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Active Blended Learning Engineering Students: A Case Study

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Abstract: An ongoing technological, economic, and societal change forces a new understanding of engineering and modifies the requirements for higher engineering education. Consequently, an educational approach based on the combination of blended learning and active learning promises great prospects for the enhancement of the knowledge and skills acquisition thanks to the flexibility it opens up. In this research, an attitude to study is first ever analysed from the standpoint of students enrolled in three various degree levels, namely, a Bachelor of Science program, a Master of Science program, and a new EuroTeQ program. The strengths and weaknesses of the blended and active learning combination are evaluated from didactic and methodological sides. It shows a fundamentally different approach to learning from students belonging to various degree programs. Most of the bachelor degree learners volunteered to participate in active learning, although a significant proportion of them was unable to succeed. In contrast, the learning of master students looks more circumspect and selective; they devote less time to study, but spend it more wisely, being more highly responsible for the outcomes than bachelors. The EuroTeQ participants did not push on many active learning activities, but demonstrated quite high motivation in quizzes, labs, and online consultations. As a result, the outcomes of the first academic year satisfied mainly the most strong of the EuroTeQ students.

Keywords: engineering education; blended learning; active learning; engagement in study

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1. Introduction

1.1. New Understanding of Engineering Education

Recent socio-economic and environmental trends force a new understanding of engineering work. Currently, development of most industries cannot be carried out without close interaction of technics with information provision on the deep interconnection of science, technology, engineering, and mathematics (STEM).

With a new understanding of engineering, the requirements for higher engineering education have also evolved. In [1–3], four prospective engineering competencies are listed, namely technical, social, personal, and methodological. The first one involves both the deep professional skill and the broad proficiency in the information sphere. The second competence forms intercultural and linguistic mastery in teamwork with the capacity to share experience and the ability to cooperate. The personal competence provides for tolerance, adaptability to changing jobs and tasks, along with an interest in continuous retraining. The methodological competence is based on a creative attitude to problem solving and conflict resolution. In order to form these competencies, the society faces the challenge of turning narrowly focused engineering professions into integrated engineering. Many firms are engaged in professional retraining of their employees, attracting cost- and time-efficient resources to education in these new circumstances [4].

The engineering educational system is changed as well in accordance with technological and market changes. New engineering specialties and disciplines are being created, curricula are updated, and approaches to certification and knowledge assessment are improved. Significant innovations in the training system lead to a change in the preferences of engineering students and an increase of the STEM role [5].

1.2. Expanding the View of Blended Learning

The consequences of the COVID-19 pandemic and the migration crisis have additionally invaded the social life and disrupted schooling around the world. In order to keep sustainability, the education system had to adapt and transform, relying on innovations that became a catalyst for its new development.

As a positive phenomenon, it should be noted that the recent events have led to the rapid development of the blended learning (BL) educational approach, called also hybrid learning [6–8]. The BL landscape promises great prospects for the enhancement of knowledge and skills acquisition thanks to the flexibility it opens up [9,10].

In recent decades, online transmission of knowledge was considered a useful component of traditional education. It has been developed and improved in various directions, and its implementation has been comprehensively discussed and encouraged. Along with this, a number of downsides in full-scale online training have been identified. Particularly, in massive open online courses (MOOCs), dropout rates reach 90% in a number of cases [11,12].

By applying the BL approach, participants of the educational process get the opportunity to combine various types of distance and online learning with traditional face-to-face methods, thereby uniting real and virtual classes [6,7]. Thanks to virtual platforms, cloud computing, and online learning management systems (LMS), a significant proportion of educational materials and teaching tools have become available to students outside the classroom. Traditional lectures are now more easily supplemented with brainstorming and problem-solving discussions that help activate students.

Currently, society is faced with a situation in which education turned out to be impossible without BL. In many cases, blending became the only way to provide the discipline content accessibility, its didactical effectiveness, ability for courses interaction, and flexibility for student engagement. An impressive list of recently practiced BL experiences of various institutions and universities worldwide can be found in [6]. Paper [13] advertises a new organizational framework with the tools and strategies of successful BL introduction along with the case report on its applications during the COVID-19 lockdown.

