QUBAHAN ACADEMIC JOURNAL
VOL. 4, NO. 4, December 2024
https://doi.org/10.48161/qaj.v4n4a808

Development of Ucing Sumput Digital Game to Stabilize Students' Achievement Emotions in Mathematics

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ABSTRACT: The achievement emotions of Indonesian students in doing mathematics activities have not relatively been stable whereby sometimes they attend math class with anxious, bored, or hopeless feelings. Therefore, the present study aims to develop and produce a Ucing Sumput game that is valid, practical, and effective in stabilizing students' achievement emotions in mathematics activities. A research and development using ADDIE model was applied to do this study. This study involved three experts and 67 eleventh-grade students at a public senior high school in Bandung City. An achievement emotion questionnaire in mathematics was used to measure students' achievement emotions in mathematics activities. Descriptive and inferential statistics (e.g., N-gain, effect size, paired t-test, and independent t-test) were used to analyze the data. Results revealed that the prototype of the game was valid and practical to be utilized in mathematics instruction. Moreover, this game had a significantly positive strong effect in increasing students' positive emotions and a significantly negative strong effect in decreasing students' negative emotions. This means that this game significantly stabilizes students' achievement emotions in mathematics activities. Consequently, the Ucing Sumput game can be utilized as an effective digital educational technology in stabilizing students' achievement emotions in doing mathematics activities.

Keywords: achievement emotions, digital educational game, direct instruction, mathematics activities, Sundanese local wisdom, Ucing Sumput.

I. INTRODUCTION

Every day students' academic life is colored by many types of emotions. Emotions have a fundamental role in an academic setting in deciding students' behaviors, perceptions, and experiences in learning environments followed by them [1, 2]. Particularly, they experience a broad variety of emotions when following courses, taking exams, and doing homework assignments. For example, in an empirical study, Suparman et al. [3] reported that emotions experienced by female secondary students in solving math exams are such as pride, enjoyment, hope, contentment, anxiety, hopelessness, boredom, anger, and frustration. Additionally, emotions generate students' behaviors and attitudes in responding to learning activities or learning outcomes. As an example, students who are bored or hopeless in attending math courses, are not interested in following activities in the learning environment [4, 5]. This shows that the boring and hopeless feelings of students do not motivate them to study a learning material [6, 7]. This indicates that emotions become one of the crucial factors that have to be noticed in academic settings.

Emotions in academic settings related to academic activities (e.g., doing homework assignments or taking examinations) or academic outcomes (e.g., success or failure) are defined as achievement emotions [8, 9]. Moreover, Pekrun [10] explained that achievement emotions are categorized by object focus (activity vs. outcome), activation level (activating vs. deactivating), and valance (positive vs. negative). Particularly, in the valance view by considering both activation level and object focus, positive emotions (e.g., enjoyment, hope, pride, contentment, and relief) are positively associated with some academic factors, such as achievement, motivation, learning interest, and performance [4, 7]. In contrast, negative emotions (e.g., anxiety, boredom, hopelessness, anger, shame, disappointment, and sadness) are negatively associated with some academic factors, such as performance, motivation, achievement, and learning interest [6, 11]. This shows that the stability of

achievement emotions in learning environments (e.g., mathematics learning, science learning, or social learning) must be generated by increasing positive emotions and decreasing negative emotions to promote students' academic achievement, motivation, and performance.

The existence of achievement emotions in mathematics activities has to be stable in supporting the optimization of students' mathematics achievement, motivation, performance, and learning interest. Bieleke et al. [1] in literature explained that the stability of students' achievement emotions in mathematics activities is characterized by the increase of positive emotions and the decrease of negative emotions. Nevertheless, several empirical studies revealed that students' achievement emotions are not relatively stable in attending math class, doing math homework, and taking math exams in which their positive emotions decrease whereas their negative emotions increase [2, 12, 13]. Particularly, a few empirical studies also reported that the achievement emotions of Indonesian students in mathematics activities have not relatively been stable whereby sometimes they attended math class with anxious, bored, or hopeless feelings [14-16]. This shows that students' achievement emotions in doing mathematics activities still have not been stable, whereas positive emotions (e.g., enjoyment and pride) are positively associated with mathematics achievement [5, 17], and negative emotions (e.g., shame, anxiety, and boredom) are negatively associated to mathematics achievement [18, 19]. Consequently, achievement emotions that are not stable in conducting mathematics activities can obstruct students' mathematics achievement.

Furthermore, the rapid and sophisticated development of science and technology in the 21st century provides abundant information for Indonesians younger. The abundance of information can be such as culture, politics, economics, education, and others. The foreign cultural information (e.g., music, food, clothes, art, craft, language, and tradition) that come to Indonesia, locally in West Java passing through social media, such as YouTube, Instagram, TikTok, and others influence Indonesian people's behaviors, especially Sundanese students in an academic context [20, 21]. Particularly, they start by adapting music and food, using clothes and language, and applying tradition in the context of Indonesian culture, mainly Sundanese local wisdom. For example, Sundanese youngers often wear clothes in Korean or Japanese style, listen to many Korean or Western songs, consume Chinese or Arabian foods, and apply English, Korean, or Japanese language in daily life [22, 23]. On one hand, this condition provides a positive impact on the literature regarding foreign cultures. On the other hand, it gradually fades traditions and identities of local cultures, specifically Sundanese local wisdom. Moreover, Ucing Sumput—one of the traditional games in West Java represents Sundanese local wisdom [24]. As a consequence, a lot of Sundanese youngsters do not understand and even know their traditions and identities related to local cultures [25, 26].

Students' unstable achievement emotions in doing mathematics activities, such as attending math class, doing math homework, and taking math exams can be one of the academic barriers for students to get the best mathematics achievements. As a consequence, the existence of stimulants which can increase students' positive emotions and decrease students' negative emotions in performing mathematics activities is extremely required in academic settings. Games become one of the potential stimulants to stabilize students' achievement emotions in academic settings. In the literature, Alcaraz-Munoz et al. [27] stated that there are many challenging and interesting things in gaming activities. Additionally, Chen et al. [28] argued that gaming activities generate stimulants that activate positive emotions and deactivate negative emotions. Lei et al. [29] in a meta-analysis study investigating educational games and achievement emotions revealed that the activities of educational games significantly increase students' positive emotions and decrease students' negative emotions. To make the utilization of educational games in doing mathematics activities more flexible and mobile, the Android system is used to digitally pack the educational games [30, 31]. Moreover, the phenomena regarding Sundanese students who do not know about their local cultures in that the traditions or identities are faded by incoming foreign cultures in many aspects, such as art, music, craft, food, clothes, and language initiate Sundanese local wisdom like as traditional games to be included to digital educational games. Thus, the development of Ucing Sumput as a digital educational game containing Sundanese local wisdom is expected to stabilize students' achievement emotions in performing mathematics activities.

To date, a lot of developmental studies that develop digital educational games as learning media promoting the process of mathematics learning have widely been conducted. Particularly, several developmental studies revealed that Android-based educational games significantly enhance students' mathematics achievements [32-39]. Additionally, some developmental studies showed that Android-based educational games significantly increase students' learning interest to mathematics [16, 40-47]. The developmental studies, however, do not include local wisdom that relates to mathematics content in the context of educational games. A few developmental studies, actually, have included local wisdom, such as Timor and Sundanese to Android-based educational games [48, 49].

Particularly, Suddin and Deda [49] revealed that Android-based educational games including Timor local wisdom can motivate and facilitate students in mathematics learning. In addition, the developmental study

performed by Irawan et al. [48] only designed and developed Android-based educational games using Sundanese local wisdom to be prototypes. Meanwhile, the present study develops a digital educational game based on Sundanese local wisdom using an Android system to stabilize students' achievement emotions in mathematics activities.

