



# Designing Mobile Game-Based Integrated Thematic Learning for Elementary School Students

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**Abstract.** Mobile game-based learning (MGBL) is a serious game, that is, a game designed for educational purposes while still remaining entertaining. MGBL has been shown in numerous studies to aid pupils in learning and reduce psychological stress. This research seeks to develop MGBL for Integrated Thematic Learning (MGBITL) for elementary school students. Building MGBITL based on mobile game development theory and integrated thematic concepts required proper procedures. This research employed the MGBL Engineering Model, which consisted of three stages: (1) pre-production (discover & dream), (2) production (design), and (3) post-production (delivery). Literature review and distribution of online questionnaires to teachers were used to collect data about the principles of developing MGBITL for elementary school students. The MGBIT application, which consisted of 21 types of games adapted from the material for Class V Theme 8 Sub-theme 1, was the result of research activities. Hopefully, the introduction of MGBITL will aid teachers in teaching materials that need imagination, make subject matter easier to understand, and promote fun learning concepts. So that students are unaware that they are participating in a learning activity.

**Keywords:** Mobile Game · Integrated Thematic Learning · Elementary School · MGBL Engineering Model

## 1 Introduction

The term “Mobile Based Learning” was used to describe the trend of using technology into education (M-learning) [1, 2]. M-learning is defined as a method of learning that takes advantage of the capabilities of mobile devices such as phones, tablets, and personal digital assistants [3, 4]. Text messages (SMS or MMU) and e-mails, mobile applications, and mobile games are all examples of M-learning use in academic interactions (m-Game) [3]. Mobile game-based learning is the name given to this type of m-Game (MGBL) [5, 6]. Students in the MGBL play meaningful games to attain learning goals. Virtual games (not physical games) that may be played on handheld devices are used to offer curriculum-defined learning materials [8–10].

MGBL is also known as a serious game because, in addition to being entertaining, it also has an educational purpose [11]. The usage of mobile games boosts the effectiveness of learning, which has prompted a major surge in MGBL research over the last two decades around the world [12]. Furthermore, MGBL can help students avoid psychological stress as a result of studying, as well as increase learning motivation through visual quality and animation [13, 14], assist in the promotion of learning materials in an engaging manner [14, 15], provide an interactive environment through missions and challenge completion [16, 17], stimulate deep learning and creative thinking [18], and help assist pupils in constructing knowledge in order to improve their academic performance [19, 20].

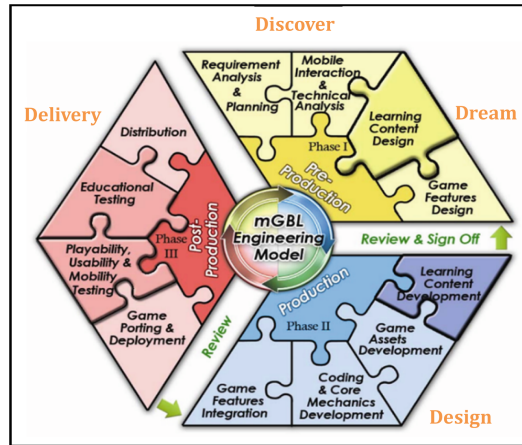
Primary schools use an integrated theme approach to learning [21, 22]. Theme-based learning connects and integrates a variety of relevant topic matter [21–23]. This is because elementary school pupils' mindsets are still holistic, and they are unfamiliar with the term “dividing” [22–24]. As a result, the content of a specific mobile game should reflect an integrated thematic concept, because the MGBL for Integrated Thematic Learning (ITL), also known as MGBITL, is based on a different concept from the standard MGBL. In general, MGBL only takes on one field or subject at a time [25], such as math games, social studies games that recognize traditional clothing, scientific games that describe different forms of rubbish, and so on. Meanwhile, MGBITL prioritizes academic components while still providing pleasure, is effective and simple to use, and considers game material to integrate the contents of many subjects. The different games in it must be interconnected and integrated in their descriptions and explanations of the theme [23, 24].

