A review on User Experience Model in Mobile Educational Games Evaluation

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Abstract

This review explores the models and frameworks used to evaluate user experience in mobile educational games. A number of seven studies were selected based on their MEG evaluation explorations. Based on the literature, three models were found in MEG user experience evaluation: playability heuristics, MEEGA+, and UEQ, where playability heuristics was the most adopted model. The review found that all of the models used have the ability to evaluate the MEG thoroughly. However, based on the definition and requirement of user experience and MEG, the models were found to be lacking in evaluating the educational and mobility part of the MEG and the immersion and flow component, where all of these components are pertinent to the MEG user experience. Therefore, this review suggests that more exploration is needed to provide a more comprehensive model for evaluating user experience for MEG.

Keywords: *user experience, mobile, educational game, evaluation model*

1. Introduction

User experience (UX) is the experience that products or services produce for the people who use them in the real world. It is different from usability, where something usable might offer a bad experience to the users [1]. Structures of good UX are vital in the creation of all services and products, including systems that utilize digital technology like websites [1], online (server-based) systems, mobile phone applications, and video games [2]. These digital systems and applications were initially assumed to be complex pieces of technology that could have been easier for users to understand. Users used to blame themselves by believing that they were not IT savvy, while the actual condition was that the website, system, and even the games were designed by ignoring the user experience aspects [1]. As time passed, the weather changed, and the technology designers put huge considerations into UX in pre-production, in-progress production, and post-production of a system or application.

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From this point on, the importance of conducting UX evaluation has emerged. Based on the definition in ISO 9241-210 [3], UX varies based on the types of users and the purpose of a product. As a result, some quite several models evaluate the UX on websites, online systems, mobile applications, and video games (off-line, online, mobile, educational, or serious games) [4]–[6]. User evaluation of these digital systems and applications has its complexity and richness in measuring human-specific experiences, leaving potential gaps for UX evaluation research in various types of digital applications.

In recent years, significant research and industry focus has been on UX evaluation research and mobile educational games (MEG). Educational games, often called "serious games" or game-based learning, are referred to simply as "educational games" for clarity. "Mobile educational game" encompasses any educational game designed for mobile devices like tablets and smartphones. In MEG, established gaming principles are applied to enhance learning rather than purely offering entertainment or "edutainment" [7]. The integration of mobile platforms and gaming mechanics in education is driven by the continuous growth in mobile technologies and the promising prospects of mobile games [8], [9]. Consequently, using mobile devices for educational gaming has highlighted the significance of MEG. Learning through mobile games is becoming a prevalent trend, facilitated by the mobility of handheld devices. As a result, MEG is emerging as a crucial area for improving the overall learning experience [10].

Given the growing significance of MEG in the eyes of researchers, practitioners, and users, there is a pressing need for a literature review in this domain. This review aims to uncover potential UX evaluation models/frameworks, identify existing research gaps and requirements, and examine components that can contribute to the ideal UX evaluation model for MEG. Although many existing studies incorporate UX evaluation into their MEG projects, a comprehensive literature review is essential to fully unearth these models and components. This study reviews research concerning UX evaluation models and frameworks in the context of MEG. It distills the key components necessary for assessing UX in MEG. The paper is structured as follows: Section 2 provides background information and relevant literature reviews. Section 3 outlines the research methodology, while Section 4 presents the SLR results and ensuing discussions. Lastly, Section 5 concludes the study by discussing the implications of the findings and potential future research directions.