The present study aims to produce the valid, practical, and effective Ucing Sumput as a Sundanese local wisdom-based digital educational game in stabilizing students' achievement emotions in doing mathematics activities. This digital educational game is expected to promote mathematics teachers in increasing students' positive emotions (e.g., enjoyment and pride) and decreasing students' negative emotions (e.g., anxiety, boredom, shame, hopelessness, and anger) in conducting some mathematics activities, such as attending math class and taking a math exam). The following research questions are used to specify the purpose of this study, such as (1) How does the needs analysis go into developing Ucing Sumput as a digital educational game? (2) What is the process for designing the digital educational game? (3) How is the validity of Ucing Sumput as a digital educational game? (4) How is the practicality of Ucing Sumput as a digital educational game to be utilized in the process of mathematics learning? (5) How much does the effect size of the digital educational game have on the stabilization of students' achievement emotions in doing mathematics activities? (6) How does the digital educational game significantly stabilize students' achievement emotions in doing mathematics activities?

II. THEORETICAL FRAMEWORK

1. ACHIEVEMENT EMOTIONS

Emotions exist in academic settings everywhere and extremely affect students' academic performance. In contemporary research, emotions are defined as multifaceted phenomena involving a series of coordinated psychological processes, including affective, cognitive, physiological, motive, and expressive components [8]. Generally, Pekrun and Stephens [9] stated that academic emotions consist of achievement emotions, epistemic emotions, topic emotions, and social emotions. Moreover, Pekrun and Stephens [9] particularly explained that achievement emotions are related to achievement activities and achievement outcomes. In detail, activity emotions encompass continuing emotions experienced by students when involved in achievement activities, such as attending classes, doing homework assignments, and taking exams. Meanwhile, outcome emotions cover prospective emotions related to success or failure in the future, and retrospective emotions related to success or failure in the past [10, 50]. This explains that achievement emotions emerge from learning activities and learning outcomes.

In the literature, Pekrun and Linnenbrink-Garcia [51] explained that achievement emotions are categorized to be two dimensions, such as valance and activation. From the dimension of the valance, achievement emotions are differentiated by positive emotions (e.g., enjoyment, hope, pride, gratitude, relaxation, contentment, and relief) and negative emotions (e.g., anger, anxiety, shame, boredom, sadness, hopelessness, and disappointment). Additionally, of the dimension of activation, achievement emotions are categorized to be activating emotions (e.g., enjoyment, hope, pride, gratitude, anger, anxiety, and shame) and deactivating emotions (e.g., relaxation, contentment, relief, boredom, sadness, hopelessness, and disappointment). Moreover, the present study involves five types of positive emotions, such as enjoyment, pride, hope, contentment, and relaxation, and five types of negative emotions, such as anger, anxiety, shame, boredom, and hopelessness to measure the stability of students' achievement emotions in doing mathematics activities. Mathematics activities in the present study are specified in students' activities in attending math classrooms and taking math examinations.

2. UCING SUMPUT—A SUNDANESE TRADITIONAL GAME

Sundanese is one of Indonesian ethnics which largely live in West Java— a province located in Java Island. Sundanese people have a lot of local cultures that are particularly well-known by their community, such as clothes, foods, crafts, arts, traditions, and languages. Traditional games are one of the local wisdoms in the community of Sundanese people. There are many types of Sundanese traditional games (e.g., Oray-Orayan, Ucing Sumput, Boi-Boian, Galah Asin, Gatrik, Hahayaman, Congklak, Engklek, Endog-Endogan, and Egrang) which have valuable cultural heritages for Sundanese community [52-58]. Some of the traditional games (e.g., Gatrik, Galah Asin, Congklak, Engklek, and Egrang) have often been played and related to mathematics contents, such as algebra and geometry. These traditional games become the ethnical context of mathematics learning. Thus, the involvement of Sundanese traditional games can be in the context of mathematics learning.

The present study uses a Sundanese traditional game, called as Ucing Sumput which has extremely not been popular in the community of West Java people. Ucing Sumput refers to Sundanese traditional games in which the "Ucing = Cat" here means that the player is on guard, while the other players are hiding [24, 59, 60]. In detail,

Giwangsa and Novianti [24] explained the rules of this game in which firstly, all players agree to determine the limits for playing and where to guard. Boundaries can be marked by certain trees, poles, or houses, and players who cross the line are declared defeated and must lose in the next round. All players do hompimpah to determine who will be the guard in the first round. The player who has the guard's turn counts a certain number while closing his eyes while standing guard and the number is between 10 – 30 (See FIGURE 1). The other players hide in their respective places of choice as long as the guard is still counting and closing his eyes. After the guard has finished counting, the guard will shout "Geus = already" to indicate that the game has started and the guard will start looking for hiding players. The players whose hiding place is discovered first will become the guard in the next round. Players who have been caught wait in the guard area until all players have been found. Players who are still hiding when the guard has found other players, have the opportunity to save the player who was caught by touching the guard without the guard knowing while shouting "Hong". The game is over when all players have been found.

FIGURE 1. The illustration of Ucing Sumput game.

3. *UCING SUMPUT AS A DIGITAL EDUCATIONAL GAME*

The Ucing Sumput game used in this study is connected to mathematics content. The mathematics contents consist of enumeration rules (e.g., addition rule, multiplication rule, permutation, and combination), and probability of compound events (e.g., mutually exclusive events, independently exclusive events, and probability of a conditional event) [61-64]. Additionally, the traditional game is modified to be educational games and packed into digital form. In the literature, Fokides [65] stated that digital educational games refer to applications or programs designed for learning and entertaining purposes, utilizing digital technologies, such as computers, smartphones, and game consoles. Digital educational games can help develop various students' abilities, such as problem-solving, logic, creativity, and digital skills [66, 67]. In addition, this game can increase students' learning motivation because it offers an interactive, challenging, and fun experience in the learning process [68, 69].

Digital educational games have some characteristics, such as interactive (players can directly interact with the game content and interface), adaptive (the games adjust the level of difficulty and content based on the players' abilities), and learning objectives (games are designed to achieve measurable and clear learning objectives [70, 71]. Generally, digital games consist of simulation games, challenging games, and educational games [72, 73]. The digital game using the context of Sundanese local wisdom in the present study is categorized as a challenging and educational game. Particularly, Hwa [72] explained that challenging games offer exciting exploration and problem-solving experiences while embedding key concepts in mathematics, such as enumeration rules and probability of compound events. Meanwhile, educational games focus on learning objectivities whereby the educational games in this study are projected as an evaluating tool to measure mathematics achievement in enumeration rules and probability of compound events. Moreover, the educational games are packed to be digital using the Android system— an open-source system providing opportunities for developers and users to flexibly use it [74, 75]. Android-based educational games can be utilized everywhere on mobile. Some studies revealed that mobile educational games can be practically accessed everywhere by students in the learning process [76-79].

A new form of digital educational game modified in this study is related to the evaluation of learning material in mathematics (e.g., enumeration rules and probability of compound events). The Ucing Sumput game in digital version is represented by the player (P) who will find the right positions of cats (O) in the locked boxes using the given map which is also locked in the single box (See FIGURE 2). To open the boxes consisting of a cat, map, or trap, every player has to solve math problems.

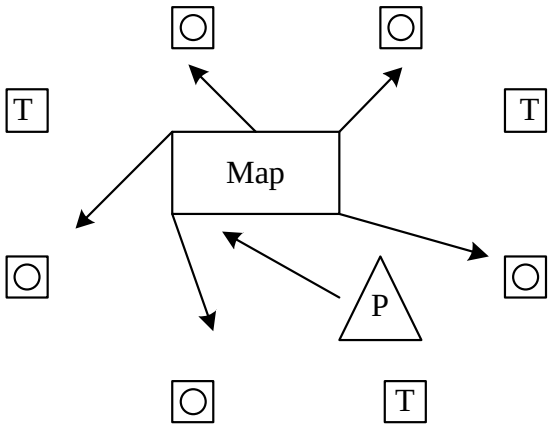

FIGURE 2. The illustration of Ucing Sumput in digital game.

This digital game can be played by several players and they will find some cats to get the scores. It is started by players who open the box containing the given map describing the right positions of cats in some boxes. To open the locked box, all of the players have to solve one simple math problem related to enumeration rules or probability of compound events. After the player reads and understands the possible position of cats, they carefully find the box containing the cat in which to open this box, the player also has to solve one math problem. If the player succeeds in opening the box containing the cat, he/she will get the score. However, if the player succeeds in opening the box containing the trap (T), he/she will get a decrease in score. All players are given the time during 15 - 25 minutes to find all of the cats as long as they can. The final score in this game is decided by the highest point in looking for cats decreased by the point in finding traps.

