Development and Evaluation of the Game LEAGUE OF QUALITY: ISO/IEC 25000 in an Educational Context

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ABSTRACT

Context: Teaching software quality concepts can be challenging due to their abstract nature and limited engagement with traditional instructional methods. To address this, educational games have emerged as an effective strategy for improving motivation and learning outcomes, particularly in Information Technology programs. **Aims**: This paper reports on the development and evaluation of the educational game LEAGUE OF QUALITY: ISO/IEC 25000, which aims to teach software product quality concepts based on ISO/IEC 25000. The goal is to introduce diversity into the course and enhance students' skills, engagement, and knowledge. **Method**: The development of the game followed four phases: pre-production, pilot testing, production, and finalization. The game was applied in classroom settings with IT students at a Brazilian university. Data was collected from both students and professors regarding their perceptions of the game's effectiveness and usability. **Results**: Most students reported that the concepts presented in the game were applicable to real-world professional scenarios. They found the dynamics of the game clear, accessible, and engaging, contributing positively to their understanding. The game provided a better learning experience, especially for students with little prior knowledge. Professors also observed increased motivation, participation, and improved learning outcomes. **Conclusions**: LEAGUE OF QUALITY proved to be an effective and engaging educational tool for teaching software product quality. It enhanced student motivation, especially among those with limited prior knowledge, and promoted better understanding and retention of key concepts. Both students and professors reported increased engagement, with students highlighting the game's relevance to real-world practice and its positive impact on the learning experience.

KEYWORDS

Teaching in Higher Education, Knowledge Sharing, Teaching Innovation

1 Introduction

Teaching Software Engineering (SE) concepts presents significant challenges due to the vast amount of content that must be covered and the continuous evolution of the software industry. These factors directly impact the skills required for professionals in the field of Information Technology (IT) [7, 19]. To address these challenges, higher education institutions are constantly exploring innovative ways to enhance the teaching and learning process, including the use of educational games, simulations, and active learning methodologies [19]. According to Vlachopoulos and Makri [29], integrating games into learning environments yields three key outcomes: cognitive, behavioral, and affective. Additionally, Mingyu et al. [21] highlighted that educational games can contribute to knowledge acquisition, educational development, behavioral change, increased engagement and motivation, improved learning effectiveness and computational thinking, skill and attitude enhancement, self-management, and, of course, adding an element of fun to the learning process.

The Software Quality course covers a broad range of theoretical and practical aspects. According to Rocha et al. [22], the syllabus for this course, based on various Information Systems programs at Brazilian universities, includes topics such as the history of quality, quality fundamentals, quality processes, product and process quality, ISO/IEC 15504 [24] and ISO/IEC 25000 standards [27], as well as software quality system planning. Additionally, software testing is covered due to its critical role in improving software quality. In a rapidly evolving technological landscape, developing the skills to understand software quality concepts from the ISO/IEC 25000 standard is essential. Thus, it is essential to present this model to the students and facilitate the discussion on possible approaches for developing higher-quality software. The main challenge is to present this model in a way that students can not only understand the concepts and their practical applications in software development but also develop a critical perspective on the benefits, challenges, and applicability in specific contexts.

Several proposals for games, digital games, simulations, playful activities, and active methodologies have been applied in higher education within the context of Software Quality. Rocha et al. [23] presented the results of a systematic literature review on digital games that support teaching and learning in Software Quality. The authors identified seven digital games used to address topics related to Software Quality, such as software measurement, inspection, process improvement, usability, and code readability. Later, Rocha et al. [22] developed a digital game called Qualif (which includes quiz, hangman, memory, and mission games on a platform), focusing on the fundamentals of quality, product quality, and testing. In this article, they provide an updated literature review and identify, in

addition to the previously mentioned digital games, one more game related to the topic of testing.

Other works related to games, gamification, and active methodologies in the context of Software Quality courses can also be found, focusing on Software Process Quality – MPS.BR [18, 26]; CMMI Artifacts [10]; Testing [6, 9, 11, 20]; and Usability [6]. In light of this scenario, it is important to emphasize the need for games and activities to study and apply the concepts of ISO/IEC 25000 [13]. This research presents an experience report on the game LEAGUE OF QUALITY: ISO/IEC 25000. The goal of the game is to empower participants to understand and apply the concepts of ISO 25000 in real-world cases through a card game. Additionally, it allows students to experience the use of tools commonly employed in the software industry to solve the problems encountered.

This article presents the details of the game's development and its application in several courses in a Brazilian university, including Computer Science, Systems Analysis and Development, and Software Engineering. Additionally, we gathered students' perceptions regarding the classroom activity, as well as the views of two professors on the students' teaching-learning process and how the activity influenced the participants' behavior.

Our key findings reveal that students shared various questions and experiences throughout the implementation of LEAGUE OF QUALITY: ISO/IEC 25000. Participants explored and identified both the advantages and challenges of using the game. Additionally, they emphasized the advantages of implementing this teaching-learning approach and recognized the assumptions and limitations associated with applying ISO 25000 concepts in the software industry. Students stated that using LEAGUE OF QUALITY: ISO/IEC 25000 facilitated their learning process, increased their motivation toward the subject, and provided a highly rewarding user experience. Professors agreed that the game fostered high levels of motivation and enhanced learning outcomes. They also observed strong student engagement and active participation from all students. Professors pointed out aspects that could be improved, considering the identified drawbacks. These included introducing multiple difficulty levels (to accommodate students with different levels of prior knowledge), adjusting colors and fonts (to enhance accessibility for all students), among other refinements.

2 Background and Related Work

It is important to enhance the teaching-learning process, especially in the Software Quality course in IT programs, within the context of ISO/IEC 25000, as there is limited practical application of these concepts in traditional teaching methods. Nevertheless, strategies applied to Software Quality education, such as educational games, are becoming more common [22, 23], and educators have been using these games and activities to support knowledge construction in the university setting [6, 20]. Below, we present ISO/IEC 25000:2014 [13] and ISO/IEC 25023:2016[14], the focus of this work, along with a survey of games and activities applied to Software Quality and the rules of the game LEAGUE OF QUALITY: ISO/IEC 25000.

