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DOI
10.34190/ejel.23.3.3757

Publication date
2025

Document Version
Final published version

Published in
Electronic Journal of e-Learning

Evaluating Value Creation, Motivation, and Personal Experiences in a Game-Based Professional Learning Network for Computer Science Education

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https://doi.org/10.34190/ejel.23.3.3757

Abstract: Gamification has emerged as a promising strategy to enhance student engagement and learning outcomes in computer science education. This study uses Wenger's Value Creation Framework to evaluate and design the gamification elements in the *Answers* platform, a Professional Learning Network (PLN) developed at TU Delft. Using a mixed-methods approach with 372 participants, this research examines the platform's impact on learning, motivation, and social interaction. Findings indicate that the platform significantly enhances academic engagement and applied value, as students actively use it for knowledge acquisition and problem-solving. However, social connectivity remains limited, as reflected in lower scores for relatedness and potential value. Qualitative insights reveal that students primarily engage with the platform for academic support rather than networking or peer collaboration. This study contributes to e-learning practice by offering design recommendations to integrate collaborative learning elements better and foster social interaction within gamified learning environments. Additionally, it advances theoretical discussions on gamified PLNs by illustrating how Wenger's framework can be operationalized to assess value creation in digital learning networks. The findings highlight the need for a more holistic approach to gamification that extends beyond point-based rewards to include community-driven engagement mechanisms. By addressing these gaps, this research provides actionable insights for educators, platform designers, and policymakers, supporting the development of more effective gamified learning environments that balance motivation, collaboration, and engagement in online education.

Keywords: Networked learning, Gamification, Value creation, Computer science education, Online

1. Introduction

1.1 Background and Context

Technology is evolving and changing every day. We face a rapid transition in how students in technical fields like computer science learn, interact, and work (Xu and Ouyang, 2022). They also need constant educational support to stay updated and solve their everyday problems effectively. Consequently, education and training providers play a crucial role in developing and delivering innovative learning solutions that meet these growing needs and ensure that learners are well-equipped to handle the challenges of a dynamic technological landscape. Students are expected to master complex concepts and skills, but maintaining motivation and engagement can be challenging. Many educational platforms need to implement a practical design that can satisfy students' demands, resulting in disengagement and suboptimal learning outcomes. Research has shown that while students may be proficient in using digital tools for entertainment and communication, this does not automatically translate into effective digital learning skills (Margaryan, Littlejohn and Vojt, 2011). The increasing reliance on technology in education, particularly in computer science, underscores the need for learning environments that scaffold meaningful engagement rather than assuming inherent technological fluency (Bennett & Maton, 2010). This study introduces "Answers," a novel Professional Learning Network(PLN) developed at TU Delft, aimed at redefining the educational landscape for computer science students.

Networked learning is an educational approach that uses digital and social networks to facilitate and enhance learning processes. It integrates technological tools and social connections to foster collaboration, resource sharing, and continuous learner interaction (Gourlay et al., 2021). PLNs are a representation of networked learning, where individuals engage in communities or networks to share knowledge, resources, and experiences for professional development (Poortman, Brown and Schildkamp, 2021). In higher education, particularly among computer science students, PLNs leverage platforms such as social media, online forums, and learning

Cite this article: Soleymani, A., De Laat, M. and M. Specht, M. 2025. "Evaluating Value Creation, Motivation, and Personal Experiences in a Game-Based Professional Learning Network for Computer Science Education", *Electronic Journal of e-Learning*, 23(3), pp 45-63, https://doi.org/10.34190/ejel.23.3.3757

management systems to provide industry-relevant knowledge, peer support, and mentorship opportunities, thus embodying the principles of networked learning (Harding and Engelbrecht, 2015).

PLNs show promising results (Harding and Engelbrecht, 2015; Badoer, Hollings and Chester, 2020). In networked learning, gamification is increasingly recognized as a powerful tool for enhancing professional development (Saleem, Noori and Ozdamli, 2022; Li, Ma and Shi, 2023). Educators and trainers can significantly boost engagement and motivation among learners by incorporating game-like elements into networked learning environments. Amidst this transformation, gamification is a potent strategy to enhance learning experiences by combining game design elements into non-game contexts. Answers integrate gamification elements within a framework inspired by Wenger's theory of value creation (Wenger, Trayner, and De Laat, 2011). This integration seeks to engage students and deepen their learning and professional development through a networked learning environment.

1.2 Related Work

PLNs are dynamic ecosystems designed to meet the diverse professional needs of educators (Trust et al., 2016). They are structured online or offline communities where individuals actively share knowledge, skills, and best practices to achieve professional growth and development (Trust, 2012). They integrate people, spaces, and tools to facilitate ongoing professional development and knowledge exchange. The individuals within PLNs provide necessary feedback, support, and mentorship, enabling personal and professional growth (Trust, Krutka and Carpenter, 2016). While leveraging networks for learning is not novel (Tobin, 1998), the digital age has amplified their potential, transforming PLNs into powerful platforms for professional development. PLNs are particularly effective in fostering collaboration and innovation among educators, offering opportunities for reflection and the exchange of best practices (Cook et al., 2017).

We use the Value Creation Framework developed by Wenger, Trayner and De Laat (2011) to frame and evaluate the value generated through learning activities in our PLN. This framework identifies five cycles of value creation: immediate, potential, applied, realized, and transformative. Each cycle represents a distinct impact that network participation can have on individuals or groups (Dingyloudi, Strijbos and De Laat, 2019). Immediate value refers to the initial benefits participants gain from engaging with the gamified learning platform, such as gaining new knowledge and skills. Potential value encompasses expected benefits, including enhanced career prospects, increased confidence, and expanded social connections. Applied value is evident when learners apply the knowledge gained from the platform in their professional and personal lives, leading to, for example, actual improvements in job performance and the initiation of new projects. Realized value manifests as significant achievements in learners' careers or personal development, such as job promotions, entrepreneurial successes, and academic achievement. Finally, transformative value reflects profound, long-term changes in learners' perspectives and behaviors, fostering lifelong learning habits and a deeper appreciation for the benefits of the PLN. This framework is particularly effective in educational settings, where learning outcomes contain academic performance and the broader development of essential skills and capabilities in today's interconnected world.

Building on the principles of value creation and the collaborative nature of PLNs, the integration of gamification in these networks can further enhance the learning experience by adding motivational elements that drive engagement and participation. Gamified learning environments can engage students effectively through intrinsic and extrinsic motivators, boosting motivation and improving academic performance (Buckley and Doyle, 2016; Schöbel et al., 2019). By intrinsic motivation, we refer to engaging in activities driven by internal satisfaction, such as interest, enjoyment, and the inherent challenge of the task, rather than external rewards or pressures (Ryan and Deci, 2000). However, the impact of specific gamification mechanics on intrinsic motivation remains contested. While game elements such as badges, leaderboards, and point systems are often designed to foster motivation (Li et al., 2024), their effectiveness in promoting intrinsic motivation has been debated (Hanus and Fox, 2015). According to the Self-Determination Theory (Deci & Ryan, 1985), intrinsic motivation arises from autonomy, competence, and relatedness. However, research suggests that extrinsic motivators, such as points-based reward systems, may undermine intrinsic motivation if they shift students' focus away from meaningful engagement (Deci, Koestner, and Ryan, 2001).

