







A Problem Analysis in Game-Based Student Response System from UX Elements Perspective

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Abstract: Game-Based Student Response Systems (GBSRS) are tools for improving learning through student interaction and participation. Promoting a good user experience in GBSRS is essential in adopting such tools in the educational context. In this sense, it is necessary to design GBSRS by thinking about how to provide the best experience for users. This paper presents an investigation of UX problems in two GBSRS tools, Kahoot! and Quizizz, to verify whether we could avoid UX problems even in the initial stages of product design. For that, we performed a rapid review, and from the selected articles, we cataloged and classified general problems in the tools from the perspective of the UX elements defined by Garret's framework. Our results showed that the problems identified in our analysis could be avoided if we applied UX principles in the tool design phase.

1 INTRODUCTION

Due to the COVID-19 pandemic, it was necessary to adopt social isolation measures to reduce the spread of the new virus (WHO, 2021). Isolation measures have heavily impacted how classes are delivered, with most countries opting for remote learning systems. Thus, school activities were predominantly carried out virtually to minimize the adverse effects of isolation during the school year (Misirli and Ergulec, 2021).

The COVID-19 pandemic has presented the need to innovate and develop new educational systems and assessment strategies. Thus, the use of teaching and learning platforms has increased significantly by many education providers worldwide (Hassan et al., 2022).


In the context of virtual learning, many tools that existed even before the pandemic became great allies of teachers during classes. Among the various types


of tools, one category gained prominence by promoting engagement through participation and competition among students, the Game-Based Student Response System (GBSRS) (Rodrigues et al., 2022).


The GBSRS brings some aspects of gameplay, i.e., it uses sounds and background music, timed questions, scores for the correct answers, and player ratings (Ranieri et al., 2021). In the educational context, these tools emerge as alternatives to promote motivation, engagement, and participation (Rodrigues et al., 2022). The effectiveness of these tools depends on many factors, such as the context of use, the application, and the aspects that influence the User Experience (UX).


UX is the term used to describe a user's experience with a product or service. It is a concept that encompasses all aspects of the user's interaction with the product, including design, usability, ease of use, feeling, and satisfaction. The goal of UX is to create intuitive, efficient, and pleasant products to use (Hassenzahl, 2003).


Many studies address the impacts of UX on using GBSRS, such as Nieto García and Sit (2022), which exploit the benefits of UX to students when using the Kahoot tool. This study focused on the desirability factor, which refers to the extent that a digital interface is "desired" by users. To do that, they adopted a quantitative deductive approach to test the hypothe-


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ses developed from the critical revision of the GBSRS and UX literature. The goal was to measure the desire remembered by the students to use Kahoot in the classroom and the subsequent effects on the perception of the utility of GBSRS and the motivation to attend a class (Nieto García and Sit, 2022).

The study of Rodrigues et al. (2022), through some usability assessments in Kahoot and interviews, has been able to visualize and compare the differences in the experience of the two user profiles of the platform, considering the point of view of teachers and students. The results indicated that the platform promoted a better student experience but presented more usability and UX problems for teachers.

The study by Degirmenci (2021) presents a systematic review of the literature on the effectiveness and role of the Quizizz tool and the perspectives of teachers and students regarding its use. The investigation showed good effectiveness of Quizizz in the learning processes in which it was applied.

With the growth of GBSRS in the educational context, developers must prioritize the user experience to ensure the efficiency of these systems. For this, they must dedicate themselves to improving and perfecting the UX of these resources. An alternative is using the conceptual model for UX design proposed by Garrett (2011). The model aims to assist in the decisions made during the product design stage, making it possible to simplify the UX in five planes, namely: Strategy, Scope, Structure, Skeleton, and Surface. We chose this model due these advantages: works in the system design phase, focuses on the user experience, and presents an easy-to-follow structure.

