

Article

Enhancing Gamified System Development Through Systematic Identification of Usability Recommendations

Kristina Magyłaite^{1,*} , Lina Čeponienė¹ , Vaidotas Drungilas¹ , Mažvydas Launikaitis¹ 
and Rimantas Butleris² 

¹ Department of Information Systems, Informatics Faculty, Kaunas University of Technology, LT-51368 Kaunas, Lithuania

² Centre of Information Systems Design Technologies, Faculty of Informatics, Kaunas University of Technology, LT-44249 Kaunas, Lithuania

* Correspondence: kristina.magylaite@ktu.lt

Abstract

Gamified systems combine information system functionality with gamification elements to support motivation and engagement. However, existing gamified system development approaches lack a unified method to identify usability recommendations for both the system as a whole and individual gamification elements. This paper proposes MIURGS, a method for identifying usability recommendations for gamified systems according to user and system characteristics, including age group, application domain, gamification goals, usability goals, and principles. The method is implemented in a dedicated tool and supported by a knowledge base containing usability recommendations and gamification element suitability recommendations. MIURGS was evaluated through two studies: a student experimental evaluation with 45 participants and an expert evaluation with 12 respondents. Results of the student experimental evaluation indicate that for general recommendations, identification, gamification element selection, and ease of identification, tool-supported process results were better evaluated than unaided identification. The expert evaluation further indicated that the method is perceived as useful and relevant, with 11 of the 12 respondents agreeing that it would reduce the effort required to identify usability recommendations.

Keywords: usability; gamification elements; gamified systems; identification of usability recommendations

1. Introduction

Gamification is commonly defined as the use of game elements or game-like design in non-game contexts to influence motivation and behavior [1], and it has been applied across education, healthcare, work, training, service and other areas [2–5]. Gamification differs from game-based learning, which uses complete games as learning environments, whereas gamification refers to the process of applying game elements to activities or systems that are not themselves games [6]. This breadth of application means that target users, tasks, and contextual constraints differ substantially across domains and populations which also signifies the importance of usability requirements [4,7].

Gamified information systems combine the functionality of an information system with gamification elements intended to motivate users and increase their engagement [8]. Gamification elements may support different motivational processes and therefore cannot



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be assumed to have the same effects across users and contexts [9]. However, the motivational benefits of gamification depend not only on selecting appropriate gamification elements, but also on ensuring that the system is usable. Interaction difficulties may discourage users and reduce the engagement that gamification aims to create [10,11].

Therefore, usability is a factor in whether a gamified system achieves its intended objectives, and it should be considered during the development process [12]. Existing usability guidelines, such as Nielsen's heuristics [13], ISO 9241-110 [14], ISO 9241-112 [15], and the Web Content Accessibility Guidelines (WCAG 2.2.) [16] provides a basis for improving interaction quality in software systems. However, these sources address interactive systems in general and do not specify how usability should be applied in gamified systems, where design decisions are shaped by gamification elements and user motivation [12]. For example, in gamified systems the same gamification element may require different usability recommendations depending on the users and the application domain [17]. Studies on serious and educational games [18,19] indicate that validated, context-sensitive usability methods remain scarce. Conventional evaluation instruments often do not capture the complex nature of gamified systems, including motivation, pedagogical objectives, and gamification mechanics.

The development of gamified systems is supported by dedicated processes, methods, and frameworks that extend the software development life cycle with gamification-specific activities [20–22]. These approaches typically follow a similar flow of analysis, goal definition, user and context profiling, gamification element selection, prototyping, implementation, evaluation, and monitoring. However, the selection of gamification elements remains insufficiently formalized in these processes, as most approaches do not provide a structured set of elements and instead leave their selection to the designer or developer [22]. Usability is also rarely incorporated into the gamified system development process as a separate step. When usability is considered, it is typically evaluated after system implementation instead of being integrated into the design of the selected gamification elements [23]. Existing research has addressed usability in gamified systems primarily through various evaluation methods, including heuristic inspection, laboratory usability testing, user experience questionnaires, observation, think-aloud protocols, and expert review. These methods assess gamified or game-based systems after design decisions have already been implemented [24].

Taken together, these directions indicate a gap: usability is typically evaluated after implementation or addressed separately from the process of selection of gamification elements. During development there is no structured way to identify which usability recommendations apply to a gamified system and to the gamification elements. The main goal of this research is to facilitate the identification of usability recommendations during the development of gamified systems by proposing a method that supports usability recommendations for the system in general and for individual gamification elements.

The proposed Method for Identifying Usability Recommendations for Gamified Systems (MIURGS) links gamification elements with usability recommendations according to user and system characteristics, such as age group, application domain, gamification goals, and usability goals. The main result of the application of the MIURGS method is a combination of sets of general usability recommendations, suitable gamification elements, and usability recommendations specific to those gamification elements. This result can facilitate both the early and later stages of gamified system development. During the initial stages, it can assist in requirements elicitation and design decisions for new gamified systems. In later stages of the system lifecycle, it can support the improvement, modification, and refinement of existing gamified systems. A web tool was developed to support the application of the method and to identify the corresponding recommendation sets for a

specified context. The tool can be used by developers, designers, analysts, usability experts, and system owners to identify relevant usability recommendations and gamification elements during the development of new gamified systems or the evolution of existing ones. To evaluate the proposed method and tool, two research questions were raised:

RQ1. Is the identification of usability recommendations using MIURGS and its supporting tool perceived as useful?

RQ2. How do experts perceive the usefulness, ease of use, and intention to use the proposed MIURGS method and its supporting tool?

To answer these research questions, two types of experimental evaluation were conducted: one with students and another with field experts. The experimental evaluation results indicate that participants perceived the MIURGS tool as useful for identifying both general and gamification-specific usability recommendations for gamified systems.

The remainder of this paper is organized as follows. Section 2 reviews related work on usability in gamified systems and existing usability recommendation sets. Section 3 presents the MIURGS principles. Section 4 describes the implementation of the web tool to support the application of the method. Section 5 presents the experimental evaluation of the method and tool. Section 6 discusses the findings and concludes the paper.

2. Related Work

The relationship between gamification and usability has been examined across multiple application domains. Sobodic et al. [25] and Issa et al. [26] evaluated the effects of usability in gamified e-learning environments and reported that incorporating usability recommendations improves user experience and supports users in predicting future system actions. Durmaz et al. [27] proposed a usability checklist for assessing the ability of gamified systems to sustain user engagement. Rajanen et al. [28] analyzed the benefits of usability in gamified systems and argued that improving usability not only increases user productivity and satisfaction but also provides business benefits by influencing sales and reducing training costs. Similarly, Mohtar et al. [29] concluded that usability is an important factor in determining whether gamified systems achieve their intended motivational and learning outcomes, as poor interface design can reduce user engagement regardless of the effectiveness of the implemented gamification elements. The interaction between gamification design and usability is further supported by studies investigating the effectiveness of gamification. Li et al. [30] and Sailer et al. [31] found that gamification generally improves learning outcomes, but its effectiveness varies depending on design-related factors. Their findings indicate that the success of gamification depends not only on the inclusion of gamification elements but also on how these elements are implemented and experienced by users. Consequently, the benefits of gamification may be diminished when the surrounding user interface does not satisfy fundamental usability recommendations, particularly for user groups that are more sensitive to interface complexity, such as middle-aged and older adults. In [32], experimental results suggest that the usability of gamified systems depends on the alignment of interface design and pedagogical structure rather than on the implementation of individual gamification mechanics alone. Similar findings are reported by Bouchrika et al. [33], demonstrating that gamified e-learning platforms can increase adoption, interactivity, and user engagement over time, provided that the system maintains an adequate level of usability to sustain user participation.

Existing research also indicates that usability recommendations in gamified systems should be considered at the level of individual gamification elements. Warmelink et al. [34] argue that game elements, as the building blocks of gamification, should be designed in accordance with user goals, user roles, and meaningful user-system interactions. Similarly, Luo [35] distinguishes visible gamification elements from underlying gamification

mechanisms and identifies factors such as goals, visualization, immediate feedback, adaptation, challenge, competition, rewards, and fun failure as key contributors to engaging gamification. This element-oriented perspective is further supported in [36], where standard user experience (UX) processes are deemed insufficient for gamified systems and proposed to be extended with techniques such as motivation- and engagement-oriented journey mapping and persona models incorporating player profiles. The study in [37] states that gamification elements should be selected according to user characteristics rather than applied uniformly. Similarly, An [38] concludes that the effectiveness of gamification depends on learner characteristics, contextual factors, and the design and implementation of gamification elements, emphasizing the importance of user-centered and personalized design. Age-related studies [39] further highlight the need for contextualized usability and gamification considerations.

