Enhancing Learning with Gamification: Empowering Students in Web Development Education

Patrizia Sailer[1,2][a], Thomas Kremsner[3][b], Franz Knipp[1,2][c] and Fares Kayali[4][d]

[1] Department of Information Technology, University of Applied Sciences Burgenland, Campus 1, Eisenstadt, Austria

[2] Doctoral School Computer Sciences, University of Vienna, Waehringerstrasse 29, Vienna, Austria

[3] Energy Transistion, Forschung Burgenland, Campus 1, Eisenstadt, Austria

[4] Centre for Teacher Education, University of Vienna, Porzellangasse 4, Vienna, Austria

{patrizia.sailer, thomas.kremsner, franz.knipp}@hochschule-burgenland.at, fares.kayali@univie.ac.at

Keywords: Web Development Education, Eye-Tracking, Human-Centered-Design, Gamified Learning Platform.

Abstract: Digitalization has transformed educational practices, extending its impact to non-technical fields by incorporating technical subjects such as web development. Students from diverse backgrounds frequently encounter difficulties when attempting to learn web development, often experiencing feelings of being overwhelmed and frustrated. This study aimed to address student challenges by identifying their needs and developing a supportive tool to enhance their learning experience in web development. Therefore, human-centered design was used to conduct preliminary interviews with the students in order gain deeper insights into their perceptions on how to enhance their learning experience. In response to this feedback, a gamified learning platform (GLP) was designed and developed. Subsequently, the same group of students evaluated the GLP through interviews, questionnaires and eye-tracking analyses. The evaluation indicated that students perceived the GLP to be a valuable supplementary tool, although not a comprehensive substitute for conventional methods. The findings suggest that refining the GLP, e.g. modifying the color scheme, and integrating it with approaches like flipped classroom could lead to enhanced learning outcomes in subsequent semesters. This study underscores the importance of student-centered design in developing effective educational tools for technical subjects.

SCIENCE AND TECHNOLOGY PUBLICATIONS

1 INTRODUCTION

In the contemporary era, the multiplicity of academic pathways in domains such as technology, business, environmental science or health care affords students the flexibility to pursue an educational program that aligns with their individual interests and aptitudes. However, many non-technical degree programs include technical disciplines such as web development as components of their curriculum, despite the fact that these programmes do not specialize in a technical field. Consequently, they enter these courses with disparate backgrounds and prior knowledge, which presents a challenging aspect for lecturers. In order to meet the diverse learning needs of the students, it is essential to consider their individual requirements.

However, given the limited teaching time, which rarely allows for intensive individual support, alternative approaches are required. In a previous study (Sailer, 2024), ten affected students were interviewed to identify the difficulties they experience when learning web development and to suggest approaches they would find helpful. This revealed that a personalized gamified learning platform (GLP) could be a promising solution. The key needs and expectations of students were identified on the basis of the survey results. These include specific requirements for a GLP that provides assistance in challenging subject areas and motivation through gamification elements.

In order to satisfy the stated requirements, a prestudy of various learning platforms for web development was conducted, which revealed that they frequently failed to meet the essential criteria. For instance, a considerable number of courses are financially inaccessible to students, the content diverges from the curriculum and essential thematic elements are absent. As the existing platforms failed to meet the desired specifications, it was resolved that a new GLP would be developed.

[a] https://orcid.org/0000-0001-7833-9475
[b] https://orcid.org/0000-0001-7387-1913
[c] https://orcid.org/0009-0002-1811-9782
[d] https://orcid.org/0000-0002-0896-4715

Sailer, P., Kremsner, T., Knipp, F. and Kayali, F.
Enhancing Learning with Gamification: Empowering Students in Web Development Education.
DOI: 10.5220/0013354800003932
Paper published under CC license (CC BY-NC-ND 4.0)
In *Proceedings of the 17th International Conference on Computer Supported Education (CSEDU 2025) - Volume 2*, pages 557-568
ISBN: 978-989-758-746-7; ISSN: 2184-5026
Proceedings Copyright © 2025 by SCITEPRESS – Science and Technology Publications, Lda.

The aim of this platform is to improve the quality of educational resources, while advancing Sustainable Development Goal 4 Quality Education, through the provision of personalized learning content tailored to meet the diverse needs of learners (Alcántara-Rubio et al., 2022). Therefore, this study aims to investigate the impact of implementing a gamified learning platform based on iterative feedback from students on its perceived usability, usefulness, user experience and acceptance among the same students.

2 RELATED WORK

2.1 Gamification in Higher Education

Gamification in higher education effectively enhances engagement, motivation and skill acquisition (Giang, 2013; Kiryakova et al., 2014). Furthermore, the research findings indicate the beneficial impact of gamification across a range of disciplines, with particular advantages observed in IT education. These include enhanced participation, problem-solving abilities and satisfaction (Iosup and Epema, 2014; Pal̆ová and Vejačka, 2022). By incorporating elements like points, levels or badges, it creates personalized, interactive learning experiences that improve pass rates and comprehension of complex content (Iosup and Epema, 2014; O'Donovan et al., 2013). An example is a meme contest in a database administration course, which used gamification elements to reinforce knowledge, foster creativity and promote social interaction (López-Fernández et al., 2023). Learning management systems (LMS) like Moodle employ gamification to provide learners with learning pathways and adaptive feedback, which serves to enhance motivation (Poondej and Lerdpornkulrat, 2019).

However, challenges such as technical issues, negative stereotypes and potential counterproductive effects highlight the necessity for a cautious approach to implementation (Nurutdinova et al., 2021; Blštáková and Piwowar-Sulej, 2019). Effective implementations are contingent upon meaningful and well-structured designs that are responsive to the diverse needs of learners (Algashami et al., 2018), including learning styles to maximize educational impact (Soepriyanto et al., 2022; Oliveira et al., 2023; Khaldi et al., 2023). Further challenges are the potential for negative classroom dynamics, learner apathy and ethical concerns (Almeida et al., 2023). It is important to consider ethical implications, including the management of performance pressures and social risks, in order to guarantee student welfare and optimize educational outcomes (Blštáková and Piwowar-Sulej, 2019).

