

Designing Educational Games in Higher Education: A Convergent Mixed-methods Pilot Evaluation of an Interdisciplinary Course on Game Design

Elwira Lewandowska¹, Martin Kuruc², Dusan D. Brezány², Klára Zubková³, Monika Cihlářová⁴ and Magdaléna Švecová⁴

¹Institute of Modern Languages, Faculty of Humanities and Social Sciences, University of Bielsko-Biala, Poland

²Institute of Pedagogy and Psychological Studies, Faculty of Pedagogy, Comenius University, Bratislava, Slovakia

³Department of Media Literacy, University of Ss. Cyril and Methodius in Trnava, Slovakia

⁴Department of Digital Games, University of Ss. Cyril and Methodius in Trnava, Slovakia

elewandowska@ubb.edu.pl

kuruc@fedu.uniba.sk

brezany1@uniba.sk

zubkova1@ucm.sk

cihlarova1@ucm.sk

magdalena.svecova@ucm.sk

Abstract: While many studies focus on the use of games as teaching tools, fewer examine the educational value of teaching students how to design educational games themselves. The *Learn to Play for the Future* project addresses this gap by developing and implementing an interdisciplinary international course focused on educational game design. The main objective of the course was to develop students' competencies in educational game design while fostering interdisciplinary collaboration and applied understanding of game-based learning principles. The course combined theoretical instruction on gamification, learning design, and game mechanics with project-based learning activities. Students worked in teams to design educational games, define learning goals and target audiences, develop gameplay mechanics, create prototypes, and conduct iterative playtesting. Both tabletop and digital game formats were explored depending on the institutional context. This paper presents a convergent mixed-methods pilot evaluation of the, said course and it combines pre- and post-course questionnaire data with reflective diaries and focus-group data in order to examine changes in students' perceptions, motivation, and readiness, and to understand their experiences of the game design process. The findings suggest that engaging students in the design of educational games can support the development of creative problem-solving skills, interdisciplinary collaboration, and deeper understanding of the relationship between gameplay mechanics and learning objectives. Students particularly valued hands-on prototyping and playtesting with real users. However, the evaluation also identified challenges related to time constraints, the complexity of concept development, and the need for clearer project milestones. The study contributes to current discussions on integrating game design and game-based learning into higher education curricula and offers practical insights for designing interdisciplinary courses that combine pedagogy, creativity, and digital innovation.

Keywords: Course evaluation, Educational game design, Game-based learning, Project-based learning

1. Introduction

In recent years, there has been a significant rise in interest in the use of both digital and non-digital games in the educational process. Games serve as a motivational tool (Prensky, 2005), but also as a way to support cognitive function and the development of soft skills and competencies in the 21st century (Barz et al., 2024). Game-based learning overlaps four perspectives: cognitive, affective, motivational, and sociocultural (Plass et al., 2015). In the academic environment, research focuses primarily on the effectiveness of games as ready-made teaching tools and positive effects on learning outcomes across domains, including science, language learning, and STEM education (Tsai and Tsai, 2020; Gui et al., 2023), as well as in developing creative thinking or problem solving (Hava et al., 2018). Similarly, research on gamification has shown to positively influence cognitive, motivational, and behavioural learning outcomes, although effect sizes are generally small to moderate and contingent on specific design features and learning contexts (Sailer and Homner, 2019; Luo, 2021). On the other side, less emphasis is placed on students and their role as educational game designers (Kafai & Burke, 2015), even though practice-oriented studies emphasize that the effectiveness of gamified and game-based approaches depends on design quality and meaningful integration, as superficial use may reduce their pedagogical value (Zakowicz and Sochacka, 2017; Sobociński, 2013). Research has shifted from questioning the effectiveness of these approaches to examining the conditions under which these approaches work best, highlighting the need to balance

cognitive, emotional, and social dimensions of learning (Greipl et al., 2020). It also shows that learning with games is shaped by broader instructional design, including preparation, scaffolding, and reflection (Bado, 2022).