Considering the need to improve the UX during the design phase, this paper seeks to answer the following research question: could the problems present in GBSRS have been avoided during the design phase by using the UX elements proposed by Garrett? To answer the research question, we performed an exploratory literature through a rapid review search to identify problems in two GBSRS tools, Quizizz and Kahoot. Then, we aimed to classify the problems according to the UX elements of Garrett (2011). Our goal is to find out if, applying these principles to the GBSRS development process, the final system would provide a better user experience with fewer errors and less frustration.

We hope this study will allow developers to understand better the main concerns when developing GBSRS, considering the UX. In addition, we expect our study to contribute to understanding the best practices to be followed in developing GBSRS systems that provide positive user experiences.

2 BACKGROUND

This section presents the main concepts discussed in this study. Thus, in the next subsections it is possible to find information about Game based student response system, Kahoot, Quizizz and the elements of Garrett's user experience.

2.1 Game Based Student Response System

The GBSRS are an interactive learning tool that allows students to answer questions in real-time, get class performance statistics, and are generally designed to help teachers assess the student (Owen and Licorish, 2020).

The GBSRS aims to increase students' interest and motivate them to learn while allowing teachers to track performance and provide immediate feedback to students (Ranieri et al., 2021). The system can be used to teach specific content and to evaluate student performance.

Among the tools that are part of this category, Kahoot and Quizizz stand out. In the study of Basuki and Hidayati (2019), students present Kahoot and Quizizz as mandatory applications in the organization of online questionnaires.

We used Kahoot and Quizizz as an object of study, as they are popular and free tools in academia. In addition, for standing out in studies in the literature that compare these tools with each other. After cataloging problems in the literature associated with the two tools, we categorized them according to a framework proposed by Garrett (2011) to support the design of GBSRS that contemplate a better user experience. Next, we present information about Kahoot, Quizizz, and the framework proposed by Garrett.

2.2 Kahoot

Kahoot shown in Figure 1 is a GBSRS, that helps teachers improve students' learning experience by providing them with a platform to create and share interactive quizzes (Wang, 2015). Games are created with custom content and can be used for anything from math to history (Aktekin et al., 2018). Students can participate in the games using smartphones, tablets, or any other device connected to the internet. As a result, students are engaged and motivated to learn, as they can compete against each other to accumulate points and win prizes (Wang, 2015).

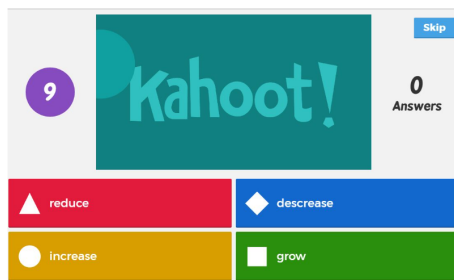


Figure 1: Kahoot Screen.

2.3 Quizizz

The Quizizz platform, shown in Figure 2 offers gamification features where users can earn points for answering questions correctly and level up (Unesa, 2022). Quizizz also allows instructors to create their unique games and share them with other platform users. Instructors can also review and customize games created by other users (Pham, 2022).

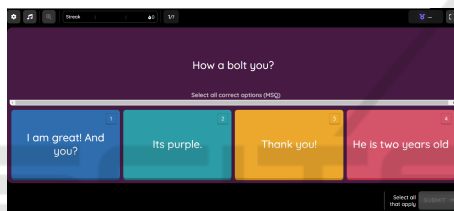


Figure 2: Quizizz Screen.

2.4 The Elements of User Experience of Garrett

According to Agusdin et al. (2021), UX elements are interdependent planes or layers to help in design phase decisions in order to design the entire user experience. This approach consists of 5 planes, the lower the level of the problem, the more abstract it will be. Likewise, the higher the level, the more concrete the problem. Each plane is highly dependent on the plane below it. So the surface depends on the skeleton, which depends on the structure, the scope, and the strategy respectively (Garrett, 2011).

Figure 3 presents the five levels of user experience proposed by Garrett (2011), organized in ascending order. Next, we present each one in detail:

Strategy Plane: At this point, user needs and stakeholder interests (business scope) related to the developed product must be taken into account (Garrett, 2011). According to Agusdin et al. (2021), some techniques can be used at this stage to acquire data, such as interviews, questionnaires, and focus groups. The result will be an integration between **product objective** and **users' needs**.