2.2 Eye-Movements and Emotions

Emotions are a crucial element in the learning process, affecting factors such as motivation, engagement and outcomes that extend beyond the scope of rational decision-making. It has been proven that positive emotions facilitate memory, a phenomenon that can be described as emotional design (Mayer and Estrella, 2014; Alemdag and Cagiltay, 2018). The visual elements of a learning environment, including layout, color and overall design, have been shown to influence learners' emotional responses and engagement (Heidig et al., 2015). For example, studies have demonstrated that warm colors, rounded shapes, and human-like avatars with expressive facial features can evoke positive emotions, which in turn enhance learning outcomes (Uzun and Yıldırım, 2018; Um et al., 2012). In contrast, designs that are neutral or purely decorative can evoke neutral or distracting emotions, which may reduce motivation (Mikheeva et al., 2021; Schneider et al., 2016). Additionally, research has indicated that emotional intensity is associated with content retention, further emphasizing the importance of design choices that appeal to learners' emotions and attention (Genç Aksaray and Ozcelik, 2023).

To assess such emotional impacts, eye-tracking represents a method for evaluating the efficacy of learning platform designs. It analyzes visual attention through eye movements and offers insights into emotional responses. Research indicates that design elements such as color coding can facilitate learning by enabling users to swiftly identify pivotal elements, thereby promoting efficient information processing (Molina et al., 2024; Ozcelik et al., 2009). The use of positive features, such as anthropomorphic illustrations has been demonstrated to attract attention and focus on relevant content (Peng et al., 2021). In particular, graphics with instructional value are more effective than decorative ones, with dynamic visuals capturing more attention than static ones (Sung and Mayer, 2012; Alemdag and Cagiltay, 2018).

2.3 Research Gap

The studies discussed highlight the efficacy of gamification in enhancing learning and motivation in technical subjects. However, there is a research gap in its application to web development education, which involves unique challenges like mastering responsive design. Additionally, an evaluation of existing learning platforms reveals limitations, such as a lack of personalized feedback, adaptive learning paths and task-specific support. This gap underscores the need for a GLP designed for web development education.

3 METHODOLOGY

3.1 Human-Centred Design

Human-centred design (HCD) is a creative approach to problem-solving that seeks to achieve a balance between human desirability, technological feasibility and economic viability. HCD was originally developed in fields such as computer science, visual design and architecture. It has since been extended beyond user-centred design to encompass a wide array of products and services. The process is structured into three principal phases: inspiration, ideation and implementation (IDEO, 2015; Dam, 2024). The inspiration phase is concerned with the development of empathy through the undertaking of research and the identification of users' needs. This is followed by the definition of the specific problems and requirements, which ensures a clear understanding of the challenges to be addressed. In the ideation phase, creative solutions are generated to address the defined needs and problems, with a particular emphasis on brainstorming and idea generation to explore a range of potential approaches. A crucial element of this phase is the creation of a prototype, which serves as a concrete representation of the proposed solutions and facilitates further development. Finally, the implementation phase entails evaluating the prototype's effectiveness through testing, incorporating direct feedback from users to refine the solution and ensure it aligns with their expectations and needs. Through these phases, HCD provides a systematic framework for developing innovative and user-centric solutions.

In this research, HCD is applied in a classroom setting where lecturers design courses, students participate and provide feedback. This feedback is used to continuously improve the courses, see Figure 1. This iterative process ensures ongoing alignment with student needs and continuous course improvement.

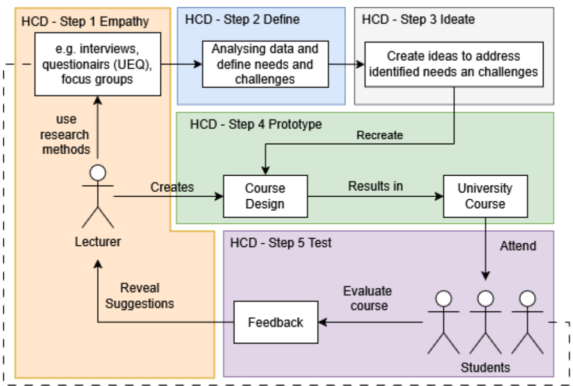

Figure 1: Visualization of the use of Human-Centred Design (Authors own creation).

3.2 Method Triangulation

This study employs a triangulation of semi-structured interviews, the Technology Acceptance Model (TAM), the User Experience Questionnaire (UEQ) and eye-tracking to provide a comprehensive analysis of user interactions. By integrating these methods, the research delivers a holistic understanding of user behavior, motivation and satisfaction, enabling informed and effective product design and evaluation.

Semi-structured interviews combine standardized questions with open-ended flexibility, allowing for in-depth exploration of complex phenomena while maintaining consistency through the use of an interview guide (Magaldi and Berler, 2020). The collected data was analyzed systematically using Kuckartz's content analysis approach, supported by the qualitative analysis tool MAXQDA (Kuckartz and Rädiker, 2024), ensuring a structured and rigorous interpretation.

The TAM is a robust framework for predicting user acceptance of technology (Davis et al., 1989) as shown in Figure 2. It identifies two primary determinants: perceived usefulness (the belief that a system enhances performance) and perceived ease of use (the belief that the system is user-friendly). These factors shape users' attitudes, intentions and usage behavior. TAM has been widely applied across domains such as education, healthcare and business (Marangunić and Granić, 2015; Davis et al., 1989).

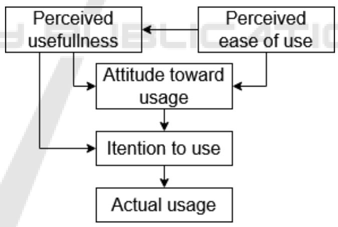

Figure 2: Visualization of the Technology Acceptence Model according to Alomary and Woolard, 2015.

The UEQ evaluates interactive products across six dimensions: attractiveness, perspicuity, efficiency, dependability, stimulation and novelty. This standardized tool captures both pragmatic (task-oriented) and hedonic (pleasure-oriented) aspects of user experience, aiding in product comparisons and identifying areas for improvement (Schrepp, 2015). Widely used in usability studies, the UEQ provides actionable data for enhancing user satisfaction and engagement.

For the usability testing eye-tracking is used. This is a method of measuring participants' eye movements, including the areas of a website that are viewed reagrding order and time (Molina et al., 2024). It offers insights into engaging or confusing parts of a website (Hyönä, 2010).

SCIENCE AND TECHNOLOGY PUBLICATIONS

4 GAMIFIED LEARNING PLATFORM gAmIcode

This section introduces the GLP gAmIcode, named to highlight its combination of gamified elements with coding and its planned integration of AI-driven feedback in the future.

4.1 Requirements

A previous study (Sailer, 2024) explored the experiences of ten non-technical students from a web development class, identifying ways to enhance the learning process. A key outcome was the concept of a GLP designed to address their challenges. The students provided detailed requirements guiding in developing a GLP, which aligns with their needs and preferences.

