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PAPER

Engaging Teens in History through a Mobile Game Utilizing the Fisher-Yates Shuffle Algorithm and Honeycomb UX Design

Dadan Zaliluddin[1], Ade Bastian[1](✉), Mira Siti Samira Yuliani[1], Esa Firmansyah[2], Sarmidi[3], Yusuf Sumaryana[4]

[1]Universitas Majalengka, Majalengka, Indonesia

[2]Universitas Sebelas April, Sumedang, Indonesia

[3]Universitas Muhammadiyah Tasikmalaya, Tasikmalaya, Indonesia

[4]Universitas Perjuangan Tasikmalaya, Tasikmalaya, Indonesia

adebastian@unma.ac.id

ABSTRACT

This study uses the Fisher-Yates shuffle (FYS) algorithm and the Honeycomb UX method to create a smartphone game to engage teens in history learning. Gaming technology has improved rapidly, creating more compelling educational techniques. Educational games are designed to boost students' computation and cognition. Few studies have merged FYS and Honeycomb in mobile history instructional games. This study uses an innovative technique to instruct young people about history. Smartphones are developed and evaluated using the FYS for randomization and the Honeycomb UX for user experience. Few studies have integrated these two aspects into mobile educational and historical games. According to a survey, this game improves teen historical knowledge and interest. Honeycomb UX testing yielded an average score of 3.75, suggesting user approval. In conclusion, algorithms and UX in educational games can increase local history knowledge.

KEYWORDS

game, Fisher-Yates shuffle (FYS) algorithm, Honeycomb UX, historical education game, smartphone

1 INTRODUCTION

The usage of digital media in both official and informal education has increased, and as a result, learning analytics has become an essential component of academic instruction. In non-traditional forms of educational media, such as serious games, the integration of requirements for the study of analytics has not yet achieved the degree of development that is needed to make use of their full potential [1]. Digital games possess the capacity to enhance student engagement and foster strong motivation for learning, hence facilitating constructive and socially interactive educational experiences [2]. Technology has made video games more diverse, high-quality,

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and social. Educational games that increase students' computational and cognitive skills are gaining popularity. Engaging pupils, especially unmotivated ones, is difficult. Game-based learning can motivate students to learn theoretical content, but it requires good design and student approval. Educational games for computational and cognitive skills are becoming more popular. Educational computer games can improve students' conceptual and computational thinking. Students studying computational thinking with adaptive instructional computer games showed increased attention, contentment, flow state, and technology adoption [3]. Through technology, video games have reached unparalleled levels of diversity, quality, performance, and societal penetration. Education, technology, and others have focused on integrating education with cross-border play. Education games may make learning more interesting and give pupils practical experience, improving their skills. Educational games improve scientific rigor, fun, and learning [4]. Successful educational interventions require learner involvement, which can be difficult without motivation. The game has been shown to motivate people to study theoretical topics [5]. Game-based learning and gamification boost skills effectively. Video games in education are explored from different angles, including their forms and criteria, evaluation methods, and student effects [6]. Teachers realize that playing games boosts children's engagement and learning through meaningful experiences. Innovative methods to inspire and engage pupils feed the teacher's passion [7]. Games are an effective and entertaining teaching method. Students are motivated and enjoy a non-threatening environment [8]. Educational computer games can be successful and engaging for advanced computer science students of any gender [9]. Digital educational games are becoming more important [10]. Mobile game-based learning has garnered scientific interest for its ability to make learning more fun and engaging for students. This strategy boosts learning, motivation, and student engagement [11]. For instance, cyberattacks are becoming more frequent and complicated, forcing companies to modify their management strategies. To mitigate risks, the company trains employees on cyber threats and defenses. Computer-based security training has been improved by serious games, which allow players to learn and apply cybersecurity topics through play [12]. Next, sustaining culture—a tradition passed down from ancestors—must be taught to children early on. Indonesian culture is poorly understood by many students. By adapting to the student's learning style, adaptable educational games promote cultural familiarity and make learning more fun. Using adaptive educational games to teach Indonesian culture improves students' knowledge and learning outcomes [13]. Digital games improve learning outcomes and are a good educational method [14].