MGBITL has the same benefits as MGBL, while having a different concept design. To attain these benefits, we are attempting to characterize the systematics of MGBITL development based on the theory of MGBL development and integrated thematic concepts in this study. Because there is currently very little study on how to develop MGBITL, more research on the MGBITL development flow is needed to assist researchers in creating games that are both entertaining and educational [26]. The methodology and framework of thinking are, of course, the most significant aspects because they will serve as a foundation for future work. Game concepts must also be taken into account to ensure that students are inspired to play and can readily explore knowledge on each subject's topic until all challenges have been solved [27, 28].

## 2 Materials and Methods

The MGBITL design process follows the MGBL Engineering Model approach, which includes three phases: (1) pre-production (discover & dream), (2) production (design), and (3) post-production (delivery) [3] (Fig. 1).

The MGBITL design process, however, only reached the production stage based on the title and research objectives. The following are the actions that take place during the pre-production and production stages.



**Fig. 1.** MGBL Engineering Model

## 2.1 Pre-production

Requirements analysis and planning, mobile interaction and technical analysis, learning material design, and game features design are the four main activities in the pre-production stage [3]. During this phase, a literature review on the development of MGBL research is conducted. In addition, teachers will be given online questionnaires to fill out in order to learn more about the best MGBITL concept. Designing game interaction models (game flowcharts), learning content, and game features are also included. When creating game interaction models and learning content, the purpose of integrating ITL concepts into MGBL begins. All of the games in MGBITL must, in essence, be interconnected and represent an integrated thematic concept. Overall, the most important aspect of the pre-production stage is to develop the MGBITL concept [29].

## 2.2 Production

The production stage entails bringing the concept to life in order to create a real-world version of MGBITL. At this point, the focus is on creating learning content. To create the MGBITL program, we worked on game features, coding processes, and integrating all game components [3]. At this point, the most essential thing is to make sure that the development of learning content for an MGBITL application focuses on integrated thematic concepts and the substance of each subject. The goal is to ensure that the use of MGBITL truly prioritizes academic functions in order to meet learning objectives [29].

At this point, the type of software for the MGBITL development process is also decided [30]. Depending on the function, several types of software are employed. Using Corel Draw software, develop learning content design and gaming elements. Adobe Audition may be used to add music and sound. While Construct 2 is used for coding and integrating all game components in order to create MGBITL.

### 3 Result

#### *Pre-Production*

#### 3.1 Requirement Analysis and Planning

##### 3.1.1 Principles of Developing MGBITL in Elementary Schools

As educators that use MGBL in the classroom, we believe it is critical to obtain the teacher's opinion. This is to ensure that the MGBITL developed meets their expectations and wishes. We surveyed 32 instructors from Padang City schools with digital classes in grades IV, V, and VI. The survey was carried out by issuing a 38-question online questionnaire. The survey's results yielded eight MGBITL development concepts, which are as follows: (1) MGBITL instills moral and educational values in students, (2) MGBITL is simple to use and can be played offline, and (3) MGBITL offers learning chances and experiences. (4) MGBITL content is in accordance with learning materials and combines various disciplines, (5) MGBITL substance prioritizes the function of education over entertainment, (6) MGBITL operations have principles and limitations of use, (7) MGBITL design is in accordance with elementary school students' character, and (8) MGBITL features must be polite and can be used as an example.

##### 3.1.2 Components of MGBITL

Clear understanding about mobile game components is required before constructing MGBITL. The goal is for the developed MGBITL to meet the MGBL's general standards. The MGBITL component is actually the same as MGBL because both are smartphone-based educational games; however, the structure of MGBITL's "Game Play" component is slightly different because it provides material from other disciplines of study. Based on our literature study, there are at least eight main components of MGBITL, namely: (1) initial display (company logo/game logo) [31], (2) player identity column [7], (3) main menu [10, 30–35], (4) setting button [10, 30–35], (5) exit button [10, 30–35], (6) game play [30–33], (7) navigation and hint buttons [31–33], and (8) game info [32, 34].