As a result, there is comparatively limited understanding of how learning processes unfold within game-based educational activities. First, although recent meta-analyses call for a shift from proof-of-effectiveness research towards investigations of design features and learning mechanisms (Gui et al., 2023), empirical studies rarely examine how learners engage in the process of creating educational games. Students are predominantly conceptualized as users rather than designers, leaving the pedagogical potential of learning through game design underexplored. Second, while the importance of aligning game mechanics with pedagogical objectives is widely acknowledged (Luo, 2021), there is limited empirical evidence on how learners develop this competence in authentic educational settings. In particular, little is known about how students conceptualize the relationship between learning goals, target audiences, and gameplay mechanics during the design process. Third, although implementation challenges are well documented, including technical, pedagogical, and organizational barriers (Hayak and Avidov-Ungar, 2020; Marklund and Taylor, 2016), these are typically examined from the perspective of educators rather than learners. There is limited research on students' experiences and challenges in complex, design-based learning, especially within interdisciplinary educational game design. Existing studies rarely explore how cross-disciplinary collaboration shapes learning and problem-solving. Addressing these gaps, this study uses a mixed-methods approach to evaluate an international, interdisciplinary course on educational game design. It examines changes in students' perceptions, motivation, and readiness, as well as their experiences and challenges during the design process. By focusing on the process rather than just outcomes, the study provides new insights into how students develop skills in aligning learning goals, audiences, and gameplay mechanics.

2. Methodology

This study used a post-positivist paradigm, recognising that research findings are provisional and context-dependent (Creswell & Creswell, 2018). It adopted a convergent mixed-methods pilot design, where quantitative and qualitative data were collected simultaneously, analysed separately, and integrated to compare, complement, or explain findings (Creswell and Plano Clark, 2018). Integration enabled one data type to clarify or contextualise the other (Fetters, Curry and Creswell, 2013). The study combined pre- and post-course questionnaires, reflective diaries, and focus groups during an interdisciplinary course on Game-Based Learning (GBL) and Educational Game Design (EGD). The quantitative component followed a one-group pre-test/post-test structure, while the qualitative component included diaries and structured focus groups. The main aim was to examine how participation influenced students' perceptions of GBL/EGD, their motivation, perceived readiness, and experiences of the game design process, as well as to evaluate the quality of the new course syllabi.

To achieve the aforementioned aims, the following research questions were created in the course of the study:

RQ1. How do students' perceptions of the pedagogical value and usefulness of GBL/EGD change after participation in the course?

RQ2. How does participation in the course change students' motivation to use or design educational games in their future professional practice?

RQ3. How does participation in the course change students' perceived readiness to implement GBL or develop educational games?

RQ4. What benefits, challenges, and improvement needs do students identify in relation to interdisciplinary educational game design courses?

2.1 Participants and Context

The intervention used two parallel syllabi from the *Learn to Play for Future* project: one for future teachers (FT), one for future game developers (FD). Both covered Game-Based Learning (GBL), Gamification Techniques (GT), Educational Game Design (EGD), instructional design, engagement, relevance, prototyping, playtesting, inclusive design, and peer evaluation. Students developed educational game prototypes through workshops and group activities. The FT syllabus focused on classroom application and pedagogy, while the FD syllabus emphasized game design for educational purposes.

Table 1: Participants' background

Category	Future Teachers (UBB, CUBA)	Future Game Developers (UCM)
Total participants	Pre-course: 29 Post-course: 16	Pre-course: 33 Post-course: 24
Field of study	Pedagogy-related programmes	Game development programmes
Gender distribution	Predominantly female (23 F; 6 M)	Predominantly male (24 M; 8 F; 1 O)
Age range	Mostly 25 - 29	Mostly 25 - 29
Study level	Mainly undergraduate & master's	Master
Prior experience (GBL/GM)	limited	limited

