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The Impact of Feedback Technologies on Student Motivation and Development of Academic Competencies. An Experimental Study

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Abstract: *Against the backdrop of increasing educational interconnectedness across Europe, the digital transformation of higher education calls for the development of essential competencies that enable students to adapt to and actively participate in the European digital society. This study explores the impact of educational technologies on students' academic motivation and performance through the integration of the Student Feedback Tool (SFT) platform into university teaching activities. The research was conducted on a sample of 200 students, divided into an experimental group and a control group, and analyzed changes in intrinsic and extrinsic motivation, as well as seminar performance. This study used four main instruments to measure the variables of interest: the academic motivation questionnaire, the Student Feedback Tool, the standardized seminar performance evaluation form, and student focus groups. The quantitative data gathered were complemented by qualitative insights from the focus group discussions. The results indicate a significant increase in intrinsic motivation and academic performance among students who received continuous digital feedback. Moreover, students reported higher levels of engagement, clarity of expectations, and perceived usefulness of feedback. The study supports the integration of educational technologies into instructional design as an effective strategy for enhancing student engagement, motivation, and accountability in the learning process within a digitally connected academic environment.*

Keywords: *academic performance; digital feedback; educational technologies; motivation; student engagement.*

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Introduction

In recent decades, the landscape of higher education has undergone profound transformations, exponentially driven by the rapid advancement of technological innovation. This digital era, marked by unprecedented global connectivity, increasing academic mobility, and growing demographic diversity among students, places universities under significant pressure to fundamentally recalibrate their pedagogical paradigms. In this context, technology-enhanced learning (TEL) transcends its traditional role as a complementary tool and emerges as a foundational and indispensable pillar of contemporary and effective education.

Thanks to their intrinsic capacity to integrate interactive digital resources, facilitate robust virtual learning ecosystems, and enable insightful analytics of students' academic trajectories, TEL contributes decisively to the construction of truly learner-centered educational environments. Moreover, such technologies democratize access to high-quality education, overcoming socio-economic and geographical barriers, and offer flexible pathways for personalized learning. This adaptability becomes essential in a rapidly changing world, where required competencies and knowledge evolve continuously.

Within this dynamic and complex framework, the present article aims to examine in depth the role of educational feedback technologies in fostering academic motivation and the development of essential competencies in an increasingly interconnected European context. The study focuses on an emerging digital tool, the Student Feedback Tool (SFT), integrated into university seminar activities.

The originality and contribution of this study lie in the systematic and applied analysis of SFT, used not merely as a means of gathering student opinions but as an integral component of an adaptive, continuous, and participatory educational process. Unlike other well-established tools such as Mentimeter, which offers real-time feedback during live sessions, or Qualtrics, which focuses on post-event data collection, SFT is designed to be embedded within the weekly instructional cycle, allowing for longitudinal and iterative analysis of students' perceptions and real-time adjustments to teaching strategies.

Furthermore, SFT functions as a reflective mechanism within the instructional architecture, actively contributing to the development of key transversal competencies such as autonomy, self-regulated learning, critical thinking, and responsible engagement. The originality of this research is also supported by its mixed-method design, which combines quantitative

evaluation (comparing motivation and performance between the experimental and control groups) with qualitative analysis conducted through focus groups, exploring students' experiences and their perceived impact of the platform on their educational journey. Thus, the study offers an integrated, applicable, and relevant perspective for advancing student-centered digital education across Europe.

Literature review

TEL and Research-Based Learning

The concept of Technology-Enhanced Learning (TEL) refers to the intentional and coherent use of digital technologies to support and transform the educational process. TEL involves more than simply incorporating digital devices or applications; it signifies a profound paradigm shift in which technology becomes an essential component of a student-centered pedagogical design (Kirkwood & Price, 2014). In the context of higher education, TEL can substantially contribute to the development of key 21st-century competencies such as critical thinking, digital collaboration, complex problem-solving, and autonomous learning (Laurillard, 2012).

Among the most widely used educational technologies are Learning Management Systems (LMS) such as Moodle, Canvas, and Google Classroom, which allow for resource organization, asynchronous communication, and continuous assessment. Other essential tools include interactive multimedia resources (e.g., simulations, animations, virtual reality), instant feedback applications (such as Mentimeter, Socrative, Padlet), and online collaboration platforms (including Microsoft Teams, Slack, and Miro), which facilitate distributed and cooperative learning.

Research-Based Learning (RBL) is an educational approach that engages students directly in authentic investigative processes, encouraging them to adopt a scientific mindset and actively contribute to the production of knowledge (Healey & Jenkins, 2009). Rooted in the principles of constructivist pedagogy, RBL emphasizes the idea that deep learning occurs when students participate in the discovery and reinterpretation of knowledge, rather than passively receiving it.

Within higher education, integrating TEL in support of RBL creates significant opportunities for reforming educational practices. For example, the use of online-accessible scientific databases (such as Scopus and Web of Science), data analysis software (SPSS, R, NVivo), and virtual laboratories enables students to explore real-world phenomena under controlled and accessible conditions. Additionally, cloud-based collaboration and

collaborative writing tools (such as Google Docs, Overleaf, or Zotero) support all stages of the research process—from hypothesis formulation to writing and presenting results (Brew, 2013).

Thus, the relationship between TEL and RBL is inherently synergistic. Educational technologies can function as enablers of research-based learning, while RBL provides an ideal context for the critical and creative application of these technologies. This complementarity is particularly relevant to the theme of the present study, as it highlights how educational digitalization can support a student-centered and applied knowledge-oriented pedagogy.

Integrating TEL to support RBL addresses the increasing demands of the knowledge-based society, in which universities must prepare not only technically competent graduates, but also emerging researchers capable of critical thinking, interdisciplinary collaboration, and the generation of innovative solutions to real-world problems (Levy & Petrulis, 2012).

TEL Innovations in Higher Education

Technology-Enhanced Learning (TEL) acts as a significant catalyst in the transformation of higher education. Leading universities such as MIT, Stanford, and Oxford have successfully integrated TEL into their curricular structures, utilizing advanced Learning Management Systems (LMS) that offer functionalities such as adaptive assessments, progress monitoring, and personalized learning content. These tools not only streamline the educational process but also make it more relevant and adaptable to the needs of students in the digital age.

- ***Adaptive assessments and personalized learning***

Artificial intelligence-assisted adaptive assessments enable the adjustment of difficulty levels based on student performance, thus facilitating a genuinely learner-centered educational process. Recent research has highlighted the positive impact of this approach on both academic motivation and student performance (Du Plooy et al., 2024). Modern platforms also provide personalized content suggestions, enabling flexible and efficient learning pathways.

- ***Flipped classroom model and microlearning***

The Flipped Classroom model, in which theoretical instruction takes place outside the classroom and in-class time is dedicated to applied activities, has been associated with increased student engagement and deeper comprehension of course content. A recent literature review concluded that this model significantly enhances student outcomes and fosters collaborative

learning (Baig & Yadegaridehkordi, 2023). Microlearning, in contrast, involves short, focused learning units that support information retention and learning flexibility-crucial attributes in the dynamic university environment.

• ***Gamification in learning***

Gamification in education extends far beyond the superficial addition of points and badges; it fundamentally transforms the learning experience, making it more engaging, interactive, and personalized. Beyond the well-documented improvements in motivation and performance (Domínguez et al., 2021), gamification offers numerous additional benefits and requires thoughtful implementation strategies.

Game elements such as compelling narratives, clear missions, and instant feedback keep students focused and engaged for longer periods. Game-based learning stimulates different areas of the brain, facilitating deeper understanding and more effective memory retention. Rules, challenges, and problem-solving within playful contexts strengthen knowledge retention. Educational games often present complex scenarios that require analysis, strategic thinking, and decision-making. Students learn to approach problems from multiple perspectives and safely test out solutions.

Games also provide immediate feedback on learners' actions, allowing them to instantly identify mistakes and areas for improvement. This supports autonomous learning and self-reflection. Furthermore, by transforming learning tasks into playful activities, gamification reduces anxiety associated with failure and encourages experimentation and risk-taking in a safe environment. A wide range of game elements can be tailored to match different preferences and learning styles of higher education students, offering multiple ways of interacting with educational content.

• ***Artificial intelligence integrated into LMS platforms***

The integration of Artificial Intelligence (AI) into LMS platforms represents a major evolution in the educational landscape. Through its advanced data analysis and processing capabilities, AI is reshaping the nature of online learning. It extends beyond basic course administration, penetrating the core of the educational process by offering tailored solutions to students' individual needs.