4. DIRECT INSTRUCTION

Direct instruction refers to a learning model using teachers' demonstration and explanation embedded with students' practice and feedback to encourage them to get the knowledge and skills required for the next learning [80]. It can be understood as a learning model that can encourage students to learn and hold basic skills and gradually get the information [81]. In the literature, McMullen and Madelaine [82] argued that there are some characteristics of direct instruction, such as: (1) there is a model effect on students including in learning purpose and assessment; (2) it has the syntax overall learning trajectory; and (3) management system and learning environment are adjusted to promote the success of learning activities. Additionally, Eppley and Dudley-Marling [83] mentioned that there are five main phases in direct instruction, such as: (1) presenting learning purposes and preparing students to learn, (2) demonstrating knowledge and skill, (3) guiding students in doing the practice, (4) checking students' understanding and giving the feedback, and (5) providing the opportunity for students to do advanced practice and applsy it. These steps are applied in mathematics direct instruction promoted by the Ucing Sumput game.

III. MATERIAL AND METHOD

This study was Research and Development applying the ADDIE model to produce the product of a digital educational game that was valid, practical, and effective in stabilizing students' achievement emotions in attending math class and taking math exams. In a book, Branch [84] explained that ADDIE is an acronym for Analyze, Design, Develop, Implement, and Evaluate which is not only a model per se but also a product development paradigm. It means that the phase of ADDIE model covers three indicators, such as validity, practicality, and effectivity in developing Ucing Sumput as a digital educational game. Therefore, the model was selected in this study to develop a product of learning technology that was an Android-based educational game using the context of Sundanese local wisdom. Briefly, some activities (e.g., collecting and selecting the appropriate Sundanese traditional games, selecting possible mathematics contents, and doing relevant literature reviews) were conducted in the analysis phase. Transforming modified concepts of the Sundanese traditional game to a digital game using Construct 2 software that could be applied to the Android system was carried out in the design phase. In the development phase, the prototype of a Sundanese local wisdom-based digital educational game was validated by involving some experts in educational technology, mathematics content, and Sundanese culture, and also examined its practicality to be utilized by users (e.g., students and teachers). The valid and practical digital game was experimented with in a mathematics learning environment in the

implementation phase. The effectiveness of Sundanese local wisdom-based digital educational games in stabilizing students' achievement emotions in attending math class and taking math exams was retrospectively analyzed in the evaluation phase.

1. RESEARCH DESIGN

Quasi-experimental research was applied in the phase of implementation and evaluation to describe and examine the effect of Ucing Sumput as a digital educational game using the context of Sundanese local wisdom in stabilizing students' mathematics achievement emotions. Moreover, the pretest-posttest control group design was used in that this study examined the increase of positive emotions and the decrease of negative emotions. Two groups, such as the experiment class and control class were selected using purposive sampling because the accesses to involve the participants in those classes were available [85-92]. The experiment class received direct instruction assisted by a Sundanese local wisdom-based digital educational game while the control class only received direct instruction (See Table 1).

Table 1. Experimental design of Sundanese local wisdom-based digital educational game in stabilizing mathematics achievement emotions.

Group	Pretest	Intervention	Post-test
Experiment	Mathematics Achievement Emotions	Direct Instruction & Ucing Sumput Game	Mathematics Achievement Emotions
Control	Mathematics Achievement Emotions	Direct Instruction	Mathematics Achievement Emotions

2. PARTICIPANTS

This study involved three experts consisting of one expert in educational technology, one expert in mathematics content and Sundanese traditional games, and one expert in the Indonesian language. Moreover, 33 eleventh-grade students of a public senior high school in Bandung City were involved in limited trials to describe the practicality of Ucing Sumput as a digital educational game to be utilized by students and mathematics teachers in mathematics direct instruction. Additionally, 67 eleventh-grade students of a public senior high school in Bandung City were also involved in an experimental process in which they were distributed to 34 students in the experimental group and 33 students in the control group. The participants were involved in the limited trial and experimental activity selected using purposive sampling in that the accesses to involve the participants in those classes were available [93-99].

3. INSTRUMENTS AND DATA COLLECTION

To validate the prototype of the Ucing Sumput game, a validation sheet consisting of the operating system, gaming content, language, and design & graphics was used. Particularly, the aspect of the operating system contained four indicators, followed by nine indicators in the aspect of gaming content, three indicators in the aspect of language, and 15 indicators in the aspect of design and graphics. Each indicator in the validation sheet used a 5-point Likert scale (1=strongly disagree; 2=disagree; 3 = quite agree; 4=agree; 5=strongly agree). All of the aspects included in the validation sheet referred to the framework proposed by Smaldino et al. [100]. Additionally, a questionnaire was used to describe students' responses regarding the practicality of the Ucing Sumput game to be utilized in mathematics direct instruction. This questionnaire consisted of 16 statements related to operating systems, features, displays, and activity in the digital educational game. Each statement in the questionnaire related to the Ucing Sumput game used a 5-point Likert scale (1=strongly disagree; 2=disagree; 3 = quite agree; 4=agree; 5=strongly agree). The content of this questionnaire had been validated by two experts in mathematics education and educational technology who stated that it was valid and eligible to measure students' responses regarding prototype practicality.

Achievement Emotions Questionnaire-Mathematics (AEQ-M) developed by Bieleke et al. [101] was adopted in this study to measure students' achievement emotions in attending math class and taking math exams. The questionnaire contained ten types of emotions consisting of five positive emotions (e.g., enjoyment, hope, pride, relaxation, and contentment) and five negative emotions (e.g., anxiety, hopelessness, boredom, shame, and anger). Each statement in AEQ-M used a 5-point Likert scale (1=strongly disagree; 2=disagree; 3 = quite agree; 4=agree; 5=strongly agree). Additionally, the questionnaire was valid and reliable whereby the value of validity and reliability for each emotional type was such as enjoyment ($r = 0.64$; $\alpha = 0.90$), pride ($r = 0.67$; $\alpha = 0.87$), hope ($r = 0.70$; $\alpha = 0.89$), contentment ($r = 0.72$; $\alpha = 0.89$), relaxation ($r = 0.64$; $\alpha = 0.90$), anger ($r = 0.62$; $\alpha = 0.88$), anxiety ($r = 0.61$; $\alpha = 0.91$), shame ($r = 0.57$; $\alpha = 0.84$), hopelessness ($r = 0.70$; $\alpha = 0.89$), and boredom ($r = 0.72$; $\alpha = 0.89$).

Moreover, the questionnaire was administered to students in each group before and after the intervention of mathematics direct instruction assisted by the Ucing Sumput game in the experiment class and only mathematics direct instruction in the control class was conducted.

4. PROCEDURE

The developmental procedure in developing Ucing Sumput as a digital educational game to stabilize students' achievement emotions in doing mathematics activities (e.g., attending math classes and taking math exams) in this study is briefly described in FIGURE 3.

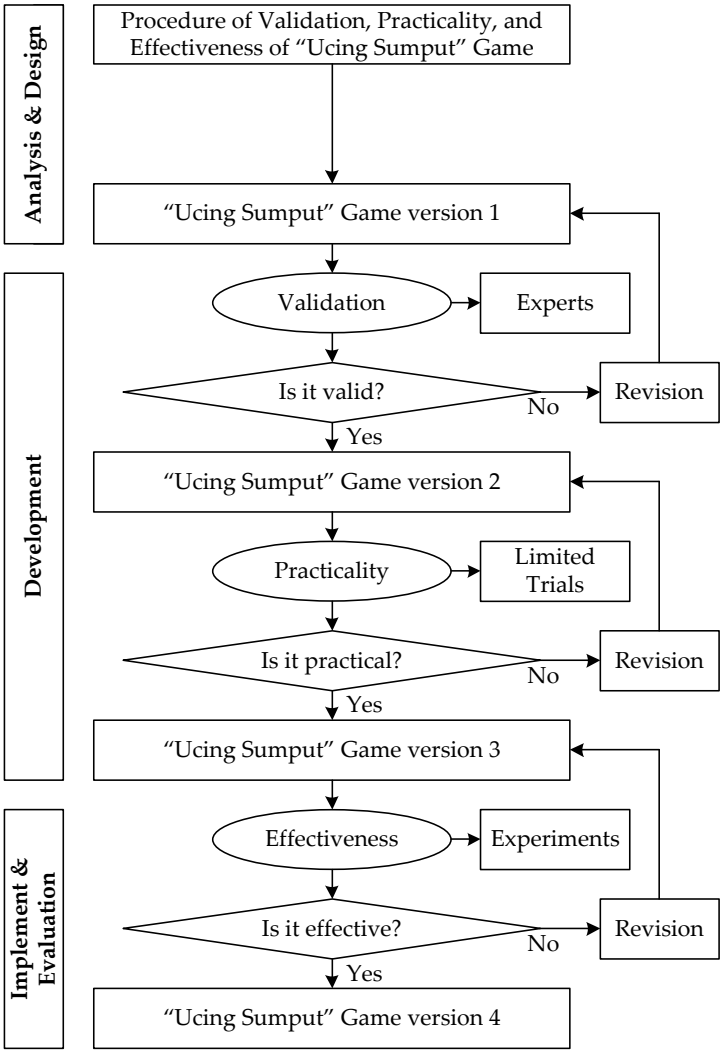

FIGURE 3. The procedure of validation, limited trial, experiment, and revision process.