#### 3.2 Mobile Interaction and Technical Analysis

We attempted to build an interaction model and game operational techniques in the form of a game flowchart based on the main components of MGBL indicated in point 3.1.3. This MGBITL is for content in class V, sub-theme 1 of theme 8. As a result, the flowchart design carries the thematic concept and accommodates material for various subjects under sub-theme 1. Figure 2 depicts the design of the MGBITL flowchart.

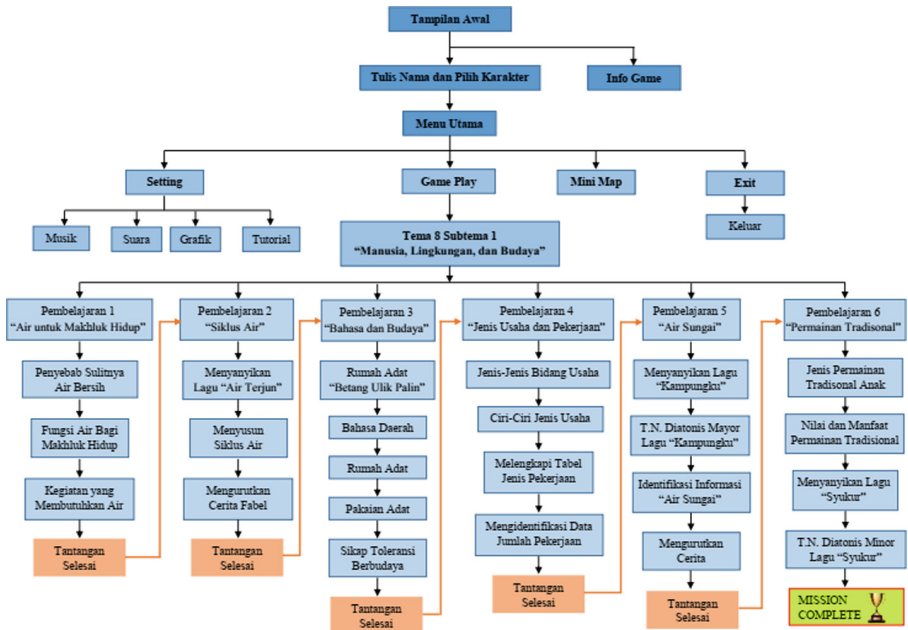


Fig. 2. Flowchart Game

### 3.3 Learning Content Design

Learning content design is the foundation for developing game concepts. The design of the learning content was inspired by the fifth-grade students' book's learning materials, theme 8, sub-theme 1. This concept was originally defined as a mapping of subject indicators from Lesson 1 to Lesson 6 (see examples in Fig. 3). The mapping of these indicators reveals that the developed mobile games are indeed designed for integrated thematic learning. Furthermore, the learning content for each subject from Lesson 1 to Lesson 6 was derived from these mapping indicators. Table 1 shows the outcomes of the learning content design.

After each subject's learning content has been described, the content is turned into a game concept. The entertainment function of MGBITL will be explained using this concept, which can be observed in how it operates or how to play the game. Despite efforts to improve the entertainment function through fascinating concepts, the focus of MGBITL development remains on the educational function, namely how to get students to like the learning contents offered. Table 2 shows several examples of turning learning content into game concepts.

**Table 1.** Content of Learning

Lesson	Subjects	Code	Content of Learning
1	Indonesian Language	1.1	Identify the causes of the difficulty of clean water
	Natural Science	1.2	Identify the role of water in the lives of humans, animals, and plants.
		1.3	Analyze water-related activities at home
2	Cultural Arts and Crafts	2.4	Sing the song "Air Terjun"
	Natural Science	2.5	Analyze the flow of the water cycle
		2.6	Identify the parts of the water cycle
	Indonesian Language	2.7	Compose the fable "The Ant and the Bear"
3	Indonesian Language	3.8	Identify information on "Ulik Palin Traditional House"
	Social Science	3.9	Match regional language vocabulary according to the region of origin
		3.10	Match traditional houses and traditional clothes according to the area of origin
	Civic Education	3.11	Determine attitudes towards cultural differences
4	Indonesian Language	4.12	Identify information on types of business fields
	Social Science	4.13	Determine the distinct characteristics of each business type
		4.14	Complete the table of work types and outcomes
	Civic Education	4.15	Determine attitudes at work and attitudes towards job disparities
5	Cultural Arts and Crafts	5.16	Complete the lyrics of the song "Kampungku" and compose the Major Diatonic scales
	Natural Science	5.17	Analyze the sources, benefits, and factors that influence river water availability
	Indonesian Language	5.18	Sort the story of the benefits of water and choose a picture that corresponds to the story
6	Indonesian Language	6.19	Determine the names of traditional Indonesian children's games
	Civic Education	6.20	Determine the value and benefits of traditional Indonesian children's games
	Cultural Arts and Crafts	6.21	Complete the lyrics of the song "Syukur" and compose the Minor Diatonic scales