The GLP must be intuitive, user-friendly and responsive for multi-device-usage, offering personalized learning paths based on prior knowledge and learning types. It should integrate practical, realistic challenges with interactive elements and immediate feedback to foster engagement. Core gamification features, like points, levels, badges, progress indicators and leaderboards, are essential. To reduce stress, leaderboards should be optional or anonymous. Social tools like forums can promote collaboration and a sense of community. The platform should provide regular, constructive feedback, complemented by tutorials and videos. Challenges should motivate voluntary, creative engagement. An integrated code editor is essential to avoid reliance on external tools. The platform must support LMS integration and have a scalable design to accommodate future growth.

4.2 Structure of gAmIcode

Once the requirements had been defined, the development of gAmIcode started. Integrated into the university's LMS via the Learning Tools Interoperability standard, the platform enables a seamless login experience as requested during the requirement gathering phase. Furthermore, it supports the transfer of course context and facilitates the transmission of grading results back to the LMS without requiring additional credentials. To facilitate intuitive navigation, the platform features seven subpages, as shown in Figure 3.

Upon logging in, students see an overview page summarizing recent activity, badges earned and rankings, as shown in Figure 4. The course page lists available courses with progress indicators, while the course detail page provides course structure, exercises and badges. The ranking page, which looks similar to the leaderboard on the overview page, includes an

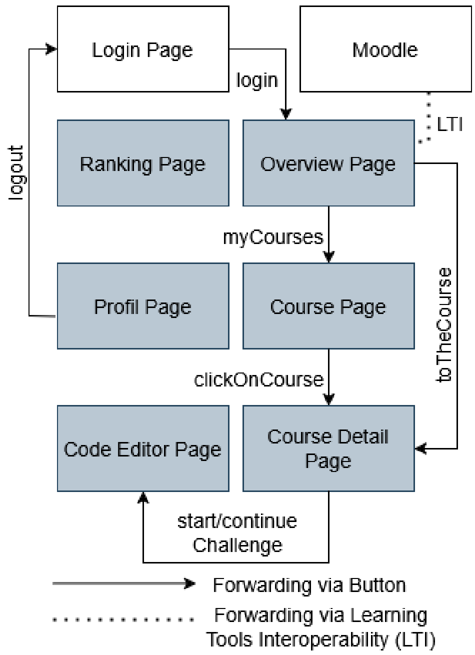

Figure 3: Subpages of gAmIcode and their interaction via buttons. The grey-shaded subpages indicate sections where navigation is possible from any other grey-shaded page through the menu (Authors own creation).

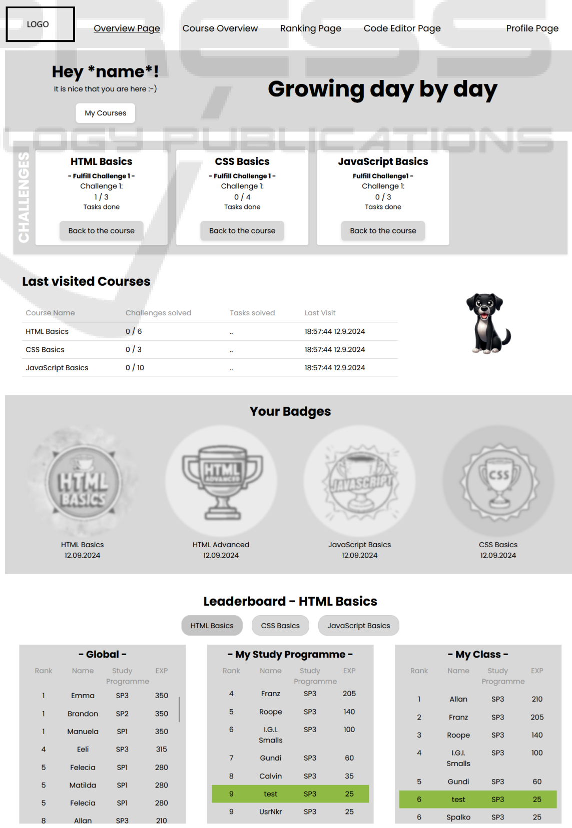

Figure 4: gAmIcode - Overview Page.

SCITEPRESS SCIENCE AND TECHNOLOGY PUBLICATIONS

additonal opt-out option for students. The integrated code editor page enables users to edit project files, preview web pages and verify solutions, thereby facilitating hands-on learning. Feedback is provided immediately after task completion, confirming success or highlighting issues for revision. The profile page allows users to personalize settings, including nicknames for anonymous leaderboard participation.

4.3 Evaluation of gAmIcode

In order to evaluate the user experience of gAmIcode, a usability test was conducted. This section provides a detailed description of the procedure.

4.3.1 Setup and Participants

Building on a prior evaluation of 57 students from non-technical web development classes, ten volunteers participated in semi-structured interviews to define platform requirements. These same students were later invited to test the platform after its development. Due to scheduling conflicts only eight participated in usability testing. Although the sample size was small, it was sufficient to uncover most usability issues, as five participants can identify about 85% of problems (Nielsen and Landauer, 1993). Sessions averaged 45 minutes, including setup, eye-tracking and post-test interviews, with adjustments made after a pre-test to refine the methodology.

In this study, the Smart Eye AI-X eye tracker (60 Hz) was used, offering greater accuracy compared to traditional methods such as observation (Alemdag and Cagiltay, 2018). The UI testing is conducted using iMotions 10.0, which integrated eye-tracking, facial expression analysis and galvanic skin response (GSR), see Figure 5. iMotions heat maps highlighted visual focus, with red for high, yellow for medium and green for low attention (Raschke et al., 2014).

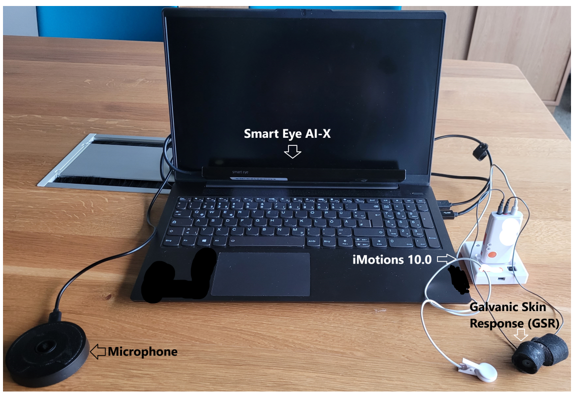

Figure 5: Setup Eye-Tracking.