In order to strengthen the involvement of the BL platform in education, it became necessary to overcome some serious obstacles [13,14].

One of them is related to the planning of classes, aimed at reducing the rotation of participants between different forms of training [15]. In [16,17], the BL approach represents a practical strategy, which combines the usage of both synchronous and asynchronous modes of learning. In [14], the flexible BL is offered, which provides a "fluid" learning schedule useful for both the students and the staff registered in the university-level programs.

Another problem concerns creation of the new mobile platforms to conduct laboratory practices in engineering disciplines [18], which is very important in different degree programs. In mastery-based BL systems offered in [19,20], both online and face-to-face learning styles are available and can run in parallel.

The third challenge is related to the assessment procedures in the BL framework. In [16], a deep learning-based tool is applied for content-related assessment development, evaluation of the knowledge enrichment, and measuring the learner's motivation in participation in the learning process. At that, technical and technological assessment requirements in BL are successfully identified.

1.3. Combining the Active Learning and Blended Learning Paradigms

In the light of BL, the importance of the active learning (AL) paradigm is currently increasing faster than ever. The AL methodology raises the concern of learners in the development of their own knowledge using the experience gained during training [21] and encourages students to take responsibility for their own education. Herewith, instructors act as facilitators responsible for the student interest by turning learning into a genuine, exciting, and meaningful process. From the traditional final assessment based on written exams, AL moves on to feedback-based formative methods provides trainees with regular information on their academic success. This approach stimulates educational activity because of the teacher's rapid responses, prompt evaluation of intermediate students' achievements, and operational support of learning [22,23].

The ultimate goal of AL in engineering education is to involve students in solving complex ambiguous problems using both individual and joint efforts, including collective thinking for building targets and discussing expected results. Such researchers as [3,5] find AL especially attractive for engineering disciplines, as the transition from front-line learning to AL deepens the understanding of theory and its practical applicability by helping students formulate, implement, and test their ideas in a more holistic way [22].

The successful use of such types of AL as project-based learning, team-based learning, outcomes-based learning, and learning-by-doing confirms the usefulness of this approach for solving problems directly related to specific topics and projects [3]. The experience gained in team-based training shows the effectiveness of its application in cooperative systems that require a clear separation of roles and responsibilities [24,25]. Similar experience gained in project-based learning attests to the ability of students to achieve diverse levels of maturity and technical skills in accordance with their role in the project [26].

Currently, there are more and more publications devoted to combined application of AL and BL in engineering education that report its enhanced outcomes and other benefits for students and highlight the usefulness of this association for didactic and pedagogical practices [27,28]. A new active blended learning (ABL) platform has already become the normal mode of knowledge delivery at several universities based on the effective use of the BL and on making the strong and explicit links between online and offline AL activities.

In particular, several challenges of joint implementation of BL and AL are addressed in [27]. Following the analysing of 152 institutional websites containing definitions of these concepts and systematic review of the literature on ABL, the authors found their strong connection and dependence. They define ABL as a pedagogical approach, which combines sense-making activities with focused interactions (with content, peers, and tutors) in appropriate learning settings outside and in the classroom.

The same can be said about the definition of BL given in [15], which looks very similar to AL as it underlines the student's independent work with some elements of control over time, place, and/or pace, and at least in part at a supervised location away from home.

The fruitful augmentation of the AL strategy into the BL courses is demonstrated by the authors of [28]. Their results point out a positive correlation between the engagements of the computer-based education platform into the BL activities with the AL performance score.

Paper [29] describes a case study of BL integrated with traditional lessons in an AL environment and social activities. The didactics was designed there by creating new learning platforms, artefacts, and teaching sequences in authentic educational contexts. Obtained results show considerable benefits in coordination of several systems, a better predisposition to the study of the subject, and the achievement of alternative teaching goals for most of the students.

The BL strategy developed in [23,30] was effective in improving student achievement in either formative or summative assessments, which provide an accessible and informative entry point for AL implementing in higher education.

