Developing Mobile Game “Brainchemist” as Senior High School/ Islamic Senior High School Chemistry Learning Media in The Topics of Solubility, Solubility Product and Colloid

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Abstract

The research aims at developing a mobile game "Brainchemist" for high school learning media in the topics of solubility, soluble product, and colloid. The mobile game "Brainchemist" is developed using the development model ADDIE (Analysis-Design-Development-Implementation-Evaluation) that is limited to the fourth phase which is implementation. The mobile game "Brainchemist" product is reviewed by material experts, IT experts and peer reviewers. The quality of the mobile game "Brainchemist" is determined with data analysis obtained from 5 chemistry teachers and 24 high school students (science class) of year 11. The product quality evaluation is obtained from a questionnaire which contains aspects of material and problems, language, conduct, audio visual layout and software engineering. The mobile game "Brainchemist" can run on Android-based mobile phones. The teachers find the mobile game as very good with the ideality percentage of 81.10%. Students find the mobile game interesting and amusing and it motivates them to learn chemistry. Based on the evaluation, the mobile game "Brainchemist" is valid to be used as chemistry learning media in the topics of solubility, soluble product, and colloid.

Keywords: *mobile game "Brainchemist', ADDIE, Android, learning media, solubility, soluble product, colloid*

1. INTRODUCTION

1.1. Background

The rapid development of technology has touched various fields including education. Technology influences learning processes that it boosts more applicative and more interesting learning activities which can improve educational quality. Suitable innovations and new methods help students' comprehension process that students can apply the knowledge they obtained in everyday life.

One of the ways in achieving effective learning is through the use of media. Learning media are message-bearing technology which can be used for learning purposes. Media which can be used by teachers in learning are, among others, games. Many people are fond of games which are amusing and motivating. Games may teach many skills and they can be alternative learning media in education (Wiwik A. Aeni, 2009).

Games as learning media can be applied to a technology which is presently widely used – mobile phone. A mobile phone is a communication device which can be used for telephoning and text messaging. The present mobile phones have supporting features such as internet, games, email, music player, and Bluetooth. This type of mobile phones comes in many varieties. A type of mobile phones with the most rapid advancement is Android mobile phones. This type

of mobile phones has various features which are not available in other types of mobile phones.

Mobile games are games available on mobile phones. Games vary depending on users' needs such as educational games as educational media. JENI (2008) stated that mobile games used as learning media are called mGBL (mobile-Game-Based Learning). The mGBL is developed in accordance with educational levels and the prevailing curriculum in order to achieve learning objectives. The mobile-phone-based learning media developed are the mobile games "Brainchemist", which are mobile games adapted from the mobile games Brainjiggle and BrainJuice which are modified so as to suit elaboration on chemistry.

Solubility, soluble products, and colloid relate to everyday life. The topics are discussed in the chemistry subject of year 11 in the second semester (science class). Solubility and soluble products actually relate to sedimentation as in kidney stone sedimentation. Whereas, colloid relates to milk, scattering of light effects and adsorption. The close relationship between the topics and everyday life supports the development of the mobile game "Brainchemist". The mobile games consist of lessons, exercises and explanation. The mobile games are developed to improve students' comprehension on chemistry especially on the topics of solubility, soluble products, and colloid.

1.2. Statement of Problem

Based on the background, the statements of problem are: (1) how to develop the mobile games "Brainchemist" as high school chemistry learning media in the topics of solubility, soluble products, and colloid? (2) How are the quality of mobile games "Brainchemist" according to the evaluation of chemistry teachers and the high school students? And (3) what is the validity of the mobile games "Brainchemist" when used as high school learning media?

1.3. Research Objective

The research aims at (1) developing the mobile "Brainchemist" as high school learning media, (2) finding out the quality of Brainchemist as senior high school learning media based on the evaluation of chemistry teachers and high school students.

2. LITERATURE REVIEW

2.1. Chemistry Learning

Chemistry learning closely relates to the concepts of learning and concepts of chemistry itself. Chemistry is a science which answers the what-why-and-how questions on natural phenomena relating to composition, structures and characteristics, changes, dynamics and energy of matters. The chemistry subject in high schools elaborates on topics related to matters including composition, structures and characteristics, changes, dynamics and energy and involving skills and reasoning. Chemistry has two inseparable elements: chemistry as products (chemistry science in forms of facts, concepts, principles, laws and theories) and chemistry as process which is scientific work (E. Mulyasa, 2008).

