Blended Learning, Flipped Classroom, and Peer Teaching as a Combination to Meet the Increasing Diversity in Higher Education

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***Abstract*—Even with increasing heterogeneity, all students should have the opportunity to learn optimally through the design of the teaching-learning environment. Studies suggest that a social learning situation, such as peer teaching in face-to-face courses, leads to increased attendance, deeper content processing, and higher scores on final papers. Here we investigate whether peer teaching reduces procrastination in blended learning within a flipped classroom design, affects the quality of submitted application assignments during the semester, and influences scores on the final exam (research purpose). The study involved 11 statistics courses with the same content, comprising a total of 268 students, five of which utilized peer teaching and six did not. In this field experiment, which employed empirical-analytical university didactics and multiple measurements, the method varied by assigning the application tasks to be completed either individually or in groups of three throughout the semester. It's worth noting that a significant portion of the student population included individuals who were already engaged in education, had familial responsibilities, work commitments, or health challenges in addition to their studies. The study's central finding indicated that peer teaching reduced academic procrastination in blended learning combined with a flipped classroom design. However, it did not significantly impact the quality of submitted application assignments or the scores on the final exam. Additionally, the study revealed a positive correlation between the timely submission of assignments (indicating an absence of procrastination) and the quality of the submitted assignments, as well as individual scores in the final test.**

***Keywords*—blended learning, higher education, peer teaching, knowledge test, procrastination, flipped classroom**

I. Introduction

In addition to students following the traditional educational path, where they begin their studies shortly after leaving school, an increasing number of students are entering higher education through alternative routes [1]. It is significant to society to provide equal support to all students and assist them in successfully completing their studies. This is particularly important due to various factors, such as demographic changes and the desire of young employees to work fewer hours [2]. In the future, many social work sectors will require more well-educated individuals [3].

Alongside the increasing student heterogeneity, there is a rising population of students who juggle multiple commitments, including full-time study, professional employment, and family responsibilities [4]. This aspect warrants special attention, especially considering that the proportion of students with caregiving responsibilities is projected to grow further in the future, primarily due to shifting demographics [5, 6] and the cost trends associated with care placements [7, 8]. Such students require greater flexibility in terms of time and location to effectively pursue their studies.

The aim of combining flipped classroom and blended learning is to meet the needs of increasingly diverse students. The combination of blended and flipped facilitates access to education for older working adults [9], people with learning difficulties [10] and students with caring responsibilities [11].

By combining flipped classrooms, blended learning, and peer teaching, the objective is to create an environment that not only supports formal learning but also enhances opportunities for informal learning [12].

Students attending universities for applied sciences exhibit significant diversity in terms of prior knowledge, previous experience, and personal commitments, particularly in subjects that can be pursued without a baccalaureate degree. This characteristic contributes to the popularity of these subjects among non-traditional students who enter higher education through alternative pathways [13].

Regrettably, the extent to which students complete their studies remains, to some degree, contingent on their socioeconomic and family background [11]. Nonetheless, teaching strategies [14], including blended learning, flipped classroom design, and peer teaching, significantly influence academic pursuits and achievements. Consequently, these approaches should be thoroughly examined to ensure that discrimination is mitigated and equal opportunities are promoted.

II. Literature Review

Blended learning, which combines online and face-to-face instruction, aims to purposefully integrate elements from both approaches [15]. Its primary objective is facilitating self-directed learning within informal, non-formal, and formal educational settings. Like purely online teaching, blended learning employs information and communication technology to deliver content via the Internet. However, the learning process deliberately incorporates in-person instruction [16]. Additionally, digital tools (such as meeting platforms and wikis) and intelligent tutor systems can support individualized learning paths [17]. During the face-to-face sessions, the content is reiterated, reinforced, and applied, often in group settings [18]. This approach enables one teacher to oversee a larger number of students while simultaneously decreasing

dropout rates [19] and enhancing the appeal of study programs [19, 20].