Conventional learning approaches are frequently perceived as tedious and lacking in interactivity, resulting in a waning of students' engagement in the educational process. The apathy of students towards local history in traditional educational settings might adversely affect the conservation of cultural assets and the preservation of local identity for future generations. Students lacking comprehension of local history jeopardize the preservation of cultural assets by undermining their own cultural identity and sense of belonging. This smartphone game has the dual purpose of providing entertainment and educating children about local history. A mobile game has been created and tested to involve teenagers in learning history. The game uses the Fisher-Yates shuffle (FYS) algorithm and the Honeycomb UX framework. This technique enhances the allure and thoroughness of studying local history. The primary challenge encountered is the dearth of student engagement in traditional and repetitive history instructional approaches. The absence of interactivity and gamification in the learning process is a challenge for pupils to effectively engage and internalize the historical principles being taught. Furthermore, given the swift advancement of technology, there is a pressing necessity to include technology in education in order to establish learning approaches that are both captivating and pertinent to the contemporary digital world.

Within this particular situation, this study assumes great significance as it presents a groundbreaking resolution by amalgamating the ideas of FYS and UX Honeycomb to fabricate a more dynamic and pleasurable learning encounter. By using this approach, there is an expectation that it will enhance students' enthusiasm and engagement in studying local history while also bolstering their cultural consciousness and sense of self. This study fills a gap in the academic literature by examining the usage of algorithms and UX frameworks in mobile instructional games. This project aims to develop a more efficient and enduring technique for learning history that is applicable not only to local students but also has the potential to be used worldwide, thereby enhancing history education.

2 LITERATURE REVIEW

2.1 Fisher-Yates shuffle

Modern gaming is a global passion. Starting with toddlers and teens. Educational games can incorporate the latest technological advances, making them suitable for teaching regional culture. This quiz randomly orders questions and responses using the FYS [15]. Games effectively encourage socialization and prevention [16]. Conventional instructional methods remain unstimulating. FYS randomization is needed in an instructional game. The game should be easy to play anywhere and anytime [17]. Learning enthusiasts find interactive educational games on mobile devices new and intriguing. Randomizing questions with the FYS algorithm ensure uniqueness and avoids recurrence [18]. To randomize the quiz, the FYS algorithm was added. Quis features can be FYS. This is feasible [19]. Multiple-choice randomization uses the FYS method [20]. Testing determines a person's subject knowledge. Randomizing question categories utilized the FYS method. A CBT uses the FYS method to randomize question order [21]. Cheating, assessment errors, and data management issues are addressed in the proposed method. A computer test that uses the FYS algorithm to randomize question order is the solution. This method reduces exam dishonesty. Exam cheating is reduced by using the FYS algorithm to generate a unique series of questions for each student [22]. Randomizing tests with the FYS approach reduce test implementation fraud [23]. Exam papers for educational evaluation are crucial in academics. FYS algorithm (Knuth shuffle or Durstenfeld shuffle) is used to randomize the question bank [24]. The following Figure 1 illustrates the sequential steps involved in the implementation of the FYS algorithm.

Figure 4 shows the FYS algorithm's randomization steps: (a) Document inquiries from questions 1 to on. (b) Randomly select k questions from 1 to the remaining uneliminated questions. (c) Based on the information provided, eliminate the remaining question and shift it to a new spot. (d) Repeat steps 2 and 3 until all questions are eliminated. (e) The step 3 question sequence is a random permutation of the original question [25].

