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DEVELOPMENT OF GAME-BASED COMPUTER AS LEARNING MEDIA ON ATOMS, IONS, AND MOLECULES MATTER

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Abstract

The aim of this research is to develop a game-based computer that is feasible used as a learning media Atoms, Ions, and Molecules. This research uses the Research and Development method (R&D) which consists of: 1) preliminary study phase, includes the potential and problems, data collection; 2) development studies phase, includes product design, product validation, product revision, and product limited trial. The instrument used was a questionnaire review and validation of media, observation of student activity sheet, tests student learning outcomes, and student questionnaire responses. Objectives of this research were 15 students of Public Junior High School 22 Surabaya. Validation results indicate that the game is developed feasible in terms of aspects of quality of content, presentation media, and the principle of educational games achieve the overall percentage of 89.07% with very valid category. The limited trial showed that the game is developed effective results in terms of student response to the overall percentage 95.61% categorized very good, supported by observation of student activity on every aspect. While the results of the t-test calculation obtained t_{value} *= 8.911 greater than* t_{table} *= 1.761, meaning that there are differences in average student achievement test between before and after using the game as a learning media. Overall results of the research above can be concluded that the game-based computer developed feasible, is used as a learning media Atoms, Ions, and Molecules, so product development as valid and effective.*
Keywords: *Games, Learning Media, Atoms, Ions, and Molecules.*

Abstrak

Tujuan penelitian ini adalah mengembangkan permainan bersarana komputer yang layak digunakan sebagai media pembelajaran Atom, Ion, dan Molekul. Penelitian ini menggunakan metode *Research and Development* (R&D) yang terdiri dari: 1) tahap studi pendahuluan, meliputi potensi dan masalah, pengumpulan data; 2) tahap studi pengembangan, meliputi desain produk, validasi produk, revisi produk, dan uji coba produk. Instrumen yang digunakan adalah angket telaah dan validasi media, lembar observasi aktivitas siswa, tes hasil belajar siswa, dan angket respon siswa. Sasaran penelitian ini adalah 15 siswa SMP Negeri 22 Surabaya. Hasil validasi menunjukkan bahwa permainan yang dikembangkan layak ditinjau dari aspek kualitas isi, penyajian media, dan prinsip permainan pendidikan mencapai persentase keseluruhan 89,07% dengan kategori sangat valid. Hasil uji coba terbatas menunjukkan bahwa permainan yang dikembangkan efektif ditinjau dari hasil respon siswa dengan persentase keseluruhan 95,61% dikatagorikan sangat baik, didukung oleh observasi aktivitas siswa pada setiap aspek. Sedangkan hasil perhitungan uji-t didapatkan t_{hitung} = 8,911 lebih besar dari t_{tabel} = 1,761, artinya terdapat perbedaan rata-rata tes hasil belajar siswa antara sebelum dan setelah menggunakan permainan sebagai media pembelajaran. Secara keseluruhan hasil penelitian di atas dapat disimpulkan bahwa permainan bersarana komputer yang dikembangkan layak digunakan sebagai media pembelajaran Atom, Ion, dan Molekul, sehingga produk pengembangan dikatakan valid dan efektif.
Kata kunci: Permainan, Media Pembelajaran, Atom, Ion, dan Molekul.

INTRODUCTION

The curriculum 2013 was developed with the improvement mindset such as interactive learning, active, independent, and multimedia-based learning. Science (IPA) has a characteristic to find out about nature systematically, so that science is not only a mastery the knowledge in the form of facts, concepts, or principles, but also a process of discovery [1].

Science involves three main levels of representation macroscopic, sub-microscopic, and symbolic. The macroscopic level related by phenomena that can be seen in the eyes. Sub-microscopic level associated with elementary particles such as Atom, Ions, and Molecules. While the symbolic level involved formulas and symbols in chemistry. It shows that the student's understanding of the representation of the sub-microscopic and symbolic representations is difficult because these are invisible to the eye and abstract, while the students' thinking relies heavily on information that can be captured by senses [2]. To help students understand the science in the junior high school level on the representations of sub-microscopic and symbolic must be understood through the point of view that can be visualized on a macroscopic or can be viewed.