One of AI's primary benefits in LMS is the delivery of personalized feedback based on students' activities and progress. Unlike generic feedback, AI provides in-depth analysis of responses, identifies strengths and weaknesses in understanding, and offers specific guidance to foster development. This individualized approach helps students become more aware of their knowledge levels and focus on areas requiring improvement.

Additionally, AI has the capacity to anticipate potential obstacles in the learning process. By analyzing data on student interactions with the platform, pacing through content, and past performance, AI algorithms can identify at-risk students early on. This allows for proactive interventions by instructors or the system itself, offering additional resources or alternative strategies before issues escalate.

Another valuable contribution of AI in LMS is its ability to recommend relevant learning materials for each student. Based on learning profiles, demonstrated interests, and recorded progress, AI can suggest supplementary content, alternative resources, or complementary activities to deepen understanding and sustain motivation. This personalized resource recommendation enhances both the efficiency and individualization of the learning process.

Recent research, such as the study by Alotaibi (2024) confirms the positive impact of AI integration in LMS. These studies show improved academic outcomes for students supported by AI-enhanced platforms. Moreover, AI plays a crucial role in cultivating independent and self-directed learning. Through personalized feedback, difficulty prediction, and relevant recommendations, students are encouraged to take ownership of their learning journey and become more autonomous in acquiring knowledge.

Essentially, AI transforms LMS platforms from mere content repositories into intelligent, adaptive learning environments that actively respond to each student's needs, supporting a more effective and personalized educational experience.

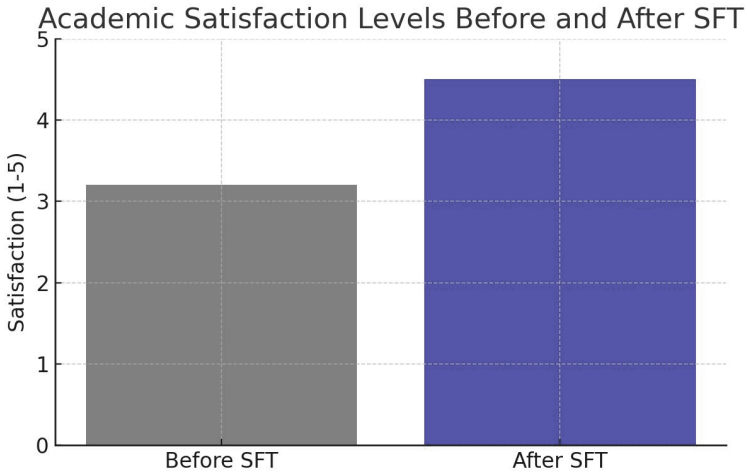
Case study: The Student Feedback Tool (SFT) - integrating technology to support research-based learning

A compelling example of how educational technologies can support research-based learning in higher education is the implementation of the Student Feedback Tool (SFT) at the University of Melbourne. SFT is a digital platform developed to collect continuous student feedback regarding their perceptions of the effectiveness of digital educational resources, particularly interactive ones.

This approach promotes a form of reflective and research-informed learning, in which students become active participants in the optimization of the educational process. The feedback gathered is systematically analyzed by academic staff, who iteratively adapt content and teaching strategies based on the data received. Thus, technology is used not merely as a medium for delivering content but as a tool for the ongoing, participatory, and evidence-based development of the educational process (Martin & Bolliger, 2022).

The results of the SFT implementation have been significant. Data analysis revealed a positive correlation between the use of interactive digital resources, such as explanatory videos, simulations, or adaptive quizzes, and students' academic performance. Furthermore, there was a marked increase in students' satisfaction with the learning experience, as illustrated in the figure below.

Figure 1. Academic satisfaction levels after SFT implementation (Martin & Bolliger, 2022)



After the implementation of SFT, the average level of academic satisfaction increased from approximately 3.2 to over 4.4, indicating a clear improvement in students' perception of learning quality. This increase reflects not only a preference for technology, but also the real effects of an educational framework tailored to students' needs and feedback, a fundamental principle of research-based learning (RBL).

In the context of this article's theme, the SFT case study provides practical evidence of the effectiveness of an integrated approach where TEL (Technology-Enhanced Learning) and RBL mutually reinforce each other. On one hand, technology facilitates the collection and analysis of data; on the other hand, this activity becomes a form of applied research with a direct impact on the educational experience.

In today's higher education landscape, multiple educational technologies have been developed to collect student feedback and support active, research-driven learning. To highlight the specific contribution of the Student Feedback Tool (SFT), it is useful to compare it with other digital solutions such as Mentimeter, Qualtrics, and Loop, platforms frequently used for real-time feedback and pedagogical analysis.

Mentimeter is an interactive tool that enables the real-time collection of feedback through polls, quizzes, and word clouds. Recent studies have shown that using Mentimeter in university lectures can enhance student motivation and engagement, fostering more active and collaborative learning (Madiseh et al., 2023).

Qualtrics is an advanced platform for collecting and analyzing feedback, widely used in higher education to assess the student experience. A 2023 report highlighted that institutions using Qualtrics recorded an increase in student satisfaction and trust, emphasizing the importance of active listening and responsiveness to student feedback (Qualtrics, 2023).

Feedback Loop is a peer feedback tool integrated into platforms like Blackboard, enabling continuous evaluation of group project performance. Studies have shown that using Feedback Loop can improve individual accountability and teamwork, providing valuable data for the development of group work skills (Feedback Loop, 2024).

Table 1. Comparative Analysis: SFT and Other Feedback and Interactive Learning Platforms

Platform	Type of Feedback	Key Features	Support for RBL	Level of Adaptability
SFT	Continuous, integrated	Anonymous and real-time feedback; analysis integrated into LMS	High - content adaptation based on real feedback	Very high
Mentimeter	Instant, in-class	Live quizzes, polls, word clouds	Medium - more suitable for short surveys	High
Qualtrics	Post-event	Advanced analytics, complex statistics, integration with research	High - very effective in RBL projects	High
Loop	Long-term feedback	Structured dialogue, automated recommendations for instructors	Medium - oriented toward overall improvement	Medium

Note: Table created by the authors based on a documentary analysis of educational feedback platforms (SFT, Mentimeter, Qualtrics, Loop) and the relevant literature (Aryal, 2021; Malekjafarian & Gordan, 2024).

The SFT platform stands out for its direct integration into the teaching and learning cycle, providing immediate feedback that allows for near real-time adjustments to content or instructional methods. In comparison, Mentimeter is effective for activating students in the classroom and obtaining quick responses, but it does not enable longitudinal analysis or pedagogical design based on trends. Qualtrics, which is widely used in social and educational research, offers more complex analyses, yet it requires advanced statistical analysis skills and involves slower data collection and processing. Loop focuses on fostering an ongoing pedagogical dialogue between students and teachers, although its impact on immediate instructional design is more limited.

What particularly distinguishes SFT is its ability to support research-based learning not only as an instructional goal but also as an active, participatory process. Students are not merely recipients of content but active contributors to its reconstruction and optimization, an essential feature of the RBL (Research-Based Learning) paradigm (Healey & Jenkins, 2009; Levy & Petrulis, 2012).

The impact of TEL on student motivation and performance

According to Self-Determination Theory (SDT), Deci & Ryan (2000) distinguish three major forms of academic motivation: intrinsic motivation, extrinsic motivation, and amotivation. Intrinsic motivation describes a student's willingness to engage in learning activities because of personal interest, curiosity, or the pleasure of the task itself, which usually promotes deeper and more lasting learning. Extrinsic motivation, on the other hand, arises from outside pressures or rewards, such as obtaining good grades, gaining recognition, or avoiding sanctions. While this type of motivation can lead to satisfactory performance, it often results in more superficial learning strategies. The third category, amotivation, represents the lack of both intention and motivation. In this case, students neither see value in the activity nor believe they can influence its outcomes, which often leads to withdrawal and weaker performance. Research has confirmed these risks: for instance, Dunn & Kennedy (2019) reported that amotivation had a negative impact on student achievement in technology-enhanced learning contexts, showing the importance of addressing this issue when developing instructional practices.

The integration of Technology-Enhanced Learning (TEL) into the higher education environment has become an essential component of the teaching–learning process, significantly influencing both students' intrinsic motivation and their academic performance. The use of digital tools such as

interactive applications, e-learning platforms, and online collaborative environments contributes to increased engagement in learning activities and improves learning outcomes.

For example, a study conducted by Awedh et al. (2015) demonstrated that the use of the Socrative app and smartphones for collaborative learning increased students' active participation and motivation, while also yielding significant improvements in academic performance. This type of interactive and personalized learning allows content to be adapted to each student's learning style, leading to more effective learning.