2.2 Data Collection Methods

Quantitative data were collected through pre- and post-course questionnaires for pre-service teachers and future game developers. Both versions included demographics and Likert-scale items (1–5) across four dimensions: Perception of GBL, Motivation, Readiness, and Syllabus Evaluation. Items were adapted for each group, making the questionnaires parallel but not psychometrically equivalent. Pre-service teachers' questionnaires had 11 repeated items (3 perception, 5 motivation, 3 readiness) and 11 post-course syllabus items. Game developers' questionnaires had 20 repeated items (4 perception, 9 motivation, 6 readiness) and 5 syllabus items. Both instruments were informed by Self-Determination Theory (Deci & Ryan, 1985; Ryan & Deci, 2000) and the Technology Acceptance Model (Davis, 1989; Venkatesh & Davis, 2000). Each instrument included 4 reverse-coded items, re-coded before scoring. Cronbach's alpha showed acceptable to good reliability for pre-service teachers (Perception $\alpha = .79$, Readiness $\alpha = .71$, Motivation $\alpha = .87$, Syllabus $\alpha = .85$) and for game developers (Perception $\alpha = .76$, Motivation $\alpha = .70$, Syllabus $\alpha = .71$), but low for developers' Readiness ($\alpha = .49$). No factor analysis was conducted due to small sample size, so results are exploratory self-report indicators. Qualitative data were collected through students' reflective diaries completed during the course. The diary template consisted of eleven sections covering lesson content, personal reflection, learning outcomes, questions and doubts, plans for the next lesson, lecturer support, teamwork, workload, project progress, resources and inspiration, and playtesting. These prompts were designed to elicit reflections on students' perceptions, motivation, readiness, and challenges during the educational game design process. In total, 197 reflective-diary entries from 61 students were analysed. The teacher cohort contributed 126 entries from 25 students: 22 entries from 5 UBB students and 104 entries from 20 CUBA students. The future game-developer cohort contributed 71 entries from 33 UCM students. The diary material covered six UBB journal rounds, eleven CUBA journal rounds, and five UCM journal rounds. Because the number of submitted entries varied across students and course weeks, the diaries were treated as process-oriented qualitative evidence rather than as a balanced longitudinal dataset. The diary data were analysed thematically, using a primarily deductive coding procedure based on the research questions, questionnaire constructs, and diary structure. The process followed the project coding guide, which included pre-coding, initial coding, code-list development, code refinement, reliability checking, second-level coding, and theme construction. This procedure is consistent with thematic analysis and qualitative coding approaches described by Braun and Clarke (2006) and Miles et al. (2014). Because diary entries varied in length and regularity, they were treated as reflective qualitative evidence rather than as a balanced longitudinal dataset. This limitation was considered when interpreting the findings.

Focus groups were conducted at the end of the course to collect students' collective reflections on the GBL/EGD course. Each group, guided by a moderator, discussed course strengths, challenges, improvement ideas, and shared anonymised quotations. Topics included pedagogy, game design, teamwork, feedback, and assessment. Notes were thematically analysed using categories from the research questions, focusing on perceptions, motivation, readiness, challenges, and improvement needs.

3. Results

Results are reported in three stages: (1) quantitative questionnaire findings on perceptions, motivation, readiness, and syllabus assessment; (2) thematic analysis of reflective diaries on course and game design experiences; and (3) focus-group synthesis of course strengths, challenges, and improvements. These provide an integrated view of changes and learning processes. In relation to the first research question, the results are as follows:

RQ1. How do students' perceptions of the pedagogical value and usefulness of GBL/EGD change after participation in the course?

Table 2: Changes in perceptions before and after the GBL/EGD course

Group	Construct	Pre N	Pre-course Mean	Pre SD	Pre Median	Post N	Post-course Mean	Post SD	Post Median
Pedagogy group	Perceptions of GBL	29	3.92	1.04	4.3	16	4.52	0.54	4.7
Designer group		33	3.55	0.93	3.0	24	3.38	1.10	3.0

Note: Pre- and post-course N are reported separately because the number of valid responses differed across measurement points. For that reason Welch's independent-samples t-tests were used, as individual-level matching was not available for all participants.

Among future teachers, mean perceptions of GBL were higher in the post-course sample than in the pre-course sample. At an item level, all three perception indicators increased. This suggests that, after the course, future teachers were more likely to view GBL as contributing not only to engagement but also to learning. In the game-developer group, perceptions of educational game development were slightly lower in the post-course sample than in the pre-course sample. The perceptions of future game developers should, therefore, be interpreted as broadly stable, with no reliable evidence of a pre/post difference in this construct.

Reflective journals showed that pre-service teachers shifted from early enthusiasm to a more design-focused understanding of educational game design. Initially, students found the course motivating, but soon recognized the complexity of making games that support learning. Over time, reflections referenced learning objectives, player experience, game mechanics, feedback, and playtesting. Students realized that designing educational games is more than adding playful elements—it requires clear goals, careful planning, and alignment with target groups. By the end, students saw games not just as fun activities, but as structured educational systems that must intentionally connect pedagogy, learner needs, and gameplay.

For future game developers, the data revealed a more critical perspective. Some students questioned whether educational games must target children or be tested in schools, and even whether a clear definition of an educational game exists. This growing awareness of complexity may explain why perceptions did not increase: students became more aware of the challenges, but not more convinced of the value or feasibility of educational game design.