Paper [31] proposes a conceptual medium for AL and summarizes a qualitative research with experts and students on the feasibility and applicability with its potentially positive results in BL. Statistical tests and descriptive analysis of the collected data indicate the benefits to use it as a tool for professional training of experts and specialists.

In [32], the logistic regression model is used to confirm the positive impact of the BL approach on the student's outcomes in AL.

Despite many advantages of the combined usage of AL and BL, several higher education actors are nervous or hesitant to implement this technique in their practice. Some recent reports investigate barriers to student engagement in ABL. It concerns, partly, the BL model developed for using AL activities and the study of this model efficacy. Students also recognise separate ABL relationships as crucial to the success and emphasise the importance of stronger socialisation and collaboration within online work [33].

Nevertheless, according to [16,34], the carefully thought-out cooperative AL and BL environment serves as a very powerful educational tool for the pandemic and massive migration obstacles.

1.4. Research Goal and Tasks

This study aims for evaluating efficiency of the combined application of BL and AL in engineering education based on the authors' experience in its introduction in Tallinn University of Technology (TalTech).

In the research, an attitude to study is first ever analysed from the standpoint of students enrolled in three different degree programs, namely a Bachelor of Science (BSc) degree program, a Master of Science (MSc) degree program, and a EuroTeQ (ETQ) program related to the regular and visiting learners. The strengths and weaknesses of the BL and AL combination are estimated here from didactic and methodological points of view.

With such a goal statement, the first task of the study was to separate the learners who succeed and the learners who fail in AL when they work together in the common BL environment. The second task was to offer a methodology that could improve the learning of both categories of students.

The material is presented in the traditional sequence. First, the groups of involved students and disciplines are presented together with the topology of the learning environment. The features of the application of the AL methodology are considered from the positions of students' engagement in lecturing, presentations, quizzes, exercises, labs, and multiple assessment possibilities. In the Section 3, several statistical data are demonstrated on the students' participation in different forms of study, on the time distribution between the study forms, and on the students' successes and failures. Further, the specific differences of BSc, MSc, and EuroTeQ students' approaches to study are discussed, and conclusions are drawn.

2. Materials and Methods

2.1. Participants and Disciplines

Three cohorts of students from the BSc and MSc degree studies in TalTech fall into the focus of this research, a total of approximately 120 participants. Both the bachelor and the master syllabuses involve the broad list of disciplines that do not belong to a single department, as is usually the case, but are disseminated among several Engineering School divisions and, partly, among other faculties, including the School of Information Technology and School of Business and Governance.

Appropriately, two disciplines are addressed in this paper, namely "Robotics" (ATR0030) for two BSc groups (65 students) and one EuroTeQ group (10 students) and "Advanced Robotics" (EEM0080) for two MSc groups (45 students), each of six credit points in the European Credit Transfer and Accumulation System (ECTS). The English language of the instruction is not the native language for all participants.

Approximately half of the students enrolled in these courses because they study in the specialty "Integrated Engineering", in which these disciplines are mandatory. Approximately the same number of learners chose these courses as elective subjects in the specialization. The participants are dominated by European students of Erasmus+, European students enrolled in the EuroTeQ project, as well as students from non-EU countries, in particular from Ukraine, Georgia, Kazakhstan, and some other countries. It is noteworthy that trainees with different experiences, backgrounds, and levels of knowledge were united in the same learning space, forming multifaceted cohorts that meet the urgent needs of modern society.

2.2. Novel Learning Landscape

The first notable feature of the approach under consideration is that the learning environments of both courses were organized in a similar way, in which the curricula were composed of two parts, namely the mandatory part and the optional part. The former part is aimed at providing students with the minimum necessary volume of knowledge and professional skills, whereas the latter one is designed to expand and deepen this volume in accordance with the specific needs, requests, and interests of participants.

The second feature of the educational landscape is that its optional part is based on the AL focused on students desire to learn and aimed at encouraging them to take responsibility for their own learning. These optional sectors in both cases were included in various training sessions, practices, and polls corresponding to specific disciplines, learning outcomes, forms, and duration of training.