2.2. Learning Media

Media derive from a Latin word *medium* literally means middle, intermediate or introduction. Media are the plural form of medium. The concept of media in the learning process is inclined to consisting of graphic, photographic or electronics devices to re-capture, re-process and rearrange visual and verbal information (Azhar Arsyad, 2011).

Chemistry learning can be supported by, among others, learning media. Good learning media consist of 4 primary elements (Mulyanta and M. Marlong Leong, 2009):

a. Relevance. Learning media must be relevant to learning needs, lesson plans, learning activities programs, learning objectives and students' characteristics.
b. Ease. The contents of learning media must be easily understood, learned and comprehended by students and operational in their use.
c. Interest. Learning media must be able to interest students. The media can be interesting when they have interesting layouts, selection of colors and contents.
d. Benefits. The contents of learning media must be valuable and beneficial to students' comprehending the lessons. Learning media must not be a waste of time and must not give bad influences.

2.3. Solubility, Soluble Product, and Colloid

Based on the regulation of Indonesian National Education Minister No. 22 year 2006 concerning Content Standard, the primary topics of solubility and soluble product are taught to students (science class) of year 11 in the second semester. The topics of solubility and soluble product are taught to meet the competence 4 which is to understand characteristics of acidic-basic solutions, measurement methods and the applications. Colloid is taught to meet the competence 5 which is to elaborate on colloid systems and its characteristics and the applications in everyday life.

The topic of solubility and soluble product is contained in 2 sub chapters, namely solubility, soluble product, and precipitation reaction. The topic of colloid is contained in the sub chapter of colloid systems, characteristics of colloid and the building of colloid system.

2.4. Development Research

Learning media development usually refers to one of the development models. One of the models which is most commonly used by instructional system developers to develop an instructional system is ADDIE Model. Several phases in ADDIE are as follows (Mulyanta and M. Marlong Leong, 2009):

a. Analysis phase
b. Design phase

c. Development phase
d. Implementation phase
e. Evaluation phase

2.5. Android Operating System

Android is a platform for mobile operating system. Android is an open-source and Linux-kernel based operating system. The platform enables developers to develop programs with Java and device settings through Google Java Libraries. The platform supports a number of connecting technologies such as GSM/EDGE, CDMA, EV-DO, UMTS, Bluetooth and Wi-Fi. Android provides various features such as application frameworks Dalvik Virtual Machine, graphics, SQLite, media supporters, rich development environment, including emulator, debugging tools, and plugin for Eclipse IDE (Stephanus Hermawan S, 2011).

2.6. Eclipse Indigo RCP 3.7

Eclipse is presently one of the most preferred IDEs due to its being free and open source which means that any one may have a look at its programming codes. In addition to that, another favorable factor which makes Eclipse preferable is its ability to be developed using a component called plugin (www.eclipse.com).

2.7. Relevant Researches

Amelia Handayani Burhan (2012) developed a chemistry game in the Stoichiometry Academy series as chemistry learning media for year 10 students of senior high schools. The quality of the chemistry game in the Stoichiometry Academy series is considered very good by 5 chemistry teachers and valid to be used chemistry learning media for year 10 students of high schools in the topics of basic laws of chemistry and stoichiometry. Another research conducted by JENI SEAMOLEC Development Team (2008) entitled *Development of Mobile-Game-Based Learning* shows that educational mobile games built with the open source software JAVA ME run on almost all mobile phones available in Indonesian market. The mobile games have met all the development prerequisites phases for instructional program development because they cover planning, developing, information source, and monitoring/evaluating aspects.

The two studies are relevant to this development research. Game-based chemistry learning media are learning media which can be used to achieve learning. Mobile games as educational games can be used as chemistry learning media. The development of Brainchemist is expected to be used as high school chemistry learning media for teachers and students.