The integration of technology in learning (TEL) has a significant impact on students' motivation and performance, a fact supported by recent research. According to the Self-Determination Theory of Deci and Ryan (2000), intrinsic motivation, arising from personal interest and enjoyment, is essential for deep and long-lasting learning. TEL can facilitate this form of motivation by offering students greater control over how and at what pace they process information.

Moreover, educational technology supports the development of learner autonomy, a key factor in academic success. Through digital resources and the ongoing feedback available via online platforms, students can manage their time more effectively and build personalized learning strategies. This autonomy contributes to increased self-efficacy and intrinsic motivation, elements that, according to the literature, have a direct correlation with academic performance (Badarne, 2019). In a study conducted in the natural sciences, the use of ICT in biology instruction was shown to improve students' motivation and deepen their understanding of the material, leading to better assessment results.

At the same time, it is important not to overlook the potential downsides of using technology in education, which can negatively affect both motivation and performance. One of the most common risks associated with TEL is digital distraction. In a recent study, Pérez-Juárez et al. (2024) demonstrated that constant exposure to digital stimuli, such as notifications or the possibility of multitasking within online platforms, significantly diminishes students' ability to concentrate and adversely affects their performance in laboratory activities and other practice-based tasks. This challenge is compounded by the fact that students do not always have effective strategies for self-regulating their digital behavior.

A comprehensive study conducted by Dunn & Kennedy (2019) examined the impact of emotional, cognitive, and behavioral engagement with TEL on student grades. The results revealed that active engagement

with technology, rather than its mere use, was a significant predictor of academic performance. Students with higher levels of intrinsic motivation were more likely to deeply engage with online learning materials.

Technology-enhanced learning has the potential to profoundly transform the way students learn and relate to the educational process. TEL can stimulate motivation and performance when used strategically, with an emphasis on personalization, collaboration, and autonomy. At the same time, it is essential for educators to establish clear policies for the use of technology and to foster critical digital competencies that can mitigate the adverse effects of digital overload and distractions. In this way, TEL is not merely a technological tool but a complex environment that demands a balanced, reflective, and pedagogically sound approach.

The value of feedback in instructional design

The integration of feedback into technology-enhanced instructional design (TEL) plays a pivotal role in supporting research-based learning (RBL) within higher education. Effective feedback contributes to the development of self-regulated learning by allowing students to identify their strengths and areas for improvement within the learning process. This is essential for promoting autonomous and responsible learning.

Nicol & Macfarlane-Dick (2006) proposed a theoretical framework that highlights seven principles of effective feedback practice aimed at fostering self-regulated learning:

1. Clarifying performance expectations.
2. Facilitating self-regulation of learning.
3. Providing high-quality feedback.
4. Encouraging dialogue between students and teachers.
5. Fostering students' belief in their ability to learn.
6. Creating opportunities for self-assessment.
7. Using feedback to close the gap between current performance and desired outcomes.

These principles can be effectively embedded in instructional design by utilizing educational technologies that enable interactive, personalized feedback. For example, online learning platforms can provide immediate and adaptive feedback, thereby supporting students' self-regulation of learning.

Constructive and timely feedback has a significant impact on students' motivation, learning, and performance. A study conducted by Williams (2024) highlights that effective feedback can substantially enhance students' motivation, learning outcomes, and academic performance,

underscoring the critical role of feedback in instructional design aimed at supporting effective learning.

In conclusion, the integration of effective feedback into technology-enhanced instructional design is vital for supporting research-based learning in higher education. By applying the principles proposed by Nicol and Macfarlane-Dick and leveraging appropriate educational technologies, instructors can facilitate the development of self-regulated learning, motivation, and improved academic performance.

Challenges and ethical considerations

While the use of technology in education brings numerous benefits, it also raises significant ethical challenges, especially with regard to data privacy, equitable access to digital resources, and dependency on virtual environments. Educational institutions must adopt clear policies and implement measures to address these issues and to ensure a fair and safe learning environment for all students.

In the context of digital education, the privacy of student data is a major concern. The collection and analysis of personal information can carry significant risks, including data breaches and unauthorized use of sensitive information. It is essential for institutions to implement robust data protection policies, obtain informed consent from students and their guardians, and ensure transparency in how data are collected and used (Manas et al., 2023).

Although technology has the potential to democratize access to education, it can also deepen existing inequalities. Socioeconomic factors, geographic location, and limited infrastructure may restrict access to digital educational resources. To prevent the marginalization of disadvantaged communities, it is vital to ensure equitable access to technology and to foster digital literacy among all students (Marín & Tur, 2024).

Excessive use of technology in education can also lead to a dependence on virtual environments, affecting students' mental health. The constant surveillance and pressure to remain connected can cause stress and anxiety. It is important for institutions to balance technology use with human interaction, offering psychological support and resources to help students manage these challenges (The Learning Accelerator, 2022).

The integration of artificial intelligence (AI) into education raises ethical questions related to transparency, accountability, and equity. Algorithms can perpetuate existing biases and make decisions that negatively affect certain student groups. It is essential to establish clear ethical frameworks for the use of AI in education, ensuring algorithmic

transparency and involving diverse stakeholders in the decision-making process (Radanliev & Santos, 2023).

Ethical depth: algorithmic transparency in the analysis of SFT

The integration of digital platforms such as the Student Feedback Tool (SFT) into higher education brings not only pedagogical benefits but also raises essential ethical challenges, among which algorithmic transparency is central. According to Radanliev & Santos (2023), any educational system that incorporates artificial intelligence or analytical algorithms must adhere to the principles of transparency, explainability, and accountability. In the case of SFT, which continuously collects, processes, and analyzes data related to students' perceptions and participation, it becomes critical to ensure that the educational decisions derived from this data are understandable to users and do not negatively impact certain student groups.

In this context, algorithmic transparency implies that the logic by which the platform aggregates or prioritizes feedback must be explicit and accessible not only to instructors but also to students. For instance, if a seminar topic is modified based on automatically identified feedback trends, students should be able to understand how these decisions were generated and what criteria were applied. Radanliev & Santos (2023) argue that a lack of such transparency can lead to "algorithmic opacity," a phenomenon that undermines trust in the educational process and may exacerbate existing inequalities within academic settings.

Furthermore, in a participatory and student-centered educational environment, as promoted by the Research-Based Learning (RBL) model, transparency becomes a necessary condition for genuine student engagement. Although SFT presents a valuable participatory model, algorithmic transparency, as conceptualized by Radanliev & Santos (2023), is only partially implemented. To transform the platform into an ethical and responsible tool for student feedback analysis, it is essential to clarify how data are automatically aggregated, to communicate the decisions made based on those data in a visible and timely manner, and to implement a feedback interpretation audit system. These elements contribute to building a transparent, equitable, and co-responsible educational ecosystem.

Despite these structural limitations of the platform, it must be emphasized that decision-making transparency can and should be actively supported by the instructors involved. Teachers can present students with summarized statistics on satisfaction and engagement levels extracted from the SFT and clearly communicate which pedagogical adjustments were made

in response to this feedback (e.g., the introduction of additional interactive exercises, adjustments to seminar structure, or clarification of specific content). This practice significantly contributes to building student trust in the platform's utility and provides a functional model of procedural transparency, even in the absence of a fully explicated algorithm. Thus, the role of instructors as mediators between technology and pedagogy remains essential to ensuring an ethical and genuinely participatory educational process.

Methodology

Pre-experimental stage

Research premises

The digital transformations shaping higher education across Europe underscore the need to integrate educational technologies as essential supports for modern teaching and learning processes. In this context, digital feedback assessment tools can play a significant role in fostering academic motivation and enhancing student performance. The Student Feedback Tool (SFT), designed for real-time feedback collection and analysis, supports the development of autonomy, perceived competence, and relatedness, fundamental dimensions of motivation, according to the self-determination theory (Deci & Ryan, 2000).

Purpose, objectives, and research question

Research purpose

The purpose of this study is to investigate the influence of using the Student Feedback Tool on students' academic motivation and seminar performance in higher education.

Research objectives

- To assess the level of academic motivation in the experimental and control groups before and after the implementation of the Student Feedback Tool.
- To compare the academic performance achieved in seminars between students using the Student Feedback Tool and those not using it.
- To evaluate the perceived impact of the Student Feedback Tool on student engagement and participation in seminar activities.
- To explore the relationship between academic motivation and seminar performance in the context of using educational technologies.

Research question

What is the influence of using a digital feedback assessment tool (Student Feedback Tool) on academic motivation and seminar performance among university students?