### 3.4 Game Feature Design

#### 3.4.1 Main Feature

MGBLTI was created with the idea of adventure in mind. To advance to the next lesson, players must complete challenges in each lesson. The game's main feature is a residential model surrounded by trees, crossed by a small river, and containing six houses. Figure 4 shows the design of the main feature.



Fig. 3. Example of subject indicator mapping

### 3.4.2 Additional Features

The developed MGBITL contains various supporting elements, as shown in the flowchart: (1) game information, (2) settings, (3) mini map, and (4) characters. The game info section offers brief information from the development team and sponsors of the game production. A round frame was used to hold a photo of each member. The Tutwuri Handayani logo, which serves as a symbol that this game is intended for educational purposes, the LP2M UNP logo, which serves as a research sponsor, and the Rabbit Dev logo, which serves as a private firm that controls game development, are all shown below the photo.

With the option to “turn on” or “turn off,” the setting feature allows you to change the game’s operating components such as music, sound, and graphics. This feature is intended to be present on every game display so that players can control it in any game they are playing. The mini map is a scaled-down version of the main feature. The player’s character will appear on the mini map when the player walks from one house to the next. As a result, this mini map feature serves as navigation, directing players to the next house.

There is also a character select feature in addition to the above features. When the player is a boy, he can choose a male student’s character, and when the player is a girl, he can choose a female student’s character. Because the algorithm has concluded that the teacher is female, the character of the teacher cannot be chosen. The characters of students and teachers are supposed to be pleasant and courteous. Long-sleeved shirts, long skirts, and headscarves are worn by female students. Long pants, tucked shirt bottoms, and belts are worn by male students. Female teacher characters are supposed to wear a long headscarf and wear blouse-dress. Students and teachers play a role in each challenge, both at the beginning and at the end. These two characters will speak with one another in order to help players complete each challenge.

### *Production*

## 3.5 Learning Content Development

Learning content development is the first stage of a game’s development before it is translated into machine language and made available for use on mobile devices. This

**Table 2.** Example of learning content design

No	Subjects	Code of Content	Concept of Game
1	Cultural Arts & Crafts	2.4	Some lines from the song Air Terjun were left out. Songs that are both instrumental and have lyrics. The song instrument pauses when it comes to empty lyrics; students must fill in the blanks with the words provided so that the song can continue. Removed song lyrics: (1) tak putus, (2) angin, (3) lembah, (4) gemuruh, (5) air terjun, dan (6) mengalir
2	Natural Science	2.5	Students are given 9 pieces of water cycle images in the shape of a puzzle and are given the task of arranging the puzzles to produce a water cycle plot. If the picture's eight pieces are correctly arranged, the final piece will appear automatically to complete the puzzle.
		2.6	The essential parts of the water cycle, such as evaporation, condensation, precipitation, infiltration, and runoff, are provided a box when the water cycle puzzle is completed. The field, however, is left blank, and students are given the task of filling in the section's name.
3	B. Indonesia	2.7	The story "The Ant and the Bear" was given to students in nine pieces. Then there are nine blank squares where the story pieces might be placed. In order to build the right story line, students place each story piece in the box. After correctly assembling the story, nine pieces of artwork appear, each depicting the contents of one of the story pieces. Each picture is placed in the appropriate story piece by the students.

content development is customized to the game concept outlined in Table 2. The Corel Draw program is used in the learning content development process, as we discussed in the methodology section. Figure 5 is an example of development result of learning content.