3. RESEARCH METHODOLOGY AND FINDINGS

3.1. Research Methodology

The research is developed in conformity to ADDIE Model which consists of five phases: Analysis, Design, Development, Implementation and Evaluation. The research is limited to the implementation phase. The media development starts with the analysis phase (benefit analysis and the objective of the mobile game development, review on competencies standards and basic competencies), design phase (mobile game design and formulation of measurement instruments), development phase (mobile game development and reviews by lecturer-advisor, material experts, IT experts, and peer review) and implementation phase (mobile game evaluation by teachers and students).

Questionnaire used for measuring the quality of the media is adapted from a readily available evaluation instrument (Romi Satria Wahono, 2006). The evaluation criteria cover 5 aspects: material and problems, language, feasibility, audio visual layouts and software engineering (material and problems for students are excluded). Qualitative data are transformed into quantitative data which are tabulated and analyzed using ideal measurement criteria to determine the quality of the learning media (Eko Putro Widyoko, 2011). The quality of the learning media given by teachers and students is used for determining the validity of the mobile game "Brainchemist". The mobile game is valid to be utilized as chemistry learning media for high schools students if it obtains at least "Good" (B) according to teachers and students.

3.2. Discussion

The development research results is a mobile game called "Brainchemist" that can be utilized as one of high school chemistry learning media in the topics of solubility, soluble product, and colloid. The mobile game "Brainchemist" is an application with an *.apk* extension that can run on mobile phones with Android as the operating system. The mobile game "Brainchemist" is developed with Eclipse Indigo which is based on Java coding. Pictures and backgrounds are made with Corel Draw X3 taking .png format and the sound is made using Audacity taking .ogg format. The following are Brainchemist layouts:

a b

c d

Picture 1: Brainchemist layouts: a. Splash scene and Main Menu, b. game options and game sub menu, c. solubility game material and solubility game fill-in problems, d. colloid characteristics material and colloid system game (landscape version)

A splash scene appears in the application start phase which displays the name of the application and product logo. The main menu displays the application title, competence buttons, menu, about, exit and mute sound. The competence buttons consist of competence standards, basic competence and indicators containing the topics of solubility, soluble products, and colloid. The *about* button contains the explanation on the mobile game "Brainchemist" and its developer. The exit button is for exiting the game. The mute sound button is for activating or deactivating the music. However, the sound effects are still active.

The menu button contains game options which are solubility and soluble products, precipitation reaction, colloid system, characteristics, and formulation of colloid system. Each game option contains navigation buttons which are material, direction, game, score and menu. The material button directs to material of each game. The material slide display explanation on the discussed material. When students find the explanation not quite clear they can find further explanation by clicking the reference button. The button is connected to www.chem-is-try.org which requires internet connection.

The direction button contains directions on each game. The game button directs to games which contain problems. There are 10 randomized problems provided and a span of time is provided to complete all the problems. The answers to the problems accompanied by explanation appear after the completion of the problems set. After completion of all problems, a score appears with a reward in form of one star or more than one star. In the score layout, discuss button is provided for discussing all the problems from beginning to the end. The score button contains the highest 5 users' scores. It contains names, scores and time taken to complete all the problems.

The solubility and soluble products games are in the forms of fill-in problems concerning the relationship between solubility and soluble product. The answers to the fill-in

problems are the relationship between solubility and soluble product constant. This game aims at students' doing simple calculation exercises. Precipitation reaction game is multiple choice problems with 3 choices which are *precipitation does not take place, precipitation has not taken place,* and *precipitation takes place* displayed in landscape mode. The problems presented are the results of more complicated calculation than that of solubility and soluble product games.

The colloid system game is matching problems. Two games are provided which are matching a formation phase with a name of colloid and matching an example of colloid in daily life with a name of colloid. This game is in landscape mode. This type of problem is to improve students' memorization. The answers are positioned around the problems. Students answer the problems by dragging the answers in the problem area. Characteristics and formulation of colloid game is multiple choice problems with 5 choices about characteristics and formation of colloid. This type of problems is used because it is the most frequently encountered problems. The problems provide 5 choices which are almost equal so that students do not choose randomly.

Various types of problems are provided as a quiz in the learning media so that students do not become bored with one type of problems. Each time students complete a problem a pop up appears stating if they do it correctly or not. A smiling emoticon appears when they do it correctly and a sad emoticon when they do it incorrectly. This is so done to motivate students to do the problems in each game.