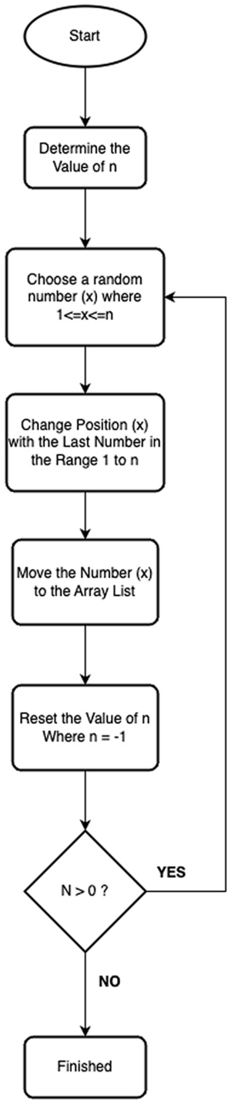

Fig. 1. Stages of the Fisher-Yates shuffle algorithm

2.2 Honeycomb UX

UX has gained significant importance. Development of systems, products, and services is its main use. Industries—services, products, procedures, society, and culture—use user experience. Negative findings may immediately affect linked systems, products, or services. Verifying user experience early in development helps avert project failure or rebuilding [26]. UX can be measured using the user interaction satisfaction questionnaire (QUIS), system usability scale (SUS), software usability measurement inventory (SUMI), user experience questionnaire (UEQ), and honeycomb method [27]. Honeycomb UX organizes seven indicators into three variables to explain user experience design. This includes thinking (being useful, valuable, and believable), feeling (being desirable and credible), and using (being findable, accessible, and usable) [28]. User experience is measured by Honeycomb UX. Usefulness, desirability, accessibility (particularly for disabled users), credibility, findability, usability, and value are crucial to a good user experience. (Priska Suseta) [29]. A UX Honeycomb model can be seen in Figure 2 below:

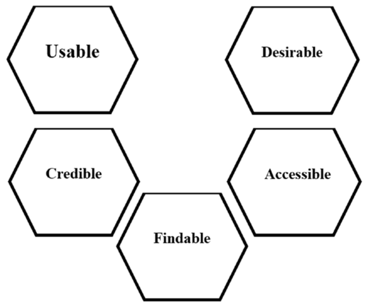

Fig. 2. Honeycomb UX model

3 METHODS

The progression of this study is depicted in Figure 3.