The third feature of the discussed methodology is its BL manner. The BL system contributed to the fulfilment of the university's mission to create a safe, sustainable, and accessible area needed to unite students and staff and allowed them to interact as a uniform educational community, even in the conditions of the pandemic and the migration crisis. Herewith, all participants of the educational process could be involved in the planned AL events using such online and offline BL resources as lectures, student presentations, practical and team-based work in real and virtual laboratories, project-based learning in computer exercises, and outcome-based training using individually selected assessment methods. To this end, students studying in the classroom and online could be supervised in different manners, and the types of classes were specially designed in such a way as to maximize both online and offline knowledge acquisition.

Table 1 introduces the study forms and assessment methods used.

Table 1. Distribution of compulsory and optional parts in BL environment.

Compulsory Study	Optional Study
Compulsory labs	Additional labs
In-class demonstration of skill in computer exercises	Supervised exercises, self-made exercises
	On-lecture discussions and fast-track polls
	Self-learning via Internet, textbooks, and e-books
	Student's presentations
	Online quizzing
Summative assessment	Formative bonus-based assessment

2.3. Active Learning in a Blended Framework

2.3.1. Attracting Students to Lecture Activity

Weekly lectures were given in the classroom. They were aimed not so much at communicating information as at involving students in the specifics of the discipline being studied, at presenting Internet and library resources, emphasizing learning goals and methods, formulating basic requirements for knowledge assessment and grading criteria, and increasing familiarity with progressive learning technologies. Along with the traditional face-to-face lectures, online broadcasting via Microsoft Teams™ was conducted accompanied by slideshows, videos, and demonstrations in the university LMS Moodle™.

All students, except for the EuroTeQ group, could choose between in-class attendance and online participation or merely skip lectures. The benefit of live lectures is their promotion of AL in the form of the regular on-lecture fast-track polls that involved (a) solving difficult tasks, (b) collecting audience responses, (c) explaining correct solutions, and (d) evaluating winners. In this way, such optional in-class events as lectures attracted the attention of students and their desire to participate, because success in assignments and polls was rewarded with bonuses, which the participants collected during the semester to form the basis of their final assessment.

2.3.2. Student's Presentations

The syllabi of both courses specify the required level of knowledge in various fields of robotics. To mitigate or decrease the examination workload, interested students were invited to develop and present short (10–15 min) Power Point™ in-class presentations simultaneously broadcasted online via Microsoft Teams™. The students' speeches concerned important topics of the curriculum, which could either be selected from the offered list of actual themes or proposed by the students themselves. The content of the presentations included the place of the described robots in a general robotics classification, examples of applications, the most popular worldwide companies and their products, development history and prospects, technical parameters, actuator and sensor types, control and programming features, benefits and drawbacks, etc. A part of the lecture time was allocated weekly for student presentations. As a rule, discussions were held after each demonstration. Thus, the speakers not only fulfilled part of the exam requirements, but also helped others to study. Like other educational materials, student files were stored in the Moodle™ repository and could be requested by the site attendees and staff. To do this, all files were provided with copyright protection attributes (name, pre-recorded sound, photo, and date).

2.3.3. Online Quizzes

Both offline and online lectures were accompanied by online quizzes that students could try at will. Each of the quizzes, consisting of 10 questions, was open in Moodle™ during the lecture week (7 days, from midnight Monday to midnight Sunday). To answer, the respondents were requested to choose from 1 to 4 options that they considered correct, using any additional resources (books, Internet, cheat sheets, consultations, etc.). Each correct result increased the individual bonus, whereas each incorrect one decreased it. Consequently, the quiz score earned by a student could be either negative or positive. The number of attempts was not limited while the quiz was open. After the time has elapsed, the last attempt was automatically assessed, and the results were published along with the correct answers.

2.3.4. Attracting to Engineering Practices

Computer exercises might be performed either in the classroom or at home. However, each student had to demonstrate a mandatory segment of exercises face-to-face and report his/her results individually. In addition, each exercise included an optional part in the mini-investigation project-based format, which also brought bonuses.