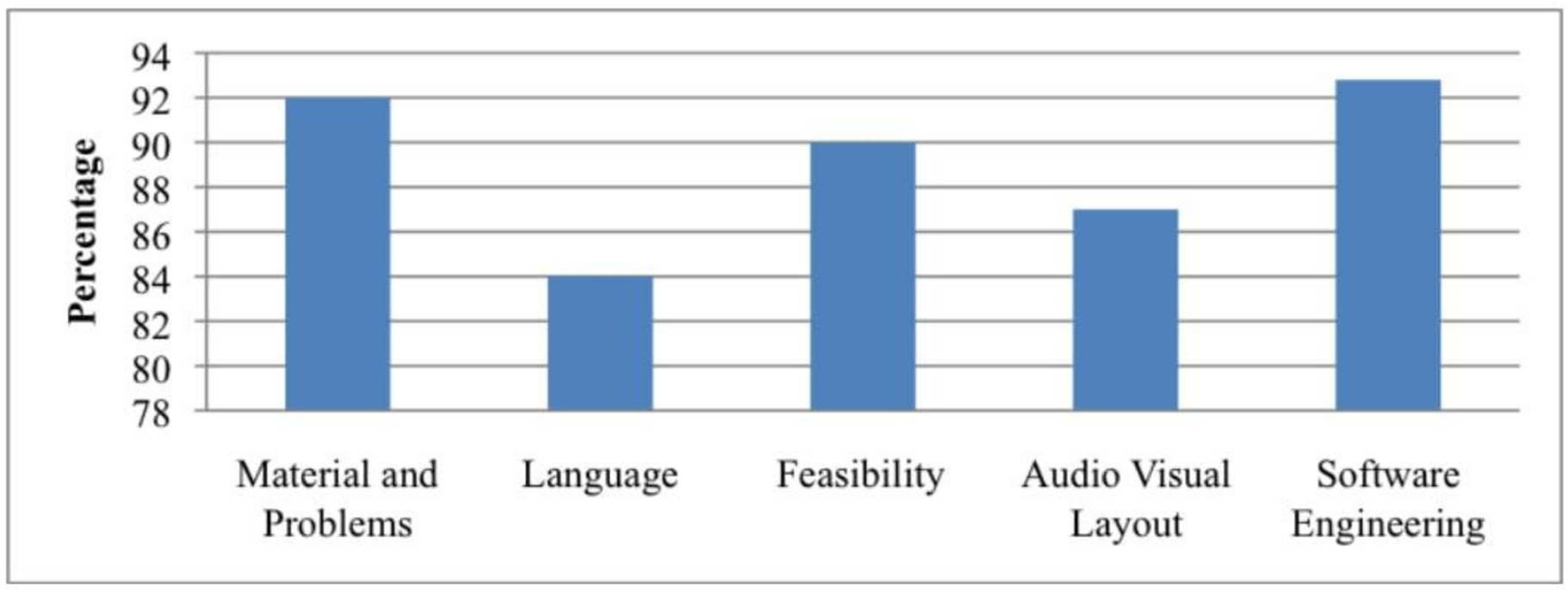
The explanation of each problem can be referred to after the completion of each problem or it can be referred to after the score appears by clicking the explanation button (after all the problems are completed). When the score appears, a star or stars as a reward appears or appear. If a student gets 71-80, he/she gets one star, 81-90, 2 stars and 91-100, 3 stars.

3.2.1 Product Quality Data from Teachers and Students

The second result of this development research is the quality of the mobile game "Brainchemist" from point of view of the chemistry teachers and year 11 high school students (science class). Based on the teachers' evaluation, the quality of the mobile game "Brainchemist" is very good with the overall score of 111.20 and the ideality percentage of 99.96%. The summary of average scores is shown in Table 1 and Picture 2. Based on the students' evaluation, the quality of the game is Good with average score of 77.04 and the ideality percentage of 81.10%. 23 students or 95.8% of the students find that the mobile game is more interesting and amusing. The summary average scores from the students' is shown in Table 2 and Picture 3.