Additionally, studies indicate that not all gamification strategies yield positive learning outcomes. Nicholson (2014) warns that superficial gamification, which relies primarily on pontification and extrinsic rewards, may fail to foster deep learning and long-term engagement. Furthermore, the effectiveness of gamification varies depending on curriculum design, student demographics, and instructional alignment (Dichev & Dicheva, 2017). Therefore, while gamification holds significant potential in professional learning networks, its impact is highly

contextual and requires careful instructional design to ensure meaningful engagement rather than short-term compliance (Sailer & Homner, 2020).

However, the literature also highlights several other limitations. Many studies focus narrowly on specific game mechanics, often neglecting their long-term impact on learning outcomes or their integration with collaborative networks like PLNs. For example, Zhan et al. (2022) emphasize that the effectiveness of gamification varies significantly based on curriculum design and the thoughtful alignment of gamified elements with course objectives. Similarly, Videnovik et al. (2023) argue that while game-based learning enhances understanding and retention, its success depends on factors such as game design, curriculum integration, and student demographics. Additionally, prior research often lacks empirical data on how gamification affects social interaction and collaboration within learning networks (Li and Liu, 2023; Sailer and Homner, 2020).

To address these limitations and research gaps, our study critically examines the integration of gamification into professional learning networks (PLNs), evaluating both its benefits and limitations in fostering value creation, engagement, and intrinsic motivation within computer science education. By leveraging Wenger's Value Creation Framework and examining qualitative and quantitative data, this study addresses the ongoing discourse on gamification's effectiveness and challenges.

1.3 Research Objectives

The motivation behind this research stems from the observed need for more engaging and effective educational tools that can address the unique challenges of computer science education. Traditional learning platforms often need to improve in fostering motivation and deep engagement, which are critical components for mastering the complex concepts inherent in computer science (Videnovik et al., 2023).

The primary aim of this study is to evaluate how gamification within a PLN affects student engagement, intrinsic motivation, and the creation of immediate, potential, applied, realized, and transformative values. The research focuses on higher education, targeting computer science courses at the Bachelor's and Master's levels. By examining the integration of gamification elements with Wenger's Value Creation Framework, this study seeks to contribute to the growing body of knowledge on gamified learning environments and their effectiveness in fostering meaningful academic and professional development.

To achieve this aim, two key research questions guide this study: (1) How do learners perceive the gamified learning experience on the Answers platform? (2) How does the Answers system impact graduate students' value creation and intrinsic motivation? The findings provide insights into the design and implementation of gamified PLNs and their role in shaping student learning and engagement in technical education settings."

2. Methodology

This study aims to explore the impact of gamification on student engagement and learning outcomes within the "Answers" platform, a novel online learning environment developed for computer science education at TU Delft. The research addresses two primary questions: (1) How do learners perceive the gamified learning experience? (2) How does the "Answers" system impact value creation and intrinsic motivation?

We employed a mixed-methods approach, combining quantitative and qualitative data collection methods to comprehensively analyze the educational impact of the "Answers" platform. The mixed-methods design allows for integrating numerical data and in-depth personal experiences, providing a richer understanding of the research questions.

2.1 Participants

This study engaged 372 participants, including Bachelor and Master of Computer Science students, course instructors, and teaching assistants, who were actively involved with the Answers-EWI platform. This platform is freely available to all bachelor and master students, who can use it based on their preferences. This sample size is considered adequate for quantitative and qualitative analyses, as it meets the recommended thresholds for statistical power mixed-methods research (Creswell & Plano Clark, 2017). According to Cohen's (1992) guidelines for statistical power analysis, a sample size of over 300 is generally sufficient to detect medium to large effect sizes with a power of 0.80 at the 0.05 significance level in educational research. Eventually, 60 participants out of a total of 372 completed our questionnaires, and 10 participants were randomly invited for in-depth interviews.

2.2 Data Collection Methods

The methodology employed in this study involved multiple data collection methods to provide a comprehensive analysis of the educational impact of the "Answers" platform. The platform automatically generates log data that captures detailed information on user interactions, including the frequency and type of activities such as question posting, answering, and commenting. This log data provided quantitative metrics on engagement levels, enabling an analysis of how actively and in what ways students and instructors utilized the platform. Two questionnaires were administered to all participants, including course instructors, TAs, and students, to gather data on perceived value creation and intrinsic motivation.

Questionnaire 1. Value Creation Questionnaire (VCQ). Based on Wenger, Trayner and De Laat's (2011) five cycles of value creation, this questionnaire was designed to measure the different layers of value participants perceived as being created through their interaction with the platform. The items in the questionnaire corresponded to the immediate, potential, applied, realized, and reframing value. This Questionnaire has ten questions (five multiple choices and five open-ended questions). Each value creation cycle has one multiple-choice and one open-ended question. For example, the first question asks, “Participation changed me as a student (change in skills, attitudes, identity, self-confidence, feelings, etc.).” Participants need to answer on a scale between 1 to 6 (Strongly disagree to strongly agree, respectively). If they respond positively (strongly agree, agree, or slightly agree), they are asked to answer an open-ended question such as “Can you explain how participation changed you as a student?”. If they respond negatively (slightly disagree, disagree, and strongly disagree), the online questionnaire automatically asks: Can you explain why participation didn't change you as a student?

Questionnaire 2. Intrinsic Motivation Inventory (IMI) - 29-item Version by Ryan, Mims and Koestner, 1983.

To measure this construct in our research, we employed the Intrinsic Motivation Inventory (IMI), a multidimensional measurement tool designed to assess participants' subjective experience related to a target activity (Ryan, 1982). The IMI includes several subscales, including interest/enjoyment, perceived competence, effort, value/usefulness, felt pressure and tension, and perceived choice. Each subscale captures different dimensions of intrinsic motivation, providing a comprehensive overview of how engaged and motivated participants feel. Higher scores indicate greater intrinsic interest in the activity (McAuley, Duncan and Tammen, 1989). In our study, the IMI was used to evaluate how the gamified elements of the Answers platform influenced students' intrinsic motivation.

This comprehensive tool assessed participants' levels of intrinsic motivation concerning their platform use. It includes five subscales: relatedness, interest/enjoyment, perceived choice, pressure/tension, and effort. The IMI was administered to help us understand the motivational dynamics influenced by the gamified elements of the platform.