Research hypothesis and variables

Research hypothesis

The use of the digital assessment tool Student Feedback Tool during seminar activities leads to a significant increase in academic motivation and contributes to improved student performance.

Research variables

Independent Variable: Use of the Student Feedback Tool (present/absent).

Dependent variables:

- Level of academic motivation (measured by a questionnaire adapted from the Self Determination Motivation Scale - Deci & Ryan, 2000).
- Academic performance in seminars (grades, formative assessments).

Control variables:

– Initial level of academic motivation (measured prior to the intervention).
– Frequency of seminar participation.
– Student's area of specialization and year of study.

Research Methodology

Participants

The study involves a total of 200 first year students enrolled in a Faculty of Social and Human Sciences, attending the Pedagogy I course (part of the psycho pedagogical training module). The participants are distributed as follows:

- Experimental Group: 100 students who will use the Student Feedback Tool during Pedagogy seminars.
- Control Group: 100 students attending Pedagogy seminars in the traditional format, without the use of the digital tool.

The selection of this participant group was methodologically grounded in two main considerations: (1) the formative nature of the course, which emphasizes reflective and participatory competencies, and (2) the relatively uniform level of academic experience among first-year students, which facilitates better control over intervening variables (such as familiarity with digital feedback tools).

The following inclusion criteria were applied:

- Enrollment in a first-year undergraduate degree program;
- Participation in the "Pedagogy I" course;
- Informed consent to take part in the study.

The exclusion criteria were:

- Irregular seminar attendance (more than 30% absences);
- Explicit refusal to participate in the research activities;
- Transfer to another study program during the semester.

By applying these criteria, a relatively homogeneous sample was ensured, thereby enhancing the internal validity of the results obtained. It is important to note that the sample was not randomized in the strictest experimental sense**.** Instead, a quasi-experimental approach was adopted, and the allocation to experimental and control groups was based on pre-existing course groupings that aligned with the above considerations. While this limits the degree of experimental control typically afforded by full randomization, it allowed for a realistic and contextually grounded implementation of the intervention within the constraints of the academic program.

Ethical considerations of the research

The study fully adhered to educational ethics standards and the deontological principles governing research involving human subjects. Participation in the research was entirely voluntary, and all participants were informed in advance regarding the following aspects:

- the purpose of the study;
- the anonymous nature of data collection via the SFT platform;
- the possibility to withdraw from the study at any time, without any academic consequences.

Informed consent was obtained digitally from all students prior to the administration of research instruments. The collected data were anonymized and stored securely, and the analysis was carried out in aggregated form, ensuring that no individual participant could be identified. Furthermore, all decisions made based on the feedback were communicated transparently to the entire group, in line with the principles of participatory education and ethical data use.

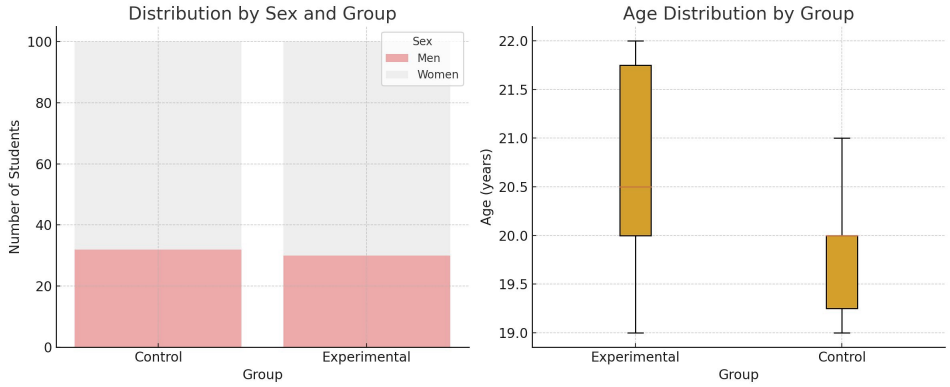
Demographic profile of the sample

The research sample was equally divided between the experimental group (n = 100) and the control group (n = 100). The demographic distribution was balanced to ensure comparability between the two groups and to minimize external variations that could affect the validity of the results.

- Gender: 75% of participants were female, and 25% were male, a typical distribution for the fields of humanities and educational sciences.
- Age: The average age was approximately 20 years, with a range between 19 and 22 years. A boxplot analysis indicated no statistically significant differences between the two groups, which supports the overall homogeneity of the sample.
- Field of Study: Students came from related academic specializations (e.g., pedagogy, psychology, educational sciences), evenly distributed between the groups. This helped control for potential disciplinary bias in learning behavior and feedback interpretation.
- Geographic Distribution: All participants originated from the same geographical region, the northern part of Romania, specifically from three neighboring counties. This territorial homogeneity was important for controlling contextual variables such as digital infrastructure, local university policies, and institutional academic culture. Although this limits the possibility of nationwide generalization, it significantly enhances the internal validity of the experimental comparison within a coherent regional context.

This balanced demographic composition supports the comparative validity of the intervention and provides a solid foundation for the partial extrapolation of results to other similar university contexts in Romania or Central and Eastern Europe.

Figure 2. Distribution of participants by gender and age in the experimental and control groups (authors' own elaboration)



Research instruments

This study used four main instruments to measure the variables of interest: the academic motivation questionnaire, the Student Feedback Tool,

the standardized seminar performance evaluation form, and student focus groups.

The first instrument, the academic motivation questionnaire, was adapted from the Self-Determination Motivation Scale developed by Deci & Ryan (2000). Its purpose was to assess students' levels of intrinsic motivation, extrinsic motivation, and amotivation. Intrinsic motivation refers to students' engagement in learning activities out of personal interest or enjoyment, while extrinsic motivation is oriented toward obtaining external rewards or avoiding penalties. Amotivation reflects a lack of intention or motivation toward the learning activity. The questionnaire contains items designed to capture these three dimensions and was administered both in the pre-test and post-test phases.

The second instrument used was the Student Feedback Tool (SFT), a digital platform designed to continuously collect student feedback during seminars. Through the SFT, students can quickly and anonymously provide their opinions on the quality of activities, the clarity of explanations, their level of engagement, and suggestions for improvement. This tool is designed to facilitate two-way communication between students and teachers and to encourage critical reflection on the learning process, thereby contributing to an increased sense of autonomy and competence.

In addition to these, a standardized seminar performance evaluation form was developed, containing explicit criteria for assessing student activity. The form covers the following dimensions: active participation in discussions, quality of oral and written contributions, ability to apply theoretical concepts in practice, and level of engagement in seminar activities. The evaluations conducted using this form provided an objective measure of academic performance, complementing the data collected through self-assessment and feedback.

The fourth instrument consisted of focus groups conducted with students from the experimental group, aiming to qualitatively explore their perceptions of using the SFT platform. The discussions addressed topics such as its perceived impact on personal engagement, sense of autonomy, relevance of received feedback, and suggestions for improving the educational experience. These qualitative data offered in-depth insights, providing context to the quantitative results and deepening the understanding of the pedagogical impact of the tool.

Through the use of these four complementary instruments, the research ensures a comprehensive, rigorous, and balanced approach to analyzing the influence of the Student Feedback Tool on academic

motivation, student performance, and the learning experience within the Pedagogy I seminars.

Administration of the pre-test

Following the commencement of the second semester, the initial assessment was conducted using the *Academic Motivation Questionnaire*, adapted from the *Self-Determination Scale* (Deci & Ryan, 2000). The purpose of this stage was to identify the baseline level of academic motivation among the participating students and to ensure the homogeneity of the experimental and control groups prior to the intervention.

The questionnaire was administered electronically in a controlled environment, at the end of the first *Pedagogy I* seminar, in order to ensure a high response rate and uniform conditions for all participants. Students were informed about the objectives of the research and the confidentiality of their responses, and they voluntarily completed the instrument.

The data collected through the initial assessment were subjected to statistical analysis. The results indicated that overall levels of academic motivation were moderately low in both groups. The mean scores for intrinsic motivation were approximately 4.0 (on a scale from 1 to 7), in both the experimental group ($M = 4.1$, $SD = 0.7$) and the control group ($M = 4.0$, $SD = 0.8$), suggesting a relatively low interest in academic activities for the sake of personal enjoyment or satisfaction.

Similarly, extrinsic motivation yielded comparable average scores ($M = 3.8$, $SD = 0.6$ for the experimental group and $M = 3.9$, $SD = 0.7$ for the control group), indicating a mild orientation towards external rewards, though not at a high level.

With regard to amotivation, the scores were slightly above the midpoint ($M = 2.6$, $SD = 0.8$ in the experimental group and $M = 2.7$, $SD = 0.9$ in the control group), signaling a moderate tendency toward disengagement or lack of purpose in the learning process.