The ISO/IEC 25000:2014 standard [13], also known as SQuaRE (Software Product Quality Requirements and Evaluation), establishes a set of guidelines and standards for software product quality. This standard was developed to meet the needs of an ever-evolving market, where software quality is essential for the success of organizations. One of the primary objectives of ISO/IEC 25000:2014 is to provide a model that helps stakeholders understand the quality characteristics a software product must meet. This is particularly important in a context where various stakeholders—such as developers, clients, and project managers—may have different expectations regarding software quality. ISO/IEC 25000 provides a clear framework for specifying and evaluating software quality, addressing aspects such as quality requirements, measurements, and product evaluation. The standard proposes five divisions: Quality Management (2500n); Quality Model (2501n); Quality Measurement (2502n); Quality Requirements (2503n); and Quality Evaluation (2504n).

According to Karnouskos et al. [16], several quality attributes and metrics are studied [1]. Standards such as ISO/IEC 25010:2011 [12] define various high-level characteristics relevant to this context. However, to obtain a quantifiable evaluation, there is a need to verify the concrete measures and their calculations as proposed by ISO/IEC 25023:2016 [14], which also belongs to the same family of standards. ISO/IEC 25023:2016 [14] defines key characteristics and sub-characteristics essential for evaluating the quality of software products. The main characteristics include functionality, reliability, usability, efficiency, maintainability, and portability. Each of these characteristics is further divided into more specific aspects (sub-characteristics), allowing for a detailed analysis of the software's qualities. The standard facilitates communication among stakeholders by establishing a common language and clear criteria for measuring and reporting quality. ISO/IEC 25023:2016 [14] enables organizations to improve their development processes and ensure that their products meet market expectations. Its application helps increase software quality while also fostering greater stakeholder confidence, contributing to the development of more robust and efficient technological solutions. Thus, one of the contributions of this paper is to promote a critical discussion on the importance and application of these measures for evaluating the quality of software products in the academic environment.

2.1 Games and dynamics focused on the subject of Software Quality in higher education

There are several concepts related to games and dynamics applied to teaching. Among them, Game-Based Learning (GBL) describes learning facilitated through games. Games for learning is a field of practice and research that has grown significantly in recent years, with an increasing number of empirical studies and case reports demonstrating its impact [4]. Educational games are often referred to as serious games (SGs), which are games designed with a purpose beyond pure entertainment, such as educational, business, or military goals [17, 19, 30]. In this work, we will consider the terms SG and games for learning interchangeably within the context of software quality. According to Medeiros et al. [20], active methodologies focus on the student as the center of the learning process. This active method makes classes highly interactive, focusing on practice and engaging students. Thus, dynamics using active methodologies, found within the context of software quality, are also presented.

Several authors investigated games and dynamics focused on higher education. Among them, Brandl and Schrader [5] explored

the use of Serious Games in higher education through a systematic review of 550 publications, of which 28 were deemed relevant. Of those, 8 focused on computer science, but none were in the context of software quality. In 2016, Battistela and Wangenheim [3] conducted a systematic review on games for teaching computer science and identified 107 games, primarily for teaching software engineering, programming fundamentals, networks, algorithms and complexity, and security. No games focused on software quality were found at that time. According to these authors, digital games are still predominant, although a trend towards non-digital games (e.g., board games, card games, etc.) can also be observed.

Focusing on the subject of software quality, Rocha et al. [23] presented the results of a systematic literature mapping of digital games that support teaching and learning about software quality. The authors identified 7 digital games used to support topics related to software quality. These are software measurement (XMED), software inspection (InspectorX), process improvement (SPICity and SPIAL), Usability (ISO 9126), Usability game, and source code readability assessment (GamiCRS). Subsequently, Rocha et al. [22] developed a digital game called Qualif (quiz, hangman, memory, and mission—platform) focused on Quality Fundamentals, product quality, and testing. In this study, they provide an extension of the bibliographic review and identify, in addition to the previously mentioned digital games, one more related to testing.

Focusing on process quality, the work of Maia et al. [18] described the adoption of the Flipped Classroom combined with gamification elements in teaching Software Process Quality with an emphasis on MPS.BR. The experience involved 40 undergraduate students in Software Engineering. Meanwhile, Silva et al. [26] presented a game proposal called MPS.Br Game, which aims to help students reinforce, exercise, and learn about the MPS.BR software maturity model. The students felt that the game taught them about the content, concluding that the MPS.BR Game can be used to support learning the MPS.BR material. In the context of CMMI, Damasceno et al. [10] conducted a study on gamification and its application to solving a real-world problem. They present a proposal for a teaching tool aimed at producing artifacts in CMMI process areas.

Considering the concepts of testing, Silva et al. [9] presented the development of a prototype for an educational game called GameTest, designed to assist in the teaching and learning process of testing. The prototype was validated through a survey conducted with 40 participants. Meanwhile, Medeiros and Prates [20] investigated and applied active methodologies, specifically problem-based and collaborative learning, in the study of Software Engineering. As a case study, activities were developed within the context of software testing. Comparisons were made between two groups: one using active methodologies and the other not. It was observed that the group using active methodologies achieved a higher rate of test case execution per minute compared to the group that did not use them.

In the context of Active Methodologies and also in the context of testing, Elbrably et al. [11] presented a teaching approach used with a curriculum and teaching plan for a software testing course, developed based on active methodologies. The results include a teaching plan built from active methodologies, consisting of 32 theoretical and practical lessons, distributed across 4 modules. This plan is based on references from a specialized curriculum in software testing and was developed from a mapping of different assets related to software testing, the main ones being the SBC's Curriculum Reference Guide, the ACM/IEEE curriculum guide, and the Software Engineering Body of Knowledge (SWEBOK) guide. Also in the context of active methodologies, Calazans et al. [6] presented playful techniques such as Bumblebee (concepts of test types) and Hands-on for discussion, analysis, and understanding of the importance of documentation, as well as Thinking aloud (usability of the software product). In the chapter on problem-solving techniques, they present the application of the Team-Based Learning (TBL) technique for software testing, measurement, and analysis.