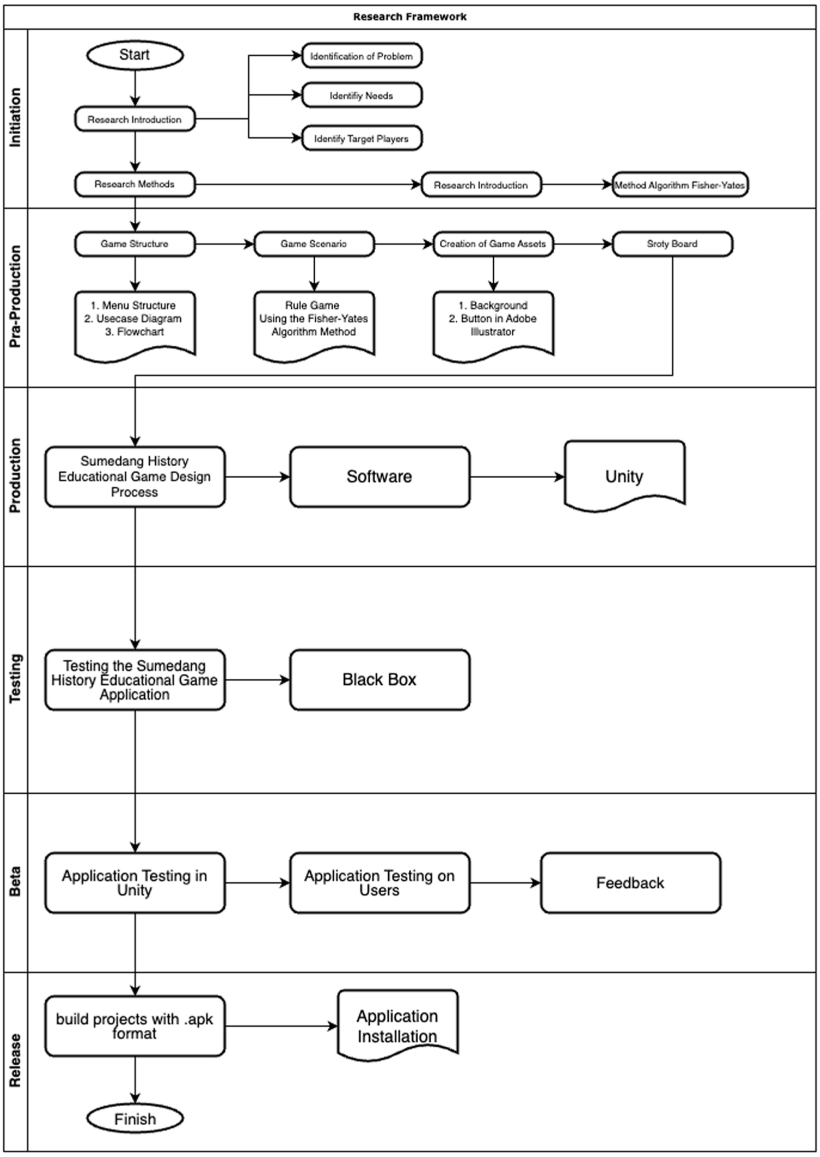

Fig. 3. Research stage

The study commences with an early phase that involves determining the problem that will be addressed by developing an instructional game. During this stage, the essential prerequisites are established, and the specific persons or users who will utilize the game are also identified. Subsequently, a preliminary inquiry was undertaken to identify specific goals and obtain a thorough understanding of the study. The study approach was established, and the FYS algorithm was selected to randomize the sequence of game content.

During the pre-production phase, several crucial tasks are undertaken, including the formulation of the game's framework. This entails designing menu structures, constructing use case diagrams, and developing flowcharts to provide a coherent roadmap for the growth of the game. Furthermore, the FYS algorithm is utilized to generate game scenarios, ensuring the establishment of game rules and promoting a wide range of options for user engagement. Game materials are produced by designing visual elements such as backdrops and buttons using Adobe Illustrator. Subsequently, a storyboard is generated to delineate the comprehensive storyline and visual arrangement of the game. The design procedure for the Sumedang historical teaching game was executed during the production phase. The development software is utilized in tandem with Unity as the principal platform for game production. During this stage, all the meticulously designed and produced elements from the pre-production phase are combined to create the first version of the game.

The testing phase entails assessing past educational game applications utilizing the black box approach. The objective of this testing is to validate the functioning of the game without inspecting the source code, verifying that all features function as intended and that there are no apparent errors or problems. Following the preliminary testing, the beta step entails evaluating the application in Unity to verify the game's stability and performance. Subsequently, the application undergoes testing with actual users in order to obtain input regarding their experience during gameplay. This feedback is really valuable for implementing enhancements and fine-tuning before the ultimate release.

In the closing phase, the game project is finalized and the game is built into a.apk file, which can be effortlessly installed on Android devices. The constructed application is installed on the user's device for the purposes of testing and first release. Subsequently, the research cycle might be initiated anew in order to incorporate enhancements and alterations derived from customer feedback.

We employed both quantitative and qualitative methodologies, in conjunction with the UX Honeycomb framework, to analyze the data and evaluate the user experience.

1. Quantitative analysis: Quantitative data is obtained by administering questionnaires to users following their engagement with the game. This questionnaire is specifically created to assess the levels of engagement, satisfaction of users, and effectiveness of learning. The acquired data was examined utilizing descriptive and inferential statistics to ascertain the game's effectiveness in attaining the anticipated educational objectives.
2. Qualitative analysis: In-depth interviews and focus group discussions were conducted to gather qualitative data from users. Thematic analysis is employed to discern prevalent patterns and topics within user replies. This data offers a profound understanding of the user experience and identifies areas of the game that require enhancement.
3. Black box testing is a type of testing that specifically examines the functionality and performance of an application without analyzing the source code. Every feature undergoes rigorous testing to guarantee the absence of mistakes or problems that could impact the user experience.

4. Beta testing: Beta testing is performed with a larger pool of users to uncover any faults that may have gone unnoticed during the original testing phase. The feedback provided by beta users is utilized to implement final enhancements before the actual launch.
5. Conducting user experience assessment using the UX Honeycomb framework: The UX Honeycomb framework is employed to assess six fundamental facets of user experience:
   a) Relevance: The extent to which the game aligns with the specific educational goals related to local history.
   b) Usability refers to the level of ease with which consumers may interact with the game.
   c) Desirability refers to the level of attractiveness that the game holds for users.
   d) Findability: The level of convenience in locating pertinent information within the game.
   e) Accessibility: The extent to which the game may be used by all individuals, regardless of any special needs they may have.
   f) Credible refers to the degree of confidence users have in the accuracy and reliability of the information offered in the game.

Each of these factors is assessed using specialized questionnaires and interviews to obtain a full understanding of the user experience and identify areas that require enhancement.

This study aims to develop an engaging and informative historical educational game for teenagers using a thorough approach. Additionally, it aims to make a substantial contribution to academic literature in the field of technology-based education.