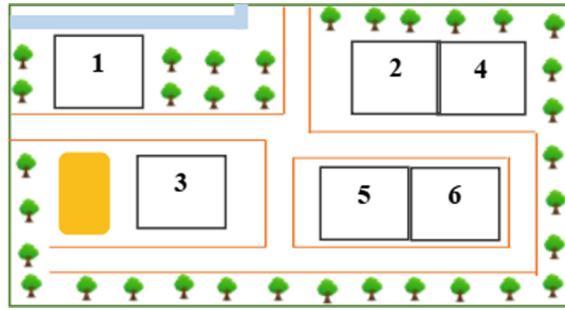


Fig. 4. Main features design of game

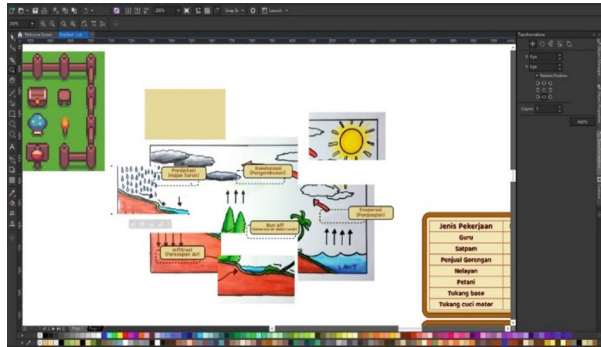


Fig. 5. Development result of content code 2.5–2.6

### 3.6 Game Features Development

The game's features are customized to the concept outlined in points 3.4.1 and 3.4.2. Corel Draw is used in the development of this feature. The feature game is MGBITL's development house, and the game's features allow learning content that will be turned into a game version to be operated. In a summary, game features are tools for presenting and playing games. Figures 6 and 7 depict are examples of development result of game features.

### 3.7 Coding and Core Mechanical Development

The coding stage is defined as the process of transforming the developed design into machine language form so that the design can be understood and implemented by the computer. Coding, to put it another way, is an attempt to translate a design into a machine-readable format. In this situation, as indicated in Table 1, the coding process for the 21-learning content tries to make the content playable according to the game concept developed. Figure 8 shows an example of the coding procedure.



Fig. 6. Development result of main feature

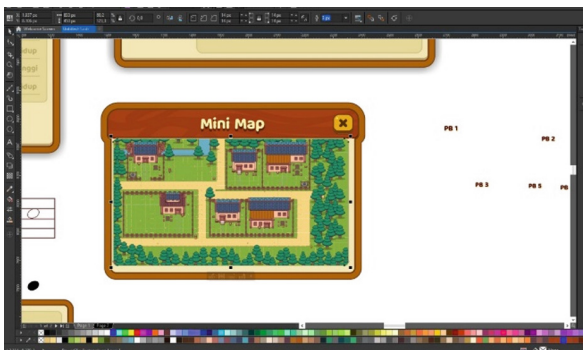


Fig. 7. Development result of mini map feature

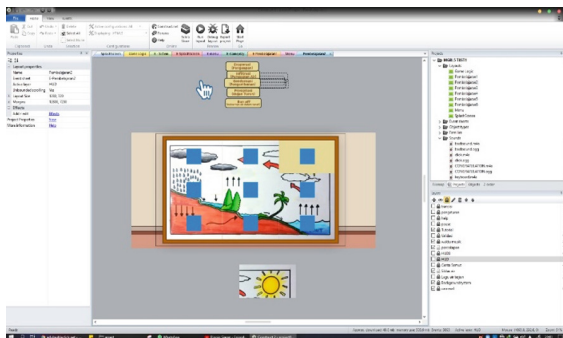


Fig. 8. Coding process on content code 2.5–2.6

### 3.8 Game Features Integration

This is the final stage of the MGBITL production process. To create the MGBITL application, all game components are integrated. With the help of game features, you can play 21 different sorts of games that have gone through the development process.