Considering the previous studies, the importance of developing and applying games, especially in the context of the Software Quality course, is highlighted. No games related to ISO/IEC 25000 or other ISO/IEC standards within this framework were found. As previously demonstrated, these concepts are fundamental for shaping a more competent and effective professional. Below, we present the first module of the card game LEAGUE OF QUALITY: ISO/IEC 25000.

2.2 LEAGUE OF QUALITY: ISO/IEC 25000

The objective of LEAGUE OF QUALITY: ISO/IEC 25000 is to contribute to the teaching and learning process by providing an opportunity for experimentation and practical examples of concepts learned through a card game. Additionally, it aims to encourage collaborative behavior, observation, and comprehension among students regarding the concepts of ISO/IEC 25000:2014 [13], with a primary focus on the concepts of ISO/25023:2016[14] in this first module. Future modules are planned to cover measurement and modeling aspects. The activity typically lasts about 1.5 hours and is usually applied to a class of 30 to 40 students. The game was developed by one of the authors, and research in articles and books was conducted to identify cases or practical examples that could be used to illustrate the lack of application of certain quality characteristics or sub-characteristics. These cases or examples were later validated and refined with input from another participant.

The following rules have been defined for LEAGUE OF QUALITY: ISO/IEC 25000: 1) Participants: A maximum of 6 participants, divided into 2 subgroups; 2) Cards: Event Cards, ISO 25023:2016 Characteristics Cards, and ISO 25023:2016 Sub-characteristics Cards; and 3) Objective of the Game: To earn the highest score. The rules of the game LEAGUE OF QUALITY: ISO/IEC 25000 are described, including the game flow, the groups, the types of cards, and the overall game dynamics (how to play): 1. **Group Division**: The 6 participants will be divided into 2 subgroups (Group A and Group B), which will compete against each other; 2. **Draw an Event Card**: Group A draws an Event Card from the top of the deck; 3. **Read the Event**: Group A reads the Event to Group B, which must identify which of the 8 Quality Characteristics from ISO/IEC 25023 is being addressed. The Characteristics and Sub-characteristics Cards can be consulted freely during the game; 4. **Score for Group B**: If Group B correctly identifies the characteristic, they earn 1 point. Group B then attempts to identify the sub-characteristic related to the event; **5. Turn Change**: Now, it's Group B's turn to draw an Event Card and continue the game; and 6. **Winner**: The group with the highest

score at the end of the game wins! The materials made available in the repository at Zenodo include the game cards, the facilitator's guide, the answer key with technical alternatives, and an illustrative example of a game round. All these materials are intended to support the implementation, facilitation, and subsequent analysis of the game.

3 Study Settings

In this study, we present an experience report on the development and implementation of LEAGUE OF QUALITY: ISO/IEC 25000 in the classroom of the Software Quality course for the Computer Science and Systems Analysis and Development programs. We adopted a quantitative/qualitative approach using a survey questionnaire as the primary research method to capture the perceptions of higher education students. We also gathered feedback from the course instructors regarding the game's application, student engagement, and learning outcomes. The LEAGUE OF QUALITY: ISO/IEC 25000 game aims to contribute to the teaching and learning process by providing an opportunity to experiment with and apply practical examples of concepts learned through a card game.

For the game evaluation based on students' perceptions, we used the Educational Game Evaluation Model in Software Engineering proposed by Savi et al. [25]. The proposed model is based on the premise that a quality game is one that has well-defined educational objectives, motivates students to study, and promotes the learning of curriculum content through enjoyable, fun, and challenging activities, grounded in a review of the benefits of educational games. The theoretical model for evaluating educational games consists of the construct reaction, its three sub-components, and 14 dimensions. The three sub-components are Motivation, User Experience in Games, and Learning. Each sub-component includes several dimensions. The Motivation sub-component includes the dimensions to be assessed: Attention, Relevance, Confidence, and Satisfaction. The User Experience in Games sub-component includes: Immersion, Challenge, Competence, Fun, and Social Interaction. The Learning sub-component includes the dimensions: Knowledge, Understanding, Application, Short-term Learning, and Long-term Learning[25].

The evaluation form for the game contained 21 questions. Of these, 20 were objective questions covering all the sub-components of the model proposed by Savi et al. [25]. One of the questions was presented in a different format, listing the educational objectives of the game, specifically the knowledge of the quality characteristics of ISO/IEC 25023:2016 in one column. In the other five columns, students were asked to indicate their level of learning before and after using the game. Additionally, there was one subjective question where students could provide comments on their perception of the game practice. Furthermore, we conducted semi-structured interviews [28] with two professors who used the technique in the classroom to assess their perceptions regarding students' learning, communication, cooperation, and satisfaction. The aim was to determine whether the application of LEAGUE OF QUALITY: ISO/IEC 25000 enabled students to understand the benefits, difficulties, and applicability of the ISO/IEC 25000:2016 model in various contexts. We also investigated the advantages and disadvantages of the approach adopted by the professors in the classroom. The following research questions were used to guide this study:

RQ.1: What is the perception of undergraduate students regarding motivation, user experience, and learning when playing LEAGUE OF QUALITY: ISO/IEC 25000? The objective was to investigate how students perceived their learning and motivation after playing the game in the classroom.

RQ.2: What is the perception of undergraduate professors regarding learning, communication, cooperation, and satisfaction when working with LEAGUE OF QUALITY: ISO/IEC 25000? The objective of this question is to investigate the advantages and disadvantages of using this approach in the classroom from the professors' perspective.