Consequently, blended learning is appealing for students facing multiple work, health, or family-related responsibilities [21]. Moreover, students who may not possess traditional academic strengths or have an uneven learning background can benefit from intentionally designed teaching and learning methods within blended learning, as these approaches enhance their ability to learn independently [22]. Meta-analyses indicate that despite a significant reduction in the amount of in-person instructional time (ranging from 30% to 79%), blended learning can yield equivalent learning outcomes [23] and even lead to significantly better knowledge outcomes [24, 25].

The flipped classroom approach entails reversing the traditional sequence of face-to-face instruction (knowledge transfer in class, followed by individual repetition) by introducing students to course content outside of the classroom. This enables them to engage more deeply with the material during in-class activities, such as group work or guided applications [26]. This intensive engagement can occur in face-to-face courses, blended learning environments, or fully online settings [27]. In the context of blended learning, the flipped classroom model involves asynchronous knowledge transfer via the Internet, followed by intensive engagement with the content during face-to-face sessions and social interactions [28].

The theoretical foundations of the flipped classroom approach are rooted in two perspectives: active doing and active information processing for knowledge acquisition [29]. The active doing perspective draws from constructivist and social constructivist approaches, positing that collaborative problem-solving, active participation in professional discourse, and practical application (such as solving learning tasks) are essential for effective learning. It emphasizes that learning involves more than mere reproduction [30]. On the other hand, the active information processing perspective asserts that active mental engagement with the subject of learning is crucial, as it stimulates cognitive activity. These two perspectives are compatible when the subject matter encompasses interconnected knowledge structures rather than isolated facts that need to be understood for later application or transfer [29]. Consequently, the design of the flipped classroom is also well-suited for supporting skill acquisition in learners with limited prior knowledge. It enables targeted teaching of complex topics and individualized practice, thus facilitating the successful completion of challenging courses like statistics [31].

The operational aspects of integrating flipped classroom and blended learning approaches still lack sufficient clarity. One of the few longitudinal studies conducted over a period of four years explored the development, implementation, and repetition of a blended learning course in a flipped classroom design. This particular study incorporated video lectures, software tutorials, supplementary online readings, and hands-on face-to-face tutorials, demonstrating the efficacy of a dialogic learning process [32]. However, despite students expressing productivity and enthusiasm towards the course content, they often struggle to independently devise meaningful and engaging activities to fully capitalize on the combination [28]. Furthermore, research indicates that teachers currently possess insufficient pedagogical knowledge to effectively implement this combination purposefully [33, 34]. Consequently, the effectiveness of blended learning may be compromised when applied within a flipped classroom design [21]. This notion finds support in a meta-analysis examining the effects of blended learning and flipped classroom, highlighting differences in outcomes depending on the subject and direction of study [35].

Cooperative learning within social learning situations, such as peer teaching, involves collaborative task processing rather than task division [36]. The group size should be small enough to ensure the active participation of all members, fostering effective learning material processing and group productivity [37]. The theoretical foundations of peer teaching draw from various theories, including the social interaction theory of learning [38], which asserts the fundamental role of social interactions in development and emphasizes that learning always transpires within a social and cultural context. Collaborative teaching theory [39], social learning theory [40], problem-solving group theory [41], and the active learning model [42] also contribute to the conceptual framework. These theories agree that humans are inherently social beings, and learning from one another yields higher quality outcomes than learning in isolation [43]. They further posit that active engagement with content enhances social and metacognitive skills development simultaneously [29, 44]. Additionally, through shared exchanges, content becomes explicit, promoting the organization and integration of new knowledge [45] and providing opportunities to address gaps in understanding, correct misconceptions, and alleviate uncertainties [42, 46]. Within peer teaching, the involvement of "peers" holds particular significance as it fosters a symmetrical and reciprocal exchange during interactions [47, 48], fosters the development of new ideas and skills [38], and helps to stabilize students' emotional states [49].

Empirical evidence consistently supports the benefits of peer teaching, even in non-institutionalized contexts, where it has been shown to enhance student learning [50], promote deeper content processing [51], improve performance in mathematical subjects [52], and have a positive impact on academic achievement overall [53]. Studies have also demonstrated that peers within academic settings play a significant role in fostering commitment and academic success, leading to a reduction in dropout rates [54, 55]. Through peer teaching, students develop their own autonomous learning strategies, bolstering their learning skills, self-confidence [56], and metacognitive knowledge and regulation skills [57]. Meta-analyses reinforce the suitability of peer teaching for imparting knowledge content [58–60]. When students explain concepts to one another, they learn the material twice, enhancing learning outcomes [61].