4 RESULTS

The manual computation technique for randomizing the FYS algorithm for five questions is presented in the following paragraphs. The outcome of the array n = {1, 2, 3, 4, 5} is as follows:

a) To determine the value of n, we can use the formula n = {1, 2, 3, 4, 5}.
b) Make a selection of a random number (x), where 1 is equal to x and n is equal to n. Let us assume that x is 4.
c) Alter the location (x) by using the most recent number in the range of 1 to on. Consequently, the expression {1, 2, 3, 4, 5} is transformed into {1, 2, 3, 5, 4}.
d) The number x should be moved to the array list. Assume that t equals \4}.
e) Rearrange the value of n, where n is equal to n minus one. Now that n minus one has been processed, only the strings {1, 2, 3, 5} have been processed. If the criterion n > 0 is still met, then proceed with the process of generating a random integer (x) where 1 is less than or equal to n (the next process).
f) Since n is now equal to n minus 1, 5 minus 1 equal 4,
   Let's use x as an example. From the set {1, 2, 3, 5}, we can deduce that it
   is {1, 5, 3}. Consequently, t equals {2, 4}, and n is now equal to n minus 1,
   4 minus 1, which is 3.
   For example, the value of x is 1.
   Consequently, the expression {1, 5, 3} is transformed into {3, 5}.
   At this point, the value of n is equal to n minus 1, three minus one, which
   equals two.

As an illustration, x is equal to three.
Consequently, the value of {5} is derived from {3, 5}.
When t is equal to 3, 1, 2, 4, the value of n is now equal to n minus 1, 2 minus 1, which equals 1.
Since t is equal to {5, 3, 1, 2, 4},

g) If the value of n is equal to zero, then the randomization process is finished.

The next stage involves determining the characteristics of the five questions that will be used as examples, the first process that is carried out is the entry of the question characteristics into the scratch (a list of questions that have not been chosen), followed by the creation of a range (a total of numbers that have not been chosen), followed by a roll randomization process (numbers are chosen at random from the range), and finally, the results of the questions that have been chosen are entered into the result (the results of all questions that have been randomized from scratch).

An illustration of the outcomes of the FYS algorithm randomization calculation procedure for five questions is presented in Table 1. The results of this calculation process are presented in Table 1.

Table 1. FYS randomization calculation results

Range	Roll	Scratch	Result
		1, 2, 3, 4, 5	
1–5	4	1, 2, 3, 5	4
1–4	2	1, 5, 3	2, 4
1–3	1	3, 5	1, 2, 4
1–2	3	5	3, 1, 2, 4
Randomization Results			5, 3, 1, 2, 4

Table 2 shows Honeycomb UX-adjusted question items for user experience assessment.

Table 2. Honeycomb UX instruments

Range	ID	Question Items
Useful	UXH-001	Is the History Game program capable of resolving user issues?
	UXH-002	Is the History Game suitable for the user's requirements?
Usable	UXH-003	Does the History Game offer user-friendly functionality?
Desirable	UXH-004	Are History Games enjoyable to utilize?
	UXH-005	Does the juxtaposition of colors and typography on the History Game UI evoke a sense of appropriateness?
Findable	UXH-006	Do the interactions in the History Game present a level of complexity that is difficult to navigate?
	UXH-007	Is the button placement and navigation in the History Game satisfactory?
	UXH-008	Do History Games exhibit favorable response times?
Accessible	UXH-009	Is the design of the History Game satisfactory and does it possess additional functionalities?
Credible	UXH-010	Can History Games instill confidence in the safeguarding of personal data?
Valuable	UXH-011	Could History Games provide you with any benefits?

To obtain a quantitative measure from respondents' questionnaire responses, a Likert scale is employed. This scale assigns positive statement values, ranging from one for strongly disagree to five for strongly agree, with intermediate values of two for disagree, three for neutral, and four for agree. Subsequently, the UX assessment findings are computed, yielding an average outcome for each facet. Following this, an evaluation is conducted to validate recommendations and facilitate additional enhancements. The participants selected to complete the user experience evaluation questionnaire consist of 100 individuals who have engaged in playing the history game.

Table 3 presents the findings of the UX Honeycomb evaluation conducted on individuals who are users of history games.