The laboratories were organized as strictly planned team events, accompanied by preliminary tests, a clear distribution of roles, individual tasks, and personal reports.

2.3.5. Assessment with a Bonus System

Assessing and assignment barriers are a part of the challenge posed by blended and online instruction. To overcome them, the assessment system was implemented with the possibility of a formative and summative assessment, from which the students could choose one way or another to complete their studies. The integral bonus score in the form of a rounded up weighted sum of quiz scores, exercise options, lecture polls, and presentation grades was considered as an expected grade for the exam or a part of it. However, instead of the bonus score, each participant could also take a traditional written exam covering the full course, without any additional sources.

To prepare for the exam, questions from all past quizzes, polls, and assignments were open to be solved with an unlimited number of attempts and with immediate feedback in a 5-score evaluation system, where each student could submit their results as many times as he/she wanted. These tuition assessments did not affect the exam grade, but helped to prepare for the exam those students who were not satisfied with their current bonus.

2.4. Methodology and Resources

To achieve the goal set in this study, a significant amount of data were processed. First, to analyse the results of AL, only those were selected from the total mass of students who chose this student-centered approach as a supplement to the traditional teacher-centered learning. For this purpose, a separate web page was created in Moodle™, where those who intended to participate in AL was invited to enroll.

Considerable attention in this study was paid to the reasons that encourage students to choose AL, in order to understand what is AL from the point of view of students: Either achieving better results, or getting higher grades in a simpler way. To resolve this issue in a scalable way, all AL activities were roughly divided into two categories, namely, long-term activities and short-term actions (brainstorming). Post-lecture quizzes and optional exercises fell into the first category, because they take a lot of time for solving, herewith requiring perseverance and patience. Student presentations also fall into this class, as they involve collecting impressive facts and creating attractive shows and videos. The second group included on-lecture polls and discussions with speakers based on quick thinking and courage. Using such a division, the numbers of participants that excelled in various forms of long-term and short-term AL were identified and compared with researches of other authors published over the past decade. Together with them, the students who were unsuccessful in all forms of AL were separated. As most of the participants succeeded in only a few forms of AL, an attempt was made to link these forms with well-known learning styles, seeking to explain the reasons for this partial success. These results were further related to the time intervals that trainees devoted to optional activities.

During the study, three categories of data sources were explored and processed. The first group includes the exam grades together with the feedback and comments of the participants stored in the university OIS™ educational system. The second resource is an extensive database of logs, activity reports, lists of course participants, statistics, and event monitoring rules, included in Moodle™. The third is the authors' own statistics published over the past decade in more than 30 conferences presentations, research articles, and theses related to BL and AL, such as [23].

3. Results

3.1. Student's Participation in Various Forms of Study

In Table 2, three different degree programs are compared in terms of the forms of study chosen by the students, both the traditional and the AL.

Although it is often argued that large lecture classes are impersonal and passive, the lectures discussed in this study turned out to be quite popular. The students attending the live lectures were involved in asking questions and discussions and engaged in on-lecture fast-track polls that increased their bonuses. Those who participated in online lectures acted as third-party observers as they could save time and spend it in comfortable home conditions. However, all groups of students had the lecture slides and the tutorial aids at their disposal for further study of the material.

The same remark concerns the exercises. In the supervised classes, the learners usually follow the instructor's guidance and produce their work systematically. They also have the possibility to ask questions and request the teacher's help in case of problems. In contrast, in the case of the independent homework, these benefits are absent, but the strong students can move faster and choose their own task-solving ways. In both cases, lab manuals with detailed exercise and work instructions were available to all students.

Table 2. Percentage of BSc, MSc, and ETQ program students participating in various forms of study.