5. TECHNIQUE ANALYSIS

Descriptive statistics (e.g., average score) was used to analyze the quantitative data of the process of validity and limited trial. The average score data of the validity process was compared to the validity level proposed by Qohar et al. [102] (See Table 2).

Table 2. The categorization of validity scale.

Validity Scale (Vr)	Category
$1 \leq Vr < 2$	Invalid
$2 \leq Vr < 3$	Less Valid
$3 \leq Vr < 4$	Valid

$4 \leq Vr \leq 5$	Very Valid

Moreover, the qualitative data regarding comments and suggestions in the validation sheet was used to revise the prototype of the Ucing Sumput game. Meanwhile, the average score data of the limited trial was compared to the practicality level proposed by Qohar et al. [102] (See Table 3).

Table 3. The categorization of practicality scale.

Practicality Scale (Pr)	Category
$1 \leq Pr < 2$	Impractical
$2 \leq Pr < 3$	Less Practical
$3 \leq Pr < 4$	Practical
$4 \leq Pr \leq 5$	Very Practical

Moreover, the qualitative data regarding comments and suggestions in the practicality sheet was used to revise the practicality of the Ucing Sumput game in the mathematics learning environment. Thematic analysis of weaknesses and errors in the prototype of the Ucing Sumput game when the validation process and limited trial were performed to revise the gaming product.

The profile of students' achievement emotions in doing mathematics activities in experimental and control groups was described using the framework proposed by Azwar [103] (See Table 4).

Table 4. The categorization of students' achievement emotions.

Profile Scale (x)	Category
$x \leq Mi - Si$	Low
$Mi - Si < x \leq Mi + Si$	Moderate
$x > Mi + Si$	High

The value of N-gain was used to describe the increase of students' positive emotions and the decrease of students' negative emotions in each group [104] (See Table 5).

Table 5. The categorization of n-gain value.

N-Gain Value (Ng)	Category
$Ng < 0.30$	Low
$0.30 \leq Ng < 0.70$	Moderate
$Ng \geq 0.70$	High

In addition, Hedges' equation was selected to compute the effect size of the Ucing Sumput game in stabilizing students' achievement emotions in attending math classes and taking math exams. Cohen et al. [105] categorized the level of effect size in the g unit (See Table 6).

Table 6. The categorization of effect size in the g unit.

Effect Size (g)	Category
0.00 – 0.20	Weak
0.21 – 0.50	Modest
0.51 – 1.00	Moderate
> 1.00	Strong

Moreover, inferential statistics (e.g., paired t-sample test and independent t-sample test) was applied to examine the effect of Ucing Sumput as a digital educational game in stabilizing students' mathematics achievement emotions. Particularly, a paired t-sample test was used to examine the effect of the Ucing Sumput game in increasing students' positive emotions and decreasing students' negative emotions. Meanwhile, an independent t-sample test was used to examine differences in the stability of achievement emotions in doing mathematics activities between students who received Ucing Sumput game-assisted direct instruction and students who only received direct instruction. All of the calculations in this study were promoted by a few software (e.g., SPSS ver. 26 and CMA ver. 4).

IV. DATA ANALYSIS

1. *NEEDS ANALYSIS AND DESIGNING PROCESS OF UCING SUMPUT GAME (RQ1 & RQ2)*

Needs analysis was conducted to identify Indonesian students' needs related to their achievement emotions in doing mathematics activities which had not been stable [14, 15] and Sundanese local wisdom gradually faded because of incoming foreign cultures, such as Korean, Japanese, Chinese, and Western [25, 26]. A survey conducted on 150 students at a public senior high school in Bandung City revealed that most of them wanted the involvement of games in mathematics learning in that it interested and motivated them to learn mathematics (See FIGURE 4).

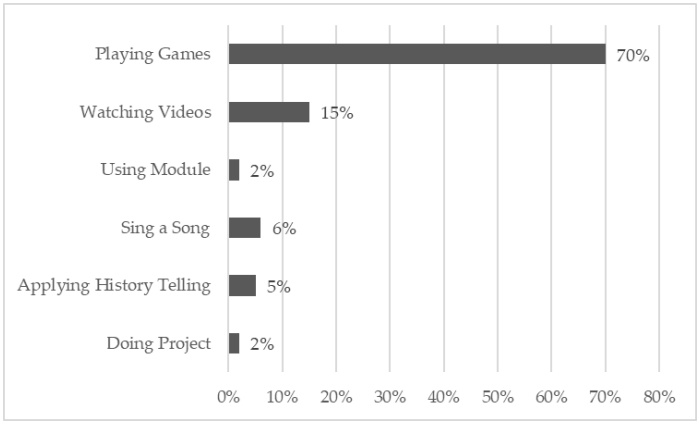

FIGURE 4. Students' response regarding interesting activities in mathematics learning.

Additionally, many students relatively selected digital games consisting of Android-based games, web-based games, virtual games, and computer games because they always bring a smartphone when attending math class (See FIGURE 5). Consequently, they can use it to play games during mathematics learning. Moreover, Sundanese local wisdom is an important part to be included in mathematics activities because its existence in Sundanese youngers, including students gradually faded in the last two decades [22, 47]. Traditional games (e.g., Oray-Orayan, Hahayaman, Ucing Sumput, Engklek, Gatrik, Boi-Boian, Galah Asin, Congklak, Egrang, and Endog-Endogan) are one of the main forms of Sundanese local wisdom. Ucing Sumput, one of the Sundanese traditional games, has extremely not been popular in the community of West Java people [24]. Therefore, the present study develops Ucing Sumput as a digital educational game projected to increase students' positive emotions and decrease students' negative emotions in attending math class and taking math exams. Indirectly, the elaboration between this game and the mathematics learning environment strengthens and sustains the existence of Sundanese local wisdom for students in academic settings.

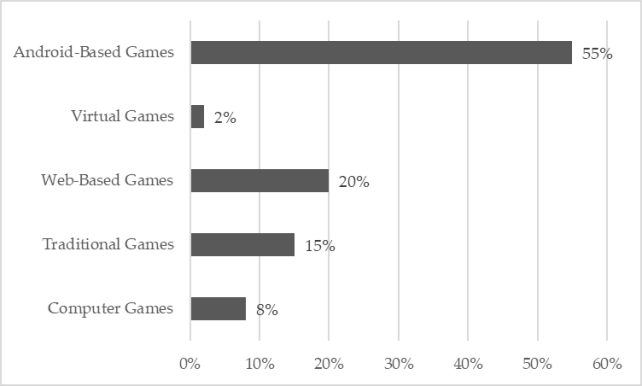

FIGURE. 5. Students' response regarding game types in mathematics activities.

Furthermore, the designing process of Ucing Sumput as a digital educational game used Construct 2 software. Some literature states that Construct 2 is an HTML5-based game creation tool specifically for the 2D platform developed by Scirra [106-108]. In Construct 2 software, this software did not use a special programming language because all the commands used in the game are arranged in an even sheet consisting of events and actions.