In the learning process the teacher demanded more active and creative in presenting the subject matter in order to be accepted easily. Based on the Goverment Regulation No. 32 in 2013 section 19 paragraph 1, it states that the learning process conducted in an interactive, inspiring, fun, challenging, and motivating students to participate actively [1]. Therefore, the learning process should be designed and implemented so that teachers can implement these regulations.

Based on the questionnaire that given to 40 students in Public Junior High School 22 Surabaya given to 40 students of class VIII, so had been got several problems, such as: 1) there was 76% students states that most of difficult matter was Atom, Ions, and Molecules; 2) mastery learning of the students was very low only 60%, it mean their score was below thoroughness minimum standard specified; 3) Public Junior High School students learning modalities obtained very diverse such as 40% visual style, 35% auditory and 25% kinesthetic, and; 4) as much as 100% students Junior High School stated that they were happy to study through playing game. These circumstances make 95% of students want to learn innovation by using the game as a learning media because 80% of students excited and interested in playing game-based computer.

The results of interview with teacher of Public Junior High School 22 Surabaya stated that the media had been used still tend to be a visual learning which is using power point. Students were not be active in learning activities because the media used was not attractive, so that as much as 70% of students have low motivation to learn. Students also spent time in the classroom learning while playing game-based computer, so the material presented by the teacher never be stored in long term memory. If combining intellectual activity and using all the senses can give a big impact on students. Various ways used in teaching overcome the learning difficulties of students, one of them with the use of games for learning media.

The media is a form of communication carries information from the source to the receiver as a source of learning [3]. The game is a competition between players who interact with each other by following certain rules to achieve certain goals anyway [4]. The game is one of the important factors in the development of Junior High School students. Utilization of educational games is expected to support students' learning, so it is not just a waste of time with the children playing, but it will be time for independent learning and fun.

The use of computers in learning can be considered to teach a lesson Atoms,

Ions, and Molecules. The computer acts as an additional tool in learning, utilization includes the presentation of the information content of the subject matter, exercise, or both [5]. In addition, the computer can also describe abstract matter into a simple visualization of the incorporation of visual images and audio are animated, so it will be easily understood by students.

A game as a learning media has a positive effect on student's academic achievement [6]. Game-based computer help teachers to teach more effective, so that students understanding is higher than use conventional manner [7]. This is because of several reasons the advantages of the use of game media, including: 1) accepting information and knowledge of the material presented quickly; 2) pictures, video, animation is more interesting than serve using text only; 3) Interactive; existence of fantasy; and 4) oriented towards problem solving [7].

Computers are used as a substitute for the role of teacher in the learning process with given through text, video, animation, or graphics on the screen as well as providing points questions or concerns. Video is a component of verbal and visual characteristics as well as the most effective for student learning modalities [8]. Students interact with the computer as the students interact with the teacher: "One-to-one session". The presentation of the matter was given in stages, starting from the basic difficulty to a higher level, and so on. Computer game can improve students' achievement in learning factual knowledge, problem-solving strategies, and a higher level of cognitive [9]. Games appropriate for students to be able make learning fun, interesting, can provide a useful learning, and can even be a tool of evaluation [10].

Consider the potential and the problems mentioned above, it created the idea to develop a game with the name *"Hero"* was defined as a hero who presents the material Atoms, Ions, and Molecules. This game was expected to be useful in learning and alternative as instructional media of Atoms, Ions, and Molecules matter. This game was being developed and there were educational concepts that students can learn by playing, so that learning will be more fun and suitable in learning modalities as needed. This game presents the concept of using video animation that has been adapted to the Atoms, Ions, and Molecules matter. The game is developed by steps tutorial models, include: 1) introduction; 2) presentation of information; 3) question and responses; 4) judging responses; 5) providing feedback about responses; 6) remediation; 7) closing [5]. Some concepts to be taught and understood, then followed by a set of questions or exercises to check understanding of the material. The selection of tutorial steps because it was effectively used in learning that has the characteristics of the matter with requires visualization. One of the software developments that strongly supported was RPG Maker VX English.