The second research question addressed the second dimension of the study, namely motivation to use or design educational games. The table below presents the quantitative findings:

Table 3: Changes in motivation before and after the GBL/EGD course

Group	Construct	Pre N	Pre-course Mean	Pre SD	Pre Median	Post N	Post-course Mean	Post SD	Post Median
Pedagogy group	Motivation to use/design educational games	29	3.77	1.03	3.8	16	4.18	0.75	4.2
Designer group		33	2.98	1.11	3.0	24	2.91	1.26	3.0

Note: As in the case of the previous construct, pre- and post-course N are reported separately because the number of valid responses differed across measurement points. For that reason, Welch's independent-samples t-tests were used, as individual-level matching was not available for all participants.

Quantitatively, the results indicate slightly different motivational patterns in the two cohorts. In the pedagogy group, the mean motivation score was higher in the post-course sample than in the pre-course sample. Increased median suggests a possible positive group-level tendency, with post-course responses being not only more favourable but also more consistent. However, the observed increase of 0.41 points was not statistically significant, $t(39.53) = -1.53$, $p = .134$, Cohen's $d = 0.44$. Therefore, this result is interpreted as a descriptive trend, not as reliable evidence of change. In the game-design group, motivation was slightly lower in the post-course sample than in the pre-course sample. The median level suggests that the overall motivational level remained moderate, but that responses became more dispersed after the course. The observed difference was not statistically significant, $t(45.80) = 0.22$, $p = .829$, Cohen's $d = -0.06$, indicating no reliable evidence of a pre/post difference in motivation among future game developers. What follows is that the intervention seems to have not produced a statistically significant motivational change in either cohort.

Qualitative results showed that, for pre-service teachers, motivation was highest during practical, creative, and collaborative activities, especially when lessons balanced theory with hands-on work. Students felt inspired when clear examples and explanations were provided, describing early sessions as enriching and motivating. However, motivation was not automatic; several teachers wanted more practical examples and opportunities to see or try educational games, indicating that enthusiasm increased as the course moved from theory to design activities.

For future game developers, reflective journals indicated a slight decline in motivation, attributed to the course's demanding nature, unclear expectations, and workload that conflicted with other academic obligations. Some students found arranging school-based playtesting difficult alongside thesis work and exams, and wanted more practical support instead of theoretical lectures. Focus group feedback confirmed these patterns: both groups valued teamwork, playtesting, and the chance to create meaningful games, but motivation was weakened by time pressure, inconsistent feedback, and unclear instructions. While some students expressed intentions to use games in their future work, others reported that balancing perfectionism and academic workload created additional pressure and sometimes reduced motivation. Overall, qualitative data highlight the importance of practical engagement and clear guidance.

In relation with the last research question, which assessed students' readiness to implement GBL or develop educational games, the quantitative results are as follows:

Table 4: Changes in readiness before and after the GBL/EGD course

Group	Construct	Pre N	Pre-course Mean	Pre SD	Pre Median	Post N	Post-course Mean	Post SD	Post Median
Pedagogy group	Readiness for future implementation	29	3.30	0.98	3.33	16	4.02	0.78	4.17
Designer group		33	3.21	1.12	3.00	24	3.39	1.14	3.50

Note: As in the case of the previous construct, pre- and post-course N are reported separately because the number of valid responses differed across measurement points. For that reason, Welch's independent-samples t-tests were used, as individual-level matching was not available for all participants.

Among future teachers, the mean readiness score was higher in the post-course sample than in the pre-course sample, increasing from $M = 3.30$ to $M = 4.02$. Among future game developers, the increase was more modest, from $M = 3.21$ to $M = 3.39$. Although higher post-course readiness scores were observed in both groups, only the difference in the pedagogy group was statistically significant, $t(37.33) = -2.70$, $p = .010$, Cohen's $d = 0.79$. This indicates a moderate-to-large group-level difference and suggests a positive tendency in future teachers' perceived readiness to apply GBL or educational game design in future practice. In the game-developer group, the difference was not statistically significant, $t(49.20) = -0.59$, $p = .556$, Cohen's $d = 0.16$. This indicates only a small descriptive increase and no reliable evidence of a pre/post difference. Overall, the quantitative evidence points to a clearer readiness-related tendency among future teachers than among future game developers.