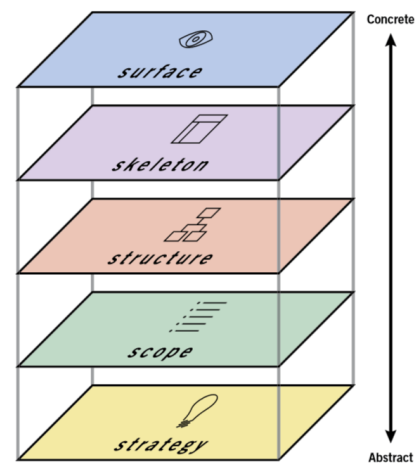


Figure 3: The theoretical model of UX elements. Source: Garrett (2011).

Scope Plane: The structure defines the way in which the various features and functions of the software fit together. This phase transforms the strategy into **functional specifications** that describe the product's functionalities. Considering the product as a way of information, the output of the strategy plane can also be converted into **content requirements** (Agusdin et al., 2021).

Structure Plane: This phase transforms the functional specifications and content requirements into the interaction arrangement between the user and system (Agusdin et al., 2021). Such interaction is represented by **Interaction Design**, where the flows are determined by user interaction, defining how the user interacts with the product functionalities. This plane also defines the structural design to facilitate access to contents (Garrett, 2011).

Skeleton Plane: In the skeleton plane, the output of the structure plane starts to be considered by other factors, such as **Information Design**, related to the presentation of information to the user, **Interface Design**, responsible for the design and positioning of elements in the interface, and finally **Navigation Design**, responsible for facilitating user navigation through the product interface (Garrett, 2011).

Surface Plane: In this phase, the combination of all the previous planes must converge in a concrete **Visual and sensorial design** of the finished product (Agusdin et al., 2021). This phase is used to validate how the design will manifest itself to the users' senses and which of the five senses (sight, hearing, touch, smell, and taste) are affected (Garrett, 2011).

3 EMPIRICAL DESIGN

We executed a rapid review to select the papers used in our analysis. A rapid review is a condensed form of systematic review in which components of the systematic review process are simplified or omitted to produce information in a timely manner (Tricco et al., 2015). It is often used to quickly identify information relevant to research, policy development, or decision-making. The rapid review can be used in many contexts, from medical research to evaluating the effectiveness of a new program (Garritty et al., 2021).

3.1 Rapid Review Procedures

We searched for papers at IEEE xplora. IEEE xplora is a search engine that provides access to scientific and technical content from the IEEE (Institute of Electrical and Electronics Engineers), IET (Institution of Engineering and Technology), and other publishing partners (Wilde, 2016).

We established five inclusion criteria to select papers: i. paper published between 2020 and 2022. We defined this period because our research focused on the main game-based student response system tools that gained prominence during the pandemic. ii. paper about Kahoot and or Quizizz. iii. paper that presents results with the perceptions of the use of tools by students or teachers; or iv. paper that presents problems identified in the tools; or v. paper that presents strengths and weaknesses of the use of the tool. The exclusion of papers is due to non-compliance with the inclusion criteria.

In the first search, we set the following search string: (“All Metadata”:game-based student response system) OR (“All Metadata”:kahoot) OR (“All Metadata”:quizz) OR (“All Metadata”:quizzes) Filters Applied: 2020 - 2022. The search resulted in 314 papers. We read the titles, abstracts, and keywords according to the inclusion criteria. After applying the inclusion criteria in all papers returned, we selected 17 papers for full reading to identify problems or perceptions about the studied tools.

We perform a second search with the following search string: (“All Metadata”:game-based student response system) AND (“All Metadata”:Evaluating) OR (“All Metadata”: kahoot) OR (“All Metadata”:quizz) OR (“All Metadata”:quizzes). Filters Applied: 2020 - 2022”. The second search resulted in 28 papers. After applying the inclusion criteria, we selected 17 papers for a full reading. We identified that of the 17 papers selected, 13 were repeated (already returned in the first search).