Currently nothing game that presents the matter of Atoms, Ions, and Molecules as a learning media with specifications based on step tutorials, as well as the presentation of the matter using videos. This is an attempt to make students more easily absorb the matter of Atoms, Ions, and Molecules with unpleasant circumstances, and communicative without reducing scientific concepts. The use of this developed game expected to give rise to a sense of interest in the students to focus on learning, allows students to learn independently, and stimulate active participation of students to locate, construct their own knowledge thus improving students' understanding on Atoms, Ions, and Molecules matter.

Based on the above, the development of *"Hero"* game-based computer that is feasible as a learning media on Atoms, Ions, and Molecules. Feasibility of data obtained based on validity test be reviewed from aspects of quality of

content, presentation media, and the principle of educational games. Whereas its effectiveness be reviewed from student activity observation, tests student learning outcomes, and student questionnaire responses to the game developed.

METHOD

The subject of this research is feasibility *"Hero"* game-based computer which was developed as a learning media Atoms, Ions, and Molecules. This research viewed the feasibility based on valid and effective game developed by involving 1 Chemistry lecturer of Mathematic and Science Faculty-Unesa, 3 practitioners, 15 students of Public Junior High School on VIII-F grade which has obtained Atoms, Ions, and Molecules matter.

The method used is the Research and Development (R&D). There is a 10 steps method using Research and Development (R&D) is the potential and problems, data collection, product design, design validation, design revisions, limited trial, product revision, utility testing, product revision, and the product of massive [11]. This research is only restricted to product limited trial and ends with reporting the feasibility game. As for the research procedure can be viewed on the following figure 1:

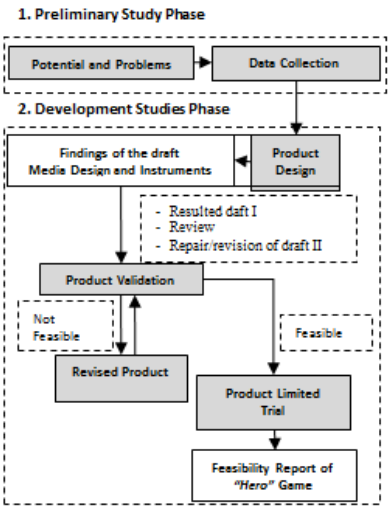

Figure 1. Stages of Research and Development (R&D)

Details of Research Procedures

The procedure research consisted of two stages that are preliminary study and development. In the preliminary study phase identification has been done about potential and problems, such as: 1) literature study includes analysis of matter in accordance with current Curriculum 2013, and main competence well as basic competences on Atoms, Ions, and Molecules matter, than cognitive development including analysis of students with their developmental psychology that is game rules genre controlled by regulations; 2) the field study, includes: a) conditions of teachers that the time provided in the study very minimal, so the teacher during lessons is often using the book school electronic media and worksheets; b) conditions of students at an average age of 12-14 years, the class is heterogeneous with different levels of student ability, economy student from the upper middle class, their pleasure in playing, interest in genre of adventure game, and those in need of learning modalities well as audio-visual aids; and c) school environment that has been existence adequate facilities and infrastructure technologies such as liquid-crystal display and computer, but it does not function very well. Then do collecting data to make learning objectives in accordance with the main competence and basic competences, collecting matter, pictures, music, and relevant research journals.