To validate the LEAGUE OF QUALITY: ISO/IEC 25000, we conducted a study with 123 students from the Computer Science programs of a Brazilian university from February 19, 2025, to March 19, 2025. The study was carried out across several courses, taught by three different professors. Each class had an average of 30 to 40 students, and the students were divided into groups of 6 or 8 people, with these groups further split into two subgroups, as shown in Figures 2, 3, and 4.

Figure 1: LEAGUE OF QUALITY: ISO/IEC 25000 rules

Figure 2: Students playing the game (group 1)

3.1 Instrument Design

Each author of this study was involved in designing and validating the questionnaire questions to assess the game. Two authors formulated the survey questions, while the other two validated them. The survey consisted of 20 closed-ended questions—19 of which were five-point Likert scale questions, and one question that provided five response options for each quality characteristic—along with one open-ended question, as presented in the Table 1. At the beginning of the survey, we presented an informed consent statement outlining the conditions for participation. These conditions complied

Figure 3: Students playing the game (group 2)

Figure 4: Students playing the game (group 3)

with ethical privacy standards under Brazil's General Data Protection Law (Law No. 13.709/2018) [8]. The complete list of survey questions along with their respective response options is publicly available on Zenodo at https://zenodo.org/records/17079511. This repository ensures transparency and facilitates reproducibility by providing access to the exact instruments used in the study.

3.2 Pilot and Data Analysis

We conducted a pilot test to assess the quality of the survey. The questionnaire was sent to three university professors who incorporate games and/or gamification into their teaching practices. The feedback received included suggestions for rewording some questions, as well as a recommendation to add an open-ended question allowing students to provide comments or suggestions for improving the process. Based on these insights, we refined the survey accordingly. Regarding the time required to complete the questionnaire, pilot test participants took an average of less than 10 minutes. This estimated completion time was communicated to students before the questionnaire was administered in the classroom.

We used the Google Forms platform to create the research questionnaire, which was then made available to the students. The questionnaire was administered after the completion of classroom activities. The game was evaluated in an academic setting, reflecting its real-world context of use, as it is designed to support students' learning about ISO/IEC 25000. The data collected through the questionnaire were organized for graphical representation. Unfortunately, during the game's implementation, we identified the need to modify the colors of the cards. Colorblind students experienced difficulties distinguishing them. The next section will present the results.

Table 1: Survey Questions

ID	Question
Q1	The way the game was presented was engaging (presentation, flow, tasks, and purpose).
Q2	The game content is relevant to my interests.
Q3	As I progressed through the stages of the game, I felt confident that I was learning.
Q4	I am satisfied because I know I will have opportunities to apply in practice what I learned from the game.
Q5	I did not notice the passage of time while playing; before I realized it, the game was already over.
Q6	I was able to interact with other participants during the game.
Q7	The game progresses at an appropriate pace and does not become monotonous, as it offers new challenges, situations, or variations in activities.
Q8	I enjoyed playing the game.
Q9	I was able to achieve the game's objectives through my own skills.
Q10	The experience with the game will contribute to my professional development.
Q11	The game was effective for my learning, especially compared to other activities in different courses.
Q12	I am satisfied with the game, as it was a practical activity distinct from traditional classes.
Q13	The game was easy to understand and can be used as a study resource.
Q14	The use of a game kept me attentive to the content.
Q15	I experienced positive feelings during the activity and perceived it as a more effective learning approach.
Q16	The game content is relevant for understanding the characteristics and sub-characteristics of Software Product Quality, in accordance with ISO/IEC 25000.
Q17	The game content complemented and expanded the knowledge I already had on the topic.
Q18	I would like to use more games as a learning strategy in other courses.
Q19	I would recommend this activity to my peers.
Q20	Please rate your level of knowledge before and after playing the game, on a scale from 1 to 5, for the concepts listed in the table below (1 = low; 5 = high).
Q21	Please add any comments you consider important.

4 Results

4.1 RQ.1. Undergraduate Students' Perceptions of Motivation, User Experience, and Learning

A total of 123 students responded to the survey. Regarding the Motivation sub-component from Savi et al.'s study [25], 96.7% of students agreed or strongly agreed that LEAGUE OF QUALITY: ISO/IEC 25000 is engaging in terms of presentation, progression, tasks, and purpose (Q1 – Attention dimension). Additionally, 95.2%

of students agreed or strongly agreed that the game's content is relevant to their interests (Q2 – Relevance dimension). Furthermore, 97.2% of students agreed or strongly agreed that the game's content is relevant for understanding the characteristics and subcharacteristics of Software Product Quality according to ISO 25000 (Q16 – Relevance dimension), as shown in Figure 5.

Similarly, 92.7% of students agreed or strongly agreed that the game reinforced their prior knowledge on the subject (Q17 – Relevance dimension). Regarding the Confidence dimension, 95.2% of students agreed or strongly agreed that they felt confident they were learning as they progressed through the game (Q3). Additionally, 94.3% of students reported being satisfied because they knew they would have opportunities to apply what they had learned in practice (Q4 – Satisfaction dimension), as shown in Figure 5. These six questions were associated with the Motivation sub-component and its dimensions—Attention, Relevance, Confidence, and Satisfaction—based on Savi et al.'s framework [25]. Thus, we can conclude that, from the students' perspective, the game effectively supports the Motivation sub-component.

Considering the User Experience sub-component from Savi et al.'s framework [25], 91.1% of students reported losing track of time while playing, realizing the game had ended only after it was over (Q5 – Immersion dimension). Additionally, 96.7% of students were able to interact with others during the game (Q6 – Social Interaction dimension). Regarding the Challenge dimension, 90.3% of students perceived that the game progressed at an appropriate pace, avoiding monotony by introducing new obstacles, situations, or activity variations (Q7). Moreover, 95.1% of students found LEAGUE OF QUALITY: ISO/IEC 25000 enjoyable (Q8 – Enjoyment dimension). In terms of competence, 92.6% of students felt they achieved the game's objectives using their own skills (Q9 – Competence dimension), and 95.1% experienced positive emotions during the game, perceiving it as an effective learning method (Q15 – Competence dimension), as shown in Figure 5. Based on these results, we can conclude that, from the students' perspective, the game effectively meets the User Experience sub-component of Savi et al.'s framework [25].