2.0 BACKGROUND OF STUDY

2.1 UX definition

ISO 9241-210 [3] defines User Experience (UX) as the way individuals perceive and interact with a product, system, or service, with a strong focus on the relationship between UX and usability [11]. In Human-Computer Interaction (HCI), UX goes beyond mere usability, recognizing its role in complex, context-influenced interactions [11]. UX is dynamic, context-dependent, and time-sensitive, shaped by the benefits it offers users [11] and the impact of technology on emotions and psychology. This understanding enables designers to craft systems that cater to cognitive and emotional needs, ultimately enhancing satisfaction and engagement

[5]. In one of the most cited UX papers, Hassenzahl & Tractinsky [5] define UX as a result of a user's internal state (expectations, motivations, mood), the characteristics of the system (complexity, usability, functionality), and the context in which the interaction occurs (organizational/social setting, meaningfulness of the activity, voluntariness of use).

When focusing on UX evaluation, the primary goal is to assess how effectively a product or service aligns with user needs. Furthermore, it aims to comprehend various aspects of technology usage beyond traditional usability, encompassing factors like aesthetics, hedonics, emotions, and overall experience [5]. Through UX evaluation, developers can pinpoint areas where their products may fall short and make future enhancements [12] to better cater to user requirements [13]. Ultimately, the objective is to create products and services that are functional, usable, and highly desirable [13], appealing, and captivating to the individuals who utilize them [5].

2.2 Mobile Educational Games

Mobile educational games (MEGs) involve mobile devices, such as smartphones or tablets, to deliver educational content through gaming experiences. This approach integrates active and context-based learning with enjoyment and engagement, enabling students to learn in real-world settings outside of formal education [14]. It encompasses the educational game concept by blending games' entertaining and engaging aspects with educational and problem-solving objectives to motivate, engage, and educate players interactively and immersively [15]. Engagement in MEG is closely tied to user immersion, significantly influencing game outcomes [16], [17]. Research has also demonstrated that the flow experienced in games positively impacts performance enhancement, learning, engagement [18], and the reflective learning process [19].

According to [17], [20], there are three fundamental principles for enhancing children's learning through mobile apps: active participation, engagement, and creating a meaningful context. Mobile learning facilitates the establishment of a meaningful context by supporting situated learning and offering an environment suited to the subject matter, as emphasized by [21] and [17]. Understanding the learning context is critical in mobile learning, as it differs from traditional or online learning methods. [22] noted that mobile learning has revolutionized education by providing an informal learning environment.

In past studies, Mobile educational games (MEG) have been researched and developed, covering considerable fields of knowledge in multiple levels of education. The MEGs were evaluated mostly by adopting usability testing, heuristics, and user experience evaluation. Among the various evaluation models/frameworks found, playability heuristics [23] are the most adopted by MEG researchers, followed by user experience questionnaire (UEQ) [24] and MEEGA+ [25] as showed in Table 1. Further discussion on applying the frameworks/models is explained in the next section.

Table 1. The list of evaluation frameworks/models adopted in past studies.

Evaluation Frameworks/Models	Studies involved
Playability heuristics	[26]–[29]
MEEGA+	[25], [30]
UEQ	[31]

3.0 METHODOLOGY

This research employed a critical review approach. According to Petticrew and Roberts (2008:19), a critical review involves a meticulous assessment of literature based on the argument, logic, and epistemological tradition related to the subject under review. Carliner (2011) defines it as a comprehensive method enabling reviewers to thoroughly examine, critique, and synthesize representative literature within the reviewed area. The outcomes yield novel conceptualizations or perspectives on the research problem. In this case, the study focused on revealing the user experience model in mobile educational games evaluation, employing a semi-systematic approach. The targeted literature encompassed the existing models and frameworks used to evaluate the user experience for mobile educational games. The emphasis was on English-language publications, with Mendeley facilitating bibliographical management, article storage, and referencing throughout the writing process.

3.1 Literature Search and Selection

The initial step involved querying the Google Scholar database to identify pertinent studies. This choice was informed by recommendations from literature review scholars who lauded its extensiveness, comprehensiveness, and open-access nature [32]–[34]. Specifically, [34] characterize the database as a potent open-access repository housing journal articles and 'grey literature,' including conference proceedings, theses, and reports. Consequently, the researchers emphasized the need to refine the sample, aligning it with the research question and study objectives to maintain both breadth and depth while rationalizing the selected scope. The initial literature scoping employed search terms "user experience evaluation," "mobile educational games," and "mobile serious games."