Additionally, ten participants were randomly selected for in-depth, semi-structured interviews to investigate value creation and the gamification experience further. Eight out of ten participants were students, and two were TAs. These interviews were designed to capture value-creation indicators, personal stories, and participants' experiences with the gamification elements of the "Answers" platform.

Each data collection method complemented the others, providing a rich, multi-faceted view of the platform's educational impact. Together, these methods enabled a robust analysis of both the measurable outcomes of gamification and the qualitative experiences of those engaged with the platform.

2.3 Procedure

Answers development and refinement started in 2022, and after approximately one academic year of iterative testing and feedback sessions, students could start using the platform. Participants were recruited through course announcements and email invitations from the start of the academic year in 2023 (September). Informed consent was obtained from all participants, ensuring confidentiality and voluntary participation. Log data were collected automatically by the platform, while the VCQ and IMI were administered online at the end of the semester (around February 2024). Interviews were conducted via video conferencing with the Microsoft Team, recorded, and then transcribed for analysis. These interviews were conducted around a month after the end of the semester in March 2024.

2.4 Description of the Intervention

The Answers platform was designed to enhance student engagement and collaborative learning by integrating game-based elements that promote participation, knowledge sharing, and peer interaction.

2.4.1 Technical features

The Answers platform uses Ruby on Rails with MySQL as the primary database. It is a modification of the open-source platform Qpixel by the Codidact organization (https://github.com/codidact/qpixel). User data is protected through end-to-end encryption and secure data storage practices. The platform complies with GDPR, ensuring that user privacy is maintained. User authentication is handled via the TU Delft single sign-on (SSO) mechanism. The source code is available at https://gitlab.ewi.tudelft.nl/eip/answers/qpixel. Figure 1 provides a snapshot of the platform and illustrate its core functionalities and user interface.

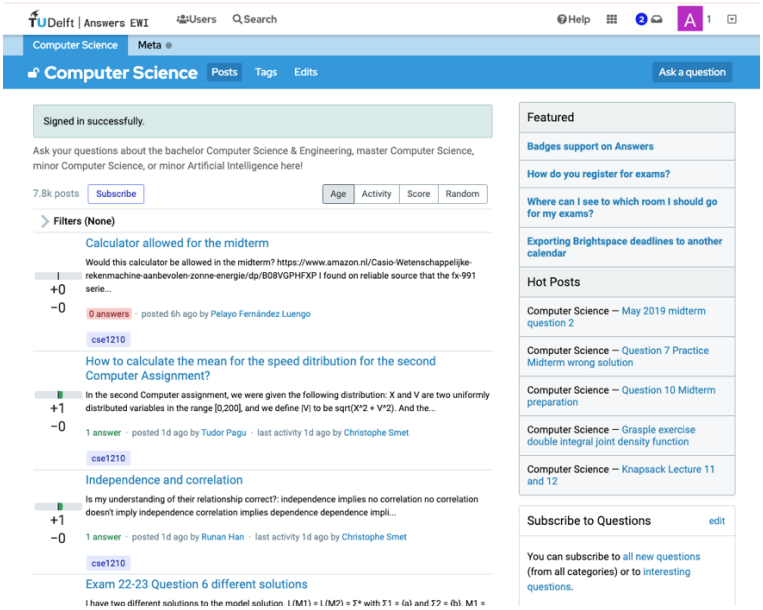

Figure 1: A Snapshot of Answers Platform

2.4.2 Design principles

Among the various gamification strategies available, we selected points and badges as our primary mechanisms, aligning them with the principles of Wenger's Value Creation Framework (Wenger-Trayner & Wenger-Trayner, 2020) to foster immediate, potential, and applied value within the learning network.

Points can serve as an immediate feedback mechanism, which could reinforce active participation by rewarding users for asking questions, answering queries, and engaging in discussions. Although several case studies showed the effectiveness of points in gamification (e.g., Huang and Hew, 2015; Ibànez, Di-Serio, and Delgado-Kloos, 2014), we should acknowledge the fact that "pontification" of education can sometimes lead to superficial engagement if not thoughtfully integrated into the learning design (Hellberg and Moll, 2023). Badges, on the other hand, were designed to recognize meaningful contributions and milestones. Also, they are designed to reflect individual achievements and community engagement (Aldemir, Celik and Kaplan, 2018). Table 1 provides an overview of badges and points designed for our platform.

Table 1: Description of Badges and Points

Badge	Description
Autobiographer	Complete your profile and upload a profile picture
First Question	Ask your first question
First Answer	Contribute your first answer
Self-Learner	Answer your own question with an answer that others find useful
Teacher	Help another community member with a good answer to their question
Top Contributor	Every two weeks the top contributor for of each course will be awarded this badge (if the course has sufficient contributions)

Badge based on points	
Great Question	Ask a question that many others are also interested in
Great Answer	Help the community by contributing a very helpful answer
Famous Question	Ask a question that many others look at

As mentioned earlier, these badges and points are inspired by the value creation framework (Wenger, Trayner, and De Laat, 2011). For example, one of the immediate value indicators is "participants bringing challenges they face for discussion" (Wenger-Trayner and Wenger-Trayner, 2020). We tried to encourage participants to ask questions on the Answers platform and bring the challenges they faced during the course by designing "First Question" and "Great Question" badges. Furthermore, one of the other typical indicators of potential value is the "Richness, diversity, and relevance of advice" (Wenger-Trayner and Wenger-Trayner, 2020) provided in the network. This inspired us to design "Great Answer" and "Top Contribution". Finally, one of the other Applied value indicators is "Stories from participants' context reporting innovations or newly discovered solutions or approaches" (Wenger-Trayner and Wenger-Trayner, 2020). This indicator helped us in designing the "Self-Learner" badge. Figure 2 illustrates an example of badges and recognitions, showcasing the types of achievements rewarded within the platform.

For the project's development, the teaching team of the computer science department initiated the concept of a system where students could exchange information, thereby building a knowledge base for future cohorts. Initial requirements were derived for posting questions and answers and ensuring the searchability of previously answered questions. After exploring existing solutions, Codidact/Qpixel, an open-source platform, was chosen as the foundation for the application. From this starting point, additional requirements were established to enhance the platform's suitability for educational purposes. Input was gathered from various stakeholders, including faculty and students, to understand their needs and expectations.

Two Computer Science students were tasked with implementing and integrating these features, adhering to an Agile development methodology to maintain flexibility and responsiveness to user feedback. User testing sessions were conducted throughout development to identify and address usability issues. Both quantitative and qualitative data were collected to inform design decisions. Features deemed generally applicable were contributed back to the Codidact project. After the initial deployment of the Answers platform, additional functionalities were added over time. Users were notified of new functionalities and instructed how they worked through the platform. Technical support was offered to address any emerging issues. Regular updates and feature enhancements were deployed based on user feedback. The platform's performance was continuously monitored through analytics, and feedback sessions were conducted with users to identify areas for improvement.