Moreover, peer teaching improves transfer performance during task completion [62]. Another benefit of peer teaching is creating a safe and supportive learning environment [63], which particularly benefits students who may not conform to traditional norms. The combined approach of flipped classroom, blended learning, and peer teaching ensures that successful course completion is attainable for all students. To

achieve this, it is crucial to focus not only on final grades but also on students' performance throughout the semester and their ability to keep pace with the course content, thereby minimizing procrastination.

Academic procrastination refers to the failure to meet deadlines for academic work and the tendency to postpone tasks until the last minute [64]. This behavior, commonly accompanied by what is known as bulimic learning, is prevalent among a significant number of university students [65]. Moreover, the occurrence of procrastination appears to be on the rise in online formats, such as blended learning [66, 67]. The issue of procrastination in college not only affects students but also concerns instructors due to its detrimental effects on academic performance [68].

Research indicates that students who delay starting their work exhibit below-average utilization rates for online learning opportunities [69], achieve lower grades on submitted assignments [65], and experience poorer academic outcomes [70]. A two-year longitudinal study investigating the correlation between academic grades and assignment submission timing concluded that early submission of assignments tends to result in higher grades [71]. Meta-analyses consistently demonstrate that procrastination negatively affects academic performance [72], with some studies indicating an overall effect size of approximately −0.61 [73], which can be interpreted as a medium effect size. These findings underscore the importance of addressing procrastination through continuous learning support to enhance academic achievement. In self-paced online learning, the allure of procrastination and subsequent binge learning is significant [74] and can have severe consequences for students [75]. Therefore, it is encouraging to note that the flipped classroom design appears to assist students in managing their time effectively [71, 76]. Unfortunately, research often overlooked social factors that contribute to reducing and preventing academic procrastination [77]. Collaborative work with peers can motivate students to meet deadlines more effectively [78] and improve their overall performance in their studies [79].

Application tasks, also known as transfer tasks, involve the practical application of previously acquired knowledge obtained through lectures or blended learning methods, such as videos or podcasts [80]. These tasks are crucial for connecting new knowledge with existing knowledge, making them highly relevant in higher education [81] and for competency development [82]. They are widely utilized in scientific subjects [83], as application plays a central role in modern teaching approaches [84]. In online classes, engaging students in hands-on activities like application tasks has been shown to significantly enhance their understanding of course materials, leading to positive effects on final exams [85]. The combination of application tasks with small group work, known as peer teaching, is a classic approach [86] that aims to foster discussions and enable groups to arrive at optimal solutions. Application tasks are well-suited for implementation within the (digital) flipped classroom design, as flipped classroom formats typically involve presenting learning content followed by opportunities for application and assignments [87, 88]. Assignments commonly used to assess knowledge at the end of the semester are typically in the form of knowledge tests.

Knowledge assessment is approached and studied by various disciplines by administering knowledge tests, many of which originate in the intelligence diagnostic concepts developed by Binet and Henri [89] and are guided by epistemological principles [90]. Psychological and educational research often measures disciplinary differences and declarative knowledge [91]. Declarative knowledge refers to knowledge that can be expressed in words and encompasses experiential, procedural, and factual knowledge. It can be taught and assessed through verbal or written means, whereas procedural knowledge is demonstrated through performance-based actions. Individual studies have reported that redesigning courses to incorporate the flipped classroom approach resulted in increased student engagement [92], higher satisfaction levels, improved attendance rates, and better final grades [93]. Furthermore, combining the flipped classroom design with peer teaching enhances performance and satisfaction [94]. However, the existing empirical evidence on this topic remains limited.

Most research on teaching and learning processes in flipped classrooms and blended learning environments relies heavily on qualitative methods and lacks inferential statistical analysis [95]. Consequently, there is limited generalizable knowledge regarding the challenges posed by an increasingly diverse student population [11, 96] and the most effective ways to enhance engagement, participation, and learning outcomes through combinations of teaching strategies [97, 98]. Regrettably, even recent reviews have not identified high-quality, semester-long experimental studies that specifically examine the effects of integrating peer teaching, blended learning, and flipped classroom approaches [11], particularly in terms of their impact on study success, including adherence to time requirements, application tasks, and knowledge tests.