In the interviews, participants shared their impressions of gAmIcode, discussing what they liked, disliked, and found engaging. They identified favorite features and suggested missing elements to improve the platform. This feedback provided valuable insights into user preferences, uncover potential pain points, and identify opportunities for improvement. By exploring both positive and negative feedback, the interviews provided a comprehensive understanding of user needs and expectations, serving as a foundation for refining gAmIcode's design and functionality.

4.3.2 Conduct Usability Tests

The eight participants of the usability study had to complete a structured series of tasks designed to evaluate the platform's usability and functionality. These tasks, outlined in Table 1, included navigating the platform, updating personal settings, accessing and interacting with the leaderboard, starting a course and completing programming exercises. Figures 6 and 7 provide mockups to visually illustrate the task sequence, with task instructions displayed on the left and the platform interface on the right, using color-coded connections and numbered steps for clarity.

The tasks in Mockup 1 were primarily focused on fundamental navigation and platform customization, encompassing the updating of profile information, the exploration of the leaderboard and the initiation of a course. In Mockup 2, participants engaged with more sophisticated tasks, including the resetting of course progress and the utilization of the integrated code editor to complete a web development challenge. Feedback mechanisms were integrated into the process, providing immediate responses to users' actions. The feedback either confirmed success or offered guidance on the necessary corrections.

The structured task sequence ensured a consistent evaluation process, while progressive task visibility encouraged logical navigation and reduced cognitive load for participants. This approach allowed the study to gather valuable insights into user interaction and identify areas for refinement in the platform design.

5 RESULTS

The following sections present the results of the usability test for each page of gAmIcode, highlighting the usability problems encountered. Furthermore, key findings were discussed from the analysis of facial expressions and eye movements, as well as results from the interviews, TAM and UEQ evaluations.

Table 1: Listing of the tasks carried out during usability testing to explore the platform including expected results.

Task	Expected Solution	Figure and color
T1 - Update your data	Go to the profile page	Figure 5, red
T2 - Change the nickname	Change the name	Figure 5, blue
T3 - Check the Leaderboard	a) Go to the ranking page b) Scroll at the end of the overview page	Figure 5, green
T4 - Opt-out of Leaderboard	Click the ”opt-out” button	Figure 5, orange
T5 - Look for Course 1	a) Go to the course overview page b) Scroll to the courses on the overview page	Figure 5, purple
T6 - Start Course 1	Click on the ”start course” button	Figure 5, yellow
T7 - Got to the Editor	Go to the editor page	Figure 5, darkblue Figure 6, red
T8 - Reset the course progress	Click on the ”reset course progress” button	Figure 6, blue
T9 - Change the color theme	Select another theme in the drop down menu	Figure 6, green
T10 - Complete the challenge	Follow the instruction	Figure 7, orange

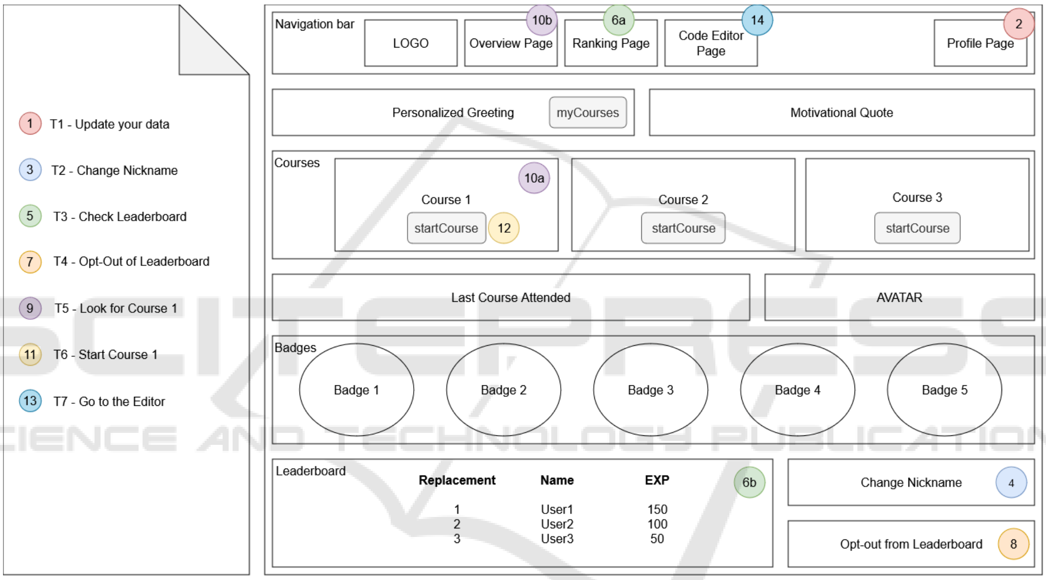

Figure 6: Mockup of the Overview Page (Authors own creation).

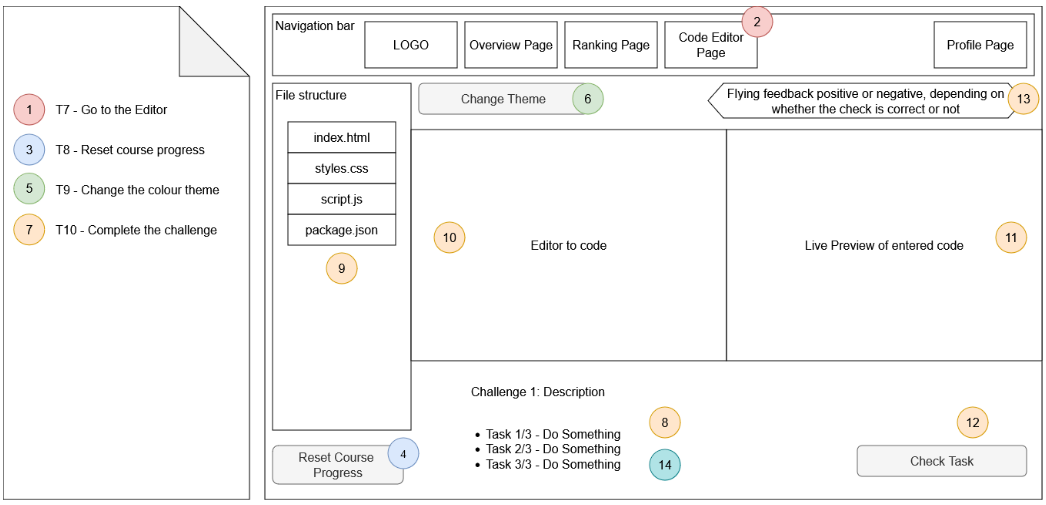

Figure 7: Mockup of the Code Editor Page (Authors own creation).