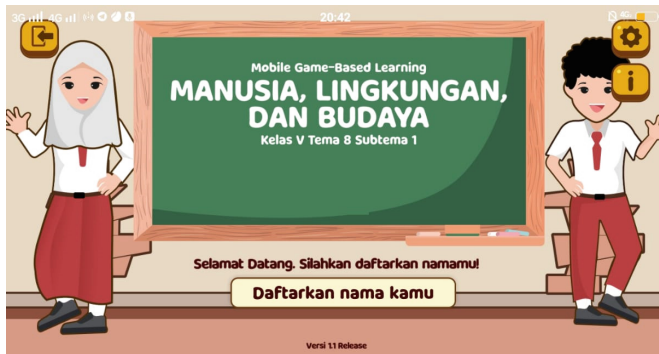


Fig. 9. Initial appearance



Fig. 10. Player ini house 3 (lesson 3)

Simply said, the value code of each type of game and game feature is entered into the system as part of the integration process (conditional). The system will automatically send an electronic signal to the chosen game value when the user plays a game. This activity will activate the game code, allowing you to play the game. Figures 9, 10 and 11 show several examples of MGBITL development results.

## 4 Discussion

In the previous decade, technological developments have compelled every aspect of life to adapt, including education. As a result of this phenomena, the term “digitalization of learning” develops [36]. Until, finally, the concept of digital-based learning media appeared. Teachers will find it easier to create up-to-date learning media with the help of technology [37]. After all, learning media must be modified in order to continue to provide learning material in an interactive way in accordance with current learning styles [38].

MGBL is a sort of digital-based learning media. MGBL is a learning platform that promotes play-based learning [39]. MBGL has emerged as a result of opportunities



Fig. 11. Game of learning content 6.19

and realities in the field, where nearly everyone owns a smartphone and children enjoy playing a variety of games on their mobile devices [40]. MGBL, in our perspective, is not the same as a Smartphone-Based Educational Game (SBEG). Because SBEG exclusively makes educational content available in the form of smartphone games. The scope is broad because the object is anything that feels like education; yet, it is unclear if the educational content in question is included in the learning materials or not. As a result, SBEG has nothing to do with classroom learning activities. While MGBL refers to the usage of smartphone apps to deliver educational materials [5, 41]. The MGBL contains the entire content of the classroom’s learning materials. Because the subject is students and teachers, the material is the object of study that is turned into a game. As a result, MGBL is intimately involved in student learning activities, and the classroom serves as his home.

In reality, however, the substance of MGBL differs from the existing elementary school curriculum concept. Elementary schools, as we mentioned in the introduction, use an integrated thematic approach to learning. Learning based on themes that integrate the competencies of multiple disciplines, rather than learning for specific subjects [22, 23]. As a result, MGBL must be modified to fit the learning approach. That’s why we present the term Mobile Game-Based Integrated Thematic Learning (MGBITL).

SBEG, MGBL, and MGBITL all go through the same stages in the development process. A needs analysis is performed first, followed by the creation of a content design, the development of content, the coding process, and finally the integration of all components [10, 33]. Because the content of MGBITL differs from that of other mobile-based educational games, the flowchart model and technique for formulating game concepts in MGBITL are unique.

Figure 2 shows a game play feature. Pay attention to it. This section establishes the distinction between MGBL and MGBITL in terms of substance and concept. The game play feature in MGBL only has one sort of game that is based on a specific subject matter. Although the game may have various variations, the type remains the same; only the level and degree of difficulty are increased. While the MGBITL game has several types, it does not have any additional types of variation. The focus of Learning Materials 1–6 is varied, as shown in Fig. 2. Each lesson’s game types do not carry the subject’s identity;

rather, they are interrelated and connected in explaining the core material. “Water for Living Creatures,” for example, is the focus of Learning Material 1. It has three distinct but related types of games, all of which revolve around the theme of “Water,” which is the core of the learning material.