Before performing the searches, we established

the papers of Rodrigues et al. (2022), and Figueiredo et al. (2021) as control papers. Both papers meet all inclusion criteria. At the end of the process, we analyzed 23 papers, 16 in the first search, 5 in the second search, and two control papers.

3.2 Analysis and Categorization of the Problems in the Five Planes of User Experience

After the selection process, we started to read the selected papers integrally. By reading the papers thoroughly, it is possible to verify whether the criteria used in the Rapid Review were adequate for selecting papers and to assess whether other relevant factors may have influenced the decision to include or exclude a paper. In addition, the complete reading of the papers also allows the extraction of data relevant to the study, such as the type of methodology used, the results obtained, and the conclusions of the author (Kitchenham et al., 2010).

From the extraction of the UX problems we obtained in the literature regarding the Kahoot and Quizizz tools, we performed the categorization of the problems considering one of the five planes presented by Garrett (2011). In order to establish an acceptable level of agreement in the categorization of problems with the consensus among the authors, we performed the Kappa (A coefficient of agreement for nominal scales) (Cohen, 1960).

Cohen’s Kappa is a concordance index that measures the consistency between two evaluators when rating the same observations. It is used to measure a rater’s accuracy for specific judgment categories. The index varies between 0, which indicates no agreement between evaluators, and 1, which means perfect agreement (Landis and Koch, 1977).

Two authors of this paper, using the concepts established in Section 2.4 on UX planes, carried out the classification of problems independently (without having contact with the other classification). Then we calculated the Kappa. The Kappa result was 0.81132, considered Almost Perfect, and means that the evaluators are “aligned” concerning the interpretation of the defined criteria (Landis and Koch, 1977).

4 RESULTS

We present, in a supplementary material, a table with the 23 works selected and read in integrally¹.

¹<https://doi.org/10.6084/m9.figshare.22213675.v3>

Regarding the tool addressed by the papers, 16 are studies on Kahoot ([01-05][07-11][13-14][16-18][21-22]); 2 on Kahoot and the Quizziz ([06][20]); 1 about Quizziz ([23]); 1 paper did not specify the tool ([03]); 1 on Kahoot and Nearpod ([12]); 1 on Kahoot, Quizziz and Quizle ([15]) and one on Kahoot, Quizziz, Socrative and Nearpod ([19]); all are GB-SRS.

However, only seven papers described problems concerning the tools ([01, 05, 07, 10, 21, 22, and 23]), which resulted in 21 problems, as shown in Table 1. We classified the identified problems within the five UX planes presented in Section 2.4. Below we will present and discuss the classification of problems.

Table 1: Problems Found.

Paper	Problems Found
[01]	Internet connection
[01]	Fast pace of the game
[01]	Competitive nature of the tool
[05]	Students found tool sounds annoying
[07]	View questions and answers in class
[07]	Time stress
[07]	Fear of losing
[07]	Difficulty keeping up with the score
[10]	Absence of any indication on the screen when a wrong answer is marked
[21]	Short timeout to reply
[21]	Confusion in multiple-choice questions
[21]	Students who cannot read fast end up falling behind, which makes them feel embarrassed in front of other students
[22]	Lack of language standardization
[22]	Confusing navigation/interface
[22]	Teachers rated it as technical, confusing, and common
[22]	An interface that is not visually pleasing and has solid colors is tiring on the eyes
[22]	Confusing and difficult-to-understand symbols
[22]	Functions difficult to access
[22]	Difficulty using some features like adding media to the created Kahoot
[23]	Menu "More" when clicked is below the "Help" button, making it difficult to access two submenus
[23]	Created activities appear on very similar white cards, which can make them difficult to distinguish

4.1 The Strategy Plane

Given the classification of problems, we associated six problems with the strategy plane:

1. Students who cannot read fast end up falling behind, which makes them feel embarrassed in front of the other students;
2. Time stress;
3. Competitive character of the tool;
4. Fear of losing;
5. View questions and answers in class;
6. Teachers classified the tool as technical, confusing, and common.