SCITEPRESS SCIENCE AND TECHNOLOGY PUBLICATIONS

5.1 Usability Test with Eye-Tracking

The results of the usability test indicated that the majority of participants were able to successfully complete the assigned tasks. The recorded facial expressions, detailed in Table 2, revealed a range of emotional responses. The overview page elicited the highest levels of fear and confusion, likely due to participants' unfamiliarity during the initial orientation phase, with an average of 8.2 emotional peaks per minute. The ranking page also triggered notable negative emotions, including 5.7% anger and 9.3% confusion. In contrast, the profile page generated the most positive responses, with 22.3% joy and less than 1% negative reactions, like fear, digust or sadness. It should be noted that the information displayed in the heat maps is fictitious.

Table 2: Overview of Facial Expressions that were triggered per sub page in %.

Subpage	Fear	Confusion	Digust	Sadness
Overview	1.4	15.2	4.7	5.1
Profile	0.5	4.0	1.1	1.3
Ranking	1.0	9.3	0.6	3.3
Course	1.3	6.8	1.5	3.1
Editor	2.5	6.2	2.3	3.0

Subpage	Joy	Contempt	Anger	Surprise
Overview	19.5	0.9	3.5	1.9
Profile	22.3	1.1	1.5	0.7
Ranking	16.0	2.9	5.7	0.6
Course	15.7	2.6	2.5	1.4
Editor	18.5	1.6	3.0	2.3

5.1.1 Overview Page of the Learning Platform

The initial task entailed a one-minute review of the website, which was followed by a discussion in which participants shared their opinions on the overview page. The feedback was overwhelmingly positive, as evidenced by the heatmap in Figure 8, which demonstrates that all elements were viewed. Participants described the page as clear, compact and tidy. While some suggested incorporating additional colours, the muted colour scheme was a deliberate design choice. The hover effect on badges, which changed from grey to colour and the avatar dog received particular praise. Only one participant found the page confusing due to the visibility of multiple courses.

5.1.2 Changing the Profile and Learning Type

After reviewing the overview page, participants were tasked with updating their profile. Most participants completed this task efficiently and praised the design of the page. As shown in Figure 9, all elements were viewed by the participants. Suggestions included au-

Figure 8: Heat Map of the overview page (n = 8). Red areas are viewed the most, followed by yellow and green areas.

tomatically populating the current level of knowledge using a test, adding a field to indicate how frequently participants use programming languages, expanding the categories for prior knowledge beyond three levels and incorporating a help button to clarify these levels. Additionally, participants recommended a drag-and-drop feature for uploading photos.

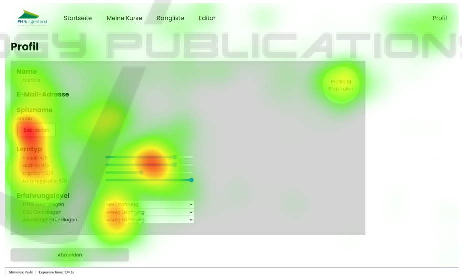

Figure 9: Heat map of Profile settings (n=8). Red areas are viewed the most, followed by yellow and green areas.

5.1.3 Ranking Page

Participants were asked to identify their name on the ranking list and indicate their preference to opt out, as shown in Figure 10. Most found the task easy, though opinions on the ranking feature were divided. While some appreciated it, others preferred avoiding comparisons. The use of nicknames helped to reduce concerns about privacy, but terms like 'Global Ranking' needed clarification. The color-coded rankings were well received, and the opt-out process was efficient, though participants suggested adding a confirmation notification and improving button visibility. Additional recommendations included detailed

SCIENCE AND TECHNOLOGY PUBLICATIONS

progress metrics and enhancing the feedback message box, which resembled error alerts.

Figure 10: Heat Map of the Ranking Page (n=8). Red areas are viewed the most, followed by yellow and green areas.

5.1.4 Course Page and Learning Progress

Upon completion of the HTML course exercises, participants were invited to review their progress on the course page. As illustrated in Figure 11, the dashboard and badges attracted more visual attention than the text. The feedback indicated a preference for presenting the course description before the progress details, with the aim of improving the flow of information. Participants also recommended distinguishing headings from text with varying sizes, replacing the confusing star progress indicators with a filling progress circle and making the page more compact in order to minimize scrolling. Suggestions included clarifying the meaning of the EXP abbreviation, which means experience points, and displaying the average time required to complete a course in order to facilitate better planning. The design was positively received, particularly the badges and the use of green for completed tasks.

5.1.5 Code Editor Page

The code editor, a central component of the platform, offers instantaneous feedback on web development tasks, as illustrated in Figure 12, which underscores its high visual engagement. Participants responded positively to the code editor, but also offered suggestions for improvements. These included displaying the number of permitted attempts for incorrect tasks, enlarging error messages with more detailed explanations and providing guidance on errors that is more accessible to beginners. They also recommended adding a red exclamation mark for error lines, renaming the *Reset Editor* button to *Repeat Task* with enhanced visibility and improving the accessibility of the colour scheme button.

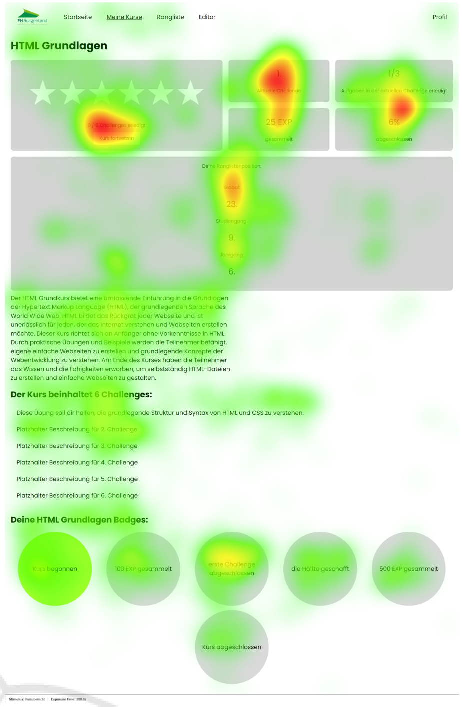

Figure 11: Heat Map of the Course Page (n=8). Red areas are viewed the most, followed by yellow and green areas.

Figure 12: Heat Map of the Code Editor (n=8). Red areas are viewed the most, followed by yellow and green areas.