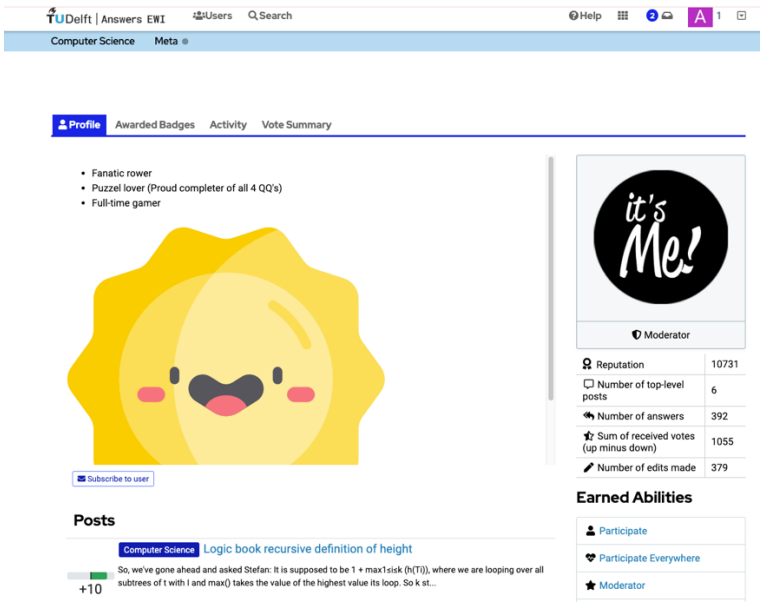

Figure 2: An example of Budges and Recognitions

2.4.3 Engagement and interaction evaluation

We expanded the platform's analytics capabilities to evaluate user engagement and interaction patterns. We track various metrics, such as the number of visits (tracks the frequency students visit the platform), activity frequency (counts the number of activities performed by the users, such as posting questions, answering questions, and commenting), and achievement and badges (monitors the badges users earn and their progress towards achieving specific milestones).

This intervention was introduced at the beginning of the academic year. It was available to all computer science students and faculty, providing a real-time, dynamic environment for enhancing educational experiences through gamified learning.

2.5 Data Analysis

The analysis of the collected data from the "Answers" platform involved a comprehensive approach, utilizing both quantitative and qualitative techniques to ensure a thorough understanding of the effects of gamification on learning outcomes and motivation.

The qualitative data collected from the Value Creation Questionnaire (Open-ended answers) and interviews were transcribed and analyzed using thematic analysis to identify recurring themes and patterns related to participants' perceptions of the gamification experience, value creation indicator, and stories. Qualitative data analysis software (Atlas ti) facilitated the coding of the data, which helped organize the data into meaningful categories based on the value creation framework. This method allowed for the in-depth exploration of how the gamification elements influenced learners' motivation, perceived value from the platform, and overall learning experience.

A mixed-methods data integration technique was used to integrate the quantitative and qualitative findings. This approach involved comparing and contrasting results from both data sets to draw comprehensive conclusions about the study's hypotheses. By triangulating the data, we aimed to validate the findings across different methods, enhancing the reliability and validity of the results.

3. Results

3.1 Quantitative Analysis

3.1.1 Quantitative analysis of value creation questionnaire (VCQ)

The methodology section explains that the VCQ has five multiple-choice and five open-ended questions. The first question explored the immediate value cycles and asked, “Participation changed me as a student (change in skills, attitudes, identity, self-confidence, feelings, etc.).” then the participant can choose between strongly agree, agree, slightly agree, slightly disagree, disagree, and strongly disagree. If they answered strongly agree, agree, and slightly agree, we asked them, "Can you explain how participation changed you as a student? And if they answered slightly disagree, disagree, and strongly disagree, they need to answer, "Can you explain why participation didn't change you as a student?". This procedure is repeated for questions regarding potential, applied, realized, and transformative value creation cycles. In this section, you can find the results of the first part of the questionnaire, and in section 3.2.1, we explain the results of the open-ended questions. Table 2 presents the descriptive statistics for the VCQ subcategories and summarizes the distribution of responses across the five value creation cycles.

Table 2: Descriptive results of VCQ

VCQ Components	Number of Positive Value Responses	Average	Std Dev	Median	Range (Min - Max)
Immediate Value	38/60	3.7	1.36	4	1-6
Potential Value	9/60	2.08	1.18	2	1-5
Applied Value	53/60	4.51	1.17	5	1-6
Realized Value	24/60	2.88	1.30	3	1-5
Reframing Value	19/60	2.71	1.40	2	1-6

Table 2 presents the descriptive statistics of the Value Creation Questionnaire (VCQ), which examines five cycles of value creation based on the framework proposed by Wenger, Trayner, and De Laat (2011). The VCQ assesses the impact of the Answers platform on participants across different dimensions of value creation.

Immediate Value: Out of 60 participants, 38 indicated that the Answers platform created positive immediate value for them. Specifically, these participants responded, "Strongly Agree," "Agree," or "Slightly Agree" to the statement: "Participation changed me as a student (change in skills, attitudes, identity, self-confidence, feelings, etc.)." This result suggests that a significant proportion of participants perceived an immediate enhancement in their personal and academic development due to their engagement with the platform.

Potential Value: The second component of the VCQ evaluates the potential value in terms of social connections with peers and other students. Interestingly, only 9 participants out of 60 responded positively to the statement: "Participation affected my social connections (change in the number, quality, frequency, emotions, etc.)." The average score for this dimension was 2.08, indicating a relatively low impact of the platform on social relationships.

Applied Value: The third component measures the applied value created by the platform. A majority, 53 out of 60 participants, responded positively to the statement: "Participation helped my practices as a student (get new ideas, insights, materials, procedures, etc.)." The average score for this dimension was 4.51, reflecting a high level of practical benefits derived from the platform.

Realized Value: The fourth part of the VCQ investigates the influence of the Answers platform on participants' ability to influence the world as students, such as enhancing their voice, contribution, status, and recognition. 24 out of 60 participants responded positively to this dimension, with an average score of 2.88. These results indicate a moderate impact on participants' perceived influence and recognition within their academic and social contexts.

Reframing Value: The final part assesses the reframing value, focusing on profound, long-term changes in participants' perspectives and behaviors. Nineteen participants responded positively to the statement: "Participation made me see my world differently (change in perspective, new understandings of the situation, redefine success, etc.)," with an average score of 2.71. This finding suggests that some participants experienced significant shifts in their worldview and understanding due to their involvement with the platform.