To assess the Learning sub-component, questions 10, 11, 12, 13, 14, 18, and 19 were designed. Regarding long-term learning, 88.6% of students agreed or strongly agreed that their experience with the game would contribute to their professional performance (Q10). For short-term learning, 92.7% found the game to be an effective learning tool compared to other activities in different courses (Q11). Additionally, 96.7% expressed satisfaction with the game because it provided a hands-on experience different from conventional lectures (Q12). In terms of usability, 90.2% stated that the game was easy to understand and could be used as a study resource (Q13). Furthermore, 92.6% reported that using a game helped them stay engaged with the content (Q14). A strong preference for game-based learning was also evident, with 94.3% of students expressing a desire to use more games for learning (Q18), and 91.9% agreeing or strongly agreeing that they would recommend this activity to their peers (Q19), as shown in Figure 5. Based on these results, we can conclude that, from the students' perspective, the game effectively meets the Learning sub-component of Savi et al.'s framework [25].

The findings partially corroborate the work of Vlachopoulos and Makri [29], who conducted a systematic literature review on the effects of games and simulations in higher education. Their review concluded that learning and motivation are key variables in this context. Additionally, these authors also identified several dimensions of the User Experience sub-component from Savi et al.'s model [25], such as interaction and fun. The findings also partially support the work of Mingyu et al. [21], who conducted a systematic literature review on Educational Games and Game-based Approaches in Higher Education. The authors identified several benefits of games, including knowledge gain, enjoyment, educational development, behavioral change, improved learning outcomes, engagement improvement, motivation enhancement, learning effectiveness, skill improvement, attitude change, and self-management, among others.

Before assessing the students' perception of the degree of learning achieved, it was necessary to identify which students were already familiar, either academically or professionally, with the quality characteristics outlined in ISO/IEC 25023. It was found that, depending on the characteristic, approximately 10.5% to 13.8% of the 123 students reported having a prior knowledge level of 5. The only exception was the Security characteristic, which was rated with a prior knowledge level of 5 by approximately 17% of the students, making it the most familiar characteristic to them.

For this assessment, participants identified their level of knowledge for each quality characteristic, both before and after the game. We classified the knowledge level as `low` when the participant scored it as 1 or 2, and as `good` when the participant scored it as 3 or 4. Participants who rated their prior knowledge as 5 were not classified. Regarding the Efficiency characteristic, 47 students (38.2%) were classified with a `low` level of knowledge, and of these, 42 students (89.3%) reported an increase in their learning level. Among the 63 students (51.2%) with a `good` knowledge level, 39 students (61.9%) perceived an improvement in their learning level, as shown in Figure 6.

In the Compatibility characteristic, 46 students (37.3%) were classified with a `low` level of knowledge, and 39 students (84.7%) of these reported an increase in their learning. Among the 63 students (51.2%) with `good` knowledge of Compatibility, 41 students (65%) identified an improvement in their learning. Analyzing the Functionality characteristic, 47 students were classified with a `low` level of knowledge, and of these, 42 students (89.3%) reported an increase in their learning. Among the 62 students classified with a `good` knowledge level, 41 students (66.1%) perceived an increase in their learning, as shown in Figure 6.

Regarding the Usability characteristic, 40 students were classified with a `low` level of knowledge, and of these, 37 students (92.5%) reported an increase in their learning. Among the 68 students classified with `good` knowledge in Usability, 42 students (73.6%) identified an increase in their learning. In the Maintainability characteristic, 50 students were classified with a `low` level of knowledge, and of these, 44 students (88%) identified an increase in their learning. Among the 57 students with `good` prior knowledge, only 37 students (64.9%) perceived an increase in their learning, as shown in Figure 6.

Finally, for the Security characteristic, 32 students were classified with a `low` level of prior knowledge, and of these, 28 students (87.5%) reported an increase in their learning. The 70 students who were classified with `good` knowledge, 44 students (62.8%) identified an increase in their learning. Analyzing the Reliability characteristic,