Independent samples t-tests conducted to compare the two groups revealed no statistically significant differences in the initial scores across any of the three measured dimensions ($p > 0.05$), thereby confirming that participants began the intervention with relatively similar levels of academic motivation.

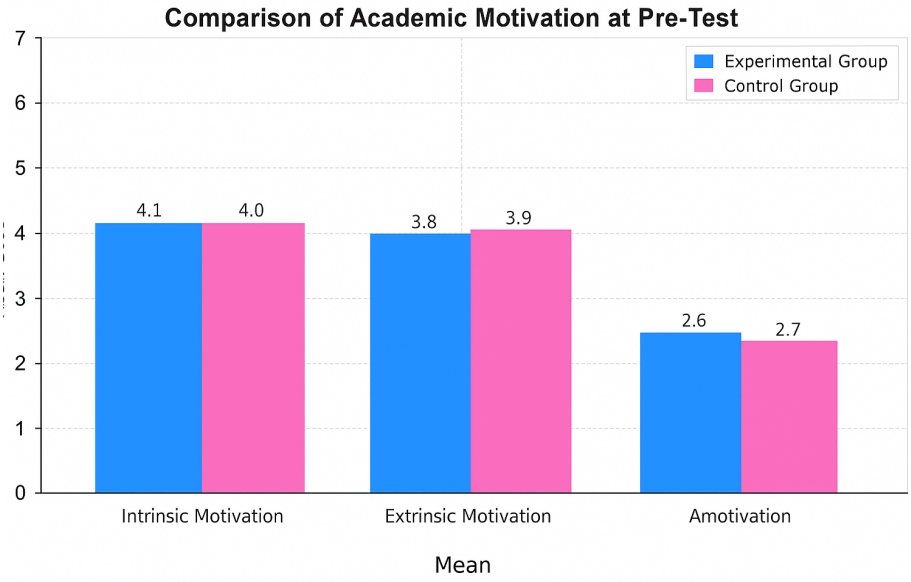
These findings justify the implementation of the intervention, as low academic motivation may represent a risk factor for educational performance. The use of a continuous feedback tool, such as the *Student Feedback Tool*, may help foster student motivation throughout seminar activities.

Table 2. Pre-Test results on academic motivation (authors' own elaboration)

Dimension	Group	Mean (M)	Standard deviation (SD)
Intrinsic motivation	Experimental	4.1	0.7
Intrinsic motivation	Control	4.0	0.8
Extrinsic motivation	Experimental	3.8	0.6
Extrinsic motivation	Control	3.9	0.7
Amotivation	Experimental	2.6	0.8
Amotivation	Control	2.7	0.9

Note: Values are based on a Likert scale ranging from 1 (very low) to 7 (very high).

Figure 3. Comparative Pre-Test results on academic motivation (authors' own elaboration)



Experimental phase: implementation of the educational intervention

The experimental phase was conducted throughout the second academic semester, spanning 14 consecutive weeks within the Pedagogy I course. This phase involved the implementation of an innovative educational intervention through the use of the *Student Feedback Tool* (SFT), a platform designed to collect and utilize real-time feedback from students. The intervention was applied exclusively in the experimental group, while the control group attended the same seminars in a traditional format, without the integration of SFT or other interactive digital tools.

During the second semester, the instructors involved with the experimental group systematically implemented the Student Feedback Tool in every seminar session. Prior to the start of the intervention, these instructors participated in a training session focused on the technical use of the SFT, data interpretation, and pedagogical adaptation based on the feedback received.

At the end of each seminar throughout the semester, students in the experimental group were invited to anonymously complete a structured digital questionnaire via the platform. The questionnaire items targeted four essential dimensions:

- Clarity and usefulness of the seminar content;
- Degree of understanding of the topic discussed;
- Perceived level of engagement and participation;
- Specific suggestions for improving teaching and instructional materials.

In this study, seminar performance denotes students' active involvement in class discussions, the substance and relevance of their contributions, and their capacity to apply theoretical concepts in practical tasks. The primary assessment of performance was carried out by the instructor, who used a standardized rubric to ensure consistent scoring across groups. To complement the teacher's perspective, students also completed brief self-assessment items through the digital feedback tool, which provided an internal viewpoint on their own engagement and learning.

To ensure the psychometric quality of the data obtained via the Student Feedback Tool, an analysis of the internal consistency of the digital questionnaire was performed. The internal reliability test, assessed using Cronbach's alpha coefficient, was based on a total of 300 individual responses collected during the first three weeks of the intervention. This approach enabled a robust evaluation of item consistency, as each student in the experimental group completed the questionnaire repeatedly after each seminar.

The resulting coefficient, $\alpha = 0.84$, indicates a high level of internal consistency among the questionnaire items, suggesting that the items coherently measure the intended constructs: content clarity and usefulness, level of understanding, perceived engagement, and students' ability to provide relevant suggestions. According to the literature (Nunnally, 1978; George & Mallery, 2003), an alpha coefficient above 0.80 is considered excellent for instruments used in applied social science research.

This result supports the validity of subsequent interpretations and ensures that the data collected through the SFT platform can be considered both reliable and psychometrically sound. Moreover, the consistent structure of the questionnaire over the 14-week intervention provides a coherent framework for longitudinal analysis, thereby contributing to the overall robustness of the study.

The data were automatically collected by the platform and analyzed on a weekly basis, offering instructors real-time insights into students' reception of the content and their satisfaction levels. After the weekly reports were generated, instructors held short debriefing sessions to review the aggregated results and identify recurring trends. Particular attention was paid to items with lower scores or to patterns that repeated across multiple weeks. When difficulties in content clarity were identified, instructors agreed to revisit explanations or provide additional examples. Low engagement scores often led to the inclusion of more interactive tasks, such as small-group discussions or applied case studies. This collaborative interpretation of data ensured that feedback was not merely descriptive but was systematically transformed into targeted pedagogical actions. Based on these insights, teaching strategies were iteratively adjusted, including:

- Providing additional explanations for concepts perceived as difficult;
- Integrating concrete examples and case studies for improved practical applicability;
- Implementing interactive exercises and reflection sessions to consolidate learning;
- Facilitating collaborative activities to enhance active engagement and peer cooperation.

This adaptive, feedback-driven approach was essential in fostering a reflective educational environment in which students were treated as active partners in the teaching–learning process, rather than passive recipients of information. In this way, the intervention aimed to strengthen students' intrinsic academic motivation by emphasizing autonomy, a sense of competence, and the personal relevance of learning activities, key components of Self-Determination Theory (Deci & Ryan, 2000).

Results

Post-experimental phase: final testing, academic performance evaluation, qualitative analysis

The post-experimental phase took place at the end of the second semester, marking the conclusion of the educational intervention carried out

over the 14-week period. This phase comprised three key components: the administration of the final academic motivation assessment, the collection of academic performance data from seminar activities based on a standardized rubric, and a qualitative analysis using focus group discussions to identify students' perspectives.

Final assessment of academic motivation

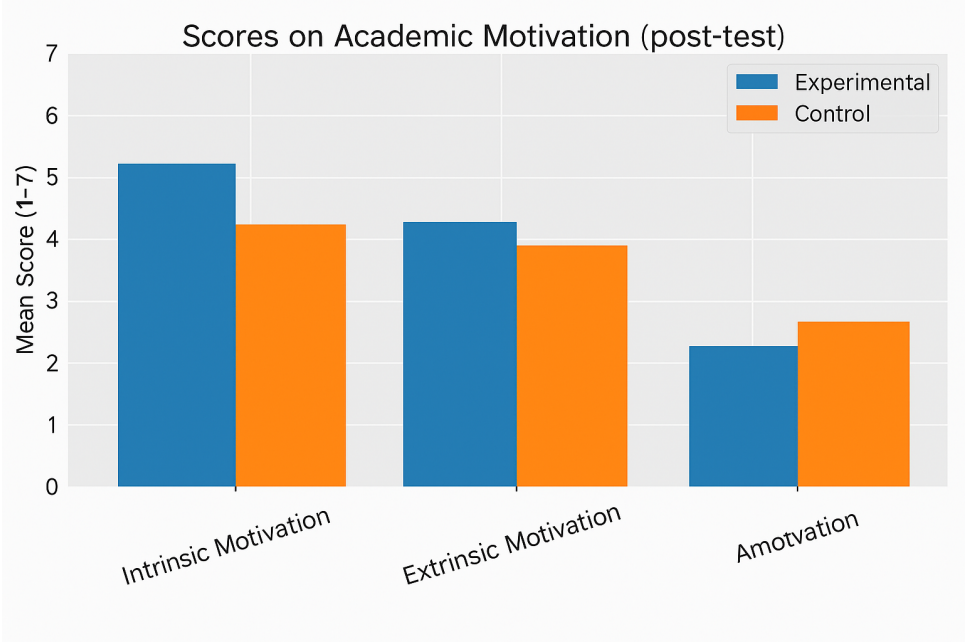
At the end of the semester, both the experimental and control groups were re-administered the Academic Motivation Questionnaire, adapted from the Self-Determination Scale of Motivation (Deci & Ryan, 2000), under the same conditions as the initial assessment. The objective was to evaluate changes in students' motivational profiles and to identify the impact of the intervention on the dimensions of intrinsic motivation, extrinsic motivation, and amotivation.