III. Materials and Methods

Data were collected in a total of 11 blended learning courses that employed a flipped classroom design. In each course, there were 268 students (N = 268) who worked on six content items in a 2-week cycle. The content items included a box plot, histogram, mean and variance, maximum likelihood, t-test, and chi-square. These contents were delivered through videos, scripts, and literature provided via the Moodle learning platform.

After each topic, students were required to complete an application task and upload it to Moodle to receive participation credit. The deadlines for these tasks were communicated to the students at the beginning of the semester and when the respective task was activated. Additionally, there were scheduled in-person appointments every three topics (twice during the semester) for students to ask questions, review the material, and deepen their understanding through practical application (in-depth application).

At the end of the semester, the seventh task consisted of an ungraded final test, which served as a survey of the students' learning status.

In five out of the 11 courses (n = 129), the application tasks

and in-depth applications were carried out in three groups during the semester. However, in the remaining six courses (n = 139), both the six application tasks and the in-depth applications were individual tasks. The ungraded final exam was performed individually in all 11 courses.

The application tasks in all courses were graded using the same scoring scheme, with a maximum of 100 points. To ensure consistency, ten percent of the submissions for each assignment across all courses were independently scored by a second rater (the second author). The second rater was unaware of which course the application tasks originated from. Additionally, the time of uploading was recorded in whole days, with negative numbers indicating submissions made before the deadline and positive numbers indicating submissions made after the deadline.

The ungraded final exam was assessed directly through Moodle, with a maximum of 30 points available. Peer teaching was evaluated using dummy coding

IV. Result and Discussion

The study did not collect information on students' demographic characteristics to ensure data protection. However, based on data obtained during student registration for the Bachelor of Social Work program, it is known that the proportion of women ranges between 70% and 75%. Additionally, between 15% and 19% of students possess a "non-classical" university entrance qualification. This category includes Bildungsinländer (foreign students who obtained their university entrance qualification in Germany but not at a Studienkolleg), Bildungsausländer (foreign students who obtained their university entrance qualification abroad or at a Studienkolleg in Germany), stateless individuals, and students with unclear citizenship status. Furthermore, statistical surveys [99] indicate that the average age of students is 23.4 years. Male students (23.7 years) tend to be slightly older than female students (23.0 years).

Based on a voluntary survey conducted among students in the course (N = 193), it was found that a significant percentage of students had prior experience in various fields. Specifically, 46% of students had completed an apprenticeship, 16% had practical work experience, and 13% had participated in a voluntary social year.

A significant majority of students, 76.4% in total, have part-time employment alongside their studies. The most common type of part-time job among students is one with less than 18 hours a week (45.3%), followed by a part-time job with 18–34 hours a week (21.7%). Other mentioned types of employment included mini-jobs (5.4%), full-time jobs (1.0%), and holding multiple jobs (2.0%). It should be noted that 23.6% of students either did not specify their employment status or explicitly stated that they did not have a job.

A significant proportion of students, 25.1%, reported that health-related issues affected their time availability. Among these students, three individuals (1.5%) also have the additional responsibility of caring for children. Moreover, over 10% of students (10.8%) have one or more children, while just under five% (4.9%) have caregiving responsibilities. As a result, a combined total of 40.8% of students face time constraints due to health reasons and/or caregiving responsibilities.

Across all 11 courses, the average time delay for submitting application tasks (n = 268) was 3.6 days (SD = 16.3 days) on the Moodle online course platform. A higher number indicates a greater delay in submission. The assessment of submitted application tasks, calculated as the sum of the scores for the six tasks (n = 268), yielded an average of 371.9 points (SD = 94.3 points). Furthermore, the knowledge test scores (n = 212) averaged 14.2 points (SD = 6.7 points).