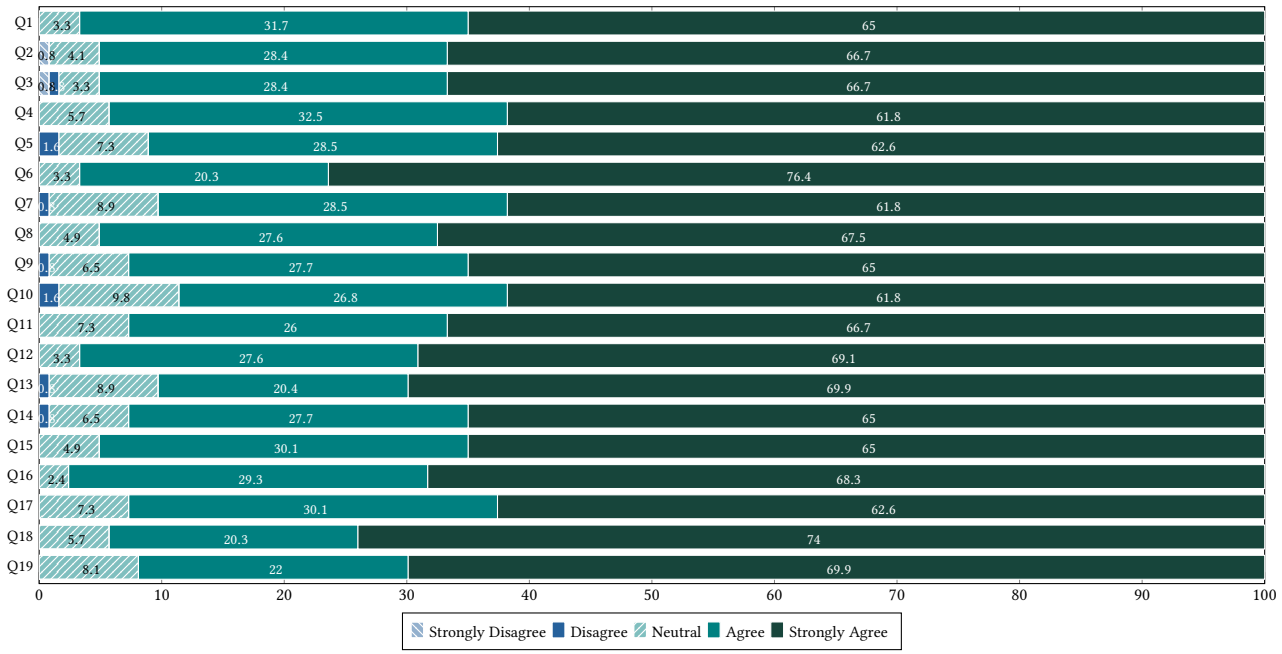

Figure 5: Participants' Perceptions N=123

35 students were classified with a low level of knowledge, and of these, 32 students (91.4%) reported an increase in their learning. Among the 71 students with good knowledge, 42 students (59.1%) perceived an increase in productivity. Regarding the Portability characteristic, 46 students were classified with a low level of prior knowledge, and of these, 42 students (91.3%) reported an increase in their learning. Among the 63 students with good knowledge of Portability, 39 students (61.9%) identified an increase in their learning, as shown in Figure 6.

Considering the results obtained, it can be inferred that the LEAGUE OF QUALITY: ISO/IEC 25000 showed the highest perception of learning for students with less knowledge about the subject. This was the case for all the characteristics, as shown in Figure 6. The percentage of perceived learning increase for students with low prior knowledge of the subject ranged from 84.78% to 92.50%, while the percentage for students with good prior knowledge ranged from 59.15% to 73.68%, as shown in Figure 6.

Although all the percentages suggest that the LEAGUE OF QUALITY: ISO/IEC 25000 game effectively contributed to increased learning on the subject, this finding is interesting as it reinforces the work of Arztmann et al. [2], who state that studies have shown that games have the potential to improve student motivation and learning outcomes. However, further insights are needed regarding the differential effects of games for different student groups. In other words, although games may generally produce positive results, these outcomes may not be the same for all students. Students may differ in age and gender, but also in the characteristics of their background, such as socioeconomic status, migration, or the presence of special educational needs. It is possible that games may not be equally effective for different groups of students, who may vary in prior knowledge or self-efficacy beliefs.

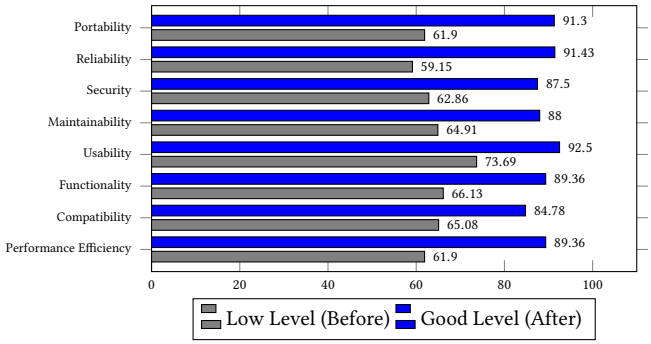

Figure 6: Students' perception of learning increase after playing LEAGUE OF QUALITY: ISO/IEC 25000

Regarding the feedback received and suggestions for improvement, we have transcribed some comments from the participants P#7, P#37, P#60, P#67, and P#94.

"The game encourages you to learn in a fun and non-tiring way, in addition to capturing our attention, allowing us to learn without realizing we're studying. This technique could be used more often in classes."

"The game contributed to interaction with classmates and helped with content retention! It was a fun lesson that deviated from the classic classroom setting.."

"Excellent game, more events with higher difficulties could be added for better student learning development in different situations, having difficulty levels (medium and hard)."

"The game could include symbols so that people with color blindness can identify the compatible cards."

"Some accessibility improvements can be made to the cards, such as symbols for the same category types and better colors for the cards, as some were difficult to read."

RQ.1 Summary:The students felt that the use of the game facilitated motivation and user experience, increased learning of the ISO/IEC 25000 concepts, and provided a more practical experience in applying the ISO. They suggested some improvements regarding the cards and the game's difficulty level.

4.2 RQ.2. Undergraduate Professors' Perceptions of Learning, Communication, Cooperation, and Satisfaction

We conducted a semi-structured interview with two professors of university subjects who had used the LEAGUE OF QUALITY: ISO/IEC 25000 through audio conferencing software. We recorded the interviews with the professors' consent. The two interviews lasted an average of 53 minutes and were conducted by two authors of this paper. We conducted the pair interview analysis followed by a conflict resolution meeting with the third author. Table 2 presents the questions asked to the professors during the interview.

Table 2: Interview Questions

ID	Question
Q1	For how long have you been a teacher?
Q2	What subjects do you currently teach?
Q3	On average, how much time was spent on each LEAGUE OF QUALITY: ISO/IEC 25000?
Q4	Was the students' knowledge about ISO/IEC 25000 improved by the dynamics? Why?
04.1	Please mark your perception of the statement.
04.1.a	It was easy for the students to understand the dynamic, and it could be used as study material.
Q4.1.b	Most students were able to achieve the objectives of each stage without major difficulties.
Q4.1.c	Each stage of the game evolved at a suitable pace and did not become monotonous.
Q4.1.d	The game used promotes moments of cooperation and communication among the people who participate.
Q4.1.e	The game contributed to learning the subject.
Q5	What is the behavior of the students towards the game?
Q6	What are the advantages of the LEAGUE OF QUALITY: ISO/IEC 25000 ?
Q7	What are the disadvantages of the game? How can they be mitigated?
Q8	What could be improved when deploying the LEAGUE OF QUALITY: ISO/IEC 25000 ?
Q9	If you want to add any other contributions concerning the LEAGUE OF QUALITY: ISO/IEC 25000, feel free.