Another area relevant to our research is the development of usability recommendation sets for gamified systems. In general, research on usability recommendations for gamified systems follows three directions. The first group of studies derives recommendations from motivational theory and therefore focuses more on behavioral outcomes than on interaction design. Roy and Zaman [40] derive nine heuristics from Self-Determination Theory; Raviya [41] proposes eight design principles based on the MDA framework and the Octalysis framework and organizes them according to the abstraction levels of the MDA framework. Tondello et al. [23] propose 28 heuristics, and Krath et al. [42] consolidate more than 60 principles, derived from a broader synthesis of motivational frameworks, into user-, system-, and context-oriented groups. The second group of studies adapts established usability heuristics to games and gamified systems. Although these recommendations are closely related to interaction quality, they focus on the overall system and rarely address the usability of individual gamification elements. Akthar et al. [43] adapt Nielsen's heuristics for game development by proposing 12 heuristics, suitable both during the initial design phase and later for usability assessment. Desurvire and Wiberg [44] define 48 heuristics for evaluating game usability; Chen [45] derives 35 guidelines from user-centered design for gamified system development. Coelho and Abreu [46] propose a human-centered model of ten heuristics for the design and the evaluation of gamified learning systems that also addresses accessibility recommendations. The third group of studies focuses on selecting gamification elements according to user characteristics and application context. Alsaleh and Alnanh [47] map seven user experience factors to gamification elements in a healthcare application for children; Koivisto and Hamari [4] relate perceived gamification benefits to demographic factors such as age; and Tondello et al. [48] associate HEXAD user types with preferences for specific gamification elements. These studies indicate that the selection of gamification elements should take into account user characteristics and system context. However, they do not provide a formal link between gamification elements and usability recommendations based on user and system characteristics.

Other related studies focus on methods, frameworks, and tools for gamified system development that address usability or user experience evaluation, support the selection of gamification elements or their adaptation to user characteristics. Coelho and Abreu [46] go beyond a set of recommendations by introducing Systemic Gamification Theory (SGT), accompanied by ten heuristics and a framework for designing and evaluating gamified learning systems. Bassanelli and Bucchiarone [49] present GamiDOC, a web-based tool intended to support the design, development, and analysis of gamified systems, by combining a gamification design model, code generation support, and standardized user experience (UX) questionnaires. The tool also guides the selection of gamification elements through pre-existing taxonomies and contextual inputs such as domain, aim, target users, and encouraged behaviors. Piras et al. [50] propose Agon, a gamification-based

framework that combines a metamodel with a method for linking acceptance requirements with gamification knowledge. The framework supports requirements analysts in deriving gamification systems according to user context, acceptance goals, and psychological factors. Fedechen et al. [51] propose a context-aware gamification process and a catalogue of 105 gamification elements to support the selection of context-appropriate gamification elements. The catalogue provides information about each gamification element, including its purpose, expected user behavior, usage conditions, practical application, examples, and relations with other elements. The main characteristics of these approaches are summarized in Table 1.

Table 1. Comparison of MIURGS with related methods, frameworks, and tools of gamified systems.

Criteria	Systemic Gamification Theory (SGT) [46]	GamiDOC [49]	Agon [50]	Context-Aware Gamification Process (CGP) [51]	MIURGS
Type	Theoretical framework	Design model	Framework	Method	Method
Aspects considered	Educational, social, cultural context	User and system characteristics	User, task and system characteristics	Gamified activity, user and system characteristics, gamification goals	User and system characteristics, usability and gamification goals
Outcomes	Gamification design recommendations and usability heuristics provided, and identified gamification elements, their interactions, and relationships	Documented gamification design and specified selected gamification elements	Identified user needs, psychological strategies, and gamification design solutions	Identified gamification elements and element-specific strategies	Identified usability recommendations and gamification elements
General usability recommendations	Yes	No	No	No	Yes
Gamification elements selection	Framework-based	Taxonomy based	Suggestions	Catalogue based	Rule based
Usability recommendations for gamification elements	No	No	No	No	Yes
Tool support	No	Yes	Yes	Partial (gamification element catalogue)	Yes
Evaluation	No	Tool presentation	Two case studies	TAM-based case study	Experimental evaluation with students and experts

Most approaches consider user or system characteristics and support gamification design or element selection, but only some provide usability-related guidance. Gamification element selection is supported through different approaches, including tool support, analyst decisions and catalogues. In summary, the analyzed studies proposing usability heuristics or principles primarily provide general usability recommendations and rarely relate them to specific gamification elements. Conversely, studies proposing methods or frameworks support activities such as gamified system design, user experience evaluation, gamification element selection, and adaptation to user characteristics, but they do not provide a structured approach for identifying usability recommendations applicable to both the overall system and individual gamification elements. The MIURGS method addresses this gap by enabling the rule-based identification of usability recommendations at both levels within a single method and supporting tool.

3. Method for Identifying Usability Recommendations for Gamified Systems

This section presents the Method for Identifying Usability Recommendations for Gamified Systems (MIURGS). The method supports the identification of usability recommendations during the development of gamified information systems and suggests that as the effectiveness of gamification depends on the usability of the overall system, developers should consider both general usability recommendations and recommendations related to individual gamification elements. Consequently, the selection and implementation of gamification elements should be guided by their corresponding usability recommendations. The overall structure of the method and its position within the gamified system development lifecycle are presented in Figure 1. MIURGS can be applied during the requirements specification phase of the gamified system development lifecycle to identify both general and gamification-specific usability recommendations. The method can also support system evolution by facilitating the analysis of already implemented gamification elements and their associated usability recommendations, as well as the planning and implementation of new features, gamification elements, and their corresponding usability recommendations.

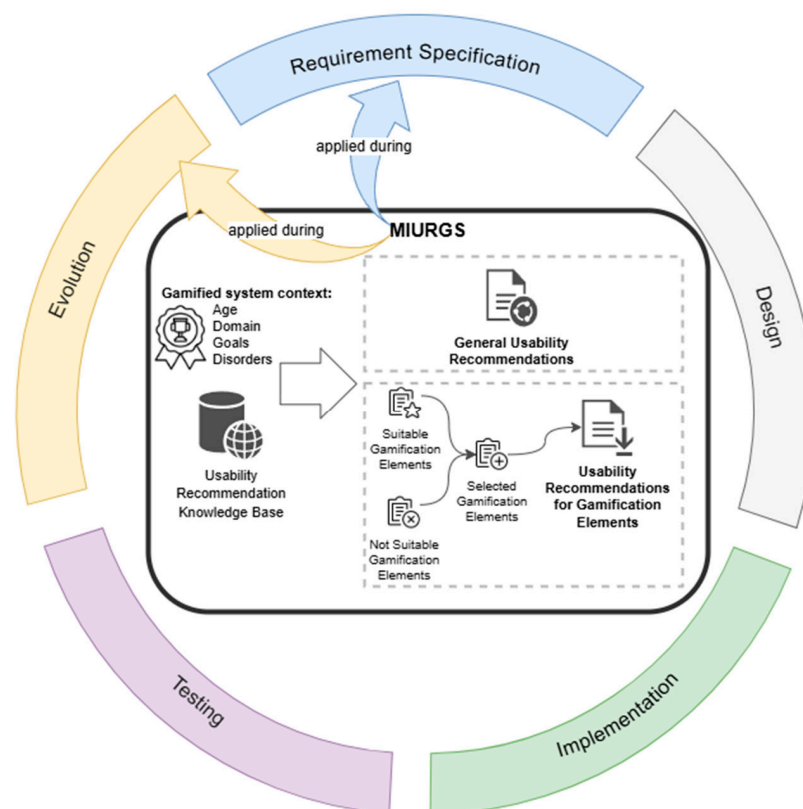


Figure 1. Overview of the Method for Identifying Usability Recommendations for Gamified Systems (MIURGS).