FIGURE 6-a. Game cover

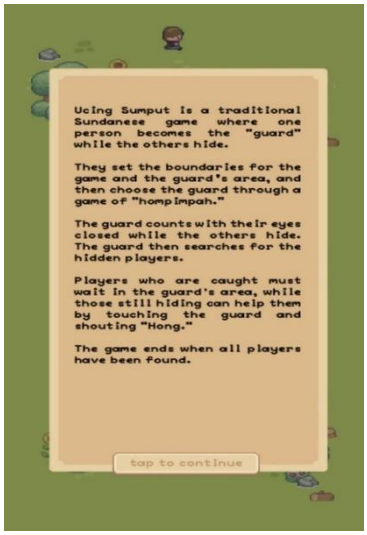

FIGURE 6-b. Game literacy

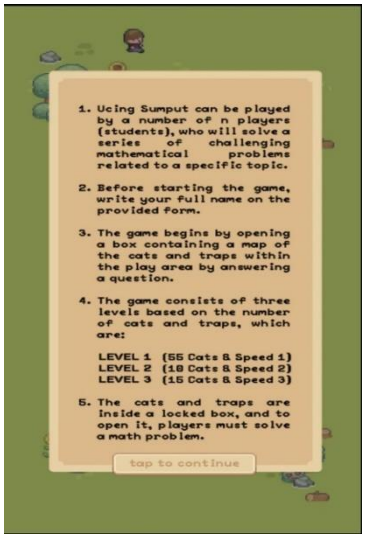

FIGURE 6-c. Game instruction

Generally, the Ucing Sumput game in the digital version was characterized by players (P), cats (C), traps (T), and maps (M). Several characters, such as cats, traps, and maps were located in the boxes in which the player had to solve mathematics problems regarding enumeration rules and the probability of compound events to open the boxes. Algorithmically, the Ucing Sumput game consisted of (1) game cover, (2) game literacy, (3) game instructions, (4) game level, (5) a map of cat position, and (6) game area. Specifically, every phase of this game is explained in the following paragraph.

The first view of the Ucing Sumput game in the digital version was started by the cover game (See FIGURE 6a). This cover illustrated the real form of the Ucing Sumput game in the daily life of the Sundanese community. The next slide was related to game literacy which described the information of Ucing Sumput as a Sundanese traditional game (See FIGURE 6b). This literacy helped players to learn information regarding the Ucing Sumput game. Then, the next screen was related to game instructions which explained the rules and steps of playing this game (See FIGURE 6c). As a consequence, players knew how to play the Ucing Sumput game. One of the substantial instructions of this game was that a player use the navigation on the touch screen of the smartphone in moving to left, right, top, or bottom. Additionally, a player tapped the black button to solve a mathematics problem.

FIGURE 7-a. Game level

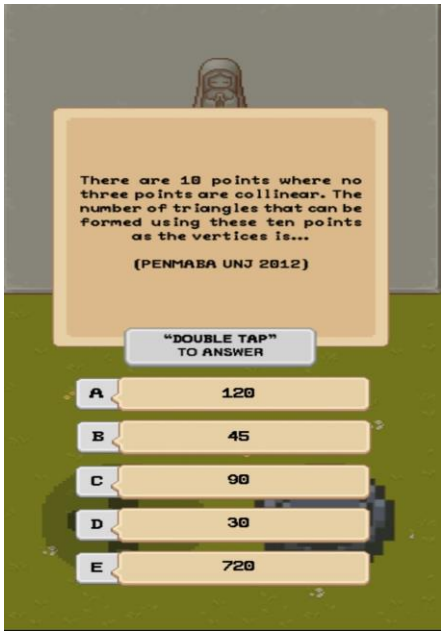

FIGURE 7-b. Math problems

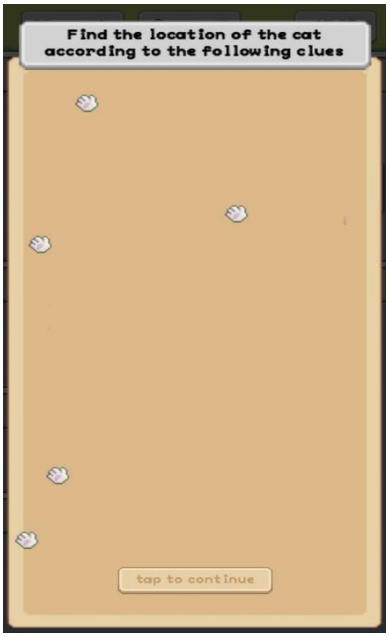

FIGURE 7-c. Map of cat position

Furthermore, a player selected the level of the Ucing Sumput game consisting of three levels (See FIGURE 7a). In detail, the first level consisted of five cats and five traps whereby a player had 15 minutes to find the cats. If a player was successful in finding a cat, he/she got two points but if he/she found a trap, his/her point was subtracted by one point. The second level consisted of ten cats and five traps in which a player had 20 minutes to find the cats. If a player was successful in looking for a cat, he/she got three points but if he/she found a trap, his/her point was subtracted by two points. The third level consisted of 15 cats and five traps whereby a player had 25 minutes to find the cats. If a player was successful in finding a cat, he/she got four points but if he/she found a trap, his/her point was subtracted by three points. Consequently, to accurately find the position of cats, a player had to carefully read a map of cat positions (See FIGURE 7c). To get the map, a player had to correctly solve a mathematics problem in a box (See FIGURE 7b). The mathematics problem was related to enumeration rules or probability of compound events.

After a player carefully read the map of cat positions, he/she started to find the cats in a variety of rooms in the home (See FIGURE 8a). He/she was able to move left, right, top, or bottom in looking for cats using the navigation. When a player is confident with the position of a cat, he/she does a double tap of the black button to appear a mathematics problem (See FIGURE 8b).

If a player was correct in answering the problem, he/she got the points but if a player was incorrect in answering the problem, the slide of a mathematics problem was closed automatically and he/she initiated to find other cats with the easy problem. If a player had found all of the cats or the time was over, he/she got the total point which showed his/her performance in each level (See FIGURE 8c). Then, a player was going to back to the slide of the game level to do the next level using the given button.

FIGURE 8-a. Game area

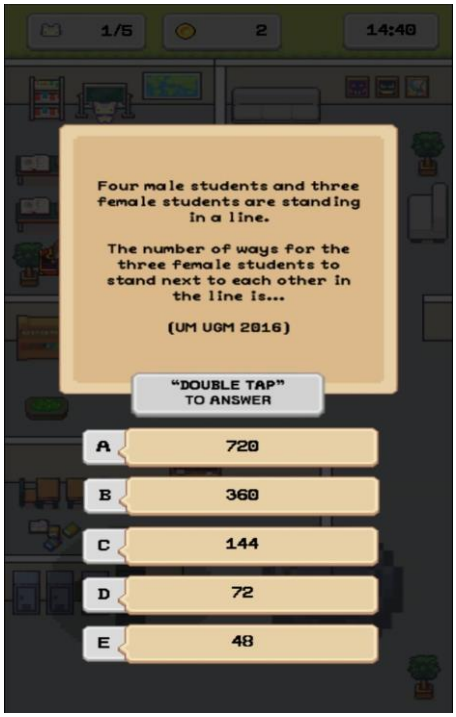

FIGURE 8-b. Math problem

FIGURE 8-c. Total point of game

2. *VALIDATION AND PRACTICALITY OF UCING SUMPUT GAME (RQ3 & RQ 4)*

The prototype of Ucing Sumput as a digital educational game has been validated by three experts in educational technology, mathematics content & Sundanese culture, and the Indonesian language. The aspects validated by them consisted of the operating system, game contents, Indonesian language, and design and graphics (See Table 7). From Table 7, it can be stated that overall, the prototype of Ucing Sumput as a digital educational game was valid. Particularly, some aspects of the Ucing Sumput game consisting of the operating system (e.g., the easy use of the operating system), Indonesian language (e.g., standardization and suitability of the language), and design and graphics (e.g., the selection of letters, layer design, character/illustrator design, music design, and layout of game contents) had been valid. Moreover, the contents of the Ucing Sumput game (e.g., clarity and suitability to learning substance and suitability to learning purpose) had been very valid. It shows that generally, this prototype has been eligible to be continued in limited trials

Table 7. The validation of Ucing Sumput game.