Figure 3 provides an overview of the average scores for each value creation cycle, illustrating the varying impacts of the Answers platform on different dimensions of value creation. The high average score for applied value highlights the platform's effectiveness in enhancing students' academic practices. In contrast, the lower scores for potential and reframing values underscore areas for improvement in fostering social connections and facilitating changes in perspectives.

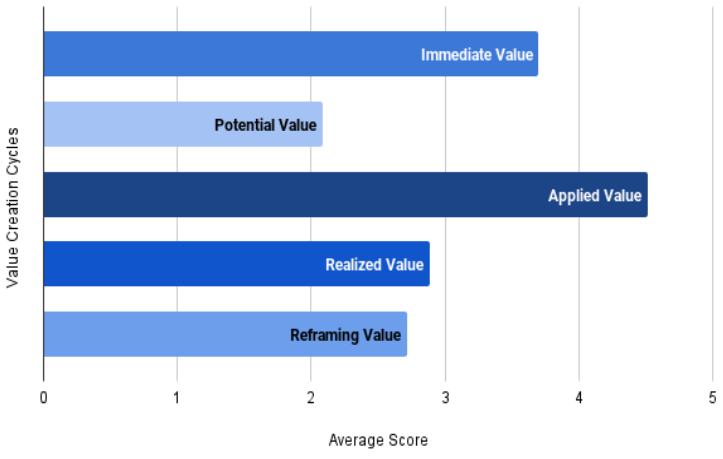

Figure 3: Average Score of Value Creation Cycles

3.1.2 Descriptive analysis of IMI

Table 3 presents the descriptive statistics of the Intrinsic Motivation Inventory (IMI) questionnaire, which measures various dimensions of intrinsic motivation on a scale from 1 (not at all true) to 7 (very true). The IMI

assesses five subscales: relatedness, interest/enjoyment, perceived choice, pressure/tension, and effort, providing insights into participants' motivational dynamics when using the Answers platform. Figure 4 also presents the average scores for the IMI subscales and visualizes the variation across different motivational dimensions of IMI.

Table 3: Descriptive Analysis of IMI Subtests

IMI Subscale	Average	Std Dev
Relatedness	*0.30*	*0.59*
Interest/Enjoyment	*2.64*	*0.87*
Perceived choice	*0.82*	*0.78*
Pressure/Tension	*0.22*	*0.90*
Effort	*2.09*	*0.71*

The relatedness subscale explores the sense of connection between participants. As shown in Figure 4, scores for this subscale clustered around the lower end, indicating that participants did not feel significantly connected to others through the platform. For example, one of the questions in this subscale was, "I felt really distant from the other members of the network." These results suggest a need to enhance the social interaction features of the Answers platform to foster better connections among users.

The interest/enjoyment subscale scores were generally high, demonstrating that participants found the platform engaging and enjoyable. For instance, one of the questions in this subscale was, "While interacting with the other Answers-EWI members, I was thinking about how much I enjoyed it." The high scores indicate that gamification effectively enhanced user engagement and enjoyment.

The perceived choice subscale examines participants' sense of autonomy in networking and communicating with other Answers platform users. For example, one of the questions was, "I felt like I had a choice about interacting with the other network members." The results for this subscale showed mixed feelings among participants regarding their sense of control over their interactions and use of the platform. Therefore, it suggests that while some users felt autonomous, others did not perceive a strong sense of choice in their interactions.

The low average score for the pressure/tension subscale indicates that most participants did not experience pressure or tension when interacting with the platform or other members. An example question from this subscale was, "I did not feel nervous about interacting with the other network members." These results highlight that the platform's design effectively minimized stress and anxiety among users, creating a comfortable environment for interaction.

The effort subscale had a high average score, indicating that participants actively tried to maximize their experience and interactions within the network. For example, one of the questions in this subscale was, "I tried hard to have a good interaction with the other network members." This implies that users were willing to invest significant effort to benefit from the platform, reflecting a high level of engagement and commitment.

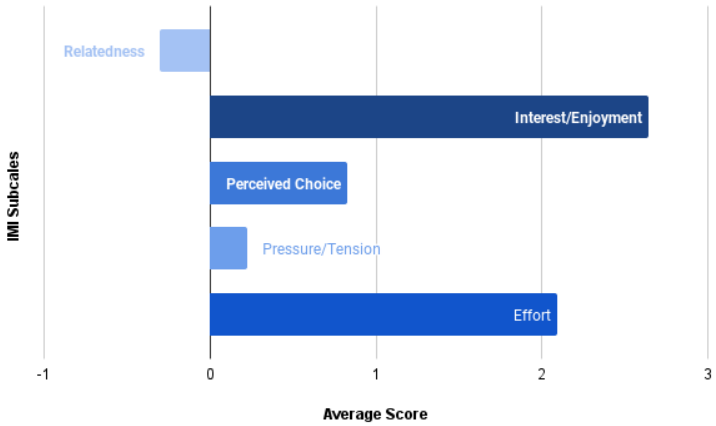

Figure 4: Average scores of IMI Subscales

3.1.3 Descriptive analysis of engagement and interaction analysis

The analytics module of the Answers platform provided detailed insights into user engagement and interaction. Our key findings include visit frequency, activity Frequency, and number of badges earned. The average number of weekly visits was 347, indicating regular engagement with the platform. As Figure 5 shows, participants constantly visit the Answers Platform, but we also see significant drops during holidays in weeks 8 and 14.

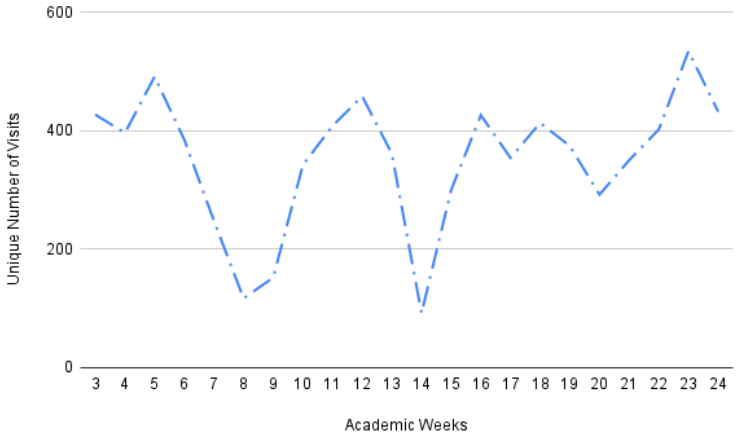

Figure 5: Visit Frequency

Activity Frequency analysis indicates that, in total, our platform users raised 616 questions, answered 608 times, and left comments 395 times. Most interactions were questions (38%), followed by direct answers (37%) and commenting (25%). An overview of these findings is illustrated in Figure 6.