Form of Study	BSc	MSc	ETQ
	Lecturing		
Live lecture participation	50%	15%	0%
On-lecture fast-track polls (AL)	28%	15%	0%
Online lecture participation	30%	25%	50%
Learning without lectures	20%	60%	50%
Student's presentations (AL)	22%	15%	7%
Online quizzes (AL)	95%	80%	100%
	Exercise and lab practices		
Supervised exercises	80%	30%	0%
Independent exercises	20%	70%	100%
Additional exercises (AL)	60%	10%	10%
Additional labs (AL)	15%	5%	0%

3.2. Time Distribution between the Study Forms

It is considered that each discipline is designed for 156 h (six credit points in ECTS), including 64 h of classes. To understand the "cost" of AL on the BL platform, the time devoted to the study was estimated for the students who participated in AL activities. Quizzing time was recorded directly by Moodle™ statistics tools. Exercise time was also estimated by Moodle™ as intervals between task commencement and deadline points. The time needed for the presentation development was self-assessed by the students. In Table 3, the average time distribution between the different study forms is presented upon their approximation with the help of the polynomial trendlines.

Table 3. The average number of academic hours that the BSc, MSc, and ETQ program participants devoted to learning (h/student).

Form of Study	BSc	MSc	ETQ
Lecturing	32	32	32
Student's presentations (AL)	42	34	13
Online quizzes (AL)	24	16	28
Exercises	32	22	34
Additional exercises (AL)	16	10	10
Additional labs (AL)	8	4	0
Total	154	118	117
Including AL	90	64	51

During data processing for Table 3, all students were divided into three categories: those who devoted above 70% of the rated time to study activities, those who spent less than 10% of time for study, and the remaining group. In Table 4, the appropriate percentages are shown.

Table 4. Percentage of the rated time used for study by the BSc, MSc, and ETQ program participants.

Category of Students	BSc	MSc	ETQ
Used above 70% of the rated time	31%	24%	18%
Used 10 to 70% of the rated time	23%	66%	49%
Used less than 10% of the rated time	46%	10%	33%

3.3. Student's Success and Failures

Although many students participated in optional AL activities, only the part of them have achieved success there being graded above 2 in the 5-score grading system. Table 5 displays the percentage of students who not only participated but also succeeded in five AL forms.

Table 5. Percentage of the BSc, MSc, and ETQ program students who succeed in various AL forms.

AL Form of Study	BSc	MSc	ETQ
Online quizzes	70%	78%	15%
Student's presentations	95%	98%	100%
On-lecture fast-track polls	12%	25%	0%
Additional exercises	20%	34%	12%
Additional labs	100%	100%	0%

Most of students were satisfied with their accumulated bonuses and agreed to consider them as their final grades. The students who did not participate in AL activities or were not satisfied with their bonus sums took the written exam, which usually included one theoretical question and five quiz questions across the full course, without any complementary sources.

In Table 6, the average assessment results of the BSc, MSc, and ETQ program students are presented.

Table 6. Bonus amounts and final exam grades obtained from various degree programs.

Form of Assessment	BSc	MSc	ETQ
Average bonus sum	2.83	2.78	2.44
Average final exam grade	3.07	3.32	2.44

4. Discussion

The analysis of the results presented in Tables 2–6 indicates a fundamentally different approach to learning on the part of students belonging to different degree programs.

4.1. Features of the BSc Degree Study

As the successful completion of a BSc degree is a prerequisite for further courses, such as a master's or doctoral degree, the main goal of an average BSc degree student was to get a highest possible exam grade. The reason for this goal lies in the desire to earn a good CV necessary for the subsequent movement on the career ladder, for choosing a profession, or for gaining admission to the MSc degree program.

It is pleasing that the novel learning environment turned out to be suitable for reaching this goal, and most bachelors volunteered to participate in AL, regardless of their specialty, level of study, and background. The fact that there are currently many types of AL activities and forms is positive, and students and instructors may choose those that could better match their interests and abilities. Because the described AL tools are built in different ways, they open up many opportunities to achieve the prescribed learning outcomes.

Nevertheless, Tables 5 and 6 display the troubling issue that a significant proportion of learners who volunteered to participate in AL were unable to succeed there. As follows from Tables 3 and 4, student failures are primarily detected in the time slots that learners devote to study, and slightly depend on the forms of AL, because many undergraduate students confuse the meaning of learning outcomes, whether they relate to better knowledge and skill or to the final grade.