The main process of preparing usability recommendations in MIURGS begins with the identification of the context of the system under development. The system context includes factors that influence both general usability recommendations and recommendations related to gamification elements. The recommendations are retrieved from the Usability Recommendation Knowledge Base, which was constructed from scientific publications and established usability and accessibility standards based on our previous research [52,53]. The scientific publication-based part was developed through a systematic review following the PRISMA guidelines and included 37 publications identified in Web of Science, Scopus, IEEE Xplore, ScienceDirect, and ACM Digital Library using predefined inclusion and exclu-

sion criteria. Only recommendations related to usability, user experience, user interface design, or user interaction in gamified systems were included. For each recommendation, the source and available contextual information, including age group, application domain, disorder, gamification goal, and usability goal, were retained. Unspecified characteristics were left undefined. Recommendation wording and gamification element terminology were standardized while preserving the original meaning. Recommendations with the same meaning and identical contextual characteristics were merged into a single recommendation. If their contextual characteristics or examples differed, they were retained as separate recommendations. Potentially conflicting recommendations were likewise retained together with their context, as they may apply to different user groups, application domains, or goals. Different names and synonyms for gamification elements were mapped to the corresponding gamification elements used in MIURGS. These recommendations were complemented with recommendations from ISO 9241-110, ISO 9241-112, and WCAG 2.2. Each standard recommendation was reviewed for its applicability to individual gamification elements. When applicable, it was adapted into a usability recommendation for that specific gamification element and added to the knowledge base. The initial review and standardization of the recommendations and their mapping to contextual characteristics and gamification elements were performed by one author and reviewed by the co-authors. Identified inconsistencies were returned for revision and discussed among the authors until agreement was reached. The knowledge base contains 873 usability recommendations and 197 recommendations on the suitability of gamification elements. The structure of the knowledge base is presented in Figure 2, together with the number of recommendations in each category.

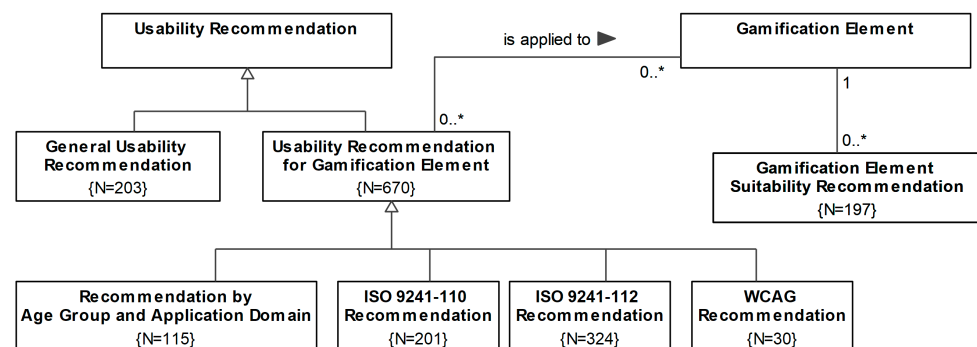


Figure 2. The general structure of the Usability Recommendations Knowledge Base.

The process of preparing a set of usability recommendations, shown in Figure 3, includes several decision points that depend on the stage of the gamified system development lifecycle. During the requirements analysis phase of a new gamified system, the set of general usability recommendations is identified directly from the system context, including factors such as the application domain or target user group. On the other hand, during the evolution of an existing gamified system, the process additionally requires an analysis of the current system to determine the extent to which it complies with the identified general usability recommendations. Based on this analysis, the recommendation set can be refined to address unmet recommendations. The preparation of gamification-specific usability recommendations follows a similar process. For a new gamified system, the gamification elements are selected, and the corresponding usability recommendations are retrieved from the knowledge base. During system evolution, the existing gamification elements are first identified. Additional gamification elements may then be selected if required, and usability recommendations are retrieved for both the existing and newly selected elements.

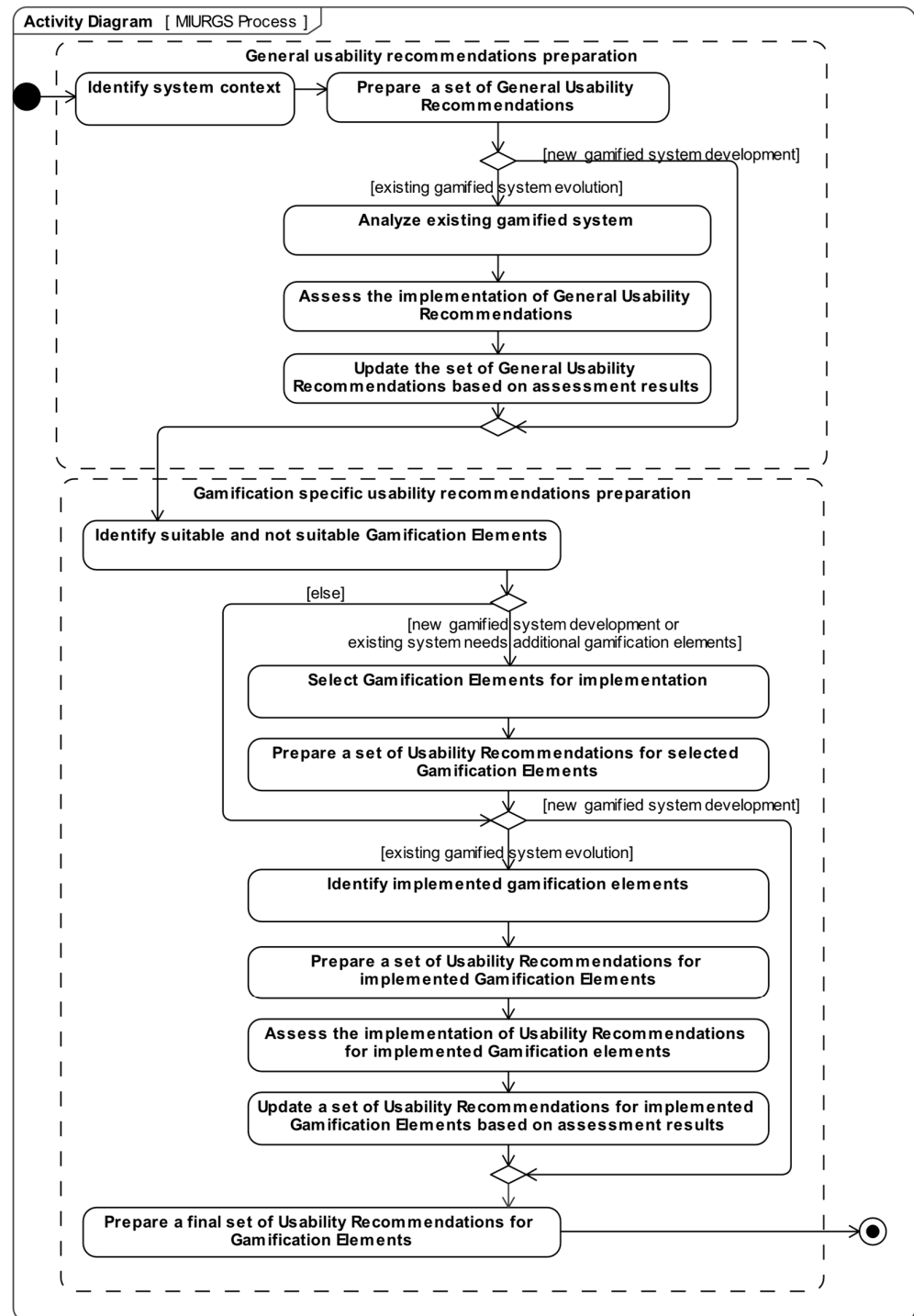


Figure 3. The process of preparing sets of usability recommendations for a gamified information system.

The knowledge base used for recommendation identification contains both usability recommendations and decision rules defined using the Decision Model and Notation (DMN) standard [54]. The decision logic was defined as part of the knowledge base development and was then formalized in DMN decision tables, which were developed and tested by the authors of this paper. The rules are organized into five decision tables comprising a total of 1070 rules. Each rule follows the structure of [condition] then [outcome], where the condition is defined by the context variables of the gamified system, and the outcome is either a set of usability recommendations or a set of gamification element suitability recommendations. The context variables in each condition are combined using the logical AND operator as shown in Table 2. The age group describes the target users by age, while

the application domain defines the area in which the gamified system is used. Disorder indicates a condition relevant to the target users. The gamification goal defines the intended purpose of applying gamification, whereas the usability goal represents the usability aspect that the recommendation is intended to support. The usability principle identifies the usability principle or heuristic used to classify general usability recommendations. Any context variable may be left unspecified (marked as not applicable), in which case it does not constrain the resulting recommendations. If multiple values are specified for a context variable, recommendations matching any of the selected values are included.