No	Indicator	Average Score	Category
1	The easy use of the operating system	3.75	Valid
2	Clarity and suitability to the learning substance	4.17	Very Valid
3	Suitability to learning purpose	4.00	Very Valid
4	Standardization and suitability of the language	3.89	Valid
5	The selection of letters	4.00	Very Valid
6	The selection of layer design	4.22	Very Valid
7	The selection of character/illustrator design	4.33	Very Valid
8	The selection of music design	3.33	Valid
9	The layout of game contents	3.78	Valid
	Overall Average Score	3.94	Valid

Students' responses regarding the practicality of the Ucing Sumput game in mathematics direct instruction using a questionnaire showed that the overall average score of 16 given statements responded by students was 3.95 (See Table 8). This score interprets that the Ucing Sumput game is practical to be utilized in the mathematics learning environment.

Table 8. The practicality of Ucing Sumput game.

No	Statements	Average Score	Category
1	The Ucing Sumput game is easy to be accessed online on the website	3.91	Practical
2	The Ucing Sumput game is practical to use on Android-based smartphones	4.06	Very Practical
3	This game contains a feature of Ucing Sumput literacy	4.18	Very Practical
4	Ucing Sumput game contains a feature of rules or playing steps	4.24	Very Practical
5	Ucing Sumput game contains a feature of challenging math problems	4.06	Very Practical
6	The graphical display on the Ucing Sumput game is interesting	3.94	Practical
7	The font size in the Ucing Sumput game is proportional	3.88	Practical
8	The presentation of instrumental music in the Ucing Sumput game motivates	3.82	Practical
9	The color combination in the Ucing Sumput game is attractive	3.76	Practical
10	The redaction of Ucing Sumput literacy is easy to understand	3.79	Practical
11	The redaction of rules or steps in the Ucing Sumput game is easy to understand	3.91	Practical
12	The redaction of math problems in the Ucing Sumput game is easy to understand	4.00	Very Practical
13	Features in the Ucing Sumput game are complete and well-structured	3.88	Practical
14	Literacy feature strengthens my knowledge about Ucing Sumput	3.97	Practical
15	Playing activities challenge me to solve math problems	3.97	Practical
16	Playing activities stimulates me to be excited or motivated	3.82	Practical
	Overall Average Score	3.95	Practical

Additionally, some suggestions of students towards Ucing Sumput as a digital educational game are shown in FIGURE 9. From FIGURE 9, it can be stated that there were some suggestions from students to the Ucing Sumput game, such as rechecking error system, adding the illustration of game instructions, explaining correct answer of a math problem, adding next game levels, making math problems easier, designing to be multiplayer, making available to play in offline, making rooms of cats more various, developing animation, song, and playing algorithm, making character colors more interesting, enlarging zoom screen, and providing rewards for the player. Moreover, most of the students suggested interesting character colors and a large zoom screen. All of the suggestions, however, helped us to revise and develop the Ucing Sumput game to be the best product of educational technology in mathematics learning.

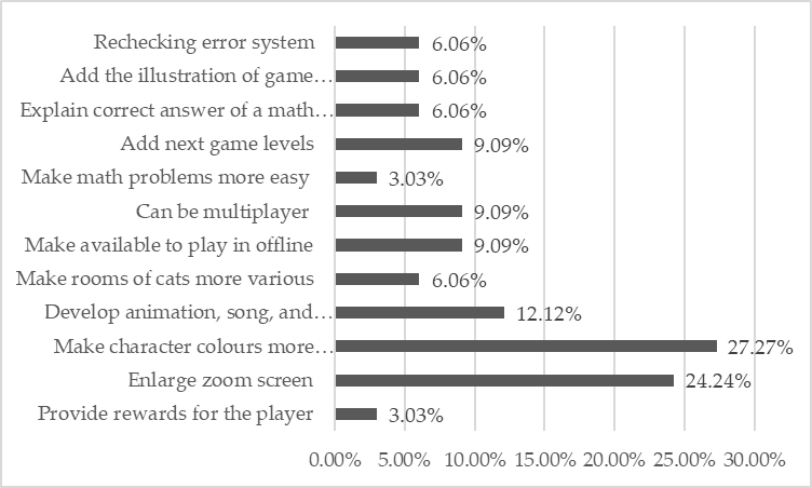

FIGURE 9. Students' suggestions regarding Ucing Sumput game.

3. *THE EFFECTIVENESS OF UCING SUMPUT GAME IN STABILIZING STUDENTS' MATHEMATICS ACHIEVEMENT EMOTIONS (RQ5 & RQ6)*

Students' achievement emotions (e.g., enjoyment, pride, anger, anxiety, shame, hopelessness, boredom, hope, contentment, and relaxation) in doing mathematics activities before and after the intervention conducted in experimental class (Ucing Sumput game-assisted mathematics direct direction) and control class (mathematics direct instruction) are shown in Table 9.

Table 9. Students' achievement emotions in doing mathematics activities.

Intervention	Achievement Emotions	Mean	DS	N	Category
Ucing Sumput Game-Assisted Mathematics Direct Instruction					
Pre-Emotions	Enjoyment	21.65	3.91	34	Moderate
	Pride	12.59	3.18	34	Moderate
	Hope	12.32	2.48	34	Moderate
	Contentment	8.97	2.29	34	Moderate
	Relaxation	9.76	2.86	34	Moderate
	Positive Emotions	65.29	9.97	34	Moderate
	Anger	20.06	2.24	34	High
	Anxiety	32.18	2.53	34	Moderate
	Shame	16.76	2.06	34	Moderate
	Hopelessness	11.85	1.26	34	Moderate
	Boredom	16.24	1.62	34	Moderate
	Negative Emotions	97.09	4.69	34	Moderate
Post-Emotions	Enjoyment	30.44	3.91	34	High
	Pride	17.62	2.00	34	High
	Hope	17.71	1.80	34	High
	Contentment	13.44	1.50	34	High
	Relaxation	17.47	1.98	34	High
	Positive Emotions	96.68	9.43	34	High
	Anger	16.59	3.19	34	Moderate
	Anxiety	18.53	4.11	34	Low
	Shame	9.97	2.44	34	Low
	Hopelessness	6.03	1.96	34	Low
	Boredom	10.41	2.52	34	Low
	Negative Emotions	61.53	8.79	34	Low
Mathematics Direct Instruction					
Pre-Emotions	Enjoyment	25.00	3.74	33	Moderate
	Pride	14.48	2.54	33	High
	Hope	14.64	2.38	33	High

	Contentment	10.39	2.59	33	Moderate
	Relaxation	12.09	3.52	33	Moderate
	Positive Emotions	76.61	10.77	33	Moderate
	Anger	10.21	2.33	33	Low
	Anxiety	27.82	7.30	33	Moderate
	Shame	13.52	5.09	33	Low
	Hopelessness	7.73	3.94	33	Low
	Boredom	12.12	4.35	33	Low
	Negative Emotions	71.39	19.51	33	Low
Post-Emotions	Enjoyment	25.76	4.57	33	Moderate
	Pride	14.00	3.36	33	Moderate
	Hope	15.55	2.54	33	High
	Contentment	10.94	2.73	33	Moderate
	Relaxation	13.21	3.44	33	Moderate
	Positive Emotions	79.45	12.87	33	Moderate
	Anger	15.94	3.17	33	Moderate
	Anxiety	23.58	7.97	33	Low
	Shame	11.82	4.61	33	Low
	Hopelessness	7.12	3.68	33	Low
	Boredom	11.82	3.73	33	Low
	Negative Emotions	70.27	17.63	33	Low

DS = Deviation Standard; N = Sample Size

From Table 9, it can be shown that using Ucing Sumput game-assisted mathematics direct instruction, students' positive emotions (e.g., enjoyment, pride, hope, contentment, and relaxation) in doing mathematics activities increased from moderate level to high level, whereas students' negative emotions (e.g., anger, anxiety, shame, hopelessness, and boredom) in doing mathematics activities decreased from moderate level to low level. Meanwhile, when implementing mathematics direct instruction, students' positive and negative emotions in attending math class and taking math exams were relatively stagnant. This indicates that there is an effective intervention of Ucing Sumput game-assisted mathematics direct instruction in increasing students' positive emotions and decreasing students' negative emotions.