3.2 Literature Inclusion and Exclusion Criteria

This research explores the models and frameworks for evaluating mobile educational games. Therefore, the inclusion and exclusion criteria of the articles reviewed are as in Table 2.

Table 2. Inclusion and exclusion criteria of the articles

Inclusion criteria	Exclusion criteria
English text only	Non-English text.
Discuss educational or serious games on mobile platform only.	Does not discuss educational or serious games on mobile platforms.
Evaluating the user experience and heuristics of the game.	Does not evaluate the user experience and heuristics of the game.
Mention the model's name and discussed the component of the model.	Does not mention the model's name and discussed the component of the model.

After screening the titles, 23 articles have gone through the abstract reading process. Finally, only three articles were chosen to be reviewed based on the inclusion and exclusion criteria.

3.3 Extraction and analysis

The first stage of this critical review involves a thorough data extraction process. Employing a systematic approach, relevant information is extracted from selected studies, encompassing crucial details such as UX model/framework name, components, methodologies, and key findings.

Subsequently, the extracted data undergoes a careful quality assessment in the second step. This entails a thorough evaluation of each study's methodological rigor and reliability. Criteria such as study design, sampling techniques, and potential biases are scrutinized. The aim is to detect the strengths and weaknesses of each study, laying the foundation for a nuanced understanding of the reliability and validity of the collective body of literature.

The third step involves the synthesis of findings, where the extracted data is organized according to the model and components used. Commonalities and contradictions are identified, offering a holistic perspective on the existing UX model landscape. Through this thorough process, the critical reviewer attempts to determine the broader implications and contributions of the UX models and components in MEG evaluation.

4.0 THE REVIEW

4.1 Playability Heuristics

Playability heuristics are guidelines or principles used to evaluate the playability of a mobile game proposed by [23]. These heuristics help evaluators identify problems related to game controls, interface, mobility, and gameplay mechanics. The heuristics are divided into three modules: Game Usability, Mobility, and Gameplay. The Game Usability module covers the game controls and interface through which the player interacts with the game. The Mobility module concerns issues that make the game mobile. The Gameplay module deals with issues that arise when the player interacts with the game mechanics and story. The heuristics help evaluators focus on specific aspects of the game and identify potential problems that may affect the overall user experience. By using playability heuristics, game designers can improve the quality of their games and provide a better user experience for players.

Mobility heuristics address the unique characteristics of mobile devices by focusing on issues that affect the game's mobility. Since mobile devices do not dictate where and when games are played, the game design should assimilate this freedom into the game experience. Mobility is defined by how easily the game allows a player to enter the game world and how it behaves in diverse and unexpected environments. The mobility heuristics concern issues such as how quickly the game and play sessions can be started, how well the game accommodates the surroundings, and how interruptions are handled reasonably. By addressing these issues, evaluators can identify problems related to the game's mobility and improve the overall user experience.

Table 1 shows four studies that adopted playability heuristics in their MEG evaluation. [26] proposes and evaluates the effectiveness of a MEG, Diabetic Mario Bros, in enhancing children's knowledge of healthy diet and lifestyle. This study adopted playability heuristics with an additional component: educability. The heuristics used in the game evaluation are Usability, Educability, Mobility, and Playability. The usability analysis found that most participants felt the navigation was consistent and straightforward. The Educability analysis showed that the game effectively increased participants' knowledge and confidence in making healthy choices and starting regular exercise. Regarding Mobility, the game was easy to start and play, adapting well to different situations and environments. The Playability analysis revealed that the game was engaging and motivating, likely to keep players returning. These analyses showed that the game effectively improved children's understanding of a healthy diet and lifestyle, and the heuristics have sufficiently evaluated the game.