Table 3. Honeycomb UX evaluation results

ID	Skor					Amount	Average
	1	2	3	4	5		
UXH-001	1	1	38	49	11	368	3.68
UXH-002	2	2	34	54	8	364	3.64
UXH-003	0	3	27	50	20	387	3.87
UXH-004	0	2	22	52	24	398	3.98
UXH-005	0	4	34	38	24	382	3.82
UXH-006	6	34	29	21	10	295	2.95
UXH-007	1	1	30	52	16	381	3.81
UXH-008	1	3	29	55	12	374	3.74
UXH-009	0	4	31	49	26	427	4.27
UXH-010	1	1	44	44	10	361	3.61
UXH-011	1	2	29	49	19	383	3.83
Overall Average							**3.75**

According to the table above, the History Game's average user experience assessment score is 3.75 with the predicate agree, indicating that it has adopted UX Honeycomb. The game needs further upgrades. The item in UXH-009 has the greatest average value of 4.27 with the predicate Agree, indicating that people find the History Game convenient. Many questionnaire respondents said the History Game was accessible to people of all abilities. Item UXH-006 has the lowest average value with a neutral predicate of 2.95. On this issue, 34 people disagreed, indicating that the History Game's interaction is not complicated. UXH-001, UXH-002, UXH-003, UXH-004, UXH-005, UXH-007, UXH-008, UXH-010, and UXH-011 have a standard average value with the predicate agree with the game history that can help solve problems according to user needs, is easy to use, enjoyable, has an interface that suits the user's eyes, appropriate navigation button placement, a good response, provides confidence in personal data protection, and has value for its users.

Lastly, the user interface of the History Game is depicted in the graphics that may be found below. The primary menu display is shown in Figure 4. The display shown in Figure 5 is a menu that provides information about historical objects, monuments, and landmarks. Another historical object is depicted in Figure 6, which is an example. In the game, the quiz display is depicted in Figure 7. A picture of the ultimate result or score of the game player is shown in Figure 8.

Fig. 4. Menu display

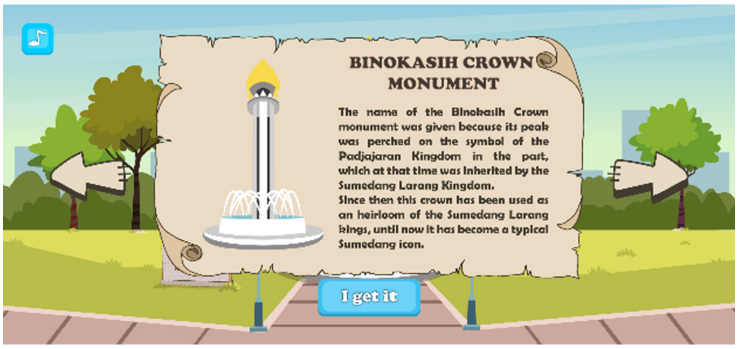

Fig. 5. Menu: Historical objects

Fig. 6. Example of an historical object

Fig. 7. Menu: Quiz

Fig. 8. Menu: Score display

5 CONCLUSION

The most current trend that has garnered significant attention all around the globe in recent years as a result of improvements in digital technology is gamification-based learning (to be specific) [30]. Student participation in the acquisition of English vocabulary may be stimulated via the use of gamification, which can also build unending passion among students [31], the development of psychological well-being [32], the practice of metacognition and sensory processing sensitivity [33], as well as the modification of behavior and the promotion of learning outcomes [34].

This Historical Game was created using the Game Creation Life Cycle, a strategy that comprises six stages: initiation, pre-production, production, testing, beta, and release. Unity 3D software was utilized in the creation process. This was accomplished utilizing the results of testing and implementation conducted by historical games. Honeycomb UX is a method employed in the testing of historical games. This method has seven distinct assessment components, namely: usefulness, usability, desirability, value, discoverability, credibility, and accessibility. According to the test findings conducted using the UX Honeycomb method, the overall average score for the history game is 3.75, showing agreement. This proves that History Games have effectively incorporated multiple components of the Honeycomb UX paradigm. Nevertheless, the History Game still needs further enhancements and refinements to boost its quality. The UXH-009 question item, with an average value of 4.27 and a predicate of agree, is the item with the highest value. This is because consumers see that the History Game application eases convenient accessibility. The item with the code UXH-006 has the lowest value, with an average of 2.95, and is rated as neutral. This item exhibits the minimum standard deviation. Out of the total number of respondents, which was 34, all of them disagreed. This shows that the interaction in the history game does not result in any confusion or uncertainty when it is used.