Table 2. Conditions and outcomes used for recommendation identification in MIURGS (all context variables in the condition are optional; if none are specified, the outcome contains all recommendations within the category).

Recommendation Category	Condition	Outcome
General usability recommendations	age group AND application domain AND disorder AND gamification goal AND usability goal AND usability principle	a set of general usability recommendations
Gamification element suitability recommendations	age group AND application domain AND disorder AND gamification goal AND usability goal	a set of suitable gamification elements a set of not suitable gamification elements
Usability recommendations for gamification elements	gamification element AND age group AND application domain AND disorder AND gamification goal AND usability goal	a set of usability recommendations for the element (from literature)
	gamification element AND disorder	a set of accessibility recommendations for the element (WCAG 2.2)
	gamification element	a set of usability recommendations for the element (ISO)

For the rules covering general usability recommendations and gamification element suitability recommendation categories, if no recommendations are returned in the outcome using the full condition, the rule execution is repeated using only age group and application domain context variables. In the gamification element suitability rules category, a conflict is detected when the same gamification element is returned in both the recommended and not recommended sets for the specified context. In such cases, a gamification element that appears in both the recommended and not recommended sets is removed from the recommended set. The conflict is not presented as a separate warning; instead, the element is shown only in the not recommended set. Elements in neither set are offered as an additional group, and when no context variable is specified, all elements are returned as recommended. The complete list of rules and recommendations is provided as a spreadsheet in the repository <https://github.com/Krikire/usability-recommendations-ruleset> (accessed on 24 August 2026).

This rule-based structure enables developers to identify recommendations relevant to the system under development without manually examining the entire knowledge base. Consequently, the resulting identification outcome contains usability recommenda-

tions and gamification element suitability recommendations applicable to the specified system context.

4. MIURGS Tool Implementation

In order to apply the MIURGS method in practice, a tool was implemented that applies identification rules to a gamified system context and returns the corresponding usability recommendations. The main functions of the tool are presented in Figure 4. Using the user and system parameters as input, the tool produces three types of output: general usability recommendations for the gamified system, recommended gamification elements, and usability recommendations for the selected gamification elements. The first output addresses usability at the system level, whereas the second and third outputs address usability at the level of individual gamification elements. The identified recommendation sets can be saved for future use. For each recommendation, users can record its implementation status as implemented, partially implemented, or not implemented. This assessment may be performed immediately after the recommendations have been identified or at a later stage by reopening a previously saved recommendation set.

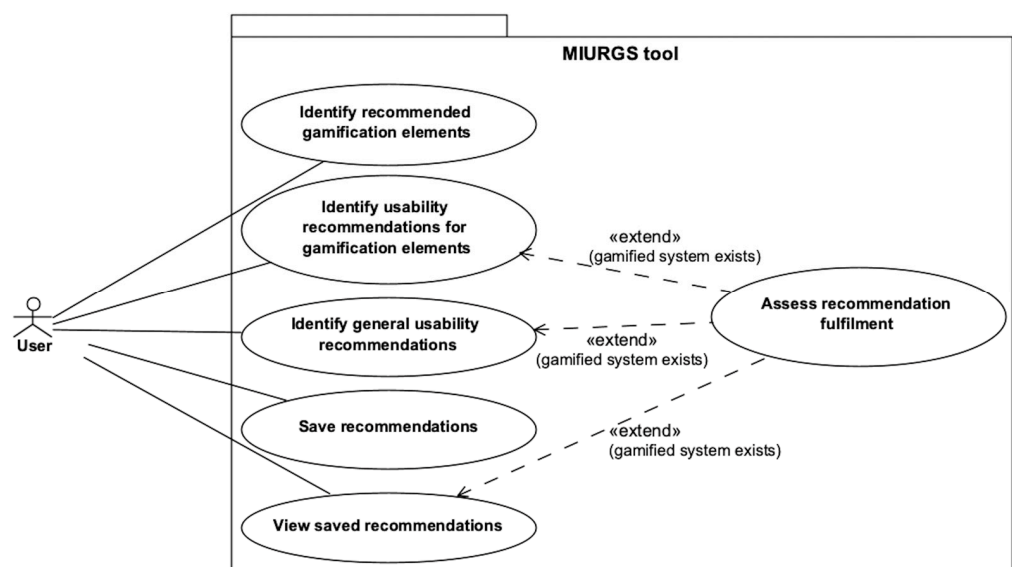


Figure 4. Use case diagram of the MIURGS tool.

The recommendation knowledge base was implemented using five DMN decision tables in Camunda Modeler (version 8.4) [55] where each table specifies rules linking application domain and user characteristics with relevant usability and gamification element recommendations. The tool was implemented as a web application using Next.js (version 15.3.2) and PostgreSQL (version 18.1) for data storage.

The tool workflow begins with the specification of the gamified system context through a set of parameters representing the context variables. Each parameter may be assigned a single value, multiple values, or be left unspecified. To illustrate the use of the tool, we consider a case of a gamified fitness application for teenagers and adults. The illustrative application allows users to track their workouts and progress and applies gamification elements to encourage continued participation. The context of this example application is defined by selecting the corresponding parameter values, including the gamification goal of promoting extrinsic motivation and the usability goal of reducing memory load. The resulting configuration that could be used to identify recommendations for the example fitness application is shown in Figure 5.

Figure 5. Context parameter selection view in the MIURGS tool.

Based on the specified context parameters, the tool identifies a set of general usability recommendations. An example of the identified recommendations for the gamified fitness application is presented in Figure 6. Each recommendation is presented together with the context in which it applies, the corresponding usability principle, the goals it addresses, and an implementation example. The example also illustrates how the recommendation can be appropriately applied in practice.

Figure 6. General usability recommendations view in the MIURGS tool.

The identified recommendations are presented in two tabs: one containing general usability recommendations and the other containing recommendations related to gamification elements. Figure 7 shows the gamification elements view, which lists the elements identified as suitable for the specified system context. In the fitness application example, the recommended set includes a broad range of gamification elements, such as points for tracking workout progress, streaks for encouraging continued participation, and achievements and challenges for supporting users in reaching their personal training goals. The tool allows users to select the gamification elements for which usability recommendations should be identified. In the example, the selection includes both recommended gamification

elements and a single element from the set of not-recommended elements. This reflects the intended use of MIURGS, as users are not restricted to the recommended elements and may select any additional gamification elements considered appropriate for their application. Figure 7 also demonstrates that the identified usability recommendations are grouped according to the selected gamification elements. For each element, the tool provides the adapted usability recommendation, an implementation example, and the source from which the recommendation was derived, such as ISO 9241-110, ISO 9241-112, WCAG 2.2, or the reviewed literature. In the example shown in Figure 7, the Challenges gamification element is selected, and the corresponding usability recommendations identified by the tool are presented.

The screenshot displays the 'Recommendations for gamification elements' section of the MIURGS tool. It features a 'Suitable gamification elements (12)' section with buttons for Leaderboard, Customization, Onboarding, Reminders, Streaks, Challenges, Avatar, Points, Teams, Competition, Performance stats, and Achievements. Below this is a 'Other gamification elements (1 selected) (Total: 48)' section with a grid of buttons including Levels, Quests, Badges, Medals, Progress, Rewards, Full game, Narrative, Virtual helpers, Missions, Choices, Cooperation, Virtual treasure, Virtual currency, Performance feedback, Personalization, Time pressure, Quizzes, Skill trees, Assistance, Tasks, Status bars, Game rules, Collections, XP, Knowledge-sharing, Questions, Trophies, Collaboration, Notifications, Unlockable content, Warnings, Health points, Virtual pets, Virtual identity, Tutorials, Gifting, Penalties, Puzzles, Retries, Chance, Storytelling, Score, Time speed, Character, Dialogues, Storyline, and State. A 'Determine gamification elements' button is located at the top right of the suitable elements section. Below the other elements section is an 'ISO and WCAG recommendations for gamification elements (322)' section with a 'Determine gamification elements usability recommendations' button. The 'Challenges' section is expanded, showing two recommendations: #1 and #2. Recommendation #1 states: 'When providing instructions, they should not rely solely on shape, color, size, or position. The control or other element must be identified by name, label, or other clear description.' It includes an example: 'The instruction 'Click the red button at the top to start the task' is insufficient. It should be: 'Click the button labeled 'Start task' (red button at the top of the screen).' Recommendation #2 states: 'If a task is marked red as incomplete and green as completed, text or an icon (e.g., a checkmark) is needed next to completed ones, and an X mark next to incomplete ones.' It includes an example: '-'. Both recommendations have a 'Copy' button and a status bar with 'Not implemented', 'Partially implemented', and 'Implemented' options.