The MEG developed in [27] study is called "Herbopolis" and is designed to improve knowledge of herbal medicines among its players. In the game, players are tasked to manage a city specializing in producing and selling herbal products. A pilot usability study was conducted for the game prototype, and data was gathered through user registration, background data collection, and a post-game survey containing a quiz on herbs encountered in the game. The pilot usability study of Herbopolis used a set of 17 true/false evaluations by adopting the heuristics questions from [23], spanning four components (usability, educability, mobility, and playability) to evaluate the game. The game was generally positively evaluated for usability, playability, and educability. The study evaluated the Herbopolis game using heuristics and found that it received positive evaluations for usability, playability, and educability, with room for improvement to make it more entertaining.

The study by [27] develops and aims to evaluate the effectiveness of a mobile game called Unus Terra in promoting social distancing during the COVID-19 pandemic. The study evaluates the game using playability heuristics and found that the evaluation approach provide a cheap, fast, and straightforward way to discover MEG's potential usability and gameplay issues. The method is well suited for smaller development teams using an iterative approach. The authors also found that using severity ratings is an effective way to score issues and that allowing expert evaluators to produce more details of issues and possible solutions for them should be encouraged. However, the study also highlighted that the sample size was too

small to generalize, and the findings require further study and should only be considered as indications.

The last study that implements playability heuristics is by [29]. The study developed a MEG named "1M'sia" and was produced based on the needs of Malaysian local content, where the 1Malaysia concept was adopted as it is the current national agenda. The MEG was developed using the mobile game-based learning (mGBL) model. The model consists of three phases: pre-production, production, and post-production phase, and each phase has specific components, activities, and deliverables necessary for developing an effective mGBL application. For the evaluation, playability heuristics evaluation strategy was adopted to evaluate the playability of the mGBL application. The strategy is intended to evaluate mGBL concerning game usability, game mobility, gameplay, and learning content. The learning content component is proposed to cope with the educational part of the game evaluation. The findings indicate that the proposed mGBL model exhibits useful development indicators for mGBL application and is a theoretical and practical contribution to the study.

Based on the reviews, adopting playability heuristics for evaluating mobile educational games (MEGs) offers several advantages, including cost-effectiveness, suitability for iterative development, the effectiveness of severity ratings in issue prioritization, and the enhancement of evaluations through expert insights. However, limitations include small sample sizes affecting generalizability, the need for further comprehensive studies to validate findings, and potential challenges in fully assessing the balance between education and entertainment aspects in MEGs. This suggests a need for supplementary evaluation methods for a holistic assessment.

4.2 MEEGA+

The MEEGA+ model [25] is an advanced version of the MEEGA model [35]. It was proposed based on the literature review and the systematic analysis of the initial version. MEEGA is a model specifically developed for the evaluation of educational games. The initial version of MEEGA was developed by systematically decomposing quality factors using the GQM (Goal/Question/Metric) approach and refining them into dimensions from which the questionnaire items are derived. The model provides a questionnaire for collecting data on the students' reactions after playing an educational game. The MEEGA+ model includes a theoretical model as well as the development of the measurement instrument. The MEEGA+ model is designed to evaluate the perceived quality of educational games in terms of player experience and perceived learning. This model gauges eight key components of user experience: attention, enjoyment, challenge, social interaction, confidence, relevance, satisfaction, and usability. These components are evaluated through in-game analysis, and the results from player ratings strongly align with in-game measurements, thereby confirming the effectiveness of MEEGA+ for evaluating the quality of mobile educational games (MEG) [25].

In the review, there are two studies that adopted MEEGA+ in their MEG evaluation. The first study is conducted by [36], where they developed a MEG aimed to raise awareness of diabetes among children. The game is called "Diabetes

Adventure," a role-playing game that allows children to learn about diabetes and its management in a fun and engaging way. The game features a character named "Dia," a diabetic child who needs help managing his diabetes. The player takes on the role of Dia's friend and helps him manage his diabetes by making healthy food choices, monitoring his blood sugar levels, and engaging in physical activity. The MEG also includes mini-games and quizzes that reinforce the learning objectives and provide feedback to the player.