To specifically describe the effect of Ucing Sumput as a digital educational game in stabilizing students' achievement emotions in doing mathematics activities, the unit of effect size in Hedges g was applied (See Table 10).

Table 10. The effect size of Ucing Sumput game on students' mathematics achievement emotions.

Achievement Emotions	Effect Size in g Unit	Category
Enjoyment	2.808 [2.137; 3.479]	Strong
Pride	1.751 [1.192; 2.310]	Strong
Hope	1.967 [1.389; 2.546]	Strong
Contentment	1.660 [1.109; 2.210]	Strong
Relaxation	2.355 [1.736; 2.973]	Strong
Positive Emotions	3.683 [2.900; 4.466]	Strong
Anger	-2.260 [-2.868; -1.651]	Strong
Anxiety	-1.868 [-2.437; -1.299]	Strong
Shame	-1.507 [-2.045; -0.969]	Strong
Hopelessness	-2.382 [-3.004; -1.760]	Strong
Boredom	-1.956 [-2.534; -1.379]	Strong
Negative Emotions	-3.792 [-4.589; -2.994]	Strong

Table 10 showed that the Ucing Sumput game had a positive strong effect in increasing students' positive emotions, such as enjoyment, pride, hope, contentment, and relaxation. Moreover, the Ucing Sumput game also had a strong effect in decreasing students' negative emotions, such as anger, anxiety, shame, hopelessness, and boredom. This indicates that Ucing Sumput game-assisted mathematics direct instruction had a positive or negative effect in stabilizing students' achievement emotions in doing mathematics activities.

Furthermore, to describe the increase in students' positive emotions and the decrease in students' negative emotions using Ucing Sumput game-assisted mathematics direct instruction, the N-gain value was applied (See Table 11). From Table 11, it can be stated that Ucing Sumput game-assisted mathematics direct instruction had a high increase in students' positive emotions and a moderate decrease in students' negative emotions in doing mathematics activities. Meanwhile, mathematics direct instruction had a low increase in students' positive emotions and a low decrease in students' negative emotions in attending math class and taking math exams. This indicates that relatively, the Ucing Sumput game moderately stabilizes students' achievement emotions in doing mathematics activities.

Table 11. The effect size of Ucing Sumput game on students' mathematics achievement emotions.

Intervention	Achievement Emotions	Mean	DS	N	Category
Ucing Sumput Game-Assisted Mathematics Direct Instruction	Enjoyment	0.68	0.21	34	Moderate
	Pride	0.63	0.39	34	Moderate
	Hope	0.69	0.23	34	Moderate
	Contentment	0.70	0.33	34	High
	Relaxation	0.76	0.19	34	High
	Positive Emotions	0.71	0.17	34	High
	Anger	-0.92	1.72	34	High
	Anxiety	-0.62	0.29	34	Moderate
	Shame	-0.55	0.32	34	Moderate
	Hopelessness	-0.76	0.39	34	High
	Boredom	-0.44	0.29	34	Moderate
	Negative Emotions	-0.58	0.21	34	Moderate
Mathematics Direct Instruction	Enjoyment	0.07	0.30	33	Low
	Pride	-0.17	0.69	33	Low
	Hope	0.13	0.41	33	Low
	Contentment	0.06	0.47	33	Low
	Relaxation	0.14	0.50	33	Low
	Positive Emotions	0.08	0.28	33	Low
	Anger	0.37	0.19	33	Moderate
	Anxiety	-0.17	0.19	33	Low
	Shame	-0.15	0.29	33	Low
	Hopelessness	-0.08	0.19	33	Low
	Boredom	-0.05	0.22	33	Low
	Negative Emotions	-0.02	0.11	33	Low

DS = Deviation Standard; N = Sample Size

A paired t-test was applied to examine Ucing Sumput as a digital educational game in increasing students' positive emotions and decreasing students' negative emotions in doing mathematics activities (See Table 12).

Table 12. The results of the paired sample t-test.

Intervention	Achievement Emotions	t-value	df	Sig. Value
Ucing Sumput Game-Assisted Mathematics Direct Instruction	Enjoyment	15.846	33	0.000**
	Pride	8.498	33	0.000**
	Hope	12.099	33	0.000**
	Contentment	10.040	33	0.000**
	Relaxation	17.684	33	0.000**
	Positive Emotions	21.246	33	0.000**
	Anger	-4.517	33	0.000**
	Anxiety	-14.472	33	0.000**
	Shame	-11.620	33	0.000**
	Hopelessness	-12.836	33	0.000**
	Boredom	-10.659	33	0.000**
	Negative Emotions	-18.480	33	0.000**
Mathematics Direct Instruction	Enjoyment	1.872	32	0.070

Pride	-1.016	32	0.317
Hope	2.864	32	0.007*
Contentment	1.557	32	0.129
Relaxation	2.159	32	0.038*
Positive Emotions	2.497	32	0.018*
Anger	9.421	32	0.000**
Anxiety	-5.564	32	0.000**
Shame	-2.991	32	0.005*
Hopelessness	-2.319	32	0.027*
Boredom	-0.744	32	0.462
Negative Emotions	-1.105	32	0.277

Note: ** < 0.0001; * < 0.05

Table 12 showed that Ucing Sumput game-assisted mathematics direct instruction significantly increased students' positive emotions (e.g., enjoyment, pride, hope, contentment, and relaxation) and decreased students' negative emotions (e.g., anger, anxiety, shame, hopelessness, and boredom). Meanwhile, mathematics direct instructions significantly increased students' positive emotions but there was no adequate evidence to state that it significantly decreased students' negative emotions. This indicates that Ucing Sumput game-assisted mathematics direct instruction significantly stabilized students' achievement emotions in doing mathematics activities.

Additionally, an independent t-test was applied to examine the different increases and decreases of achievement emotions in doing mathematics activities between students who studied using Ucing Sumput game-assisted mathematics direct instruction and students who studied using mathematics direct instruction (See Table 13).

Table 13. The results of the independent sample t-test.

Achievement Emotions	t-value	df	Sig. Value
Enjoyment	9.621	65	0.000**
Pride	5.913	65	0.000**
Hope	6.940	65	0.000**
Contentment	6.419	65	0.000**
Relaxation	6.802	65	0.000**
Positive Emotions	11.041	65	0.000**
Anger	-4.255	65	0.000**
Anxiety	-7.635	65	0.000**
Shame	-5.365	65	0.000**
Hopelessness	-9.208	65	0.000**
Boredom	-6.196	65	0.000**
Negative Emotions	-13.368	65	0.000**

Note: ** < 0.0001

From Table 13, it can be stated that there was a significantly different increase of positive emotions in doing mathematics activities between students who studied using Ucing Sumput game-assisted mathematics direct instruction and students who studied only using mathematics direct instruction. Moreover, there was also a significantly different decrease in negative emotions in attending math class and taking math exams between students who studied using Ucing Sumput game-assisted mathematics direct instruction and students who studied only using mathematics direct instruction. This provides strong evidence that Ucing Sumput as a digital educational game can significantly stabilize students' achievement emotions in doing mathematics activities.

V. DISCUSSION

1. UCING SUMPUT GAME AND ACHIEVEMENT EMOTIONS IN DOING MATHEMATICS ACTIVITIES

Students' needs related to interesting and motivating mathematics learning initiate this study to develop and produce an educational game because it can make students joyful and happy in attending math class [27]. Moreover, to play on mobile, the educational game is designed digitally for Android system-based smartphones using Construct 2 software. Gilski and Stefanski [30] stated that digital educational game makes students more

flexible and mobile in playing it in academic settings. Additionally, the existence of Sundanese local wisdom, including traditional games like Ucing Sumput in young generations gradually faded in the last decade [22, 47]. As a consequence, the context of the digital educational game designed in this studys adapts Sundanese local wisdom. Furthermore, Ucing Sumput as a digital educational game has some characters, such as player (P), cat (C), trap (T), and map (M). Specifically, the characters, such as cats, traps, and maps are located in the boxes whereby the player has to solve a math problem to open the box. The Ucing Sumput game consists of a game cover, game literacy, game instruction, game level, a map of the cat's position, and a game area. Systematically, this game starts from the game cover to the game area.