Figure 7. Gamification elements and their usability recommendations view in the MIURGS tool.

The final step of the illustrative case demonstrates how the identified recommendations can be assessed in an existing gamified system. The tool supports not only initial recommendation identification but also the assessment of existing gamified applications and planning of their evolution by facilitating the identification of unimplemented or partially implemented recommendations and gamification elements. Each recommendation can be marked by the tool user as implemented, partially implemented, or not implemented. A recommendation is considered implemented when it is applied consistently in all relevant parts of the system and all its requirements are satisfied. It is considered partially implemented when it is applied only in some relevant parts or only some of its requirements are satisfied. Otherwise, it is considered not implemented. This allows recom-

recommendations that require further implementation or improvement to be identified. Figure 8 shows an example of the implementation status assessment for the fitness application.

Challenges

#1 When providing instructions, they should not rely solely on shape, color, size, or position. The control or other element must be identified by name, label, or other clear description. Copy

Example: The instruction 'Click the red button at the top to start the task' is insufficient. It should be: 'Click the button labeled 'Start task' (red button at the top of the screen).'

1.3.3 Sensory Characteristics

Not implemented Partially implemented **Implemented**

#2 If a task is marked red as incomplete and green as completed, text or an icon (e.g., a checkmark) is needed next to completed ones, and an X mark next to incomplete ones. Copy

Example: -

1.4.1 Use of Color

Not implemented Partially implemented **Implemented**

#3 If music starts playing immediately when the task window opens, there must be a button or link to turn off or stop the music. Copy

Example: The task window opens and themed music starts playing in the background. A button is displayed in the upper right of the screen: Stop music.

1.4.2 Audio control

Not implemented Partially implemented Implemented

#4 If the user needs to enter an answer, it must be validated for formal correctness, and upon detecting an error, a text message must be provided stating what went wrong and in which field. Copy

Example: The user must enter an answer. If no answer was entered, a message is displayed: 'Error: The 'Answer' field is missing an answer. Entering an answer is required.'

3.3.1 Error Identification

Not implemented Partially implemented Implemented

Figure 8. Recommendation implementation status assessment in the MIURGS tool.

The MIURGS tool is publicly available at <https://tool.miurgs.tech> (accessed on 24 August 2026); its source code is available in the Github repository <https://github.com/Krikire/usability-recommendations-for-gamified-systems-selector> (accessed on 24 August 2026).

5. Experimental Evaluation of MIURGS

To evaluate the proposed method and the MIURGS tool, the experimental evaluation was divided into two parts: student evaluation and expert evaluation. Both evaluations were conducted as surveys based on the Method Evaluation Model (MEM) [56], which is grounded in the Technology Acceptance Model (TAM) [57]. MEM was selected because it evaluates three perception-based aspects and the questions used in both parts were designed to assess these aspects: perceived ease of use, perceived usefulness, and intention to use.

The first experimental evaluation used a within-subject comparative design and focused on a broader assessment of the proposed MIURGS method, addressing the first research question. It was conducted in a university setting with student participants. The within-subject design was selected so that the same participants could use and compare both recommendation identification approaches, reducing the influence of differences between participants. The participants were students from computer science and social science programs enrolled in the Information System Graphical Interface course at Kaunas University of Technology. The course includes topics related to graphical user interface development, usability evaluation, and user experience evaluation; therefore, participants were familiar with relevant information system development concepts and usability evaluation methods.

Of the 87 students enrolled in the course, 45 agreed to participate in the evaluation. The survey was conducted in person, and participants were provided with an example gamified application. Two application examples were used: one from the children's learning domain

and one from the adult psychology domain. These domains were selected because education and healthcare are among the most common application areas of gamification [4,5], making the tasks more closely aligned with real-world software development contexts. The first application example was a gamified foreign language learning system for children, in which users complete learning tasks, monitor their progress, and receive rewards. The second application example was a gamified system for adults designed to support emotional well-being through mood tracking, stress-management activities, and daily habit formation. Participants were alternately assigned to one out of two application examples.

The participants compared two approaches for identifying usability recommendations. In the first approach, participants identified recommendations independently using their own knowledge, supported by search engines and large language models (LLMs) of their choice. The choice of search engine or LLM and the formulation of queries or prompts were not controlled, to maintain as close to a realistic environment as possible. In the second approach, participants used the MIURGS tool to generate usability recommendations. All participants used the two approaches in the same fixed order; the order was not randomized. To ensure a consistent comparison, each participant worked with the same assigned application example and completed the same tasks using both approaches. In both cases participants were required to identify five general usability recommendations for the example system, select three suitable gamification elements, and propose five gamification element-specific usability recommendations for one selected gamification element. As the evaluation focused on perceived usefulness rather than task efficiency, task completion time was not measured to avoid introducing time-related pressure on participants. After completing the tasks, participants evaluated the perceived quality and suitability of the usability recommendations identified using general knowledge, search engines and LLMs compared with those provided by the MIURGS tool. They also evaluated the ease of use of both approaches. These pairwise evaluations comparing MIURGS tool usage and no tool usage were later analyzed statistically. The statements evaluated by participants using a five-point Likert scale are presented in Table 3.

Table 3. Student survey questions and their encodings.

Statement	Evaluated Approach for Identifying Recommendations	Question Code
Identified set of general recommendations is suitable for the provided domain	General knowledge, search engines, LLMs	GenRec_NoTool
	MIURGS tool	GenRec_Tool
Identified gamification elements are suitable for the provided domain	General knowledge, search engines, LLMs	Elem_NoTool
	MIURGS tool	Elem_Tool
Identified gamification element-specific recommendations are suitable for the selected gamification element	General knowledge, search engines, LLMs	ElemRec_NoTool
	MIURGS tool	ElemRec_Tool
The recommendation identification approach was easy to use	General knowledge, search engines, LLMs	Easy_NoTool
	MIURGS tool	Easy_Tool

The second experimental evaluation, aimed at addressing the second research question, evaluated the MIURGS method with field experts recruited through purposive expert sampling. Experts were selected based on their research activity in at least one relevant domain: gamification, usability and user experience, human–computer interaction, soft-

ware engineering, or accessibility. Potential participants were identified among the authors of academic publications cited in this paper, as well as authors of additional relevant publications identified during the research process by reviewing publications addressing topics directly relevant to MIURGS. The aim was not to identify all researchers working in these broad domains, but to recruit experts with demonstrated research activity in areas relevant to MIURGS. Researchers were included if they had authored or co-authored at least one publication in one of the relevant domains and a professional email address could be identified. Candidates whose publications were outside the relevant domains, those without an identifiable contact address, and duplicate contacts were excluded. The authors meeting these criteria were contacted by email and invited to participate in the survey. The invitation included a link to the survey and supporting materials. Participants were provided with a detailed description of the MIURGS method, an overview of its components, a demonstration video, and access to the MIURGS tool (<https://miurgs.tech> (accessed on 24 August 2026)) for hands-on evaluation. The use of the supporting materials was not mandatory, and participants could choose which materials to review before completing the questionnaire. Experts who did not test the tool evaluated MIURGS based on the other supporting materials they reviewed. The anonymous survey consisted of 11 questions addressing the experts' background, experience, and assessment of the MIURGS method and tool using a five-point Likert scale [58]. A total of 155 email invitations were distributed. The raw data from both experimental evaluations are available at <https://github.com/Krikire/usability-recommendations-ruleset/tree/main/results> (accessed on 24 August 2026).

5.1. Results of MIURGS Evaluation by Students

A total of 45 participants completed the task of identifying recommendations for a gamified system. Of these, 22 participants identified recommendations for the example system in the children's learning domain, while 23 worked with the example system in the adult psychological health domain. Regarding academic background, 32 participants (71%) were from computer science and 13 (29%) from the social sciences. Participants reported moderate familiarity with the domains relevant to the task. On a five-point scale, the mean self-reported familiarity with gamification was 3.0, while familiarity with usability concepts averaged 3.78.