The game was evaluated using the MEEGA+ evaluation instrument. The evaluation involved children ages 8 and 12 who played the game and provided feedback on its usability, engagement, and educational value. The evaluation also involved experts in the field of game design and diabetes education who provided feedback on the game's technical design and educational content. The evaluation results showed that the game was effective in raising awareness of diabetes among children and improving their knowledge of diabetes management. The game was also engaging, enjoyable for children, and easy to use and navigate. The feedback from the experts was used to improve the technical design and educational content of the game, and the evaluation instrument was also improved based on the evaluation results.

The study examines the advantages and disadvantages of employing the MEEGA+ evaluation instrument for assessing serious games. Some benefits of MEEGA+ include its comprehensive evaluation of usability, user experience, and learning outcomes, its standardized framework for comparing serious games, and its user-centric focus. However, drawbacks include limited scope, reliance on questionnaires, and potential inflexibility in accommodating diverse game features. Consequently, the study recommends that MEEGA+ be used alongside other evaluation methods to offer a more holistic assessment of the user experience and learning outcomes in serious games.

Another study that adopted MEEGA+ is by [30]. The MEG developed in this study is called "Unlock Me," a game designed to stimulate COVID-19 awareness. The game is designed to educate users about certain COVID-19 norms and information in a fun and interactive way. The game features various levels that the user must complete by solving puzzles and answering questions related to COVID-19. The game also includes a tutorial that is crucial in creating the user's desire to play and helps less experienced players master the game. The game was evaluated using a two-fold evaluation method, where it was evaluated as a learning tool and as a user-centered interface. The evaluation was carried out by adopting the MEEGA+, a questionnaire-based evaluation model that measures the game's effectiveness in enhancing COVID-19 learning and evaluating the game's quality. The MEEGA+ model calculates various metrics, including the Average Score Difference (ASD) calculated from in-game analysis. The evaluation was conducted across multiple age groups and has shown that Unlock Me effectively enhanced COVID-19 learning and was well-received by users across all age groups.

In this study, the MEEGA+ model evaluates the effectiveness of a game in enhancing learning and evaluating the game's quality. The model uses a post-game questionnaire to assess the game's impact on the players. The questionnaire consists of several components: player engagement, player motivation, player satisfaction, player learning, and player usability. The MEEGA+ model also includes in-game

analysis to measure the game's effectiveness in enhancing learning. The in-game analysis measures various metrics, including learnability, which is how easy the game is for the players to learn, and the percentage of players who cleared the initial level in the first attempt. Other metrics measured by the in-game analysis include player performance, behavior, and experience.

Evaluating the "Unlock Me" game using the MEEGA+ model presents advantages and disadvantages. On the positive side, MEEGA+ is a well-established model for assessing game effectiveness and quality, offering a comprehensive evaluation covering player engagement, motivation, satisfaction, learning, and usability, including in-game analysis for objective assessment. It is also user-friendly and suitable for various age groups. However, drawbacks include its subjectivity due to reliance on self-reported player responses, its limited coverage of game design and technical aspects, potentially inadequate for specific-purpose games like educational ones, and it may not capture specific learning outcomes. Thus, while MEEGA+ offers valuable insights, it should be complemented by other evaluation methods for a more well-rounded assessment of the "Unlock Me" game.