Often cited potential sources of success or failure in learning are differences in personality traits, prior knowledge, language proficiency, and cognitive abilities, which are usually summarized by the term "learning styles" [35]. However, these styles more or less successfully explain the behaviour of those students who succeed in one or more AL activities, but only slightly cover unsuccessful participants. Since the courses are focused on specific learning outcomes regardless of learning styles, there are significant challenges in the learning process that often lead to dissatisfaction of students and teachers [36].

Following [37], four groups of BSc learners were compared depending on their individual engagement and success in learning. The groups located in the I and II quadrants include students who usually achieve success in AL (average final grade 3 to 5), whereas the groups in the III and IV quadrants involve unsuccessful participants (final grades 0 to 2). The members of groups I and IV demonstrate their motivation in learning regardless of their success, whereas groups II and III are indifferent regardless of their success. The ratio of motivated and indifferent students varies depending on the obstacles.

Just like in [37], Group I includes successful students, especially progressive in their learning, interested in overall study and in separate subjects. Similar to the results obtained in [37,38], this research demonstrates that the members of Group I excel in several AL activities since AL contributes to the development of their cognitive skills, such as the ability to understand, synthesize, evaluate, and create.

Members of Groups II and III have neither a habit of hard work nor enough patience for long-term activities. As follows from Table 3, the average time they spend on the course is much less than that of strong students from Group I. Participants of Group II often get not bad results in AL and in the final assessment, mainly because of the ability to cheat and seek help from classmates, although they fail in quizzes and fast-track polls. In turn, Group III represents candidates for dismissal due to their mistake in choosing a specialty or for other social or psychological reasons.

As was highlighted in [33,37], the "slow" students of Group IV are motivated to learn, but do not succeed. Current research shows that these students benefit more from constant teacher feedback, which helps them in learning, improves work, and increases their final grades, rather than bonuses. In this case, it makes sense to talk not about AL benefits, but about the new steps forward in teacher-directed education.

4.2. Features of the MSc Degree Study

As the MSc degree has to demonstrate mastery in a specific area of professional practice, the goal of an average MSc student is different from the goal of an average bachelor. Commonly, MSc students have already chosen a specialty or the direction of activity. Many of them have their own business or are in the workplace. In this situation, they use the MSc degree programs to enhance CVs, to climb the service ladder, or to take senior positions.

This is the main reason why their participation in the class and online lectures demonstrated in Table 2 is much less than the bachelors demonstrate, and many MSc students learn without lectures using other sources of knowledge, such as textbooks, Internet, and different tutorial aids and manuals. They participate in online quizzes not for the sake of grades, but for accumulating bonuses necessary to reduce the exam workload. Much less often than bachelors, they undertake the preparation of presentations, despite the fact that they have a higher professional experience and more materials for exchange with the audience. For the same reason, most of them are not interested in additional exercises and labs that could increase their bonuses.

As follows from Tables 3 and 4, an average MSc student devotes less time to study, but spends it more wisely than a bachelor does. Being more responsible for the studies, he/she makes more effort not to drop out of school and not waste time. This is why percentage of the MSc students who succeed in the chosen AL forms is higher than for the BSc students. Their average final exam grade is also higher, albeit with a lower average bonus amount.

4.3. Features of the EuroTeQ Study

The social changes of recent years require the cooperation of universities in order to make the knowledge space in the field of education, research, innovation, and service a reality. To this end, six leading European universities have joined to make a shift in the paradigm of engineering education of the future through responsible co-creation of values in the field of technology. The goal of the EuroTeQ project is to ensure open learning opportunities for students by developing flexible solutions and innovative learning formats for all interested parties. This initiative implements one of the European Commission's prestigious funding schemes aimed at establishing an ambitious European university alliance over the next few years that will make the European university landscape even stronger. The EU is funding EuroTeQ through the Erasmus+ and Horizon 2020 projects. In addition, cooperation between the teaching staff is carried out jointly through teaching, exchange of experience, and research.