This work advances historical teaching, mobile technology, and local cultural preservation. This project uses the FYS algorithm and the Honeycomb UX architecture to make history learning more engaging and interactive for students. Main contributions of this study:

1. This project used mobile gaming technologies to make learning more interactive and interesting for pupils. The FYS algorithm provides game material variety, reducing boredom and enhancing history student interest.
2. This study is one of the few to use the FYS algorithm with the Honeycomb UX framework in historical teaching games. User experience evaluation utilizing the

honeycomb UX paradigm reveals usability, convenience, and trustworthiness factors that affect learning satisfaction and efficacy.

3. Preserving local culture: These studies educational game preserves and introduces local culture and history to children. Thus, this study helps preserve local culture and identity, which standard schooling neglects.
4. Social Impact: This study promotes cultural identity and heritage awareness in young people by boosting historical understanding and knowledge. This helps preserve cultural treasures for future generations.
5. Innovation in learning methods: This study allows mobile technology and random algorithms in teaching. This method can be used in assorted topics to make learning more fun and interactive.
6. A vacuum in academic literature is filled by this study's exploration of the FYS algorithm and UX Honeycomb in a mobile educational game. Other game-based learning and UX design academics and developers can use this study.

Nevertheless, there are limitations in this study. Firstly, the game trial was conducted on a restricted sample, which means that the findings may not accurately represent the experiences of a broader range of users. Additionally, while the FYS algorithm was employed to randomize questions and proved to be effective, it has not been compared to other algorithms that are commonly used. May provide superior performance or outcomes. Additionally, this game is exclusively built for the Android platform, hence restricting access for those with alternative devices. This study has provided various new paths to expand technology-based education literature and practice. Future scholars should examine these suggestions:

1. Multiplatform development: This game is just developed for Android. Research should be done to provide a multiplatform version for iOS and Windows the users. This increases user reach and accessibility of this instructional game.
2. Random algorithm comparison: This game uses the FYS algorithm to randomize material. Future researchers can compare these algorithms to Mersenne Twister and Linear Congruential Generator to assess their efficacy in instructional games.
3. To boost user engagement and motivation, consider introducing game features like level systems, awards, daily challenges, and leaderboards. These elements may encourage players to keep studying and playing.
4. Long-term evaluation: This study generated positive short-term outcomes. Future academics should perform longitudinal studies to assess these games' long-term effects on students' historical and cultural awareness. This will reveal the game's ongoing efficacy.
5. Future studies could examine how these games can be formally included in the school curriculum. We engage with teachers and educational policymakers to ensure the game fits learning objectives and requirements.
6. Future researchers can enhance game appeal and instructional value by adding richer content, including movies, animations, and interactive simulations. Students can find this content more engaging and understandable for complicated historical ideas.
7. Evaluating the impact of games on students' social and emotional components is crucial, in addition to cognitive aspects. More research could examine how these activities affect students' social skills, teamwork, and empathy for local history and culture.
8. Adapting the game to other languages and cultures is possible, taking into account the diverse cultures of other countries. Future studies might customize this game to teach local history and culture in different countries, considering local context and educational needs.

9. Technology uses like augmented reality (AR) and virtual reality (VR) can enhance learning experiences. Future academics can use this technology to make historical educational games more immersive and interactive.

By investigating these suggestions, upcoming scholars can further advance and enhance mobile educational game strategies, thereby making a more significant impact on enhancing the quality of education and safeguarding cultural heritage in the future.

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8 AUTHORS

Dadan Zaliluddin is with the Universitas Majalengka, Majalengka, Indonesia.

Ade Bastian is with the Universitas Majalengka, Majalengka, Indonesia (E-mail: adebastian@unma.ac.id).

Mira Siti Samira Yuliani is with the Universitas Majalengka, Majalengka, Indonesia.

Esa Firmansyah is with the Universitas Sebelas April, Sumedang, Indonesia.

Sarmidi is with the Universitas Muhammadiyah Tasikmalaya, Tasikmalaya, Indonesia.

Yusuf Sumaryana is with the Universitas Perjuangan Tasikmalaya, Tasikmalaya, Indonesia.