5.2 Method Triangulation

The platform evaluation used semi-structured interviews, TAM and UEQ to analyze its strengths and areas for improvement.

The semi-structured interviews gathered user feedback on design, usability, functionality and overall impressions. Users praised the platform's clarity and intuitive layout but criticized the muted color scheme as uninspiring. Suggestions included vibrant, institution-aligned colors, customizable avatars and a dynamic color scheme that adapts to user progress. Badges and the integrated editor were praised for fostering accomplishment, but users suggested clearer feedback, such as progress bars over stars, plus social features and better navigation, like a "jump back" button. Overall, the platform was described as structured, transparent, intuitive and functional, though

Table 3: Results Technology Acceptance Model Mean and Variance (Var.).

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Mean	2.375	2.500	2.625	2.750	1.000	1.000	1.125	1.000	1.750	1.000	1.250	1.125
Var.	0.839	0.857	1.411	1.929	0	0	0.125	1.071	0	0.214	0.125	0.214
	Q13	**Q14**	**Q15**	**Q16**	**Q17**	**Q18**	**Q19**	**Q20**	**Q21**	**Q22**	**Q23**	
Mean	1.250	1.250	1.625	1.500	1.625	2.000	3.000	3.250	1.875	2.375	3.000	
Var.	0.214	0.214	0.554	0.571	0.554	1.143	1.714	1.357	0.982	1.125	0.857	

with room for enhancements.

The TAM analysis, summarized in Table 3, used a scale of 1 (best) to 5 (worst) to evaluate platform-specific and general usage. Visual appeal and meaningful use of color (Q1–Q4) received moderate scores (mean: 2.375–2.5). Navigation and readability (Q5–Q8) were rated highly, with mean scores ranging from 1.0 to 1.125, indicating unanimous approval. Users found the platform easy to use (Q10), self-explanatory (Q11), and generally well-liked (Q12, Q14), with mean ratings between 1.0 and 1.25, reflecting high satisfaction and a strong likelihood of continued use and recommendations (Q13). Technical engagement (Q15–Q18) showed moderate scores (mean: 1.625–2.0), with notable variability, while practical usage (Q19–Q20) received higher ratings (mean: 3.0–3.25). General willingness to adopt new systems (Q21–Q23) displayed variability, with mean scores ranging from 1.875 to 3.0, reflecting mixed perspectives among users.

The UEQ results, shown in Table 4, assessed six UX dimensions on the same 1 to 5 scale. Perspicuity (mean: 2.250) and efficiency (mean: 2.219) were the highest-rated dimensions, indicating clarity and practicality in task completion. Attractiveness (mean: 1.563) and dependability (mean: 1.875) received moderate ratings, with dependability showing the highest variance (1.05), highlighting divided opinions on reliability. Stimulation (mean: 1.563) and novelty (mean: 1.250) scored lowest, suggesting limited user engagement and innovation. Variance data pointed to enhancing reliability, visual appeal and stimulation to create a more engaging UX.

Table 4: Results UEQ Mean and Variance.

UEQ Scales	Mean	Variance
Attractiveness	1.563	0.33
Perspicuity	2.250	0.79
Efficiency	2.219	0.40
Dependability	1.875	1.05
Stimulation	1.563	0.71
Novelty	1.250	1.41

6 DISCUSSION

6.1 gAmIcode

The evaluation of gAmIcode offered valuable insights into its alignment with user requirements, usability and the influence of design elements on user engagement. The platform's features were evaluated using a combination of eye-tracking (ET) data, interview (I) feedback and supplementary evaluations based on the TAM and the UEQ. Each requirement was classified as either implemented, partially implemented, inadequately implemented, or missing, as summarized in Table 5. While the platform received positive feedback with regard to its intuitive interface, motivational gamification features and immediate feedback mechanisms, there were also a number of areas identified for improvement, including the absence of learning paths, social interaction tools and multi-device usability.

The findings confirm that the implementation of gamification elements, such as badges, progress indicators and leaderboards has a positive impact on motivation and a sense of accomplishment. However, as evidenced by research on gamification strategies (Almeida et al., 2023), the ambivalent response to the leaderboard feature underscores the necessity for personalization to accommodate diverse learner preferences. Although some participants reported that the leaderboard was motivational, others perceived it as a conduit for negative competition. This underscores the necessity of providing anonymity options, which were effectively implemented in gAmIcode.

The integrated code editor was well-received for its functionality, providing immediate feedback that aligns with prior research regarding real-time feedback in maintaining engagement and reducing frustration (Giang, 2013; Kiryakova et al., 2014). However, user feedback indicated the need for more detailed error messages, task-specific guidance and enhancements to visual progress indicators. This suggests that augmenting these features could further align the platform with recommendations for personalized and adaptive learning tools (Oliveira et al., 2023).

The visual design was another critical element subject to evaluation. The muted grey colour scheme,

Table 5: Overview of Requirements and Implementation Ratings Based on Eye-Tracking (ET) Data and Interview (I) Feedback.

Requirement	Method	Implemention
Learning Paths	I	Missing
Immediate Feedback	ET/I	Inadequate
Realistic challenges	I	Missing
Social Interaction	I	Missing
Integrated Code-Editor	ET/I	Implemented
Learning Types	I	Partial
Integration LMS	I	Partial
Scalability, Flexibility	I	Implemented
Visual code Feedback	ET/I	Implemented
Task-related Feedback	ET/I	Implemented
Badges as reward	ET/I	Implemented
Leaderboard	ET/I	Implemented
Progress indicators	ET/I	Inadequate
Tutorials, videos	I	Missing
Nicknames	ET/I	Implemented
Avoid external tools	ET/I	Implemented
Responsive Design	ET/I	Missing
Multi-device usage	I	Missing
Levels/stages	I	Missing
Attractive design	I	Inadequate
Colour Scheme	I	Inadequate
Intuitive UI	ET/I	Implemented

selected to reflect a sense of professionalism, was critiqued for its lack of vibrancy. This observation aligns with prior research indicating that colours can significantly influence user emotions and engagement(Ozcelik et al., 2009; Uzun and Yıldırım, 2018). Participants indicated a preference for institution-aligned colours and a dynamic colour scheme, which aligns with prior studies on emotional design and the balance between aesthetics and functionality (Molina et al., 2024; Um et al., 2012). Decorative elements, such as the dog avatar, attracted positive attention without detracting from usability, contrary to earlier studies that suggested visual embellishments can impair functionality (Mikheeva et al., 2021).