Substantially, Branch [84] explained that a developmental prototype, including the Ucing Sumput game, is required to be validated by experts and pass through some limited trials before the prototype is utilized in academic settings, such as mathematics learning. The prototype of Ucing Sumput as a digital educational game has overall been valid. Particularly, several aspects of this game, such as the operating system, Indonesian language, and design and graphics have been valid. Moreover, the contents of the Ucing Sumput game have been very valid. This shows that the prototype of the Ucing Sumput game has been eligible to be conducted in limited trials. The process of the limited trial revealed that overall, Ucing Sumput as a digital educational game is practical to be utilized in mathematics instruction. This interprets that the operating system, features, redactions, design, and graphics of the Ucing Sumput game are practical to be used by users, such as teachers and students in mathematics learning. There, however, are some suggestions (e.g., making character colors more interesting and enlarging the zoom screen) from students to revise and re-develop the Ucing Sumput game to the best technological product in mathematics instruction.

Moreover, Branch [84] stated that the effectiveness of an educational prototype or product projected to the cognitive, affective, or psychomotor dimension is an essential aspect of the developmental phase. The prototype of the Ucing Sumput game in this study is projected to stabilize students' achievement emotions in doing mathematics activities. In the literature, Suparman et al. [3] explained that the condition of students' stable achievement emotions is represented by the increase in students' positive emotions and the decrease in students' negative emotions. Descriptively, this study reveals that students' positive emotions (e.g., enjoyment, pride, hope, contentment, and relaxation) increased from moderate to high levels while students' negative emotions (e.g., anger, anxiety, shame, hopelessness, and boredom) decreased from moderate to low level in attending math class and taking math exam. Additionally, this study shows that the Ucing Sumput game had a positive strong effect in increasing students' positive emotions and a negative strong effect in decreasing students' negative emotions. In a meta-analysis study, Lei et al. [29] also reported that digital educational games had a positive moderate effect ($g = 0.526$ [0.319; 0.733]) in increasing students' positive emotions and negative moderate effect ($g = -0.517$ [-0.709; -0.324]) in decreasing students' negative emotions. This indicates that the Ucing Sumput game is an effective treatment to stabilize students' achievement emotions in doing mathematics activities.

Students who studied using Ucing Sumput game-assisted direct instruction had a high increase in positive emotions and a moderate decrease in negative emotions. Moreover, significantly this treatment increased students' positive emotions and decreased students' negative emotions in attending math class and taking math exams. Lei et al. [29] also showed that digital educational games significantly increased students' positive emotions and decreased students' negative emotions. Additionally, this study has proved that there was a significantly different increase in positive emotions and a significantly different decrease in negative emotions between students who studied using Ucing Sumput game-assisted mathematics direct instruction and students who studied only using mathematics direct instruction. Descriptively, the increase in students' positive emotions who studied using the Ucing Sumput game was higher than the increase in students' positive emotions who did not use the Ucing Sumput game. In addition, the decrease in students' negative emotions who studied using the Ucing Sumput game was also higher than the decrease in students' negative emotions who did not use the Ucing Sumput game. Chen et al. [28] also stated that gaming activities in educational settings stimulated activating positive emotions and deactivating negative emotions. This evidence justifies that Ucing Sumput as a digital educational game is effective in stabilizing students' achievement emotions in mathematics activities.

Several relevant studies revealed that Android-based educational games significantly increased students' learning interest in mathematics [16, 40, 41, 43, 45]. Additionally, digital educational games can increase students' learning motivation because they provide interactive, challenging, and fun experiences in the learning process [68, 69]. Particularly, Suddin and Deda [49] showed that Android-based educational games using Timor local wisdom motivated and facilitated students in mathematics learning. Students who are interested and motivated in mathematics learning indicate that they have high positive emotions and low negative emotions [40]. This means that digital educational games using the Android system can stimulate students to stabilize their achievement emotions. Moreover, the effectiveness of the Ucing Sumput game in stabilizing students' achievement emotions indicates that digital educational games can stimulate students to enhance their

mathematics achievement. Some empirical studies also revealed that Android-based educational games significantly enhanced students' mathematics achievement [32-35, 39]. This indicates that Ucing Sumput as a digital educational game can enhance students' mathematics achievement moderated by the stability of students' achievement emotions in doing mathematics activities. Therefore, academic settings, including mathematics learning have to ensure that students' achievement emotions are stable in doing mathematics activities, such as attending math class, taking math exam, and conducting math homework.

2. IMPLICATIONS TO MATHEMATICS LEARNING

The present study has produced Ucing Sumput as a digital educational game that is valid and practical to be utilized in mathematics instruction. Descriptively, the Ucing Sumput game has a positive strong effect in increasing students' positive emotions and a negative strong effect in decreasing students' negative emotions in doing mathematics activities. Additionally, this study also has proved that the Ucing Sumput game significantly increases students' positive emotions and decreases students' negative emotions in attending math class and taking math exams. As a consequence, the digital educational game can be an emotional treatment in mathematics instruction to stabilize students' achievement emotions. Stable achievement emotions promote students' mathematics achievement. Some empirical studies showed that achievement emotions and mathematics achievement have a significant positive relationship [109-111]. This indicates that achievement emotions can be a predictor of students' mathematics achievement. This implies that mathematics practitioners, such as teachers and lecturers must pay attention to the stability of students' achievement emotions in doing mathematics activities such that they can get the best mathematics achievement in educational settings.

3. LIMITATIONS AND SUGGESTIONS

Limited trials of the Ucing Sumput game involve 34 students who are studying enumeration rules and probability in which there are 3-5 students who can't access the Ucing Sumput game on the given website online. The school institution has provided the service of an internet network for all of the students but they are unable to connect to the given website (https://game-v3.reedsproject.com/). Additionally, the experimental process to examine the effectiveness of the Ucing Sumput game in stabilizing students' achievement emotions is only a one-shot study conducted in mathematics learning applying direct instruction. Consequently, the future experimental process should be conducted with as many as 3 – 5 shots to investigate the consistency of effectiveness of the Ucing Sumput game in stabilizing students' achievement emotions in doing mathematics activities. Moreover, educational practitioners like mathematics teachers have to ensure that every student can access and connect to the given website using the settled internet network.

VI. CONCLUSION

Indonesian students' needs regarding interesting and motivated mathematics learning and Sundanese local wisdom which has gradually faded because of incoming foreign cultures initiate this study to develop and produce a digital educational game called as Ucing Sumput, including the context of Sundanese culture. The Ucing Sumput game in digital version is characterized by players (P), cats (C), traps (T), and maps (M). Several characters, such as cats, traps, and maps are located in the boxes in the player has to solve math problems to open the boxes. The prototype of the Ucing Sumput as a digital educational game has been valid and practical to be utilized in mathematics instruction. Moreover, most of the students suggest providing interesting character colors and a large zoom screen. Significantly, the Ucing Sumput game has a positive strong effect in increasing students' positive emotions and a negative strong effect in decreasing students' negative emotions. Consequently, the Ucing Sumput as a digital educational game can be one of the effective technological interventions and utilized by mathematics teachers in mathematics instruction to stabilize students' achievement emotions in doing mathematics activities.

Funding statement

We are also thankful to the Indonesian Endowment Fund of Education (LPDP) for partial financial support (Granted Number: SKPB-3939/LPDP/LPDP.3/2023).

Author Contributions

All authors contributed to this developmental study. Suparman: conducting needs analysis, designing the gaming prototype & instruments, analyzing the data & interpreting it, and writing the original manuscript; Hestu Tansil La'ia and Alberta Parinters Makur: conducting limited trials & experimental research and collecting the

data; Turmudi: validating and supervising developmental study; Dadang Juandi, Masniladevi, and Yullys Helsa: reviewing and editing the manuscript.

Conflict of Interest

There is no conflict interest of this study.

Data Availability Statement

To access the data supporting the reported results, this email (arman95@upi.edu) can be contacted.

Acknowledgement

This study greatly appreciates the involvement of the head of an educational institution, mathematics teachers, and students at a public senior high school in Bandung City who have permitted us to do limited trials and experimental research related to the Ucing Sumput game and achievement emotions in mathematics activities.

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