To compare post-intervention scores for intrinsic motivation, extrinsic motivation, and amotivation between the two groups, an independent samples t-test was conducted.

Table 3. Comparison of mean scores for academic motivation (Post-test) (authors' own elaboration)

Dimension	Group	Mean (M)	Standard deviation (SD)	t	p
Intrinsic motivation	Experimental	5.2	0.6	6.43	<0.001
	Control	4.1	0.7		
Extrinsic motivation	Experimental	4.2	0.5	2.21	0.028
	Control	3.8	0.6		
Amotivation	Experimental	1.9	0.6	-4.88	<0.001
	Control	2.7	0.8		

Figure 4. Comparison of mean academic motivation scores (Post-test)
(authors' own elaboration)



To further validate these findings, a one-way ANOVA was conducted to examine whether the post-test differences in motivational dimensions between the experimental and control groups were statistically significant. The results confirmed robust between-group effects for intrinsic motivation, $F(1,198) = 140.68$, $p < .001$, and amotivation, $F(1,198) = 57.66$, $p < .001$. Extrinsic motivation also showed a significant, though smaller, group effect, $F(1,198) = 23.58$, $p < .001$. These results reinforce the conclusion that participation in the experimental intervention with the SFT platform significantly enhanced intrinsic motivation and reduced amotivation, while also exerting a moderate positive influence on extrinsic motivation.

The findings revealed a statistically significant increase in intrinsic motivation among students in the experimental group, who engaged weekly with the Student Feedback Tool (SFT). Specifically, the mean score on this dimension rose from 4.1 to 5.2, indicating an enhanced engagement in academic activities driven by personal interest and the inherent satisfaction derived from the learning process. Concurrently, a significant decrease was observed in levels of amotivation, with mean scores declining from 2.6 to 1.9, suggesting a reduction in feelings of purposelessness or lack of interest regarding seminar participation. In contrast, the control group exhibited no

statistically significant changes in these motivational dimensions, maintaining scores comparable to their pre-test values.

Analysis of academic performance in seminars

Academic performance was assessed using a standardized scoring system applied at the end of each seminar session, with a maximum score of 3 points per session, distributed as follows:

- 1 point for active attendance,
- 2 points for engagement and the quality of contributions (oral or written).

Evaluations were compiled at the end of the second semester, and the results revealed clear differences between the two groups:

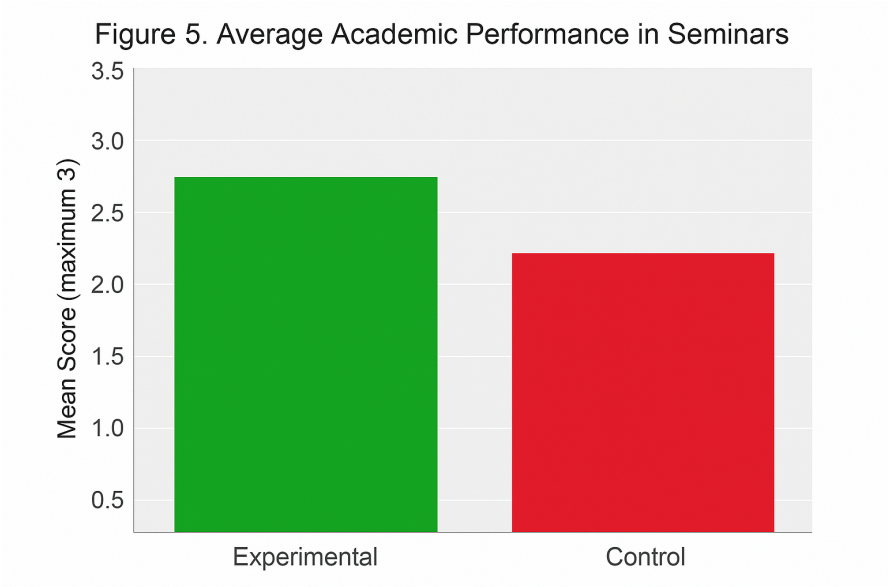
- The experimental group achieved an average score of 2.7 out of 3 points per seminar, reflecting consistent attendance and a higher level of engagement in academic activities.
- The control group obtained an average of 2.1 out of 3 points, indicating generally good participation but lower levels of active involvement compared to students who were exposed to the intervention.

Performance was expressed as the mean of the scores obtained across all seminars (maximum score: 3). A comparative analysis was conducted using an independent samples t-test. The difference was statistically significant, indicating superior performance among students who benefited from continuous digital feedback.

Table 4. Academic performance in seminars - final scores (authors' own elaboration)

Group	Average Seminar Score	Standard deviation (SD)	t	p
Experimental	2.7	0.3	9.62	<0.001
Control	2.1	0.4		

Figure 5. Mean academic performance scores per seminar (authors' own elaboration)



The findings suggest that the integration of the SFT platform had a beneficial impact not only on students' academic motivation but also on their actual performance in seminar-based activities. The provision of continuous and timely feedback appears to have facilitated higher levels of active engagement, which, in turn, was associated with significantly improved participation and a more committed and constructive approach to learning.

An additional one-way ANOVA was conducted to test the robustness of the difference in seminar performance between the two groups. The analysis revealed a highly significant main effect of group, $F(1,198) = 92.54$, $p < .001$, confirming that students in the experimental group consistently outperformed those in the control group. This finding provides strong evidence that the integration of the SFT platform had a substantial positive effect on students' active participation and overall seminar performance.

The correlation between motivation and performance

To further explore the relationship between the level of academic motivation and seminar performance, Pearson's correlation coefficient (r) was employed. This analysis was conducted on the full sample of 200 students, regardless of their assignment to the experimental or control group, in order to identify overall trends between the psychopedagogical variables under investigation.

Table 5. Correlations between dimensions of motivation and seminar performance (authors' own elaboration)

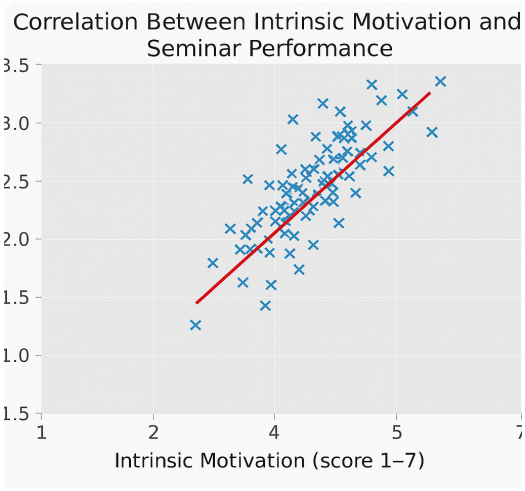
Correlated Variables	Pearson Coefficient (r)	p
Intrinsic motivation – Performance	**+0.68**	<0.001
Extrinsic motivation – Performance	+0.34	0.002
Amotivation – Performance	**–0.53**	<0.001

Intrinsic motivation exhibited a strong positive correlation with seminar performance ($r = +0.68$, $p < 0.001$). This finding suggests that students who are driven by personal interest and the inherent satisfaction of learning tend to achieve higher scores in seminar activities, engaging more actively and demonstrating higher levels of cognitive and affective involvement.

Extrinsic motivation showed a moderate positive correlation with performance ($r = +0.34$, $p = 0.002$), indicating that external rewards (such as grades, recognition, or social validation) may contribute to improved academic outcomes, albeit to a lesser extent than intrinsic motivation.

Amotivation was significantly and negatively correlated with performance ($r = –0.53$, $p < 0.001$), reflecting the idea that a lack of clear direction, interest, or perceived value in educational activities is associated with lower participation and poorer academic results.