Development studies of phase conducted product design aims as the initial design process that will produce a draft of the findings of the media and instrument design. Design products are prepared using 6 stages of designing media such as concept, design, collecting material, assembly, testing, and distribution [12]. Product design produces a design draft findings media and instruments (Draft I). Draft I is generated consisting of: 1) guidelines for teachers and students of the game; 2) the grating

about the pretest, posttest, and games; 3) questions of pretest and posttest; 4) student worksheet; 5) game that developed; 6) review sheet; 7) validation sheet; 8) student questionnaire responses sheet; and 9) observation of student activity sheet. Then the design of media had been reviewed and the result was draft II.

Games that have been revised then validated with the validation instrument by 4 validators consist of 1 Chemistry lecturer and 3 practitioners. Aspects assessed by validator include 3 criterias, such as criteria for quality of content, media presentation criteria, and principle of educational games criteria. After that, if a game is assessed valid by the validator then conducted product limited trial in school to determine its effectiveness as a learning media in the classroom. If declared unfeasible by validator, so that must be product revision again until it declared feasible. The research instruments that used were review sheet, validation sheet, observation of student activity sheet, tests student learning outcomes, and student questionnaire responses.

Methods of Data Analysis

This research obtained descriptive data consisting of qualitative and quantitative. Qualitative descriptive is obtained from data analysis of review media sheet. Whereas quantitative descriptive is obtained from data analysis of validation media sheet, observation of student activity sheet, tests student learning outcomes, and student questionnaire responses.

Incoming data from the questionnaire validation by Chemistry lecturer and practitioners obtained of percentage based on calculation analysis of Likert scale with scores criterion 5 (very good), 4 (good), 3 (medium), 2 (bad), and 1 (very bad) [13]. The formula used to obtain the percentage of validation the results of as in equation 1, as follows:

$$P\,(\%) = \frac{\Sigma \text{ Results of data collection score}}{\text{Criterion scores}} \text{ x } 100\%$$

$$\text{Criterion score} = \text{highest score x} \sum \text{aspect in criteria x} \sum \text{validator} \quad (1)$$

Feasibility criteria developed game can be matched by using scores interpretation [13]. The game is developed feasible as a learning media when the percentage of ≥ 61% fulfill valid category.

Data obtained from observation of student activity sheets were analyzed by using a percentage based on the calculation of the Guttman scale comparison of students who do "Yes" 1 score and "No" 0 score [13]. The formula used to obtain the percentage of the observation of the activities of students as in equation 2, as follows:

$$P(\%) = \frac{\Sigma \text{ Results of data collection score}}{\text{Criterion scores}} \text{ x } 100\%$$

Criterion score = highest score each item x sum of aspect x sum of respondent (2)

Student activities by utilizing the game that was developed as a learning media can be matched by using a scores interpretation [13]. The game is developed feasible as a learning media when the percentage of ≥ 61% fulfill effective category.

Data obtained from tests of student learning outcomes used effectiveness test of the game as learning media. In calculating the t-test is obtained the hypothesis that the two groups were tested in pairs aided by SPSS system. In this research used test for the left because of the thoroughness of student compared with the score thoroughness minimum standard specified ≥ 75. Requirement to know the hypothesis is accepted if t_{value} greater than t_{table}, thus fulfill effective category.

Incoming data from the student questionnaire responses obtained percentage calculation based on the analysis of the level Likert scale with a score of 5 (very good), 4 (good), 3

(medium), 2 (poor), and 1 (very bad) [13]. The formula used to obtain the percentage of student responses result as in equation 2. Feasibility criteria were developed using the game score interpretation [13]. The game is developed as a feasible learning media when the percentage of ≥ 61% fulfill effective category.