4.3 Use Experience Questionnaire (UEQ)

The User Experience Questionnaire (UEQ) developed by [37] is a tool used to measure the user experience of interactive products. It considers pragmatic and hedonic quality aspects and allows for fast and immediate user experience measurement. The UEQ is used in evaluation scenarios to collect quantitative data on user experience, which can then be analyzed to determine areas of improvement for the product. Regardless, there are some cases where a full UEQ is considered too time-consuming. Therefore, a shorter version of UEQ [38] was designed to capture a user's opinion towards a product's user experience in a more efficient manner. The short version, named UEQ-S, consists of only eight of the 26 items of the UEQ and is intended for specific scenarios that do not allow employing a full UEQ.

This review found out two studies that adopted UEQ in their MEG evaluation. [31] developed the MFolktales MEG prototype for children aged 5 to 7 years old. It is an Android-based MEG that contains an animation story module followed by four game modules. The MEG aims to promote Malay folktales to the new generation to preserve them for future generations. The game modules are intended to test and strengthen the comprehension skills among users through the message delivered in the animated story.

The User Experience Questionnaire (UEQ) was adopted in the study to evaluate the user experience of the MFolktales MEG. The questionnaire was translated from English to Bahasa Malaysia by an expert translator and used a semantic differential method with a scale from 1 to 7. The UEQ contains six elements, namely attractiveness, efficiency, perspicuity, dependability, stimulation, and novelty, with 18 items in total. The questionnaire measured the user's perception of the MEG regarding these elements. The order of the positive and negative terms for each item was randomized in the questionnaire, and half of the items started with the positive term and half with the negative term. The UEQ was used to evaluate the children's

experience of the MFolktales application concerning its overall impression, usability, and benchmark quality level relative to other products.

The evaluation was conducted on 15 kindergarten students from KEMAS, assisted by their teacher. The evaluation results showed that the MFolktales MEG received positive impressions from the children regarding attractiveness, efficiency, perspicuity, dependability, stimulation, and novelty. The MEG scored an excellent quality level in the attractiveness and efficiency categories. The perspicuity, dependability, and novelty categories scored a good quality level. Overall, the evaluation results suggest that the MFolktales application effectively promotes Malay folk stories and promotes good reading habits among children.

Based on the review in [31], there is potential limitation of using UEQ in the evaluation, that it relies on self-reported data, which may be subject to bias and may only sometimes reflect the actual user experience. Additionally, the questionnaire may not capture all aspects of the user experience, such as emotional and affective responses. Another limitation is that the questionnaire may only be suitable for some applications or users, as it was originally designed for desktop applications and may not be appropriate for mobile applications or users with different cultural backgrounds or language proficiency. Finally, the questionnaire may not provide detailed information on specific usability issues or design problems that must be addressed in the application.

5.0 DISCUSSION

In this review, we have explored various aspects of user experience (UX) evaluation, particularly in the context of mobile educational games. UX evaluation critically assesses the alignment between MEG and user needs, extending beyond traditional usability to encompass aesthetics, emotions, and overall experience. Moreover, in mobile learning and educational games, principles such as active participation, engagement, and creating a meaningful context have emerged as fundamental for enhancing children's learning experiences.

Several evaluation models and frameworks have been employed to assess the quality and effectiveness of mobile educational games (MEGs). Among these, playability heuristics, as proposed by Korhonen and Koivisto [23], have been widely adopted, providing valuable guidelines for evaluating game controls, interface, mobility, and gameplay mechanics. However, it is important to acknowledge the limitations, such as the potential for small sample sizes affecting generalizability and the need for supplementary evaluation methods to fully capture the balance between educational and entertainment aspects in MEGs.

Additionally, the MEEGA+ model, an advanced version of MEEGA, has been introduced as a comprehensive tool for assessing the perceived quality of educational games, focusing on user experience and perceived learning. It encompasses eight key user experience components, with in-game analysis providing objective insights. While MEEGA+ offers numerous advantages, it is essential to consider potential limitations, including its scope and reliance on self-reported data, and to complement it with other evaluation methods for a more holistic assessment.