Figure 6. Relationship between intrinsic motivation and seminar performance (authors' own elaboration)



The graph above provides a visual representation of the significant positive relationship between intrinsic motivation scores and academic performance in seminar activities. A clear upward trend is evident, indicating that seminar performance increases as levels of intrinsic motivation rise. The linear regression line (highlighted in red) suggests that, overall, students with higher intrinsic motivation scores tend to achieve better academic outcomes, approaching the maximum possible score of 3 points per seminar. This visual depiction supports the statistical analysis and highlights the fact that engagement driven by personal interest and the enjoyment of learning is a strong predictor of academic success in interactive university settings.

These correlations underscore the importance of fostering intrinsic motivation within the higher education context, a goal that can be supported through student-centered interventions such as the use of the Student Feedback Tool platform. Continuous, personalized, and responsive feedback strengthens students' sense of autonomy, competence, and engagement, core components of intrinsic motivation as outlined by Self-Determination Theory (Deci & Ryan, 2000).

In conclusion, the findings demonstrate that deep motivational engagement not only enhances active participation in seminars but also serves as a robust predictor of academic performance, thereby confirming the effectiveness of technology-enhanced pedagogical approaches in higher education.

Qualitative analysis: students' perceptions of using the student feedback tool

To complement the quantitative data obtained through questionnaires and formative assessments, the research also incorporated a qualitative component aimed at exploring in greater depth the students' perceptions and experiences related to the use of the Student Feedback Tool (SFT) platform. This analysis sought to highlight how continuous digital feedback influenced students' motivation, engagement, and the quality of learning in university seminar contexts.

Two focus groups were organized, each consisting of 6-8 volunteer students from the experimental group. Participants were selected based on availability and diversity of participation (e.g., gender, academic performance, frequency of interaction with SFT). The discussions lasted approximately 60 minutes and were moderated by a facilitator with experience in qualitative research, using a semi-structured interview guide.

The questions addressed five main dimensions: perceived usefulness of SFT, impact on seminar engagement, experienced academic motivation, quality of the student, instructor relationship, and suggestions for improvement:

1. How did you perceive the use of SFT in the context of your seminars?
2. Did you feel that your feedback was heard and acted upon? Can you provide examples?
3. To what extent did this platform motivate you to engage more actively in the learning process?
4. Have you noticed any changes in the teaching approach as a result of feedback provided through SFT?
5. How does this experience compare to other forms of assessment or feedback in your other courses?
6. What did you appreciate most about this feedback method? What would you improve?

The discussions were audio-recorded, fully transcribed, and analyzed using thematic analysis (Braun & Clarke, 2006), which enabled the identification of recurring themes and patterns of meaning. The results derived from the focus groups provide in-depth validation of the impact of the Student Feedback Tool (SFT) on students' academic experience. Responses to the exploratory questions revealed not only positive perceptions but also specific psychopedagogical mechanisms that supported motivation and research-informed learning.

The question "How did you perceive the use of SFT in the context of your seminars?" generated responses centered on openness, psychological safety, and relevance. Students reported that SFT was perceived as a safe space for expression, particularly due to the anonymity it provided. For instance, one participant stated: "I didn't feel judged for what I said, but I knew the teacher actually read and considered it," which contributed to a sense of autonomy and personal engagement.

The question "Did you feel that your feedback was heard and acted upon? Can you provide examples?" led to the identification of specific instances in which instructors adjusted the structure of seminars, revisited explanations, or introduced new applied activities based on prior suggestions. This responsiveness was interpreted as a form of authentic validation of student voice, reinforcing trust in the instructor and enhancing intrinsic motivation.

In response to "To what extent did this platform motivate you to become more involved in the learning process?", students reported that the

SFT fostered a state of reflective vigilance, knowing that their feedback could directly influence the quality of future sessions. Thus, their engagement was no longer driven solely by grades or attendance, but also by the perceived impact of their input on the learning environment. One student summarized this notion by stating: "Knowing that my voice could change something made me want to be there—actively involved."

The question "Did you notice any change in the teaching style as a result of the feedback provided through SFT?" brought to light the theme of pedagogical flexibility. Many students reported rapid adjustments in teaching methods, topics covered, or seminar pacing, which led them to perceive the course as responsive to the group's real needs, rather than delivered in a standardized format.

In response to the question "How do you compare this experience with other forms of evaluation or feedback in different courses?", students consistently emphasized the contextual relevance of the SFT platform, contrasting it with traditional forms of feedback such as end-of-semester surveys or occasional teacher observations. While conventional methods are often retrospective and rarely acted upon in a timely manner, SFT was perceived as a tool for real-time intervention, capable of generating concrete changes in seminar structure and dynamics. Students appreciated that the platform enabled "real-time adjustments" and provided a sense of responsibility and co-participation in the educational process. This feature of SFT was associated with a model of adaptive learning, where the pedagogical trajectory is built collaboratively, and student engagement is continually stimulated through responsive actions aligned with their evolving needs.

Moreover, some participants remarked that SFT promoted continuous learning, in contrast to traditional feedback mechanisms which, lacking a structured framework for application, are often ignored or perceived as mere administrative formalities. This distinction highlighted the difference between a student-centered educational approach and a bureaucratic, summative-oriented model. As such, the SFT experience was seen not as an external or decorative element, but as an integral part of the learning process.

Finally, in response to the question "What did you like most about this feedback method? What would you improve?", students highlighted the interactive, rhythmic, and collaborative nature of the platform. They appreciated that feedback was solicited regularly, in a structured and accessible format, which encouraged ongoing reflection on their own learning. Several voices emphasized that the moderate repetition of feedback opportunities helped them self-assess their involvement and articulate their

academic needs more clearly. Students reported experiencing a culture of dialogue within the seminar context, where their opinions were valued and considered. This, in turn, strengthened their sense of belonging and responsibility regarding their educational trajectory.

In addition to the positive evaluations, participants also proposed several suggestions for improvement. These included the introduction of open-ended feedback options (detailed textual comments), allowing for more nuanced expression of ideas, as well as the creation of a transparency section within the platform. Such a section would enable students to see how their feedback was concretely used—what suggestions were implemented, which pedagogical decisions were influenced, and to what extent their input had an impact. Some participants also suggested the inclusion of synthetic visualizations of collective feedback trends, reflecting recurring themes across the group. This feature would foster a form of collective awareness and mutual support. These enhancements could further emphasize the reflective and community-building value of the platform, strengthening its role not only as a pedagogical adjustment tool but also as a learning environment in itself.

The implementation of focus groups provided a valuable and in-depth perspective on how students perceive the integration of digital feedback technologies in the teaching–learning process. The qualitative analysis revealed that the Student Feedback Tool (SFT) is not viewed merely as a technological mechanism for gathering opinions, but rather as an essential driver of student engagement, autonomy development, and pedagogical relationship-building. Students consistently highlighted the platform's immediacy, adaptability, and collaborative nature, all of which contributed to heightened intrinsic motivation and a stronger sense of shared responsibility in the educational act.

Moreover, when compared to traditional forms of feedback, SFT was seen as offering significant added value, particularly in its capacity to influence the structure and content of academic activities in real time. Participants' suggestions for platform enhancement—such as the inclusion of open feedback fields and increased visibility of how suggestions are implemented—demonstrate a high level of reflective involvement and a willingness to co-construct the educational environment.

Therefore, the focus group findings were essential in validating the quantitative results and in deepening the understanding of the mechanisms through which digital feedback supports a more participatory, personalized, and student-centered university education—in alignment with the goals of a digital, inclusive European education area.

Limits

Although the results of the study indicate significant and promising effects of the Student Feedback Tool (SFT) in the university context, several methodological limitations must be acknowledged, as they may affect the interpretation and generalization of the findings.

First, the instruments used to measure academic motivation and students' perceptions of their learning experience relied primarily on self-report questionnaires. This approach may introduce subjectivity and self-assessment bias, particularly in relation to socially desirable responses or overestimation of one's own engagement. Although anonymity was ensured, the possibility cannot be entirely excluded that students provided responses aligned with perceived expectations from the researcher or instructor.

The risk of algorithmic bias must not be overlooked. If the platform prioritizes frequent or more assertive feedback, minority opinions, often expressed by more reserved or marginalized students, may be disregarded. Therefore, any automated analysis must be complemented by balanced pedagogical reflection to ensure the representativeness of all student voices.

The effectiveness of the intervention was strongly linked to the willingness and ability of instructors to adapt their teaching strategies based on the SFT data. This reliance introduces a potential confounding variable, as differences in instructors' engagement with the feedback process may have influenced student outcomes independently of the tool itself. Although both experimental and control groups were coordinated by instructors with comparable teaching experience and exposure to the same training session, perfect uniformity in the interpretation and use of feedback could not be guaranteed. Consequently, part of the observed effects may reflect instructor-related differences rather than the SFT mechanism alone.