Table 3 shows a summary of the professors that participated in our study. They are Brazilian, and their interviews were conducted in Portuguese. Professor P#1 has already used the game LEAGUE OF QUALITY: ISO/IEC 25000 more than four times during his subjects

Table 3: Professors' profiles

ID	Experience	Taught Subjects
P#1	10 years	Systems Development Methodology
		Software Engineering
		Software Testing and Quality
P#2	15 years	Systems Development Methodology
		Requirements engineering
		Software Testing and Quality

and professor and an average of 1.40 hours was spent with the game P#2 has performed between 2 and 3 games (**Q3**), and an average of 50 minutes was spent (**Q4**). Regarding the students' knowledge of the ISO/IEC 25000 having been improve with (**Q5**), both P#1 and P#2 stated:

"...I noticed that during the events, the students discussed the characteristics and sub-characteristics, even explaining them to other subgroups. Furthermore, after the game, the students identified the quality requirements of the Integrative Project they are developing in another course, and it was possible to observe the use of the content they had assimilated during the game. We were able to capture a better understanding of the characteristics and the relationship of the sub-characteristics with the situations presented. The survey form completed after the game application reflects this perception. When asked about software quality during the same class, at the end of the game, and in the following class, it was noticeable that the students were more confident and had improved their understanding of ISO/IEC 25000."

Regarding student engagement with the dynamics and the applicability of the concepts learned, it is interesting to highlight the perception of the professors:

"...The game allowed participants to discuss their understanding of the characteristics and sub-characteristics of the ISO standard through real-world examples. More than half of the students chose to stay in the classroom playing instead of taking a break. Software quality requirements are often overlooked by students due to a lack of knowledge. I noticed that they had an easier time identifying and raising the quality requirements for the final projects they are developing after the game."

Considering the students' behavior during the game, the following points were mentioned:

"...Most students achieved the objectives, and some stood out, even applying optimization in the process. For example, one group answered three event cards in a row, followed by the other group answering three consecutively. This approach worked well, and they finished earlier with a good success rate. They were learning and having fun. At times, they were more excited due to the competition and disagreements over the answers. As a teacher, I also acted as a mediator and moderator."

Regarding the professors' perception of the advantages of using the dynamics, as addressed by question **Q6** in Table 2, implementing an active methodology based on games (gamification) adds fun to the teaching-learning process, encourages active learning, enables the development of collaboration and teamwork skills, stimulates healthy competition in an intellectual challenge, promotes focus and organization among students, fosters discussion, exchange of

ideas, and different perspectives, develops the ability to understand and analyze scenarios and problems, and motivates and engages students around the topic. Furthermore, it allows learning about a highly relevant content for software quality, which can otherwise be tiring if explored through a traditional lecture.

Regarding the identified disadvantages, the following were mentioned:

" Classes and students with varying levels of comprehension, different amounts of prior knowledge on the subject, as well as very large or very small groups, require adjustments in the organization and group division, especially when the class size is not a multiple of 6. Additionally, accessibility issues (e.g., card colors for students with color blindness) should be considered. Another drawback is that the physical space needs to be appropriate. The game works well in multipurpose classrooms with larger tables or tables that can be combined. However, it is not suitable for traditional classrooms with individual desks or in labs. Furthermore, the time spent by different groups varied. Some groups spent more time discussing the characteristics and bringing in additional examples, while others were quicker to finish the game. Perhaps setting a time limit for each event could reduce these discrepancies."

Regarding what could be improved by applying the the LEAGUE OF QUALITY: ISO/IEC 25000(**Q9**), P#1 and P#2 affirmed:

"I believe the scoring could be differentiated based on the difficulty of the events. Additionally, we could explore actions that need to be taken to address unmet quality characteristics, adding extra points for these actions."

Table 4 presents all the improvement suggestions for the game from professors P#1 and P#2. These suggestions aim to enhance the dynamics, accessibility, and effectiveness of learning, considering aspects such as group organization, event difficulty levels, and the suitability of the physical environment. These suggestions can contribute to a better utilization of the gamified methodology.

RQ.2 Summary: The use of the LEAGUE OF QUALITY: ISO/IEC 25000 in the classroom by professors has shown good results and positively impacts the teaching-learning process of the students.

ID	Suggestions for Improve the Game
P#1	Build sets of events with different levels of difficulty. A round of 30 minutes could start with the easiest level, and subsequent rounds could increase the difficulty level. Alternatively, certain groups could start from the intermediate to advanced level, providing challenges and encouraging the search for better answers.
P#2	We could consider implementing a test or round to assess the class or groups' level, so they play at the most suitable level.
P#1	Another idea is to mix basic and advanced questions (events), creating randomness and a surprise factor for the groups.
P#2	Organize the number of groups and subgroups based on class size. Example: for a class of 60 students: 5 x 5 (or increase the card sets above 6). For smaller classes with 18 students, maintain 3 x 3. In cases where there is no multiple of 6, we organized into 2 x 3 or 3 x 4, which may create an imbalance between teams.
P#1	Regarding accessibility, study the colors that are hard to distinguish for colorblindness (such as blue and purple), and consider including symbols/figures to identify the characteristics and sub-characteristics in addition to colors.
P#2	Some card colors, with black font, were not very legible (such as dark blue cards), and the color/ shade of the card or the font could be changed. The font size could also be larger. If necessary, increase the card size.
P#1	Program, plan, and reserve the physical space before conducting the game. As we have few multi-use spaces in the institution, an inadequate space (such as a room with desks or a laboratory) can hinder the experience during the game.
P#2	Another suggestion, which generated some doubts, is in the printed answer on the event card. It would be more intuitive or easier to understand if the characteristic were listed with the sub-characteristic in parentheses. For example: Performance Efficiency (Time), Reliability (Fault Tolerance), Usability (Learning).

Table 4: Suggestions for improving the game.