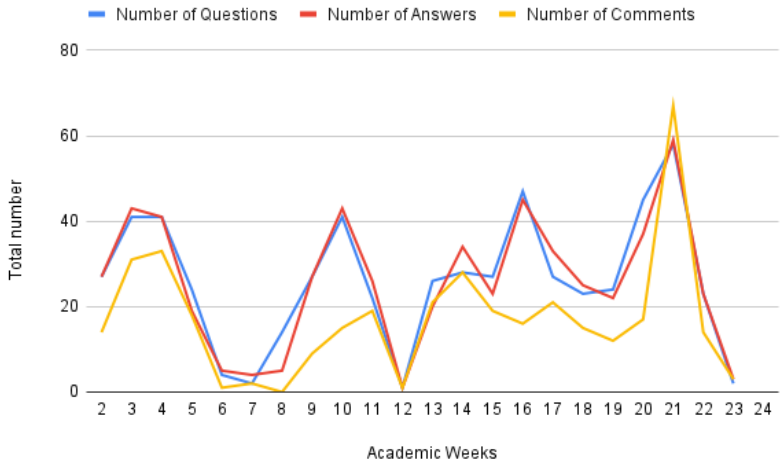

Figure 6: Activity Frequency of Answers Users

Answers' users earned 428 badges during the study period, reflecting their achievements and milestones. Figure 7 shows the patterns of users' peak activity during exam periods.

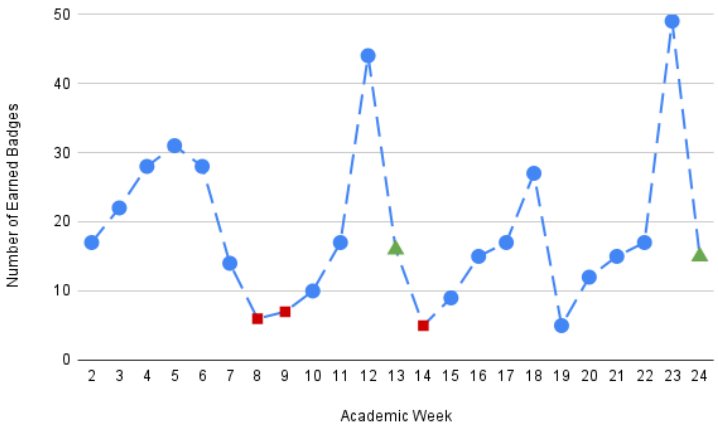

Figure 7: Total number of budges earned by Answers' users. Red squares indicate holiday weeks, and green triangles indicate exam weeks

In conclusion, our quantitative analysis results indicate that while the immediate value perceived by participants is relatively high, this value is more personal than social. This can be supported by the low potential value and the relatedness subscale scores of IMI, which reflect limited social engagement and connection among users. This pattern suggests that students find the Answers platform valuable for individual learning but must utilize it to fully build social connections or collaborative learning.

Moreover, the engagement data, such as the frequency of visits and the number of questions asked, supports this interpretation. While students actively use the platform, the low relatedness scores suggest that these interactions are more transactional than community-building. This trend aligns with the qualitative analysis, where students expressed that they primarily use the platform for academic purposes rather than socializing.

These findings are consistent with Wenger, Trayner, and De Laat's (2011) value creation framework, which claims that personal value may only translate into potential value with intentional design efforts to foster social connections. The following qualitative analysis section will explore these patterns further, providing more context and depth to these quantitative findings.

3.2 Qualitative Analysis

3.2.1 Qualitative analysis of open-ended answers of VCQ

In VCQ, participants were asked multiple-choice and open-ended questions that explored the five value creation cycles: immediate, potential, applied, realized, and transformative. While the multiple-choice questions allowed participants to express their "level of agreement" with the provided statements related to these cycles, the open-ended questions provided more profound insights into the reasons behind their responses.

Participants who agreed with the statements for each cycle were asked to elaborate on how their participation influenced them, such as "Can you explain how participation changed you as a student?" Contrariwise, those who disagreed were prompted to explain why the participation did not have an impact, with questions like "Can you explain why participation did not change you as a student?" The responses to these open-ended questions were subjected to initial coding, which enabled us to group the data into different themes. This thematic analysis provided a richer understanding of the various dimensions of value creation experienced by the participants beyond what could be captured through the multiple-choice responses alone. A summary of these findings is presented in Table 4.

Table 4: Result of Qualitative Analysis of Open-ended Response of VCQ

Value Creation Cycle	Positive and negative value	Theme	Occurrence	Example Quotes
Immediate	Positive	Knowledge Acquisition	15	"I became more familiar with material."
		Improved Communication	7	"It is nice to be able to ask questions and having people respond. It helps with

Value Creation Cycle	Positive and negative value	Theme	Occurrence	Example Quotes
				communication skills and understanding of the material."
		Problem Solving	7	"Solved questions I had."
		Peer Learning and Interaction	7	"I can see what type of problems others also struggle with, and it's very informative."
	Negative	Low Usage	6	"I didn't really participate and have not really used Answers.ewi that much"
		Utility-Driven	5	"It did not change my way of studying, just the way I sought out help"
		No Significant Impact	4	"It was not that much of an effect on me, I just received help when needed
		Challenges in Participation and availability of alternative support	5	"I feel like I would still be able to ask questions to my peers, or TAs during labs, without posting them on Answers"
Potential	Positive	New and Improved Social Connections	3	"Participation affected my social connections in a good way because I had the opportunity to make new friends."
		Increased Closeness and Unity	2	"It creates union between students."
		Professional and Peer Recognition	2	"It helped me recognize dedicated colleagues. It also made me a bit more confident in my skills, and made me dedicate more to cooperation."
	Negative	Educational Utility and Focus	18	"The people I interact with on Answers-EWI I either already know or I did not start interacting with them more."
		Lack of Social Interaction	17	"I only look at the answers."
		Low Engagement and Usage	6	"I didn't participate much for that to happen."
		Preference for Other Platforms and Methods	5	"While I do agree that it gives a positive emotion when someone took the time to answer your questions, I feel like other (unofficial) platforms give more social interactions. (Such as the WhatsApp groups)."
Applied	Positive	New Ideas and Approaches	9	"Provided innovative ideas and clear explanation of certain concepts."
		Problem-Solving and Insights	7	"I've gotten valuable answers from it that helped me with studying."
		Peer Learning and Perspectives	8	"It gives good extra views on topics by other students, lecturers and TAs."
		Additional Learning Support	20	"In the rare case that someone had the same problem that I did, it boosted my confidence because I wasn't the only person struggling."
	Negative	Low or No Usage	3	"I haven't really felt it was necessary to use it."
		Preference for Traditional Resources	2	"I guess, but getting that info from either course staff or course material would have helped a lot more."
		Lack of Useful Outcomes	2	"So far nothing useful has come of trying to use the platform."