RESULTS AND DISCUSSION

This section describes the results and discussion of the data obtained during the research process about *"Hero"* game-based computer, as follows:

Validation Results

Assessment results by Chemistry lecturer and practitioners, the game developed is valid as a whole meets the feasibility with a total percentage of 89.07% with very feasible category be specified based aspects as follows:

1. Criteria of Quality Content
   The game is developed otherwise been fulfill feasibility criteria in view of the quality aspects of the content [14]. The percentage of the overall feasibility of this aspect is 90.83%, which has fulfilled criteria of quality of content and declared is very feasible.
2. Criteria of Presentation Media
   Good game media should pay attention to the presentation views of the educational and technical terms [15]. The percentage of the overall feasibility of this aspect of 89.28%, which has fulfilled criteria of the media presentation and declared is very feasible.
3. Criteria of Principles of Educational Games
   The principle that should be applied in the game media are individualization, active feedback, active learning, motivation, scaffolding, transfer, and assessment [16]. The percentage of the overall feasibility of this aspect is 87.14%, which has fulfilled the criteria and a principle of educational games declared is very feasible.

Based on the description every aspects above about assessment results by validator of game developed, the percentage obtained on the content quality criteria which is very high compared to the others. That high percentage because matter and questions used in the game is referring to reliable references from various source books adapted to the learning needs of Atoms, Ions, and Molecules, which book school electronic on public junior high school, college-level books, and journals. Besides the presentation of matter also can improve cognitive aspect of student. That is because the cognitive aspect of this game is simple to explain the concept with the incorporation of text, audio, and animated visual [3].

Another case for assessment on the principle of education game criteria aspect to get a very low percentage compared to other aspects. That is because there were some deficiencies in the aspect, one of which is the lack of information transfer/knowledge from one context to another in the game. But overall showed that the game was developed is feasible for use as learning media in classroom.

The game which has been developed through a process of revision of the product and is valid then performed the product limited trial to the 15 students on class VIII-F in Public Junior High School 22 Surabaya with heterogeneous capabilities. When conducted limited trial, other than the game that was developed also gave student a worksheet as a support so that the students learned about Atoms, Ions, and Molecules matter.

Based on product limited trial obtained data in the form of student activity observation, tests student learning outcomes, and student responses. Below are presented the results of the data during product limited trial activities, as follows:

Results of Observations Student Activity

These observations were carried out using observation of student activity sheet. The data obtained is used to provide a

snapshot of student activity during limited trial in progress to support the student's response. Based on observations of student activity which is carried out by 3 observers as a whole has fulfilled effective category with a total percentage of 96.21% which is very good.

Results of Student Tests

The test results of student learning through the pretest and posttest were analyzed using SPSS help system, calculation of the t_{value} obtained was 8.911. Using the t_{value} and df = 14, t_{table} is obtained of 1.761 with 5% accuracy level. The hypothesis has been formulated is that there are differences in average student test scores between before and after using the game as a learning media. Hypothesis assessment criteria can be seen as follows:
Accept H_0, if t_{value} is smaller 1,761
Accept H_a, if t_{value} is greater 1,761
Based on the above criteria t_{vakue} is outside the reception area of H_0, so H_a accepted because t_{value} is greater than t_{table}. So it can be concluded that there are differences in average student achievement test between before and after using the game as a learning media. It means the game is developed has fulfilled the effectively categories to used as a learning media Atoms, Ions, and Molecules matter in the classroom. One characteristic of effective games as guiding student to improve their mastery of learning [17]. This is evidenced an increase in the average value of student learning outcomes of 33,33% pretest to 80% posttest with score thoroughness minimum standard specified ≥ 75. Games as learning media have a positive effect on academic achievement [6]. The game is developed generally considered effective, so it feasible to be used as a learning media Atoms, Ions, and Molecules.