5 Discussion

The findings from this study suggest that LEAGUE OF QUALITY: ISO/IEC 25000 is an effective and engaging tool for teaching software product quality concepts in higher education. The high rates of student agreement across motivation, user experience, and learning dimensions—based on the model proposed by Savi et al. [25]—demonstrate that students perceived the game as both enjoyable and educationally valuable. Notably, students with lower prior knowledge of ISO/IEC 25000 reported greater learning gains, reinforcing the game's potential to bridge knowledge gaps and support inclusive learning experiences. These results align with prior literature emphasizing the benefits of game-based learning in computing education [21, 29], particularly in fostering engagement and improving the retention of abstract or technical content. Compared to previous educational games in the software quality domain [22, 23], LEAGUE OF QUALITY stands out by addressing all quality characteristics and sub-characteristics of ISO/IEC 25023:2016 in a structured and interactive format, filling a notable gap in current pedagogical resources.

The professors' perspectives further corroborated the positive reception, indicating that the game stimulated classroom discussion, critical thinking, and collaboration—essential skills for software engineering professionals. However, their feedback also highlighted areas for improvement, such as adapting the game's visual design for accessibility, introducing varied difficulty levels to address heterogeneous knowledge levels among students, and considering physical space limitations in traditional classroom settings. While the results are promising, it is important to acknowledge contextual constraints. The study was conducted within a single institution, and although the sample size was adequate, broader studies are

needed to confirm the game's applicability across different academic settings and cultural contexts. Furthermore, the absence of a control group using traditional teaching methods limits direct comparisons regarding learning effectiveness.

Nevertheless, the study reinforces the importance of active learning strategies for teaching software quality—an area often treated as peripheral in computing curricula despite its foundational role in developing reliable, maintainable, and user-centered systems. By incorporating standards such as ISO/IEC 25000 into engaging learning activities, students can develop both technical understanding and an appreciation of quality as a critical concern in software development practice. Future research could investigate the longitudinal impact of the game on student performance, the integration of new modules (e.g., software measurement based on ISO/IEC 2502:2024 [15]), and its use in hybrid or online learning environments. Additionally, studies could explore how different student profiles—based on gender, background, or learning preferences—respond to this type of pedagogical intervention, ensuring equity and effectiveness across diverse groups.

6 Threats to Validity

Although the results presented in this experience report offer valuable insights into students' and professors' perceptions of learning ISO/IEC 25000 concepts through a game-based approach, certain limitations must be acknowledged to contextualize the findings. **External Validity.** This study was conducted with students and professors from a single higher education institution in Brazil. Although the initiative involved a reasonably large sample (123 students) and multiple course offerings, the results may not be fully generalizable to other institutions, regions, or cultural contexts. The specific characteristics of the student population and institutional environment may have influenced the findings. Thus, caution is advised when extrapolating these results to broader contexts. However, this local focus was intentional, as the primary goal was to evaluate the feasibility and effectiveness of the game before considering broader implementations.

Internal Validity. Only students who participated in the complete game activity were invited to respond to the questionnaire. This selection criterion may have excluded students who were absent or less engaged, potentially leading to a more favorable assessment of the game. Additionally, the absence of a control group limits our ability to compare learning outcomes with those of more traditional teaching methods. **Construct Validity.** The constructs of motivation, user experience, and learning were assessed using an instrument adapted from the evaluation model proposed by Savi et al. [25]. While this model is well-established in the literature, the questions were interpreted by students in the specific context of this game, and some subjectivity in responses is expected. However, the instrument was reviewed by experienced faculty and pilot-tested to enhance clarity and appropriateness.

Reliability. The same game and questionnaire were applied across different classes taught by different instructors, which may have introduced some variation in how the game was conducted. Although all instructors followed the same instructions and materials, slight differences in classroom facilitation could have affected students' experiences. Furthermore, students' responses might have been influenced by social desirability bias, especially because they were asked to reflect on an in-class activity facilitated by their professors. Despite these limitations, the study provides important empirical evidence about the effectiveness and acceptance of game-based learning in software quality education. The results can inform future adaptations, broader implementations, and follow-up studies in other institutions and disciplines.

7 Conclusions

This paper reported on the development and classroom implementation of the educational game LEAGUE OF QUALITY: ISO/IEC 25000, designed to enhance students' understanding of software product quality, as defined in the ISO/IEC 25023:2016 standard. By transforming abstract concepts into concrete and engaging scenarios, the game enabled students to explore all quality characteristics and sub-characteristics through practical, collaborative, and interactive activities. Our study provides empirical evidence that the game promotes student motivation, engagement, and knowledge retention in the context of software quality. The results from the student survey indicated significant perceived learning gains, particularly among those with little prior knowledge of the subject, reinforcing the game's effectiveness as a didactic tool. Professors also observed improved communication, cooperation, and the ability to apply quality requirements to real-world projects—highlighting the practical value of integrating quality standards in academic training.

The main contribution of this work lies in providing an accessible and replicable strategy to support the teaching of software quality standards, especially ISO/IEC 25000, which are often underexplored in undergraduate education. Unlike most existing approaches that focus on process maturity or testing, LEAGUE OF QUALITY offers a structured and enjoyable way to internalize product quality attributes—thus strengthening both theoretical understanding and practical application of key software engineering principles. Future work includes the expansion of the game with additional modules focused on software measurement and modeling (e.g., ISO/IEC 2502x), enabling broader exploration of the SQuaRE framework. We also intend to refine the game based on the suggestions provided by students and faculty, incorporating features such as adaptive difficulty levels, accessibility improvements, and enhanced feedback mechanisms. Ultimately, this study contributes to advancing software quality education by demonstrating that well-designed educational games can bridge the gap between theory and practice, cultivating more competent and quality-aware future professionals in software engineering.

ARTIFACT AVAILABILITY

The materials produced during the research, including the survey form and the file containing all the survey responses, are available on Zenodo at https://zenodo.org/records/17079511

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