Value Creation Cycle	Positive and negative value	Theme	Occurrence	Example Quotes
Realized	Positive	Recognition and Confidence	4	"By answering questions, mostly in-person, I could make an impact in my study group. Moreover, I feel like it raised my level of confidence."
		Peer Interaction and Contribution	4	"The network makes it easy for a student to talk to other students about similar topics, so I think it has a big impact on students."
		Influence on Course and Problem-Solving	5	"It is an accessible way to bring possible problems forward to course staff."
		Potential and Limitations	4	"Personally it has not influenced me as a student, but I have seen posts where students help each other, and therefore the student that is helping is usually very appreciated."
	Negative	No Effect or Impact	7	"Not using the network has had no effect on me as far as I'm aware."
		Low Usage and Contribution	6	"I have not participated on EWI answers enough to feel like I was an influence there."
		Educational Utility and Question-Focused	5	"I only used answers to ask questions so it did not change my view of the world or influence or anything."
		Low Impact and Recognition Issues	5	"It's not that deep."
Transformative	Positive	Varying Perspectives and Changed Views	7	"It made me see the world differently in some area in which I changed my view after seeing an answer/asking a question."
		Shared Struggles and Supportive Environment	3	"It's very nice to see previous students / teachers helping out with students' questions, it's a very supportive environment."
		Self-Understanding and Inspiration	4	"Now I have a much more in-depth perspective of this field."
		Low Usefulness and Mixed Impact	4	"It is good that I see people help each other without any form of compensation."
	Negative	No Significant Impact	12	"No significant impact."
		Educational Utility	7	"It's just a help, it doesn't change world views."
		Low Usage	5	"I have not used answers.ewi that much so idk a lot of things do not apply to me."
		Question-Focused	5	"It helps me when I do not know what to do, but that is all I use it for."

Several patterns emerge that align with and expand upon the quantitative results presented earlier by reviewing the qualitative findings from the open-ended questions. The themes of 'knowledge acquisition' and 'improved communication' are frequently mentioned in the immediate value cycle, which aligns with the relatively high scores for perceived usefulness and engagement in the quantitative data. This finding suggests that while students benefit from the Answers platform regarding individual learning and skill development, their interactions could be more collaborative, as evidenced by the low relatedness scores in the IMI.

Another pattern observed is the frequent mention of 'lack of social interaction' in the potential value cycle, which corresponds with the low scores in the relatedness subscale of the IMI. These findings indicate a consistent challenge in fostering a sense of community and social connectedness on PLN platforms. Despite the platform's success in facilitating academic support, it fails to promote deeper social interactions among users.

Moreover, the recurring theme of 'preference for traditional resources' in both the applied and transformative value cycles provides additional context to the mixed feelings of autonomy and choice reported in the IMI. While

the platform offers valuable resources, students may still rely on more traditional forms of support, such as direct interaction with course staff or peers, potentially limiting the platform's impact on broader educational outcomes.

Finally, these patterns reveal a complex interaction between the platform's design, its intended outcomes, and the actual experiences of its users. By contrasting these qualitative insights with the quantitative data, it becomes clear that while the platform is effective in certain areas, there are opportunities to enhance its social and collaborative dimensions to realize its full potential.

3.2.2 Qualitative analysis of in-depth interviews

This section presents the insights derived from ten in-depth interviews conducted with students and TAs who used the Answers platform. The interviews aimed to explore students' and TAs' experiences, motivations, value creation, and the platform's impact on their learning practices. The analysis revealed several key themes: awareness and communication of gamification features, expectations and experience, social connections and platform usage, instructors' and mediators' influence, platform benefits, technology comparison, and trust and reliability. We briefly explain each of these themes in detail as follows.

Theme 1. Awareness and Communication of Gamification Features.

Nine out of ten interviewed participants noticed the gamification elements like badges. However, they needed to engage more deeply with them, indicating a need for better communication about these features. For instance, Participant Eight mentioned, "I didn't really notice a lot of change, *but I haven't used answers in a while either.*" Similarly, Participant Four said, "*I've noticed the badges, but I don't notice the points or other gamification elements on it*."

Effective communication strategies are essential to ensure students understand and utilize new features. This includes targeted notifications and clear explanations about the benefits and functionalities of the gamification elements.

Theme 2. Expectations and Experience

Students expected the platform to be a resource for finding answers and sharing knowledge, and it met these expectations. However, engagement with gamification elements could have been higher. Participant One stated, "*I kind of expected it to be what it is. It's an answer platform. If you ask questions, people can see your questions and respond.*" she added, "*It was nice because there were answers and questions from the year before, which is very useful for general questions about course material*." These findings raise the importance of providing clear guidance on the platform's benefits and capabilities, which could enhance student participation and engagement with gamification features.

Theme 3. Social Connections and Platform Usage

The platform was primarily used for academic purposes, with limited impact on fostering social connections. Many students preferred alternative, informal communication methods, such as WhatsApp and Discord, for social engagement and quick exchanges. Participant Two noted, *"I don't really see it very much as a social platform."* Similarly, Participant Four stated, *"There are obviously WhatsApp groups or Discord servers made by students for networking."*

Low engagement with the platform was largely attributed to the availability of alternative platforms that students found more efficient for networking and discussions. Participant Eight mentioned, *"We mainly use WhatsApp for communication."* These findings suggest that integrating the platform with existing student-preferred communication tools could improve engagement and enhance social interactions.

Theme 4. Instructors' and mediators' Influence

Instructor recommendations played a significant role in how students used the platform. Instructors' active involvement can enhance the platform's perceived value and encourage more frequent use. Participant Two mentioned, "*It was great to get in touch with the lecturer through the platform*." Similarly, Participant Eight said, "*Some teachers use the forums actively, which is very helpful*." Promotion of the platform during lectures and instructor participation can significantly increase its usage and effectiveness.

Theme 5. Platform Benefits and Technology Comparison

The platform provided valuable records of past discussions and immediate access to information, which benefited students. Participant Four, for example, mentioned, "It really helps to see previous questions and answers." Participant Nine added, "Having access to past discussions is very helpful." While AI tools like ChatGPT offer quick answers, students trust human responses for accuracy and context. Participant Ten stated, "I don't fully trust ChatGPT because I've seen what it can spit out, and it's not always smart." Ensuring the accuracy and reliability of the information delivered on the platform is critical.

Theme 6. Trust and Reliability

Students prefer human responses over AI-generated ones due to their reliability and accuracy despite the longer response time. Participant Four highlighted, "When I see someone answer your question, I look at the votes and see if I know the person already." Factors such as upvotes, the credibility of responders, and personal experience influenced trust in the platform. Ensuring the trustworthiness of the information provided is essential for the platform's success.