The internal consistencies of the application tasks yielded a value of 0.490 (Cronbach's Alpha), while the interrater reliability for the submitted application task scores was 0.911 (Cohen's Kappa). In the groups utilizing peer teaching, the mean adherence to time requirements was 0.1 days (SD = 6.8 days), whereas, in the groups without peer teaching, the mean adherence to time requirements was 6.9 days (SD = 21.2 days). The application tasks yielded a mean score of 387.2 (SD = 70.8) with peer teaching and a mean score of 357.6 (SD = 110.1) without peer teaching. Regarding the knowledge test, a score of 14.21 (SD = 6.1) was achieved in the variant with peer teaching, while the courses without peer teaching obtained a score of 14.3 (SD = 7.2).

The two-tailed t-test revealed a significant improvement in adherence to time requirements in the conditions with peer teaching compared to the courses with individual performance, $t(266) = 3.58$, $p < 0.001$. However, peer teaching did not have a significant effect on the other two independent variables, namely the sum of the six application tasks and the knowledge test (Fig. 1). For the application tasks, the t-test yielded $t(266) = -0.97$, $p = 0.332$, while for the knowledge test, $t(210) = 0.12$, $p = 0.903$.

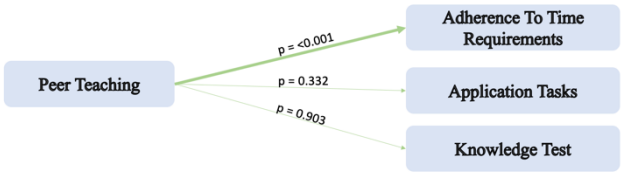

Fig. 1. Significanceof the t-tests (p values).

An exploratory correlation analysis (bivariate, two-sided, Pearson) revealed that the six application tasks did not show a significant correlation with the knowledge test, $r(212) = 0.10$, $p = 0.142$. However, there was a significant negative correlation between time adherence and the scores obtained in the submitted application tasks, $r(268) = -0.14$, $p = 0.01$ (Fig. 2), as well as the scores in the knowledge test, $r(212) = -0.13$, $p = 0.04$ (Fig. 3). These relationships are illustrated in the scatterplots with their respective regression lines and equations. Additionally, it is worth noting that the time compliance exhibited a surprisingly wide range of values. The R^2 value indicates the proportion of variance in the dependent variable (sum of tasks 1–6 and points in the final test) that can be explained.

Considering that the application tasks progressively increase in difficulty throughout the semester and the course covers a wide range of material in blended learning, the observed low alpha value aligns with expectations. However, the interrater reliability for assessing the application tasks exhibited a very good value exceeding 0.80 (Cohen's Kappa),

thereby affirming the interpretability of the results.

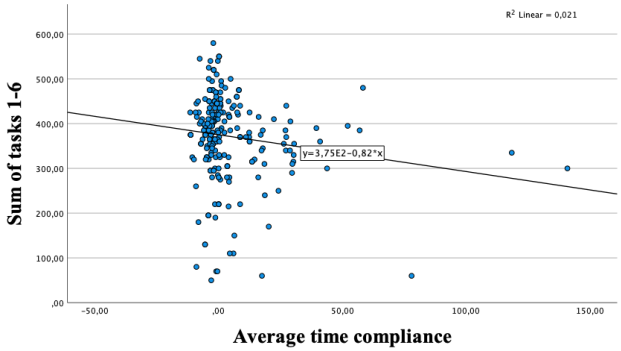

Fig. 2. Scatter plot with bivariate correlation of time adherence and submitted application tasks.

The interpretation of the results is as follows: Peer teaching has a direct and significant effect only on adherence to time requirements, while it does not directly impact scores in the application tasks or the knowledge test. However, the results suggest that peer teaching, when mediated by adherence to time requirements, has an indirect effect on overall performance in the course (i.e., on application tasks and the knowledge test).

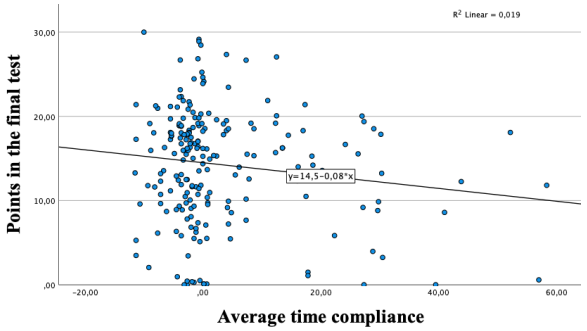

Fig. 3. Scatter plot with bivariate correlation of time adherence and knowledge test.