Moreover, while the Student Feedback Tool was used to collect quantitative data on student engagement and perceptions, the current pilot study did not include a full analysis of the internal reliability of all questionnaire items administered via SFT. However, for a relevant subset of items focused on engagement and motivation, Cronbach's alpha was 0.84, indicating good internal consistency. Future research is encouraged to conduct a more rigorous assessment of the platform's psychometric structure and temporal stability (e.g., test–retest reliability).

Discussions

The use of the Student Feedback Tool (SFT) adds significant value to the educational process by enabling the continuous collection of student opinions and the real-time adjustment of teaching strategies. However, from a digital ethics perspective, it is essential to examine to what extent the data analysis processes adhere to the principles of algorithmic transparency, as defined in the specialized literature (Radanliev & Santos, 2023).

In the case of SFT, data analysis appears to be primarily conducted by instructors, supported by the visual and synthetic tools provided by the platform (e.g., average scores, thematic trends). Nevertheless, the exact manner in which these summaries are generated, whether algorithmically or manually, is not clearly specified, which may lead to confusion or the perception of "black-box" processing. Without a clear explanation, students cannot fully understand how their feedback concretely contributes to pedagogical adjustments.

Another important issue concerns students' access to the results of feedback interpretation. While focus group discussions indicate that students perceived the platform positively, they did not have direct access to how their responses were synthesized or acted upon. To align with the principles of algorithmic accountability and inclusion, it is recommended that the platform incorporate a visible section where students can view which concrete adjustments were made in response to their feedback.

The study was conducted on a sample of 200 first-year students enrolled in a faculty of social sciences and humanities, which limits the generalizability of the results to other academic domains, levels of study, or institutional types (e.g., technical universities, vocational education). Additionally, the effects of using the SFT platform were not tested in fully online or hybrid environments, but exclusively in face-to-face formats. Therefore, the external validity of the study is moderate, and caution is advised when extrapolating these findings to other educational contexts.

Moreover, the educational intervention was implemented in real-life classroom settings, which inherently involve multiple uncontrolled variables (e.g., differences in teaching styles, students' initial preparedness, instructors' attitudes toward feedback). Although both experimental and control groups were exposed to the same curricular objectives and similar types of activities, perfect replicability of the intervention cannot be guaranteed, this in itself constitutes a methodological limitation. Future research should consider testing the platform in more strictly controlled quasi-experimental settings in order to more accurately isolate the specific effects of SFT on learning outcomes.

These findings should be interpreted with caution, as the quality of the intervention depended not only on the technical features of the SFT platform but also on the degree to which instructors engaged with and acted upon the feedback. Prior research suggests that teacher responsiveness plays a critical role in determining the motivational impact of feedback tools (Winstone & Carless, 2019). Future studies should therefore consider strategies to control for instructor-related differences, for instance by standardizing the interpretation of data or by including multiple instructors across groups to mitigate bias.

The findings drawn from this experimental study support the formulation of several concrete and scientifically grounded directions aimed at guiding the implementation and valorization of digital feedback tools and other modern educational technologies, such as the Student Feedback Tool (SFT) in higher education settings.

A first recommendation concerns the systematic integration of digital feedback into instructional design, so that platforms of this type become structural and recurrent elements of the teaching process rather than isolated initiatives. This implies designing seminars and lectures based on iterative cycles of feedback and reflection, which enhance content adaptability and relevance while aligning pedagogical objectives with students' evolving needs.

International studies, such as those by Nicol & Macfarlane-Dick (2006) or Carless & Boud (2018), emphasize the importance of embedding formative feedback into the instructional framework. Their findings show that ongoing and interactive feedback fosters students' self-regulation and critical thinking, leading to deeper learning.

A second key recommendation is the development of university teachers' competencies regarding the interpretation and application of data derived from digital feedback platforms. It is advisable to include these themes in continuing professional development programs, so that instructors are prepared to use the data and analytics provided by Technology-Enhanced Learning (TEL) tools in a pedagogically meaningful way. In this respect, research by Winstone & Carless (2019) underscores the need for preparing educators to transform digital feedback into a two-way pedagogical dialogue, rather than a unidirectional evaluation mechanism.

It is equally essential to promote an institutional culture of feedback and participatory reflection, one that fosters active engagement and shared responsibility between students and educators in the teaching–learning process. Digital feedback should be perceived and valued as a central and legitimate element of education, stimulating critical engagement and helping

to build an adaptive and resilient learning community. Students should be encouraged and supported to contribute actively and responsibly to the continuous improvement of courses and seminars. As shown in the study by Leibold & Schwarz (2023) fostering a digital feedback culture significantly strengthens the student-teacher relationship and supports collective accountability for learning.

On the other hand, the extensive use of TEL and digital feedback must address issues of equity and accessibility. Clear strategies and institutional policies should be adopted to ensure equal access to digital platforms and resources for all students, including those from socioeconomically disadvantaged backgrounds or regions with limited digital infrastructure. Selwyn (2010) warns of the risks of digital exclusion in higher education and emphasizes the need for inclusive technology policies.

In addition, the implementation of TEL and AI-based tools must be accompanied by the development of a responsible and ethical framework. It is imperative to formulate and enforce policies that guarantee student data protection and prevent algorithmic biases and discrimination. In this regard, Prinsloo & Slade (2017) highlight the urgent need for ethical data governance in educational contexts, particularly when leveraging feedback and learning analytics platforms. Establishing transparent and participatory organizational cultures, rooted in shared accountability and the protection of individual dignity, is essential.

Finally, the integration of digital feedback tools and TEL platforms should be strategically aligned with a research-based learning (RBL) approach. The use of digital feedback and platform-generated analytics must directly support the adaptation and refinement of instructional and research activities, reinforcing the connection between theory and practice and enhancing student agency and engagement. This requires an integrative and iterative pedagogical model, positioning TEL and RBL as foundational pillars of a modern university education that meets the demands of a digital and inclusive European higher education landscape.

Conclusions

The findings of the study conducted over the course of the second semester indicate that the integration of educational technologies, particularly the Student Feedback Tool (SFT), has a significant and positive impact on the learning process in higher education. Specifically, the systematic use of this digital feedback platform led to a consistent increase in academic motivation, especially in its intrinsic dimension, among students in the experimental group. These students demonstrated greater engagement

during seminars, reported higher levels of satisfaction with their educational experience, and achieved superior academic performance compared to those in the control group. These results confirm the hypothesis that a student-centered learning environment, which emphasizes continuous feedback and reflective involvement, can substantially foster cognitive and affective engagement, as well as self-regulation and learner responsibility.

The correlations identified between motivational dimensions and seminar performance further strengthen the study's conclusions. Intrinsic motivation was strongly associated with higher academic outcomes in seminar assessments, whereas amotivation was found to be a negative predictor, diminishing both student engagement and the quality of their contributions. These findings are consistent with the Self-Determination Theory (Deci & Ryan, 2000), reinforcing the idea that an educational environment that supports autonomy, competence, and active participation contributes to academic success and nurtures a positive attitude toward learning.

The integration of a qualitative research component, through focus groups conducted with students from the experimental group, confirmed and deepened the quantitative insights. Participants described SFT as a valuable tool for expressing opinions, regulating learning, and personalizing the educational pathway. Their accounts included specific examples of how digital feedback prompted adaptations in seminar activities, encouraged active participation, and improved the student–instructor relationship. Beyond empirical validation, this qualitative perspective highlighted students' experiences in terms of perceived autonomy, recognition, and a sense of belonging, all essential elements of a modern and effective learning environment.

In an educational context marked by the ongoing transition toward digitalization, the findings of this study are relevant not only at the institutional level but also in relation to the broader goals of the European Education Area. The use of interactive digital tools that facilitate continuous feedback and reflective engagement directly supports the development of a connected, inclusive, and competency-oriented university education. In this regard, platforms such as SFT emerge as pedagogical mediators in the transformation of European educational culture, promoting a participatory and adaptive pedagogy aligned with the demands of an interconnected digital society.

Thus, the results of this study underscore the need for higher education policies to integrate technology not merely as an accessory tool, but as a core element of teaching structure and academic culture, supporting the formation of a reflective, autonomous, and engaged European citizen.

Statement on the Use of AI Tools |

This article was translated from Romanian into English with the assistance of ChatGPT (OpenAI, version GPT-4). The tool was used exclusively for translation and for refining certain informal linguistic structures to align with academic style. No artificial intelligence tools were employed in generating, analyzing, or shaping the scientific content of the manuscript, which remains entirely the work of the authors.

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