Results of Student Questionnaire Responses

The results of questionnaire responses on game developed obtained student responded are very good. The results of student responses, shown in the following table:

Table 1. Results of Student Responses

No	Aspect	Percentage (%)	Criteria
1	Students' understanding of matter	96,33	Very good
2	Student interest	93,33	Very good
3	Attractiveness of the media	91,67	Very good
4	The clarity of media presentation	98,33	Very good
5	Ease of media	95	Very good
6	Students' motivation	96,33	Very good

Based on Table 1 above can be explained, as follows: students' understanding of the material, has fulfilled the criteria with a percentage of 96.33% which is very good category. This indicates with video and exercises features in the game can help student understand on Atom, Ions, and Molecules matter. Information that presented using video imposes a lower cognitive demand on student without overloading memory [18].

Interest the student has fulfilled the criteria with a percentage of 96.33% which is very good category, so that student feel interested in game development. This is consistent with the game media has advantages compared with other media because the game makes learning more interesting, exciting, and not monotone [19].

Attractiveness of the media has fulfilled the criteria with a percentage of 91.67% which is very good category. Ideal criteria for game as a good learning media should be able to attract the attention of students such as presentation, colors, and content of media [20]. The game is developed can attract students' attention on the features of appearance/design, colors, text, images, and how to play.

Clarity of media presentation has fulfilled the criteria with a percentage of 98.33% which is very good category.

Based on these components are instructions, language, and writing used easily understood by students so that the game can be flexible [4].

Ease of media has fulfilled the criteria with a percentage of 95% which is very good category. Student responses about the ease of the media get a low percentage compared to most others. That is because there are students do not read the menu navigation with keyboard system that is used if want to playing a game well. However, these deficiencies can be resolved by granting the student handbook for a given before playing game, so that student read the instructions carefully. Criteria of ideal game for a good learning media should be easier for student to learn and make the lessons easy to understand, be studied and understood by student [20].

Students' motivation has fulfilled criteria with a percentage of 96.33% which is very good category, because the students declared that they felt motivated to learn using games developed. This is supported by a statement that, the media game-based computer in education makes the students happy and enjoys it so that students are more relaxed, motivated and have a desire to continue learning [21].

All the results of the data from the student questionnaire responses provided include: 1) students' understanding of the material, 2) the student's interest, 3) the attractiveness of the media, 4) the clarity of media presentation, 5) ease of media, and 6) students' motivation, obtaining overall percentage of 95.61% with the very good category. These results are supported by the observation of the student activity during product limited trial that show a positive attitude toward the game that was developed with a percentage of 96.21% is very good category. The game is developed generally considered effective, so making it feasible to be used as a learning media of Atoms, Ions, and Molecules.

Based on the criteria of validity and effectiveness of the developed game fulfilled, then obtained a final product in the form of a game-based computer are valid and effective so that feasible to be used as a learning media of Atoms, Ions, and Molecules matter on school.

CONCLUSION

Based on the analysis results can be concluded that the *"Hero"* computer game developed feasible used as a learning media Atoms, Ions, and Molecules so the product development as valid and effective with details of the results, as follows:

1. Game-based computer that developed by assessment feasible of Chemistry lecturer and practitioners based on the criteria include: quality of content, presentation media, and the principle of educational games, earned an overall average percentage of 89.07% is included in the category of valid.
2. Students' response to the game that developed showed a positive response with an average percentage of 95.61%, supported by observation of student activity assessment of 96.21% is included in the category of effectively used as a learning media.
3. Student learning outcomes shows that there are differences in average student achievement test between before and after using the game as a learning media, because H_0 is rejected and H_a is accepted with t_{value} = 8.911 is greater than the t_{table} = 1.761.

SUGGESTION

Based on the research that has been conducted, obtained some suggestions as follows:

1. This research conducted only at the stage product limited trial. Therefore to obtain additional data information which is more about the use of games, implementation needs to be done to students in the actual class as a learning media Atoms, Ions, and Molecules.
2. In limited trial, there are students who cannot run the game that developed.

This is because students tend to directly play the game without reading the instructions, so the students ask and difficult to finishing the game. Overcoming these constraints teachers must condition the students to read guidelines and instructions for using the game beforehand until clearly before using it as learning media in the classroom.

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