sessions independently of the course activity.

4. Conclusion

In summary, the online preparatory physics course yields a drop out comparable to conventional preparatory physics courses. The online course yields a significantly higher improvement in online courses as compared to conventional courses indicted by the ratio of the average post-test score to the average pre-test score although it is not clear if the improvement might be partially caused by an adaption of the students to the online test environment. To avoid long lectures in courses, peer instruction and blended learning elements can be used to increase interaction between participants in online courses which is important to lower drop out in online courses.

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