We can observe that Problems 1 and 2 are related to the time each question can be answered. We identified these issues in Kahoot. The problems identified inform the direction the development team should take when creating and improving their products and services.

However, some tools have features that increase the time factor when creating a match. In this sense, it is possible to adjust the time limit for questions, add a countdown, and even create games in real-time.

Problems 3 and 4 are related to each other. The competitive character represents the desire to be the best among other competitors, which can lead to the fear of losing. These are usually factors used to encourage users to improve their performance level. In addition, problem 5 motivates competitors to fight for their goals and overcome challenges, i.e., it can also improve engagement positively or negatively. Problem 6 is important because the use of these tools is often a teacher's decision, if the teachers don't like the tool it is not used.

The strategic plane should be developed based on a deep understanding of the needs and preferences of the users (Garrett, 2006). User needs are objectives of external origin identified through user research. We can obtain user information through interviews, questionnaires, and direct observation, in addition to data analysis and user feedback (Garrett, 2011).

The development team can use user needs to drive the creation of new features, improve the usability and accessibility of systems, enhance the user experience, and increase service quality. These needs must be used to identify opportunities to create new products or services that meet users' needs.

4.2 The Scope Plane

The scope plane specifies the functionality and content elements that the system must include to satisfy user needs. Functional specifications are a set of detailed functionality that the system must have. Content requirements are the content elements necessary for the system to meet the user's needs (Garrett, 2006).

The classification revealed four problems associated with the scope plane:

1. Short timeout to reply;
2. Fast pace of the game;
3. Absence of any indication on the screen when a wrong answer is marked;
4. Difficulty keeping up with the score.

Scope Problem 1 is related to the problems of the previous plane. Therefore, Problem 1 could have been categorized in the Strategy or Structure planes. However, Problem 1 was categorized as Scope, as it can be considered a requirement to be implemented in the tools.

Another factor that could have been considered a requirement is Scope Problem 2, related to the information scrolling too quickly on the screen, which significantly affects the user experience. Problems 3 and 4 point to the lack of more appropriate feedback. The information must be presented clearly and objectively, so the user can absorb it without rereading or going back to be sure of what s/he has read.

4.3 The Structure Plane

The structure plane establishes the guidelines for implementing elements in the system. Interaction design defines how users will interact with the product, while information architecture provides the structure for the organization, accessibility, and location of product information. In this sense, two main problems were associated:

1. Difficulty using some features, like adding media to the created kahoot;
2. Functions that are difficult to access.

The two Structure problems show difficulties encountered by users in functionalities that should be easy to access. Difficulties characterize poor interface design and affect the flow of information. The structure should be designed to give the user access to the desired information as quickly as possible, providing a direct path to the necessary data. In addition, the structure needs to be intuitive and straightforward so that the user does not feel lost or disoriented. Finally, navigation must be organized clearly and logically, so the user can easily find the information.

4.4 The Skeleton Plane

The skeleton should help organize information into logical sections, allowing users to access the content they want quickly. In interface design, the skeleton

establishes the visual and interactive components necessary for users to interact with the system. The navigation design provides users with clear paths to the desired content, allowing them to navigate the product easily. Problems with the skeleton's plane focus on the confusion and doubts that some interface elements caused the users. In this sense, we found four problems:

1. Confusing and difficult-to-understand symbols
2. Confusion in multiple-choice questions
3. Confusing navigation/interface
4. Menu "More" when clicked is below the button "Help", making it difficult to access two sub-menus

Skeleton Problems 1, 2, and 3 show a lack of consistency between the interface and difficulty understanding how functions and interface elements work. Regarding Skeleton Problem 4, the navigation menus must be well positioned so that users can easily find what they are looking for in the interface.