Across all four statements (Table 3), the mean ratings were higher for outputs generated with the MIURGS tool than for those prepared without tool support. Figure 9 demonstrates the distribution of responses across Likert scale scores for each statement. This finding suggests that participants perceived the tool-supported recommendations as more appropriate for the selected application domain and easier to identify. This advantage was not uniform; it was most pronounced when rating the ease of identification, where the tool addresses the problem of manual effort in locating relevant recommendations. On the other hand, while the MIURGS tool still achieved higher ratings, it had the lowest difference in gamification element-specific recommendations. The cause of this may stem from the participants' confidence in their own answers or the ability of LLMs to answer more specific questions. Participants in both the children's learning and adult psychological health domains tended to favor the MIURGS tool, assigning higher ratings for ease of use and identification of gamification elements. Domain-specific results for the children's learning system are presented in Figure 10. The results indicate the smallest improvement for recommendations related to gamification elements, whereas the remaining evaluation criteria showed a more pronounced increase in ratings with the use of the MIURGS tool. The results for the adult psychological health domain, presented in Figure 11, show higher ratings for the MIURGS tool across all evaluated statements. The observed improvements

were consistent across all assessment criteria, indicating that participants perceived the tool-supported approach as more effective than the manual approach in this domain.

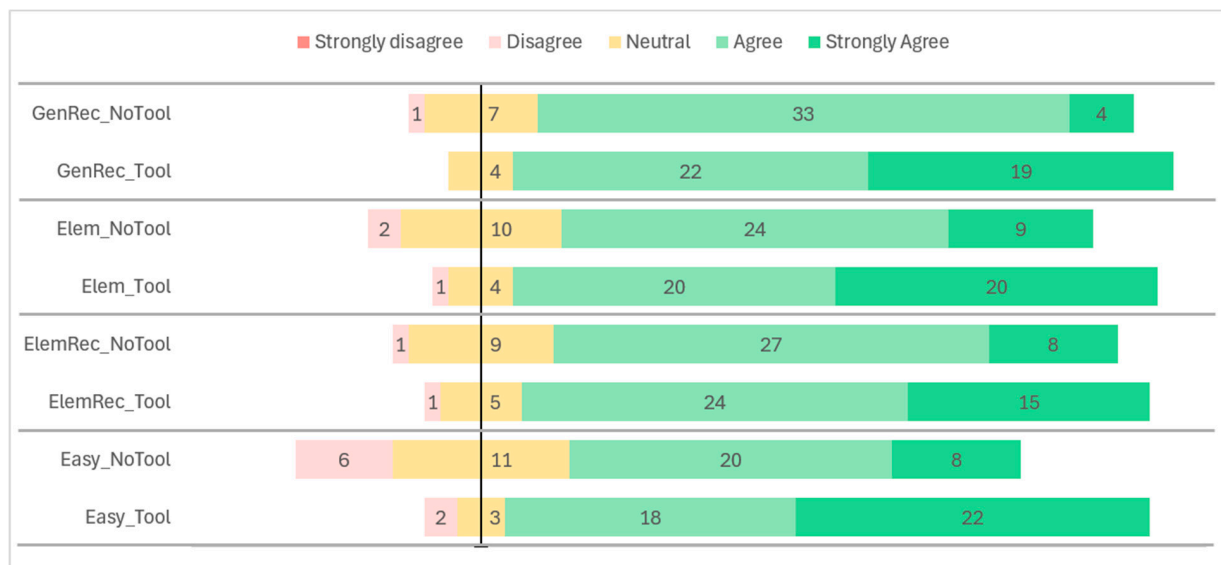


Figure 9. Survey results for student experimental evaluation tool usage comparison.

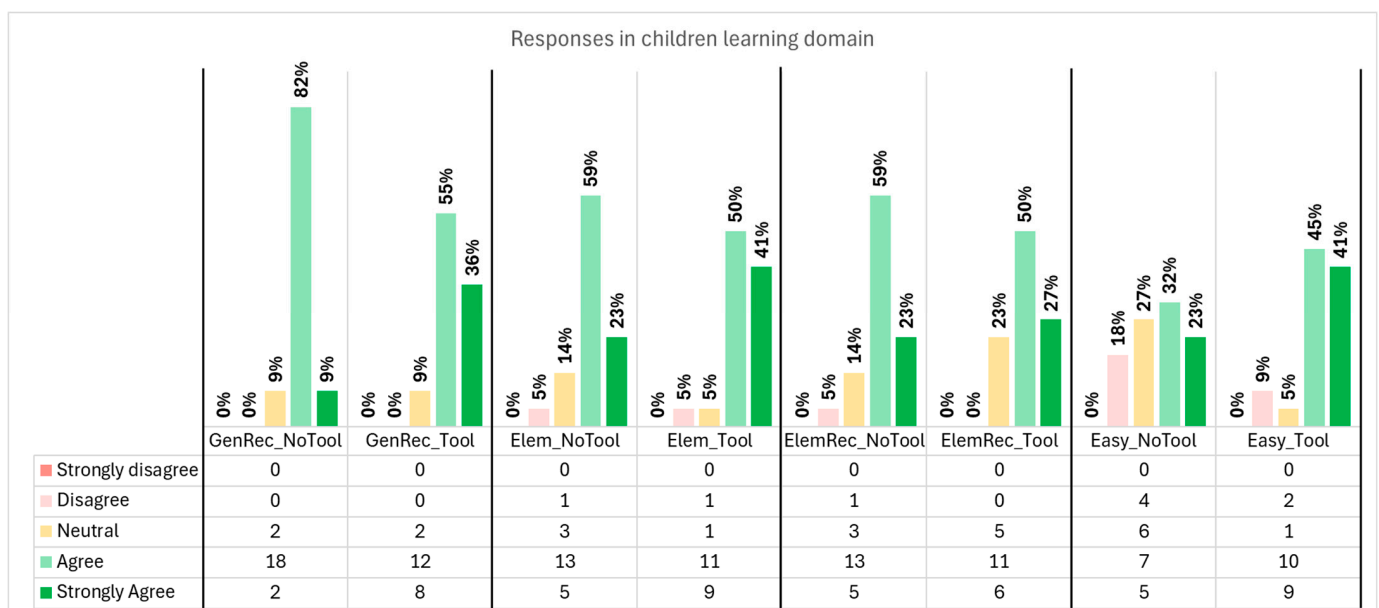


Figure 10. Distribution of responses across the Likert scale scores in students' evaluation with the children learning domain.

The statistical analysis exploration results are presented in Table 4. The normality of the survey response distribution was evaluated with the Shapiro–Wilk test. The Shapiro–Wilk test indicated that the differences between the tool-supported approach and the approach without tool support deviated from normality for all evaluated aspects (p in the range from 0.00000004 to 0.0001). Due to the paired comparison of recommendations without and using the tool with a lack of normality in participant response results, Wilcoxon signed-rank tests were conducted. The results of this test ranged from 0.35 to 0.84. and were reported as rank-biserial correlation.

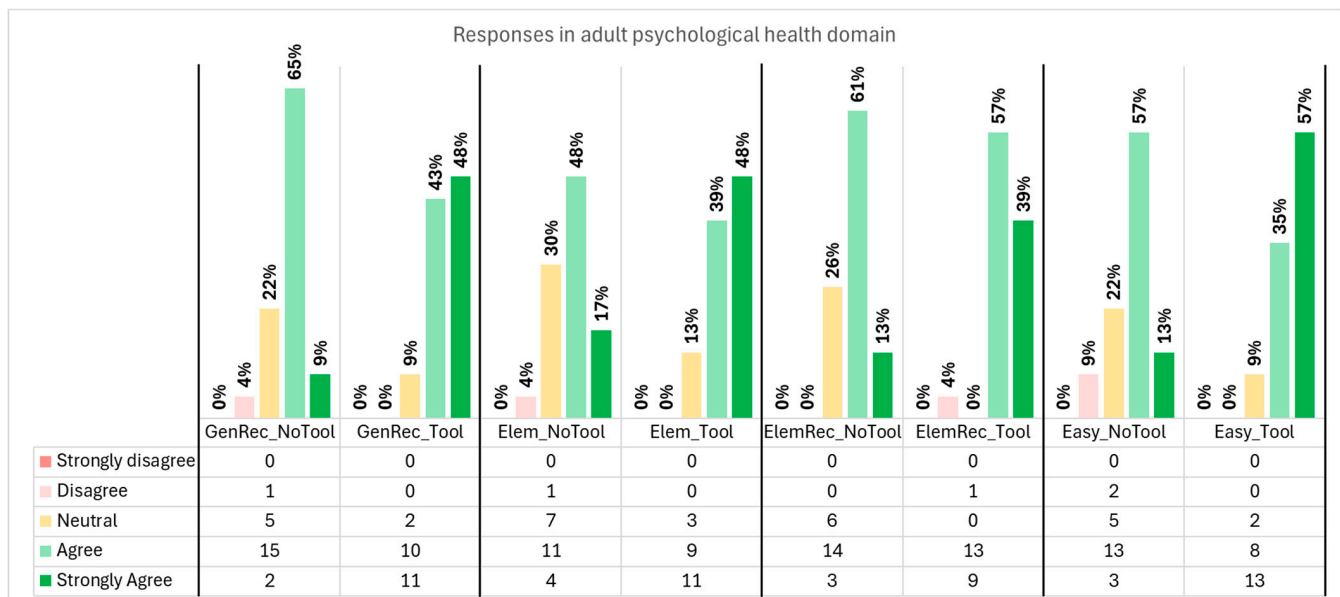


Figure 11. Distribution of responses across the Likert scale scores in students' evaluation of the adult psychological health domain.