The amount of learning content determines the number of games in MGBITL. The curriculum (in the teacher’s and student’s books) determines the substance of this learning, which is modified from the main material of each lesson. This indicates that if a class has three main materials, the amount of learning content is the same, and thus the number of games that may be created is the same. The subject matter is each subject’s competence in terms of knowledge and skills (see Table 1).

The appearance or workings of a game is reflected in the concept of the game [42, 43]. As a result, converting learning content into a game concept necessitates a creative thinking process [43]. Because this will be the primary factor determining whether pupils like or dislike the MGBITL that has been produced, the concepts compiled are also used to identify operational techniques and features in the game. Consider the content code 2.7 found in Tables 1 and 2. The learning content in Table 1 is summarized in a single sentence: “Composing the fable story of the Ant and the Bear.” This sentence does not convey how the game will be conducted. This content was evolved into a game concept after going through the creative thinking process in Table 2. It was finally determined that content 2.7 would be provided in nine story pieces based on this concept. If students are successful in arranging the story pieces into a whole story, they will be rewarded with nine pieces of artwork. Each picture must be placed in the right story piece, which is a challenge for students.

One of the things to consider when designing games for elementary school students is if the game concept is developed in accordance with the students’ cognitive and intellectual development [44]. Because MGBITL is aimed at high school students, game content 2.7, for example, is divided into nine story pieces. If the subject of the MGBITL is a low-grade student, then 3–5 story pieces would be enough. This is due to the fact that the ability to think and remember differs between high- and low-grade student.

Game features are an essential component of the game. Game features can be used to play games. As a result, game features must be built in accordance with the game concept [44, 45]. The main feature of MGBITL is that it is designed to look like a nice residential model with six houses. The design of this main feature corresponds to the learning theme of “Human, Environment, and Culture,” with the six houses representing Lesson 1 to Lesson 6. These houses contain 21 different sorts of MGBITL games. As a result, when the player enters House 1, he will face three obstacles (three different sorts of games) derived from the three main materials in the lesson.

We make every effort to meet or exceed teacher standards. Based on the preliminary study’s findings, they wanted the MGBITL to be simple to use and the characters to serve as role models. That’s why we included a mini map and allowed teachers and students to interact. The mini map function allows players to quickly determine the location of the house, while the conversation guides them on how to play the game. The player characters are meant to be neat and courteous in the hopes that students will be driven to take care to their appearance while playing this game. Other classroom features, such

as the first display of the game and the gaming room, are designed to give students the feeling of studying in class while playing games on their smartphones.

Furthermore, even though the game cannot be played yet, game concepts and features are collaborated on and evolved into a game with a clear form. We chose Corel Draw for this process because: (1) the image resolution produced by this application can be reduced to the lowest level, but the quality is not inferior to that of other applications; (2) the tools in Corel Draw are simple to use, making them very useful for novice users; and (3) Corel excels at collaborating images with words, which is critical in the creation of MGBITL [46, 47].

The following components are brought together by supplying an operational code that the machine can understand. This is comparable to a life where characters can walk around, game features may be used, and games can be played. We chose Construct 2 for this approach since the MGBITL game is a two-dimensional game, and Construct 2 is built exclusively for this type of game [48, 49]. Furthermore, the MGBITL operating system is also not too complicated, so it is very suitable if you use the Construct 2 application [48].

MGBITL must first be exported (formatted) to the “apk” format using the Cordova application before it can be played on mobile devices. Then, using the Android Studio application, proceed to the “build” stage. At this point, make any necessary changes to the ID, application name, application icon, and game orientation. Researchers will find it easier to share games for testing purposes using this MGBITL application.

## 5 Conclusion

As stated in the beginning, the goal of this research is to develop MGBITL for elementary school students. The MGBITL application was finally developed after going through a number of development procedures using the MGBL Engineering model, and it was adopted from the subject matter for Class V Theme 8 Sub-theme 1. The developed MGBITL comprises 21 different types of games divided into six lessons. We are confident that this MGBITL will aid students in understanding the subject matter and will assist teachers in presenting learning in an interesting and enjoyable way for students. Any suggestions and comments will be appreciated so that we may continue to improve the quality of MGBITL in order to fulfill the needs of students in the classroom.

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