4. Discussion

4.1 Perceptions of the Gamified Learning Experience

The first research question explored how learners perceive the gamified learning experience on the *Answers* platform. The quantitative results indicated that most students perceived the platform positively, particularly in terms of its academic utility. The qualitative data supported this perspective, with students appreciating the Answer's role in accessing learning materials, answering questions, and understanding peers' challenges. However, engagement with gamification elements, such as badges and points, was mixed. While some participants reported feeling motivated by progress-based rewards, others found these elements unnecessary or unnoticeable. Previous research on gamification in education suggests that the effectiveness of game elements depends on individual preferences, perceived relevance, and alignment with intrinsic learning goals (Hamari, Koivisto, & Sarsa, 2014; Sailer & Homner, 2020). To increase engagement, system designers and instructors could enhance awareness and visibility of gamification mechanics, try to satisfy the psychological needs of their participants (e.g., autonomy, competence, and relatedness)(Suh, Wagner, and Liu, 2016), integrate more meaningful incentives, and provide peer recognition for contributions.

4.2 Impact of Answers Platform on Value Creation and Intrinsic Motivation

Our second research question focused on how the platform impacts value creation and intrinsic motivation. The VCQ results highlighted strong applied value, with 88.3 percent of participants agreeing that the platform helped their academic practices. Interview responses confirmed this, as students noted that exposure to different problem-solving approaches enhanced their learning. This finding is consistent with Wenger's applied value cycle, where learners integrate new knowledge into their existing skill sets (Wenger, Trayner, & De Laat, 2011).

However, findings From IMI indicated low scores in the relatedness subscale, which suggests that students did not feel socially connected through the platform. This challenge in gamified learning environments, where game elements alone may not be sufficient to foster collaborative or social learning experiences, has also been emphasized in another research (Kraut et al., 2008). Our qualitative analysis supports this, as students frequently mentioned relying on external communication tools (e.g., WhatsApp, Discord) for peer interaction.

4.3 Social Connections and Community Building

The platform's impact on social connections could have been more pronounced, with only 9 out of 60 participants reporting positive effects on their social interactions. Many students indicated that they primarily used the platform for academics rather than socializing. This finding shows the importance of informal learning networks and their roles in promoting professional development (Nijland, Van Amersfoort, Schreurs, and De Laat, 2018; De Laat, Schreurs, and Sie, 2014).

Researchers have identified several limitations in how gamification fosters social interaction. A key concern is that game mechanics can sometimes encourage superficial or competitive behavior rather than deep, meaningful collaboration. For instance, if poorly implemented, gamification with points might push students into *"destructive competition"* where they feel pressured or controlled by the game (Bovee, Jernejcic, and El-Gayar, 2020). A 2024 review similarly warns that gamification can over-emphasize competition at the expense of collaboration (Wulan, 2024). When students focus too much on winning or rankings, true community-building may suffer.

There are also social and emotional considerations. Gamification can introduce social comparison that is not always healthy. A recent study on the "dark side" of gamified communities found that intense use of game elements can lead to stress, anxiety, or interpersonal conflicts (e.g., feelings of inequity or jealousy) if not moderated (Srivastava et al., 2022). In summary, gamification may encourage quantity over quality without careful design, foster unhealthy competition, or not engage students as intended.

However, one solution to maximize the social benefits of gamification while mitigating its drawbacks can be designed for cooperation, not just competition. Many studies emphasize collaborative gamification to foster meaningful peer interaction. This means structuring game elements so students work together (in teams or as a class) toward goals instead of solely competing against each other. Cooperative or team-based challenges can satisfy students' need for social connectedness and shared purpose. An (2021) has found that *social gamification* (integrating social networking and teamwork into the game) tends to outperform purely individual gamification in terms of student interaction and even academic performance. Also, Dindar, Ren, and Järvenoja (2021) compared gamified cooperation vs. competition and found no loss in achievement or motivation but significantly higher social relatedness in the cooperative condition. In practice, we can encourage community building using team points or group leaderboards instead of individual rankings. By making peers depend on each other for success, gamification can encourage help-seeking, communication, and a supportive learning community.

4.4 Engagement and Interaction

Descriptive analytics of engagement and interaction highlighted the platform's effectiveness in maintaining regular student involvement. The average number of weekly visits was 347, demonstrating consistent engagement. Moreover, users actively participated by raising 616 questions, providing 608 answers, and leaving 395 comments. This high level of activity aligns with existing literature on the positive impact of gamification on student engagement (Rivera and Garden, 2021; Alsadoon, 2023). However, our findings align with studies that argue that engagement metrics alone do not reflect deeper cognitive involvement or collaboration (Dillenbourg, 2021). Future studies should measure student-generated content depth, response quality, and long-term knowledge retention to provide a more comprehensive understanding of engagement.

4.5 Influence on Student Voice and Perspective

The realized and transformative value scores were moderate, with 40% of participants feeling that their ability to influence their learning environment improved. However, in follow-up interviews, some students expressed that *Answers* had enabled them to raise their academic concerns in ways that were not previously possible. This finding suggests that while the immediate transformative value may be unpretentious, the platform might contribute to a longer-term shift in student agency and participation. A potential area for future research is exploring how gamified platforms can promote more structured student-led initiatives. An example could be developing feedback loops between students and instructors to address learning challenges or co-designing gamification elements to reflect student needs.

4.6 Practical Implications and Recommendations

Our findings have a few practical implications for designing gamified learning platforms. First, we aim to improve social interaction by integrating discussion-based features and collaborative activities, which can foster a stronger sense of relatedness. Second, educators need to enhance motivation mechanisms by moving beyond points and badges. To achieve this goal, platforms can integrate peer recognition systems, narrative-based progression, or personalized incentives. Finally, reinforcing engagement beyond task completion. Future studies should investigate how to sustain long-term engagement through adaptive game mechanics, explore interventions to improve social connectivity and measure long-term learning retention.

5. Conclusion

This study explores two main research questions. First, how do learners perceive the gamified learning experience on the Answers platform? Second, how does the Answers system impact graduate students' value creation and intrinsic motivation? The findings indicate that while the platform successfully enhances learning practices and engagement, its impact on social connections and broader perspectives is less pronounced. Points and badges have limitations in sustaining engagement; alternative motivational designs should be explored. Future research should focus on strategies to increase active participation and foster a sense of community, ensuring the platform's content remains relevant and challenging. Also, Wenger's Value Creation Framework provides a powerful lens for evaluating multi-dimensional learning outcomes in gamified environments.

Platforms like *Answers* can maximize their impact on student learning and professional development by refining game design elements and fostering community-driven participation.

AI statement: No AI tools were used in this research to generate the text, data, or any type of information.

Ethics statement: Participation in this study was voluntary, and all students signed an informed consent form acknowledging their understanding and agreement to participate. No further ethics approval is required.

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