The BL format of the EuroTeQ study has some differences from the above described BSc and MSc programs. Particularly, the special one-week lab session was organised at TalTech, and the personal consultations were conducted via Microsoft Teams™ for the EuroTeQ participants. Other issues that have to be noted in this regard are as follows:

- The EuroTeQ students have the only online lectures and exercises broadcast at the time of the live classes and saved for possible further use;
- They could not participate in the on-lecture fast-track polls;
- Weekly online consultations have replaced supervised exercises;
- They usually had problems with classes scheduling as it was impossible to synchronise the timetables of all universities participated in the EuroTeQ project;
- Some of them had problems with travel to the host university to attend the lab session.

The goal of an average student enrolled in the EuroTeQ program was to possess international cooperation experience and broad-based knowledge in the subject they selected at the host university, along with those offered at their home universities. As Tables 2–6 demonstrate, EuroTeQ learners did not push on AL activities, such as the student's presentations and additional exercises. However, they looked more motivated in quizzes, labs, and online consultations. As participation in EuroTeQ is optional, these students could drop out at any time, which some of them did. As a result, the outcomes of the first academic year did not satisfy all the participants, but only the strongest of them, which is very similar to MOOC. Thus, the attitude to study of an average EuroTeQ participant can be considered to some extent intermediate between the BSc and MSc degree students and lower than the Erasmus+ students show.

4.4. Analysis of Differences and Proposed Methodological Improvements

As the ABL brings many benefits to strong and average students, regardless of whether he/she belongs to a BSc, MSc, or EuroTeQ degree program, the presented approaches should be further developed and improved as a useful optional educational activity.

First of all, this applies to the MSc level, in which, as a rule, more prepared and experienced students enroll. The MSc degree participants commonly enter the course in order to enhance CVs, to climb their service ladder, or to take senior positions. They are less likely to attend lectures, develop presentations, and perform optional exercises and laboratory work than bachelors. Herewith, they devote less time to study, but spend it more wisely, being more responsible for their studies than bachelors. As a result, their average final exam grade is higher, albeit with a lower average bonus sum.

There is more diversity among BSc students. Here the instructor has to choose which of the learners should be invited to AL and BL and who will not benefit from them. As the main goal of an average BSc degree student is to get the high exam grades, most of them volunteered to participate in AL, although a significant proportion of these learners was unable to succeed there. It is noted that many BSc students confuse the meaning of learning outcomes, whether they relate to better knowledge and skill or to the final grade.

EuroTeQ study is a new phenomenon in higher education. This research shows that the goal of most students enrolled in the EuroTeQ program was to possess international cooperation experience and broader knowledge. Due to the novelty of an educational environment and many restrictions, the EuroTeQ learners did not push on AL activities, such as the student's presentations and additional exercises. At that, they demonstrated quite high motivation in quizzes, labs, and online consultations. As a result, the outcomes of the first academic year probably satisfy only the strong and average EuroTeQ students. As BL is the only possible method of study for them, one should be extremely careful about AL to avoid the situations when the additional load hinders the training of weak students and may force them to interrupt their studies.

5. Conclusions

This study demonstrates that BL and AL can support each other more than ever and are interdependent. At the same time, it requires that students are not only motivated to accept the overall benefits of ABL, but also have the necessary background.

During the efficiency evaluation of the combined application of BL and AL among the engineering students, three different degree programs were compared, namely a BSc degree program, MSc degree program, and the EuroTeQ program. The analysis of the results displays a fundamentally different approach to learning by students belonging to various degree programs on the one hand and the students with different preparedness on the other hand.

In general, it has been proven that the ABL benefits strong and average students, regardless of whether a learner belongs to a BSc, MSc, or EuroTeQ degree program. First of all, this concerns the MSc level, in which, as a rule, more prepared and experienced students enroll. As there is more variety on the BSc degree level, instructors have to choose between learners who are able and unable to benefit from ABL. As for the EuroTeQ study, caution is required with regard to AL in order to avoid situations where additional workload interferes with the learning of weak students and may force them to interrupt their studies.

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