The User Experience Questionnaire (UEQ) and its shorter version, UEQ-S, have been discussed as tools to measure user experience in interactive products. While these questionnaires provide valuable quantitative data on user experience, they also come with limitations related to self-reported data, cultural and applicability considerations, and the potential for capturing only some aspects of the user experience.

In conclusion, the field of UX evaluation is evolving, with a range of models and frameworks available for assessing user experiences in various contexts. However, it is important for researchers and practitioners to consider the strengths and weaknesses of these tools carefully and to employ a combination of methods to obtain a more comprehensive understanding of user experiences in different settings. Additionally, as technology and user expectations evolve, UX evaluation methods must adapt and expand to provide more accurate and meaningful insights into user experiences.

Another limitation of the three evaluation models could be highlighted when referring to the definition of UX in the MEG context in the previous section. If the playability heuristics, MEEGA+, and UEQ are mapped with the needs of MEG, immersive and game flow components should be included in UX evaluation. Additionally, UX relates to the personal interaction and satisfaction users experience while using mobile devices), which have distinct physical attributes compared to traditional computers, as pointed out by [39] and [40]. Consequently, traditional UX models like SUS and EQ may not fully address the unique mobile related UX elements required for evaluating Mobile Educational Games (MEG).

Moreover, the influence of mobile devices and MEG on various aspects of learning, such as behaviors, skills, problem-solving, and critical thinking, has been emphasized by [41]. Therefore, the absence of a mobility component in the MEEGA+ and UEQ and educability or learning component in playability heuristics underscores the need for further research to propose a comprehensive UX model tailored to assess MEG. To better understand the scope of the evaluation components found in the reviewed articles, a summary of all components proposed and used in each of the models are listed in Table 3. The table shows that 16 components found in the literature have been utilized to evaluate MEG. None of the components are applied in many models except the usability component. This component exists in playability heuristic and MEEGA+ models.

Table 3. Summary of UX components according to the model and frameworks

UX Model or Frameworks	Mobility	Gameplay	Usability	Attention	Enjoyment	Challenge	Interaction	Confidence	Relevance	Satisfaction	Attractivenes	Efficiency	Perspicuity	Dependability	Stimulation	Novelty
Playability heuristics	/	/	/													
MEEGA+			/	/	/	/	/	/	/	/						
UEQ											/	/	/	/	/	/

6.0 CONCLUSION

This review investigated the area of UX evaluation model/framework for mobile educational games (MEG). Throughout this review, we encountered several evaluation models and frameworks tailored to evaluate the quality and efficacy of UX in MEG. Adopting playability heuristics emerged as a prominent practice. These heuristics offer valuable guidance for assessing critical components of MEG, including gameplay, usability, and mobility. However, the review noticed some limitations of the heuristics, such as potential issues related to small sample sizes and the need for supplementary evaluation methods to comprehensively address the intricate balance between educational and entertainment aspects in MEG. Another model reviewed is MEEGA+ model, an advanced version of MEEGA designed to evaluate the perceived quality of educational games holistically. MEEGA+ focuses on user experience and perceived learning, encompassing eight essential components. Despite its numerous merits, including in-game analysis for objective insights, the self-reported data may cause bias in the evaluation. Other than that, MEEGA+ is also reported to need to improve in evaluating the mobile context of MEG. Furthermore, the User Experience Questionnaire (UEQ) and its shortened version, UEQ-S, were found as instruments to quantify user experiences within MEG. These questionnaires yield valuable quantitative data. However, there are still potential gaps in capturing the entirety of user experiences, such as no components in UEQ examine the educability and mobility of the MEG. Lastly, the review also recognized that existing evaluation models may need to be revised to fully address the MEG context's unique demands concerning immersive and game flow components. The distinctive characteristics of mobile devices and their influence on UX further emphasized the need for specialized evaluation models. Therefore, a comprehensive UX model explicitly designed to assess MEG must be explored, bridging the gap between the dynamic world of mobile education and user experience evaluation practices.

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