The absence of adaptive gamification strategies, such as personalized learning paths, was identified as a limitation. Participants underscored the importance of such features for personalization, aligning with research indicating that adaptive gamification enhances engagement and learning outcomes (Oliveira et al., 2023; Khaldi et al., 2023). Additionally, recommendations for social interaction tools (López-Fernández et al., 2023), such as forums or chats, reinforce the importance of collaborative learning environments in fostering engagement and peer support.

In conclusion, the results confirm the positive impact of gamified elements on perceived usability, usefulness and user experience, thereby directly addressing the research. The findings are in accordance with existing literature on the essential function of feedback mechanisms, adaptive design and engaging visuals in learning platforms (Dambic et al., 2021; Soepriyanto et al., 2022). By eliminating the identified limitations, the platform will be better aligned with user expectations. With these refinements, the platform will be prepared for comprehensive classroom testing to validate its potential to enhance learning outcomes and engagement.

6.2 Future Work

In advance of the platform's launch a number of enhancements are considered. These include adapting feedback messages to provide hints after multiple failed attempts, resizing badges, clarifying abbreviations and replacing progress stars with progress bars. Feedback mechanisms will be improved with leaderboard opt-outs and nickname changes. Additionally, chat features will be introduced to promote a collaborative supportive learning community.

The Goal-Access-Feedback-Challenge-Collaboration model (Huang and Hew, 2018) will guide gamification. Immediate feedback will come from mini-assignments with automated testing, while open-ended tasks will foster creativity and intrinsic motivation (Sharmin, 2022). As traditional auto-grading falls short, innovative grading solutions (Messer et al., 2023) will be developed. Large Language Models will be explored for real-time feedback on complex tasks (Hou et al., 2024), and peer assessment will support collaboration and motivation (Di Mascio et al., 2021).

To align with advancements in adaptive learning and automated formative feedback, the platform will integrate chatbots capable of providing detailed, real-time responses, thereby enhancing personalization and engagement (Elhayany et al., 2024). These features will adhere to ethical AI guidelines (du Boulay, 2022) to ensure equitable and transparent practices. These improvements aim to create an engaging, effective learning experience for non-technical students.

7 CONCLUSION

Students of non-technical programmes frequently encounter considerable difficulties when confronted with technical classes, such as web development. These difficulties frequently result in frustration, disengagement and poor course evaluations, underscoring the necessity for solutions that better align with the specific needs of these learners. Insights gathered through interviews revealed that students encounter difficulties with traditional approaches to technical education and expressed a desire for more engaging, user-friendly tools. This feedback directly informed the development of the GLP gAmIcode, which was designed to incorporate functionalities and gamification elements tailored to student preferences.

The HCD (Human-Centered Design) approach was a key element in the development of gAmIcode, with student input being given consideration in the shaping of its design and features. The prototype was subjected to a comprehensive evaluation process, which included eye-tracking studies, TAM and UEQ assessments, and follow-up interviews. The feedback indicated that the intuitive interface and ease of use were well-received, with eye-tracking data confirming effective task completion and emotional analysis revealing a generally positive user experience.

However, areas for improvement were identified, including a preference for a more vibrant color scheme, more effective feedback mechanisms, and an FAQ section for common queries. Once these enhancements have been integrated, the prototype will be tested further in classroom settings. This phase will involve at least 25 students per class across three classes, addressing a key limitation of the initial usability testing, which included only eight participants.

ACKNOWLEDGEMENTS

The authors would like to thank the University of Applied Sciences Burgenland, the University of Vienna and the UniVie Doctoral School Computer Science (DoCS) for their support in developing and evaluating the gAmIcode platform. Special thanks go to DeepL and DeeplWrite for their support with the partial translation and proofreading in terms of spelling and grammar as well as ChatGPT as a reliable sparring partner during the creation process.

REFERENCES

Alcántara-Rubio, L., Valderrama-Hernández, R., Solís-Espallargas, C., and Ruiz-Morales, J. (2022). The implementation of the sdgs in universities: a systematic review. *Environmental Education Research*, 28(11):1585–1615.

Alemdag, E. and Cagiltay, K. (2018). A systematic review of eye tracking research on multimedia learning. *Computers & Education*, 125:413–428.

Algashami, A., Cham, S., Vuillier, L., Stefanidis, A., Phalp, K., and Ali, R. (2018). Conceptualising gamification risks to teamwork within enterprise. In *The Practice of Enterprise Modeling: 11th IFIP WG 8.1. Working Conference, PoEM 2018, October 31–November 2, 2018, Proceedings 11*, pages 105–120, Vienna, Austria. Springer International Publishing.

Almeida, C., Kalinowski, M., Uchôa, A., and Feijó, B. (2023). Negative effects of gamification in education software: Systematic mapping and practitioner perceptions. *Information and Software Technology*, 156:107142.

Blštáková, J. and Piwowar-Sulej, K. (2019). Gamification as an innovative idea within human resources management. *International Scientific Conference Hradec Economic Days 2019*.

Dam, R. F. (2024). The 5 stages in the design thinking process. https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process [Accessed: 06.08.2024].

Dambic, G., Kesscec, T., and Kucak, D. (2021). A Blended Learning with Gamification Approach for Teaching Programming Courses in Higher Education. In *2021 44th International Convention on Information, Communication and Electronic Technology (MIPRO)*, pages 843–847, Opatija, Croatia. IEEE.

Davis, F. D., Bagozzi, R., and Warshaw, P. (1989). Technology acceptance model. *J Manag Sci*, 35(8):982–1003.

Di Mascio, T., Peretti, S., and Temperini, M. (2021). The role of intrinsic motivation in peer assessment activity: an empirical evaluation. In *2021 19th International Conference on Information Technology Based Higher Education and Training (ITHET)*, pages 1–7. IEEE.

du Boulay, B. (2022). Artificial intelligence in education and ethics. In *Handbook of open, distance and digital education*, pages 1–16. Springer.

Elhayany, M., Steinbeck, H., and Meinel, C. (2024). Adaptive learning at scale: Investigating the effects of automated formative feedback in mooc-based data science learning. In *2024 IEEE 3rd German Education Conference (GECon)*, pages 1–6.

Genç Aksaray, S. and Ozcelik, E. (2023). Attention mediates the effect of emotional arousal on learning outcomes in multimedia learning: an eye-tracking study. *Educational Psychology*, 43(1):38–56.

Giang, V. (2013). Gamification. *Techniques Increase Your Employees' Ability to Learn by*, 40.