Qualitative findings show readiness improved mainly through practice. Future teachers learned to define educational goals, target groups, and player experiences, and valued quick prototyping over overthinking. Reflections highlighted the need to tailor games to specific learner needs and supported the observed rise in readiness. For future game developers, readiness also increased, though some challenges remained. Students

appreciated the importance of playtesting, feedback, and balancing engagement with educational value, aligning with quantitative gains in readiness and instructional design.

Finally, the last research question was as follows:

RQ4. What benefits, challenges, and improvement needs do students identify in relation to interdisciplinary educational game design?

Both cohorts evaluated the syllabus design moderately positively, as presented on the figure below:

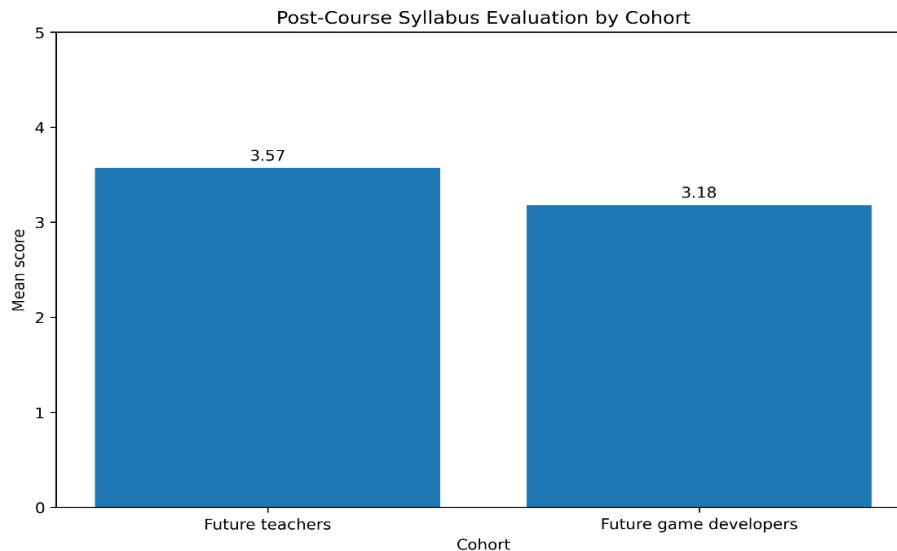


Figure 1: Post-course syllabus evaluation by cohort

The pedagogy group reported a somewhat stronger and more consistent evaluation of the group ($M = 3.37$, $SD = 1.22$, Median = 4.00) than the designer group ($M = 3.18$, $SD = 1.13$, Median = 3.00). The higher standard deviation in the designer group indicates greater variability in how future game developers experienced the syllabus, which aligns with the qualitative findings concerning differing expectations, workload, and the balance between tabletop and digital game design. Qualitative data showed students valued practical creation, teamwork, feedback, playtesting, and supportive lecturers. Challenges included time pressure, unclear expectations, need for more examples, and inconsistent feedback. Students asked for more mentoring, clearer structure, and practical support. Focus groups recommended clearer instructions, structured playtesting, more feedback, longer courses, clearer milestones, and choice of game format (digital or tabletop).

4. Discussion

Quantitative and qualitative results were integrated through a joint-display matrix. For each construct, the authors compared the direction of quantitative change with qualitative themes. Findings were classified as convergent, complementary, or divergent. Integrated interpretations were then developed as meta-inferences. Below is the summary of the findings:

Table 5: Integrated interpretation across strands

Construct assessed	Quantitative results	Reflective journal results	Focus group results	Integrated findings
Perception	Increased among teachers; developers slightly declined.	Teachers moved from enthusiasm to pedagogical design awareness; developers became more critical.	Students valued GBL/EGD when linked to practical use, children, culture, and real contexts.	Perceptions became more sophisticated; more positive for teachers, more critical for developers.
Motivation	Teachers increased; developers slightly declined.	Motivation rose during hands-on creation and teamwork; declined with overload or unclear tasks.	Creation, teamwork, and playtesting motivated; feedback/time pressure demotivated.	Motivation depended on practical ownership, support, and feasibility.

Construct assessed	Quantitative results	Reflective journal results	Focus group results	Integrated findings
Readiness	Both cohorts increased; teachers more significantly.	Readiness developed through target-group thinking, prototyping, testing, and feedback.	Playtesting and feedback supported readiness; unclear expectations limited it.	Readiness emerged through iterative practice.
Course design	Post-course evaluation moderate - positive. The syllabus is rated useful but demanding.	Alignment of goals, users, mechanics, and experience emerged as the central learning challenge	Request for clearer concept-to-prototype milestones. Benefits: practical work and playtesting; challenges: time, feedback, instructions.	Alignment was the core learning challenge. The course was valuable but needs stronger scaffolding.