Table 1. Brainchemist quality data from teachers

Criteria Aspects	Number of Indicators	Avg. Score	Max. Score	Quality Criteria	Ideality Percentage
Material and problems	6	27	30	SB X>25,20	92%
Language	2	8,4	10	SB X> 8,39	84%
Feasibility	4	18	20	SB X>16,81	90%
Audio visual layout	8	34,8	40	SB X>33,59	87%
Software engineering	5	23,2	25	SB X>21,00	92,8%



Picture 2: Teacher Evaluation Results on Components of the Media

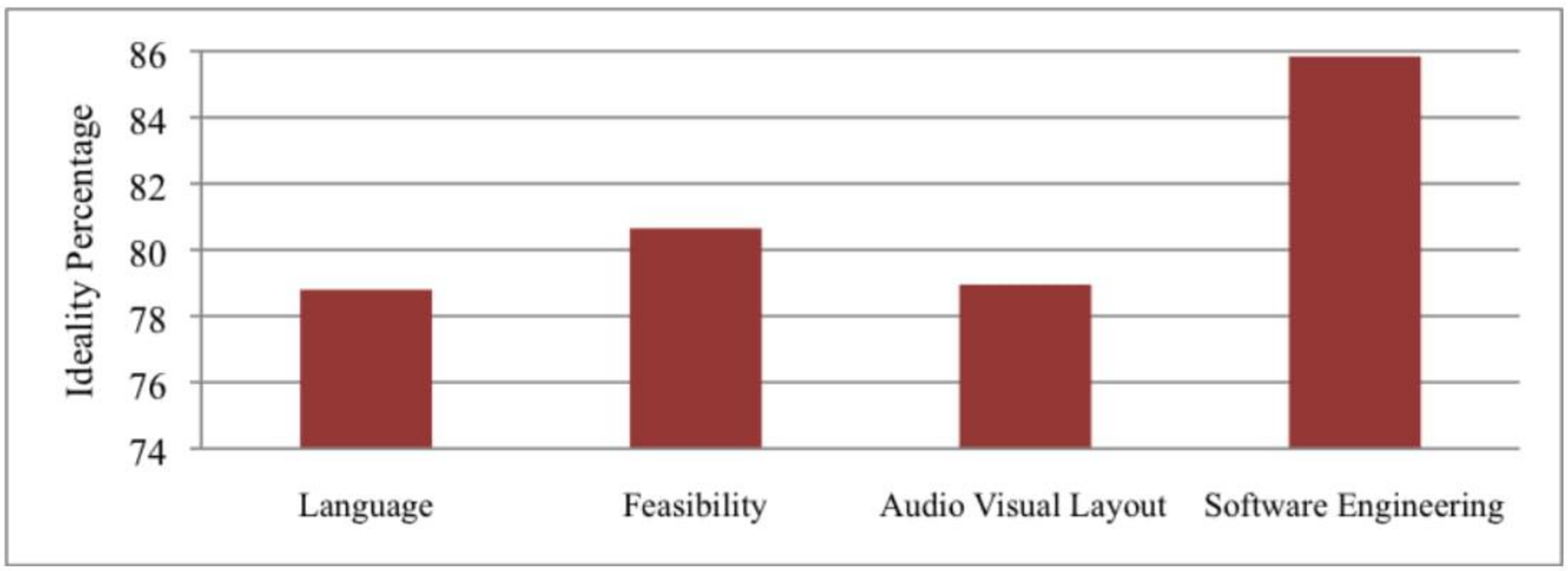
Based on the graph shown in Picture 2, the material and problem aspects which are evaluated only by teachers obtain Very Good score with a high ideality percentage of 92%. It so happens because the material and the problems in the mobile games "Brainchemist" are organized in accordance with competence standards and basic competence. The software engineering aspect obtains Very Good score with a high ideality percentage of 92.8%. The teachers think that the mobile game "Brainchemist" is an innovation in the development of chemistry learning media. The language aspect obtains Very Good score with the lowest ideality percentage of 84%, the lowest compared to that of other aspects.

The feasibility aspect obtains Very Good score with the ideality percentage of 90%. Based on the evaluation from the teachers, the developed learning media are interesting due

to the presence of rewards in form of stars and the learning media offer more benefits than other media do. The teachers' evaluation on audio visual layout is Very Good with the ideality percentage of 87%. The teachers find this aspect very good because the media have good selection of colors, music and clear illustrations.