Heidig, S., Müller, J., and Reichelt, M. (2015). Emotional design in multimedia learning: Differentiation on relevant design features and their effects on emotions and learning. *Computers in Human behavior*, 44:81–95.

Hou, X., Zhao, Y., Liu, Y., Yang, Z., Wang, K., Li, L., Luo, X., Lo, D., Grundy, J., and Wang, H. (2024). Large Language Models for Software Engineering: A Systematic Literature Review.

Huang, B. and Hew, K. F. (2018). Implementing a theory-driven gamification model in higher education flipped courses: Effects on out-of-class activity completion and quality of artifacts. *Computers & Education*, 125:254–272.

Hyönä, J. (2010). The use of eye movements in the study of multimedia learning. *Learning and Instruction*, 20(2):172–176.

IDEO (2015). *The Field Guide to Human-centered Design: Design Kit*. IDEO.

Iosup, A. and Epema, D. (2014). An experience report on using gamification in technical higher education. In *Proceedings of the 45th ACM technical symposium on Computer science education*, pages 27–32.

Khaldi, A., Bouzidi, R., and Nader, F. (2023). Gamification of e-learning in higher education: a systematic literature review. *Smart Learning Environments*, 10(1):10.

Kiryakova, G., Angelova, N., and Yordanova, L. (2014). Gamification in education. In *Proceedings of 9th international Balkan education and science conference*, volume 1, pages 679–684.

Kuckartz, U. and Rädiker, S. (2024). *Fokussierte Interviewanalyse mit MAXQDA: Schritt für Schritt*. Springer.

López-Fernández, D., Gordillo, A., Tovar, E., and Alarcón, P. P. (2023). Gamification in computer science education: An empirical study of a meme contest. In *2023 IEEE Frontiers in Education Conference (FIE)*, pages 1–6.

Magaldi, D. and Berler, M. (2020). Semi-structured interviews. *Encyclopedia of personality and individual differences*, pages 4825–4830.

Marangunić, N. and Granić, A. (2015). Technology acceptance model: a literature review from 1986 to 2013. *Universal access in the information society*, 14:81–95.

Mayer, R. E. and Estrella, G. (2014). Benefits of emotional design in multimedia instruction. *Learning and Instruction*, 33:12–18.

Messer, M., Brown, N. C. C., Kölling, M., and Shi, M. (2023). Automated Grading and Feedback Tools for Programming Education: A Systematic Review. *ACM Transactions on Computing Education*, page 3636515.

Mikheeva, M., Schneider, S., Beege, M., and Rey, G. D. (2021). The influence of affective decorative pictures on learning statistics online. *Human Behavior and Emerging Technologies*, 3(3):401–412.

Molina, A. I., Arroyo, Y., Lacave, C., Redondo, M. A., Bravo, C., and Ortega, M. (2024). Eye tracking-based evaluation of accessible and usable interactive systems: tool set of guidelines and methodological issues. *Universal Access in the Information Society*, pages 1–24.

Nielsen, J. and Landauer, T. K. (1993). A mathematical model of the finding of usability problems. In *Proceedings of the INTERACT'93 and CHI'93 conference on Human factors in computing systems*, pages 206–213.

Nurutdinova, A., Shakirova, D., Fazlyeva, Z., Dmitrieva, E., Sheinina, D., and Galeeva, G. (2021). Gamification Method to Improve Speech Skills and Proficiency Among Students: Methodology for Implementation. In *2021 World Engineering Education Forum/Global Engineering Deans Council (WEEF/GEDC)*, pages 461–467, Madrid, Spain. IEEE.

O'Donovan, S., Gain, J., and Marais, P. (2013). A case study in the gamification of a university-level games development course. In *Proceedings of the South African Institute for Computer Scientists and Information Technologists Conference*, pages 242–251, East London South Africa. ACM.

Oliveira, W., Hamari, J., Shi, L., Toda, A. M., Rodrigues, L., Palomino, P. T., and Isotani, S. (2023). Tailored gamification in education: A literature review and future agenda. *Education and Information Technologies*, 28(1):373–406.

Ozcelik, E., Karakus, T., Kursun, E., and Cagiltay, K. (2009). An eye-tracking study of how color coding affects multimedia learning. *Computers & Education*, 53(2):445–453.

Paľová, D. and Vejačka, M. (2022). Implementation of Gamification Principles into Higher Education. *European Journal of Educational Research*, 11(2):763–779.

Peng, X., Xu, Q., Chen, Y., Zhou, C., Ge, Y., and Li, N. (2021). An eye tracking study: positive emotional interface design facilitates learning outcomes in multimedia learning? *International journal of educational technology in higher education*, 18:1–18.

Poondej, C. and Lerdpornkulrat, T. (2019). Gamification in e-learning: A Moodle implementation and its effect on student engagement and performance. *Interactive Technology and Smart Education*, 17(1):56–66.

Raschke, M., Blascheck, T., and Burch, M. (2014). Visual analysis of eye tracking data. *Handbook of human centric visualization*, pages 391–409.

Sailer, P. (2024). Learning web technologies: Overcoming educational challenges. In *EdMedia+ Innovate Learning*, pages 466–475, Brussels, Belgium. Association for the Advancement of Computing in Education (AACE).

Schneider, S., Nebel, S., and Rey, G. D. (2016). Decorative pictures and emotional design in multimedia learning. *Learning and Instruction*, 44:65–73.

Schrepp, M. (2015). User experience questionnaire handbook. *All you need to know to apply the UEQ successfully in your project*, pages 50–52.

Sharmin, S. (2022). Creativity in CS1: A Literature Review. *ACM Transactions on Computing Education*, 22(2):1–26.

Soepriyanto, Y., Azzahra Fazarini, P. F., Sulthoni, Maulida, T. R., Nurfahrudianto, A., and Afandi, Z. (2022). The Effect of Player Type in Learning Programming with Online Gamification Activities on Student Learning Outcomes. In *2022 2nd International Conference on Information Technology and Education (ICIT&E)*, pages 382–386, Malang, Indonesia. IEEE.

Sung, E. and Mayer, R. E. (2012). When graphics improve liking but not learning from online lessons. *Computers in human behavior*, 28(5):1618–1625.

Um, E., Plass, J. L., Hayward, E. O., Homer, B. D., et al. (2012). Emotional design in multimedia learning. *Journal of educational psychology*, 104(2):485.

Uzun, A. M. and Yıldırım, Z. (2018). Exploring the effect of using different levels of emotional design features in multimedia science learning. *Computers & Education*, 119:112–128.