Table 4. Statistical exploration results for student evaluation of MIURGS.

Evaluated Parameter	Mean (IQR)	95% CI Mean Lower Bound	95% CI Mean Upper Bound	Median (Q1–Q3)	Standard Deviation
GenRec_NoTool	3.89 (0.00)	3.72	4.06	4 (4–4)	0.57
GenRec_Tool	4.33 (1.00)	4.14	4.53	4 (4–5)	0.64
Elem_NoTool	3.89 (1.00)	3.66	4.12	4 (3–4)	0.78
Elem_Tool	4.31 (1.00)	4.09	4.53	4 (4–5)	0.73
ElemRec_NoTool	3.93 (0.00)	3.73	4.14	4 (4–4)	0.69
ElemRec_Tool	4.18 (1.00)	3.97	4.39	4 (4–5)	0.92
Easy_NoTool	3.67 (1.00)	3.39	3.95	4 (3–4)	0.93
Easy_Tool	4.33 (1.00)	4.09	4.57	4 (4–5)	0.80

Figure 12 presents the mean ratings for the survey statements. Compared with the approach without the tool, the MIURGS tool-supported approach received significantly higher ratings for three of the four evaluated aspects: the suitability of the identified general usability recommendations ($W = 15.0$, $p = 0.00071$, $r = 0.84$), the suitability of the identified gamification elements ($W = 69.0$, $p = 0.00348$, $r = 0.61$), and the ease of the identification process ($W = 45.0$, $p = 0.00064$, $r = 0.74$). Such results for these three aspects can be interpreted as a high preference for tool usage, when compared to a no-tool approach. After a Bonferroni correction for the four comparisons ($\alpha = 0.0125$), all three differences remained significant. No statistically significant difference was found for the suitability of the recommendations identified for the selected gamification element ($W = 75.0$, $p = 0.149$, $r = 0.35$), indicating that the tool preference for suitability recommendations was not as pronounced even though the average rating for this aspect was in favor of MIURGS tool usage.

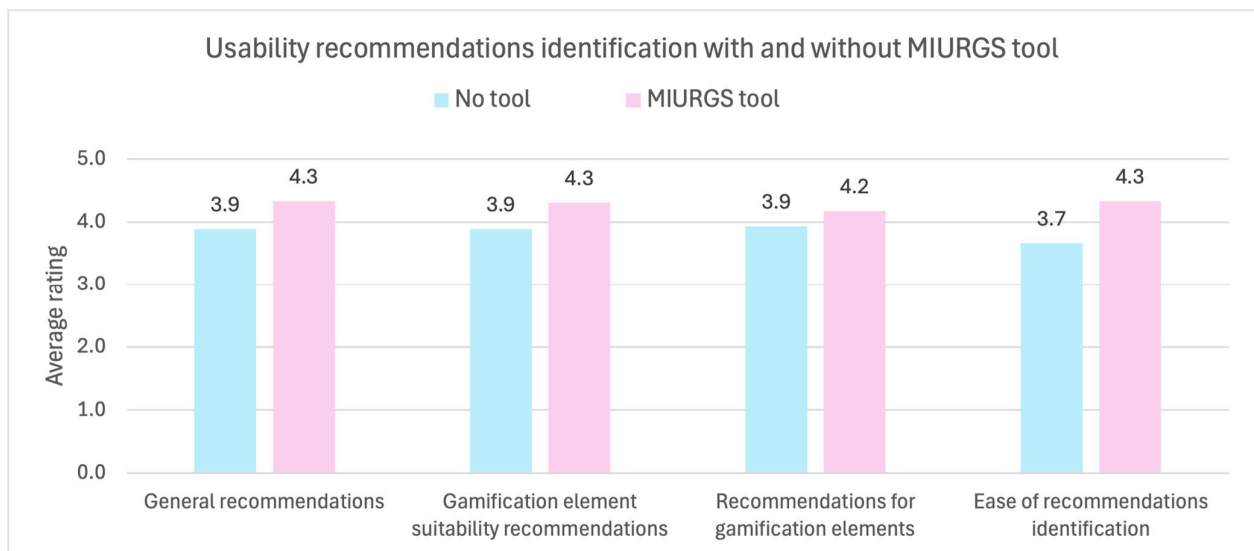


Figure 12. Combined averages of MIURGS tool evaluation results.

The results presented in Figure 12 indicate that the MIURGS tool can facilitate the identification of general usability recommendations, as well as the selection of suitable gamification elements and associated recommendations. The absence of a statistically significant difference in the suitability of recommendations identified for a selected gamification element suggests that participants were generally confident in their ability to identify relevant recommendations once an appropriate gamification element had been selected. Similar evaluation by participants for recommendation suitability could also be attributed to a smaller set of possible choices to be made when the gamification element is already selected. Consequently, the primary contribution of the tool appears to lie in supporting the earlier stages of the recommendation process, particularly the identification of applicable usability recommendations and the selection of suitable gamification elements.

5.2. Results of MIURGS Evaluation by Experts

A total of 12 expert responses were collected. Among the materials provided, the video demonstrating the MIURGS tool was accessed most frequently, with 10 respondents (83%) viewing it. The PDF description of the MIURGS method was accessed by six respondents (50%), while seven respondents (58%) tested the tool.

The MIURGS method was evaluated using five statements derived from the three constructs of the Method Evaluation Model (MEM) and assessed on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The results are summarized in Figure 13. Following the MEM constructs, statement S1 measured perceived ease of use, statements S2–S4 measured perceived usefulness, and statement S5 measured intention to use.

Perceived ease of use (S1), expressed as the clarity and understandability of the method, received an average of 4.00, with 9 of the 12 respondents in agreement. Perceived usefulness (S2–S4) was the most positively rated aspect: the respondents agreed that the method would reduce the effort required to identify usability recommendations (average 4.25, 11 of 12 in agreement), that it would make it easier to verify whether a gamified system follows appropriate usability recommendations (average 4.25, 10 of 12 in agreement), and that the method was useful overall (average 4.17, 11 of 12 in agreement). Intention to use the method (S5) received a mean of 4.00, with 10 of the 12 respondents in agreement.

The positive evaluation was consistent across the respondents. The average ratings of respondents with two to five years of experience and those with more than ten years of experience were almost identical, at approximately 4.3 in both groups. Five experts

evaluated the method based on the method description and video demonstrating the tool, while seven experts used the tool directly before completing the survey. Experts who did not use the tool tended to provide higher ratings for several statements. For example, for S1, which assessed whether the method was clear and easy to understand, the mean rating was 4.4 among experts who did not use the tool, compared with 3.7 among those who used it. A similar pattern was observed for statements S3, S4, and S5. In contrast, the ratings for S2, which assessed whether the method would reduce the effort required to identify usability recommendations, were similar between the two groups, with mean ratings of 4.2 among experts who did not use the tool and 4.3 among those who used it. Most of the lower ratings were concentrated in a single response, in which all five statements were rated at the two lowest points of the scale. Perceived usefulness received the highest ratings, suggesting that the experts regarded the method as useful even when their ratings of it being easy to understand or their intention to use it in future work were lower.