The findings suggest that students, especially future teachers, developed a more professional understanding of educational games. The course did more than boost enthusiasm; it helped students grasp what makes games usable in education and why achieving such usability is challenging. This supports studies showing educational game use is limited by organizational, technical, pedagogical, and time-related barriers (Hayak and Avidov-Ungar, 2020; Marklund & Taylor, 2016). While the educational role of games is discussed, less is known about preparing future teachers and developers to create and implement educational games. Future teachers often lack design knowledge, while future developers may lack pedagogical skills. The course aimed to bridge this gap by teaching both groups through hands-on educational game design.

For future teachers, the course clarified the logic behind educational game design, shifting their view from games as merely engaging tools to structured educational systems with clear goals, mechanics, and feedback. For future game developers, it revealed the pedagogical complexity of designing learning games, leading to greater awareness of the need for alignment with real educational contexts. The process-oriented approach allowed students to experience challenges and benefits firsthand, supporting research that stresses the importance of aligning game mechanics with learning goals (Plass et al., 2015; Bado, 2022) and echoes constructionist views on learning through creating games (Kafai & Burke, 2015).

5. Conclusions

A key contribution of the study is that it shows how learning emerges through the process of designing educational games. Students learned not only by receiving information about GBL/EGD, but by making design decisions, encountering problems, testing prototypes, and responding to feedback. This directly addresses the need for more process-oriented research on GBL and educational game design. The findings also show that playtesting is central to learning. It helped students understand whether their games worked, whether rules were clear, whether users were engaged, and whether the educational purpose was visible. In this sense, playtesting connected perception, motivation, and readiness. Finally, the study highlights the importance of scaffolding. Students need clear milestones, examples, templates, feedback protocols, and realistic timelines. Without these, educational game design can become overwhelming, particularly for students who are unfamiliar with either pedagogy or game development.

At the same time, the pilot character of the study is important. The course should be understood as a first implementation cycle rather than as a finished model. The findings show that students can develop a deeper understanding of educational game design through practice, but also that this process requires stronger scaffolding than initially assumed. Clearer milestones, more examples, structured feedback, differentiated pathways for tabletop and digital formats, and more realistic expectations for playtesting are needed. These lessons will inform the second cycle of the game-based courses and support further refinement of the interdisciplinary model.

6. Limitations

This study has several limitations, especially in light of the fact that it is a pilot for a larger methodological implementation. First, it was an exploratory pilot evaluation conducted with naturally occurring course groups, without random assignment or a control group. Therefore, the findings should be interpreted as indicative rather than causal. Second, not all pre- and post-course questionnaire responses could be matched at the individual level, so Welch's independent-samples t-tests were used. This allowed group-level comparison but limited the precision of the pre/post analysis. Third, the adapted questionnaire was theoretically informed by IMI and TAM and showed mostly acceptable reliability, but its factor structure was not tested because of the limited sample

size. Finally, the qualitative diary data varied in length and regularity across participants, and both diaries and focus groups relied on self-reported experiences. Future research should use larger matched samples, validated instruments, and, where possible, assessment of the educational quality and learning impact of the games produced.

Acknowledgement

The study is a partial outcome of the project 2024-1-SK01-KA220-HED-000252451 Learn to Play for the Future financed by Erasmus+ KA220 programme. The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Ethics Declaration: This research was subject to ethical review and received approval from the Ethical Committee for Science and Research at the Faculty of Mass Media Communication, University of Ss. Cyril and Methodius in Trnava, Slovakia. The ethical evaluation was conducted on April 10, 2025, under reference number 2025/FMK-UCM/02. The committee confirmed that the research complies with the faculty's Code of Ethics, including standards for informed consent, anonymity, confidentiality, and participants' right to withdraw at any time.

AI Declaration: AI tools were used in the preparation of this paper. Specifically, AI was employed for preliminary qualitative analysis of the reflective journals to support the identification of emerging themes. Additionally, AI tools were used for final proofreading, stylistic editing, and assistance in identifying relevant related literature. The DeepL tool was used for translation purposes. All outputs generated by AI tools were carefully reviewed, validated, and interpreted by the authors. The authors take full responsibility for the content of the final manuscript.

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