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This longitudinal study aims to examine the development of higher education students' competence satisfaction in two different pedagogical approaches. The fundamental purpose is to develop the teaching and learning of mathematics in the direction of more supportive methods and environments. The first approach investigated in this study was a flipped learning approach whereas the second was a lecture-based approach.

One way to explore students' motivation and well-being in the context of learning mathematics is to measure the satisfaction of psychological needs. Basic Psychological Needs Theory (Ryan & Deci, 2017) focuses on three psychological needs, which are autonomy, competence and relatedness. Autonomy refers to the feeling of self-determination in one's own actions. The second of the three needs, competence, refers to a feeling that one is mastering a domain and able to accomplish. Finally, the third need refers to the feeling of belonging and contributing to relevant groups. The satisfaction of these three needs leads to motivation and well-being. Furthermore, the basic psychological needs affect positively to one another's satisfaction (Ryan & Deci, 2017).

The participants of this study were 430 higher education students taking three engineering mathematics courses during the period from August/September 2020 to March 2021. In the flipped courses, there were approximately 230 students and in the lecture-based courses, there were approximately 200 students. Students were assigned to the flipped and lecture-based courses based on their study areas. The topics of the courses included themes repeated and expanded from high school mathematics, matrices and differential and integral calculus. The courses implemented with the two models had the same learning objectives, containing both mathematical and generic skills. Both teaching models utilized the same textbooks for the courses, as well as written course materials that contained the core topics of the courses.

The intervention group was taught utilizing a flipped learning approach (Bergmann & Talbert, 2017) accompanied with the Prime time teaching model (Koskinen et al., 2018). For the intervention group, there were no lectures. Instead, there were two hours of problem solving sessions and a two-hour prime time session. In the prime time sessions, each small group of students had each a 30-minute conversation with the teacher. When the teacher discussed with one group, the rest were solving a collaborative problem. The purpose of the prime time sessions was to make sure that students had learnt the core content of the week. On the online learning platform, there were automatically assessed online tasks for developing procedural fluency and conceptual understanding.

The control group was taught more traditionally using lectures though the lectures were held distantly. There were three two-hour lectures per week and two hours of problem solving sessions. The lectures were for large classes of approximately 200 students.

Assessment in both approaches was based on points that were accumulated during the course. In the flipped courses, 70 % of total points were given for the weekly tasks solved, and 30 % for the exam; for example, self- and peer-assessment was such a task. In the lecture-based courses, the corresponding percentages were both 50 %.

The basic psychological needs satisfaction, including the competence satisfaction, was measured four times during the period from August 2020 to March 2021. In this study, basic psychological needs satisfaction was measured using 12 items of a validated 24-item instrument (Chen et al., 2015) for adults. For each basic psychological need, there were four items to self-assess in five-point Likert scale; the four items for competence satisfaction were: "I feel confident that I can do things well in my studies", "In my studies, I feel capable at what I do", "When I am at the university, I feel competent to achieve my goals" and "In my studies, I feel I can successfully complete difficult tasks". For the university context, items were slightly modified from the original.

To analyze students' competence satisfaction in the intervention and control group, the unpaired samples t-test was conducted for each measuring point using SPSS software; hence, we have four p-values. In the first two measurements, there were no statistically significant difference between groups' competence satisfaction scores. The means of competence satisfaction scores were calculated from the four above-mentioned items that were self-assessed in five-point Likert scale. Between the second and the third measurement, the scores of the intervention group increased whereas the scores of the control group decreased. Thus, in the third measurement, a statistical difference appears (p = 0.003). In the fourth measurement, the statistical difference remains (p = 0.04) even though the scores of the control group begin to increase, too. Therefore, we can say that in these mathematics courses the flipped learning approach supports the basic psychological needs satisfaction more than the lecture-based approach, which can be seen in the last two measurements.

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