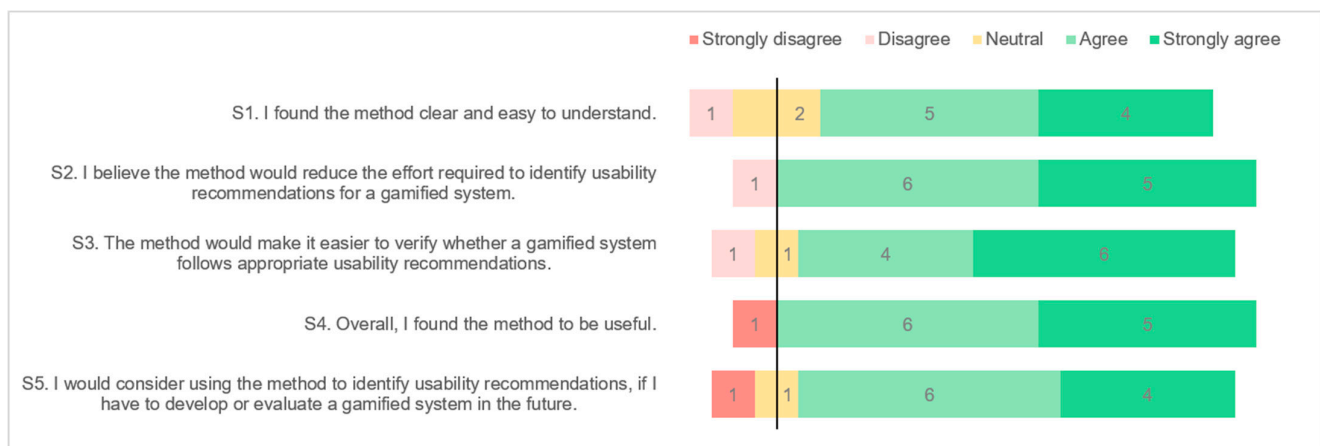


Figure 13. Survey results of expert evaluation.

The experts were asked to provide feedback on the strengths of the MIURGS method and possible improvements or missing aspects. These comments provided additional insight into the value and limitations of the MIURGS method and tool. The open-ended responses were analyzed using the principles of qualitative content analysis [59]. Five experts described the tool as useful, promising, and relevant for designers, researchers, teachers, and developers working with gamified or serious game systems. Three experts valued the idea that the tool brings together gamification and usability considerations in one place and that the recommendations are based on established standards such as ISO and WCAG. One respondent noted that the recommendations were more detailed and context-sensitive than initially expected.

The comments identified several directions for improvement. A recurring point, mentioned by two experts, concerned the transparency of the recommendation process. Experts suggested that the tool should explain why particular gamification elements and recommendations are proposed for a given context. This was considered important when the tool returns a large number of gamification elements or recommendations, as users may need support in deciding which results are most relevant to their own system. Two experts also noted that some combinations of parameters may return no recommendations and suggested that the tool should explain such cases or provide an alternative way of identifying potentially relevant recommendations.

Other comments were concerned about the structure of input parameters and the presentation of results. Two experts suggested clarifying the meaning of age groups and making it clearer that the disorder parameter is optional. Two respondents also proposed to include additional user characteristics, such as gender or racial profiles, and

additional evaluation perspectives, such as playability and prevention of game addiction. Another suggestion was to make the full recommendation catalogue available as a read-only resource, so that users could inspect the complete knowledge base rather than only the recommendations returned for a specific context.

In general, the experts' feedback and suggested improvements were valuable for shaping future tool development plans. Most experts evaluated the research positively and did not identify major issues with the method or tool. Their responses also highlighted further research opportunities and encouraged continued work on MIURGS.

6. Discussion and Conclusions

The MIURGS method proposed in this paper addresses usability at two levels: the gamified system as a whole and individual gamification elements. By relating usability recommendations to user and system characteristics, the method provides a structured approach for identifying recommendations applicable to a specific development context.

The method evaluation results indicate that the usefulness of MIURGS is perceived positively by survey participants and is considered a preferred tool for usability recommendation identification. In the student experimental evaluation, 45 participants compared recommendation identification using the MIURGS tool with unaided identification based on their own knowledge, search engines, and large language models (LLMs). Across all four evaluated statements, the mean ratings were higher when the MIURGS tool was applied. The mean rating for identifying general usability recommendations increased from 3.89 without the tool to 4.33 using the MIURGS tool, while the rating for identifying gamification element suitability recommendations increased from 3.89 to 4.31. The rating for the ease of use of the recommendation identification process increased from 3.67 to 4.33. The suitability of the specific recommendations for the selected gamification element was evaluated similarly with the tool (4.18) and without the tool (3.93). The tool therefore does not appear to have provided a substantial additional advantage in formulating recommendations for an already identified gamification element. One possible explanation is that participants were sufficiently confident in their own knowledge and ability to identify relevant recommendations once the gamification element had been selected. Thus, identifying an appropriate gamification element may have been more challenging than identifying specific recommendations for it. Additionally, LLM-based assistance may be more beneficial when responding to specific and well-defined questions, as a clearly identified gamification element provides a more focused context for generating relevant recommendations. These findings address RQ1 by indicating that the use of MIURGS for usability recommendation identification was perceived positively, particularly for identifying general recommendations, selecting suitable gamification elements, and facilitating the recommendation identification process, although the perceived advantage was less evident for element-specific recommendations.

The expert evaluation further supported the perceived usefulness of the method. The statements that the method reduces the effort required to identify usability recommendations and facilitates verification of whether a gamified system complies with appropriate usability recommendations both received a mean rating of 4.25. The overall usefulness of the method received a mean rating of 4.17. Although the expert sample was limited to 12 participants, the respondents represented diverse areas of expertise, including human-computer interaction, gamification, usability, user experience, software engineering, and accessibility. These findings address RQ2 by showing that experts generally evaluated MIURGS positively in terms of perceived usefulness, ease of use, and intention to use.

The experts' responses to the open-ended survey questions highlighted several advantages of the method and identified opportunities for further improvement of the method

and its supporting tool. The experts appreciated the integration of gamification and usability considerations and the use of established sources, including ISO standards and the Web Content Accessibility Guidelines (WCAG). They also suggested providing clearer explanations of why particular gamification elements and usability recommendations are selected for a given context. Such explanations would be particularly valuable when the tool returns either a large number of recommendations or no recommendations for a specific combination of input parameters. Additional suggestions included clarifying certain input parameters, such as age groups and disorders, and improving navigation of the complete recommendation catalogue.

The evaluation results are consistent with previous studies emphasizing that gamification design should account for user characteristics and application context [31,34–36]. The higher perceived suitability of gamification elements identified with MIURGS also supports previous approaches that use contextual information to guide gamification design and element selection [46–48]. Previous empirical evaluations of structured usability and gamification guidance have likewise reported positive results, including improved identification of usability or design issues and positive assessments by practitioners or experts [36,51].

Several limitations of our research related to the research design and participant selection should be considered when interpreting the results. The student experimental evaluation involved participants with experience in graphical user interface design and usability evaluation; however, they were students rather than software developers. Consequently, the findings demonstrate the usefulness of MIURGS in an educational setting, while additional studies involving professionals developing gamified systems are required. The approaches for performing the tasks with and without the MIURGS tool were evaluated in a fixed order, which may have introduced a learning effect. To maintain a realistic task environment, the evaluation did not restrict the use of additional tools, which may have introduced biases related to the tools used or participants' individual preferences. These factors limit the comparability of the two approaches and should therefore be considered when interpreting the observed differences in participant ratings.

The expert evaluation also involved a relatively small sample. The low response rate may have introduced self-selection bias, as experts with greater interest in the topic may have been more likely to participate. Although the participants possessed relevant expertise and represented multiple research areas, a larger expert panel would enable more robust conclusions regarding the usefulness and applicability of the method. Therefore, we plan to conduct additional evaluations by experts and software developers in future work. The current evaluation did not assess the usability of systems with end users after applying MIURGS recommendations. Future work will therefore include a controlled real-world study comparing systems developed with and without MIURGS and evaluating the resulting usability differences with end users. Independent assessment of the identified recommendations could be included to evaluate their correctness and completeness.

An additional limitation is that the knowledge base mappings and DMN decision rules were reviewed internally by the authors but were not independently validated by external experts. Because the recommendations returned by MIURGS depend on these mappings and rules, future work will include their independent expert validation.

Future work will also focus on extending both the knowledge base and the supporting tool. The knowledge base will be expanded with additional user characteristics, application domains, gamification objectives, and accessibility-related recommendations. Future updates of the knowledge base will follow the same review, standardization, and mapping procedure as the initial process of knowledge base development, with new relevant publications and updated standards incorporated and recommendations based on

outdated or superseded standards revised or removed. The tool will be updated accordingly to allow recommendations to be added, revised, or removed as the knowledge base changes. The tool will also be enhanced by providing explanations for recommendation results, indicating why particular gamification elements and usability recommendations were selected.

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