4.5 The Surface Plane

The surface plane is responsible for creating a pleasant and beautiful environment. It is the first impression that users will have of the system. If the surface plane is developed correctly, it can help establish trust and create a foundation for a good user experience. Therefore, we associate four problems with the surface plane:

1. Created activities appear on similar white cards, which can be difficult to distinguish;
2. An interface that is not visually pleasing and has solid colors is tiring on the eyes;
3. Students found the tool's sound effects annoying;
4. Lack of language standardization.

Problems 1, 2, and 3 presented for the Surface plane show that visual and aesthetic elements can be unpleasing or tiring, diminishing the positive experience of using the tool. For Surface Problem 4, it was reported that even when changing the tool's language, information still appears in the original language, thus not maintaining the language pattern in the interface.

The surface plane must be designed in such a way as to meet the functional and aesthetic needs of the product. Visual elements such as colors, fonts, images, and icons contribute to the user experience. The design should be used to make the user experience more intuitive, attractive, and easy to use. In this sense, an unpleasant visual design can affect the user experience.

From our analysis, we classified the problems according to the planes presented by Garrett (2011). However, the problem of “Internet connection” is related to a problem outside the context of the application. Therefore, we classified the problem in the “External problems” category, which represents problems that affect the use of the tool from external factors.

5 DISCUSSION

UX planes were initially framed in the practice of web design. However, these same principles apply to products with both functional and informational aspects. In these products, UX design focuses on user tasks or as a form of information where the design considers the information offered by the product (Garrett, 2006), i.e., any system that helps users to perform tasks and promotes communication between users. GBSRS allows teachers to provide immediate feedback to students through multiple response options (Ranieri et al., 2021), in addition to providing students with interactive assignments.

In the elements presented by Garrett (2011), the experience is built from the bottom up. The lowest elements of the framework represent the product design phases, up to the interface that will be presented to the end user. We analyzed the problems classified in each plane. We can infer that some problems could have been prevented by adequately solving the previous plane’s problems, since each plane depends on the decisions in the below planes.

The problems considered in the lower plane are quite abstract. We suppose that their possible solutions could only be applied in higher planes, since design decisions become perceptible and visual as we approach the top.

The development team must ensure the GBSRSs are correctly implemented to satisfy the user. Thus, the GBSRS can help quickly and intuitively in the proposed task.

Applying UX elements in the GBSRS development process can allow designers to plan all aspects of UX. Consequently, ensuring that no aspect of the user’s experience with the software happens without their conscious and explicit intention is possible.

In general, Garret’s model offers a guide to develop guided experiences, involving all the necessary elements to create deeper emotional connections with the target audience. The model does not result in standard designs but well-crafted systems tailored to the specific user from the ground up (Garrett, 2006).

To get the best out of Garrett’s plans, we must continually verify each plane to ensure it is consis-

tent with our planned goals in the present and former planes. We need to create a test planning for each plane, analyze the test results, and identify the points that need to be improved. Also, check the performance of the GBSRS continuously, and carry out periodic updates and improvements to ensure the system meets users’ needs over time and we to follow what we established in planning. Besides that we must do verification of the UX planes in a systematic and documented way to ensure the quality of the system and meet user expectations. To ensure the quality of the system and meet user expectations, we need to verify the UX planes systematically and document this process in a rigorous manner. This will help us optimize the UX planes for usability, accessibility, and overall user satisfaction. It is important to adhere to accepted academic standards while conducting this verification process.

6 CONCLUSION

This paper aimed to investigate whether applying the principles of Garrett’s UX planes could help improve the UX in the Game-Based Student Response System in the development process. In this sense, we conducted a Rapid Review to gather studies on the GBSRS according to the established criteria. In this way, we identified problems, which we classified and analyzed in each plane. We can assume that some UX problems could have been avoided if Garret’s elements principles had been applied correctly and appropriately.

Classifying the problems identified according to Garret’s UX elements can help identify possible solutions to the problems or at least prevent such problems from happening. Thus, provide developing more effective and more satisfactory systems for users. In future work, we intend to propose guidelines for verifying UX plans for GBSRS to guarantee the quality of the systems we develop.

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