The association between increased academic procrastination (reflected in decreased adherence to time requirements) and decreased performance in university courses is not a novel finding [64]. Various studies have demonstrated these effects in both face-to-face and blended learning environments [65, 68]. Nevertheless, the negative impact of academic procrastination in the context of blended learning combined with a flipped classroom design has received limited research attention, making these results particularly insightful.

Based on the results, several recommendations for future research and work can be proposed. Firstly, conducting a qualitative interview study with students to explore their perspectives on the factors (such as professional and/or emotional support, additional structure, sense of connectedness, etc.) that contribute to increased adherence to time constraints would provide valuable insights. A logical next step would be to investigate the factors that positively influence grades in both the application tasks and the knowledge test. This could be accomplished through a quantitative study incorporating previously unexplored variables, such as gamification and multiple-choice exercises. Such an investigation would be appropriate to gain a more comprehensive understanding of these influencing factors.

Several requirements (e.g., a pre-data collection design, more than two measurement time points, randomized allocation) were diligently implemented in the follow-up studies to the best of our ability. However, it is important to acknowledge the limitations of this study when interpreting the results.

Before the study, sample size planning and a priori power analyses were not conducted due to the uncertainty surrounding the dispersion of the study variables. We aimed to capture a comprehensive survey of the accruing sample in both semesters. However, post hoc power analyses conducted after the second survey period revealed that additional data collection in the form of a third wave was not required per the optional plan.

Possible limitations arise from utilizing a non-probabilistic sample and the absence of randomized group assignments.

Due to privacy concerns, students' specific challenges are not known in greater detail, as questions regarding health burdens and personal/work obligations were limited to nominal data levels. The intention behind collecting nominal data was to emphasize the broader spectrum of student diversity and the necessary supports and degrees of freedom required to complete the degree program rather than focusing on specific educational disadvantages such as single parenthood, impairments, special needs, or migration background. However, this rudimentary approach to capturing diversity does not eliminate the possibility of an uneven distribution of burdens among the experimental groups, potentially influencing the results. Additionally, the characteristics were only collected during the initial wave, thus failing to capture changes over time. For instance, there may have been students who reported not having any current job obligations but were actively seeking employment. Furthermore, the survey did not inquire about the subjectively perceived level of stress or the availability of resources to cope with stress due to data protection considerations.

The internal validity of the findings may be constrained by self-selection and potential confounding variables [100, 101]. However, naturalistic studies yield representative results, particularly in terms of practical application, as they are conducted under realistic conditions, enhancing the generalizability of the findings. While overall representativeness cannot be assumed, the diversity recording does not impact the representativeness of the target group concerning the research question.

The observed correlations may be attributed to an unobserved third variable [102]. For instance, it is plausible that factors such as general or linguistic intelligence and reading and spelling skills could have played a role, given that all tasks were conducted in written form. Moreover, the prior experience was not documented, and non-linear progressions that can arise during skill acquisition were not considered. It is also possible that the teacher's behavior during synchronous sessions influenced the outcome of the data collection, potentially introducing the Rosenthal effect.

V. Conclusion

In conclusion, it can be inferred that in blended learning

courses with a flipped classroom design, where students face challenges in meeting deadlines and academic procrastination threatens their performance throughout the semester and in final exams, group work can be an effective remedy. Although peer teaching did not yield the anticipated deeper engagement with the subject matter, and peer teaching groups did not outperform individual students in assignments and tests, it did have an indirect impact. By promoting better adherence to time constraints, peer teaching indirectly contributed to academic success. Therefore, the combination of blended learning, flipped classrooms, and peer teaching appears well-suited to mitigate the potential negative effects of distance learning and foster inclusivity among students.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Boehm-Fischer conducted the research; Beyer supervised the research and wrote abstract and introduction, Boehm-Fischer wrote the rest of the paper; all authors approved the final version.

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