Table 2: Brainchemist Quality Data From Students

Criteria Aspects	Number of Indicators	Max. Score	Avg. Score	Quality Criteria	Percentage
Language	2	10	7,88	B 6,80<X<8,39	78,80%
Feasibility	4	20	16,13	B 13,60<X≤16,81	80,65%
Audio Visual Layout	8	40	31,58	B 27,20<X≤33,59	78,95%
Software engineering	5	25	21,46	SB X>21,00	85,84%



Picture 3: Students' Evaluation Results on The Components of The Media

Based on the graph in Picture 3, the software engineering aspect obtains Very Good score with the ideality percentage of 83.85%. The mobile game "Brainchemist" can potentially be further developed as science and technology innovation. The ease of use and operation, in addition to touch and drag is another strong point of this mobile game. The mobile game "Brainchemist" is accompanied with clear directions on how to play the games which make it easier for users to play it. The language aspect obtains Good score with the ideality

percentage of 78.75%. The language used has to suit the language which students use for communication in their daily life or to suit their age brackets.

The feasibility aspect obtains Good score with the ideality percentage of 80.625%. The developed learning media are considered very interesting with the presence of rewards. The mobile game "Brainchemist" offers more benefits than other available learning media do. In addition to that, "Brainchemist" can be repeatedly used. The audio visual layout obtains Good score with the ideality percentage of 78.96%. The audio visual layout is considered very well because of the fine selection of colors, music and clear illustrations. The students compare the mobile game "Brainchemist" with the available entertainment games. Based on the comparison, the students find the game good. The color, background and picture presentations are very clear due to high color resolution.

The students' response on the mobile game "Brainchemist" is obtained based on the result of the measurement instrument. There are 23 students out of 24 or 95.8% of students find that chemistry learning with the mobile game "Brainchemist" is more interesting. Learning media in the form of mobile games are an innovation which can be used without being depended on distance and time. Such learning media are expected to support independent learning so that students can improve their understanding in chemistry without having to bother the teachers too much.

3.2.2 Validity of the Mobile Game Brainchemist as the Chemistry Learning Media for High School Students

The overall aspects (material and problems, language, feasibility, audio visual layout and software engineering) of the learning media obtain Very Good score according to the teachers and Good score according to the students. Based on the evaluation, the mobile game "Brainchemist" is considered valid to be utilized as high school chemistry learning media. Based on the responses obtained from the teachers and the students, the mobile game "Brainchemist" meets the criteria as good learning media which are the suitability of the mobile game "Brainchemist" with students' learning needs, ease of use which makes it easy for students to learn and understand the contents of the media, interesting layout of the mobile game "Brainchemist" which is used as learning application that can run on mobile phones so that students are interested in learning, and benefits offered by the media which help students understand the subject of chemistry.

The final product of the research is the mobile game "Brainchemist" which can run on Android mobile phones with the minimum specifications: Android Froyo 2.2, RAM 256 MB, 600 MHz processor and 2x4096 textures. The mobile game "Brainchemist" which takes the capacity of 27MB can be installed on the mobile phone external memory.

4. CONCLUSION, SUGGESTION, AND FOLLOW UP

4.1. Conclusion

The mobile game "Brainchemist" as high school chemistry learning media in the topics of solubility, soluble products, and colloid has been successfully developed in accordance tothe development phases of ADDIE Model for Instructional System Development. The quality of the mobile game "Brainchemist" is Good based on the teachers' evaluation with the ideality percentage of 88.96% and Good based on the students' evaluation with the ideality percentage of 81.10%. The students find the mobile game "Brainchemist" amusing, interesting and motivate them in learning chemistry. Based on the quality data, the mobile game "Brainchemist" is valid to be used as high school chemistry learning media in the topics of solubility, soluble products, and colloid.

4.2. Suggestion and Follow Up

The researcher suggests that the mobile game "Brainchemist" be enabled to run on any operating system other than Android so that the learning media can be holistic, contain more topics other than solubility, soluble product, and colloid, be in 3D so that it contains animated pictures, and be tested on students to study the influence of mobile games on the achievement of chemistry learning.

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