Interactive Multimedia Product Based on Green Chemistry in the Acid-Base Concept of Chemistry Learning Process

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Abstract
This research aims to develop the interactive multimedia product based on green chemistry in the acid-base concept and to study the feasibility of the interactive multimedia. The Four D model was applied to the 4D model: define, design, develop and disseminate. The feasibility study of the interactive multimedia-based green chemistry showed that it had 83.33 % validity with highly valid criteria. The feasibility study of the student worksheet, the syllabus, the lesson plan, the scientific literacy, and creative thinking instruments was gained 82.50 %, 89.06 %, 87.96 %, 80.00 %, and 62.50 % respectively. In conclusion, the interactive multimedia product based on green chemistry in theacid-base concep twas feasible to be applied in chemistry learning processes.

Keywords
Interactive Multimedia Product, Green Chemistry, Acid-Base Concept, Chemistry Learning Process

1. Introduction
Educators through the chemistry learning processes expect their students to need improved 21st-century skills (Jufri 2015). Without skills such as collaboration and team work (Gunawan, 2015), creativity and imagination (Binkley, et al. 2012), critical thinking and problem-solving skills (vanLaar et al. 2017), students will not be able to participate in the global economy (Pekdag 2010). Additional skills that students must possess are skilled at using information and communication media (Greenbowe). The use of information technology in science learning was proven to be able to help improve problem solving skills (Gunawan et al.2017), and student creativity (Gunawan et al. 2017; Gunawan et al. 2018). The observations in the chemistry learning process in all classrooms in Indonesia shows that learning is still teacher-centered, students receive all the information from the teacher without additional information from other sources. This causes students unable to relate lessons received with their daily lives so that students' understanding of the content is only superficial (Agung and Schwartz 2007). The use of interactive media that supports the chemical learning process is also very rarely used (Coppola 2008). It causes chemical learning processes is less attractive (Ardac and Akaygun 2004). This interactive media is expected to explain many abstract concepts in chemistry easily. Furthermore, it can be used as a tool for visualizing chemical models and can be used as a substitute for chemical laboratory demonstrations. In this paper, we present the feasibility of green chemistry based interactive multimedia for use in chemistry learning. The development of interactive multimedia is based on the contextual teaching and learning model. The choice of acid-base topics for media development is in accordance with the contextual teaching and learning model because

it relates to everyday life (Russell et al 2004). The use of interactive multimedia in learning has proven to improve learning outcomes (Andayani et al. 2018), motivation (Ramandha et al. 2018) critical thinking skills (Gunawan et al. 2018), understanding concepts (Hermansyah et al. 2019) and learning activities (Cole and Todd 2003).

2. Research methods

The method used in research is the development of using a 4 D model consisting of define, design, develop, disseminate development model by Thiagarajan et al. (1974) This research focuses on developing interactive multimedia products based on green chemistry on the acid-base material. The supporting products developed in this study includea syllabus, learning plans, interactive multimedia, teaching materials, scientific literacy instruments, and creative thinking. The product validation data from the validator then calculated by using the following formula:

$$\text{Validity Percentage} = \frac{\text{Validator Total Score}}{\text{Maximum Score}} \text{ x } 100\%$$

The level of instrument validation (Arikunto) is depicted in Table1.

Table 1. The level of instrument validation

Score Validation Range (%)	Level of Validation
0 – 20	Very Low
21 – 40	Low
41 – 60	Enough
61 – 80	High
81 – 100	Very High

3. Result And Discussion

In this research multimedia, interactive learning has been developed on the acid-base concept for chemistry learning in senior high schools. The interactive multimedia was developed based on multimedia design principles. Figure 1 below is an example of an interactive multimedia display that was developed.

Figure 1. Example of Multimedia Display (a) Multimedia start page; (b) material; (c) animation; (d) Green chemistry

Interactive multimedia developed includes several key concepts including acid-base theory, acid-base pH, acid-base indicator and application of the concept of acid-base pH. Each concept provides several interactive animations and simulations to support the learning process. Animation and simulation by exploiting the

advantages of interactive multimedia on each concept (Gunawan, et al 2016). This interactive multimedia developed in general has similarities with other multimedia, including multimedia components consisting of text, images, animation, simulation, video,and audio. Multimedia was developed to be a tool for chemistry learning, especially the concept of acid-base learning in class both by teachers and students. Multimedia is made to be used independently by students with the help of students worksheet. However, in general, this multimedia can also be used as a media presentation by the teacher in the classroom. This interactive multimedia is used in learning with contextual teaching and learning models. Various learning innovations with efforts to expand teaching materials have positioned the computer as a tool that contributes positively to the learning process, especially learning chemistry on acid-base material (Morgil et al. 2004). Computers can do some activities to help teachers. One innovation in computer-based learning is interactive multimedia. Computer-based interactive multimedia helps in delivering information in the learning process, carrying out teaching management, and providing stimulus to students during the learning process. Green chemistry-based interactive multimedia that we developed was computer-based multimedia. Feasibility test data from green chemistry-based interactive media were obtained from the results of questionnaire filling. The instrument is given to 3 experts to assess the feasibility of the product being developed. The results of the feasibility test are analyzed and carried out to revise the product in accordance with the expert's advice. The results of the feasibility test are shown in Figure 2.

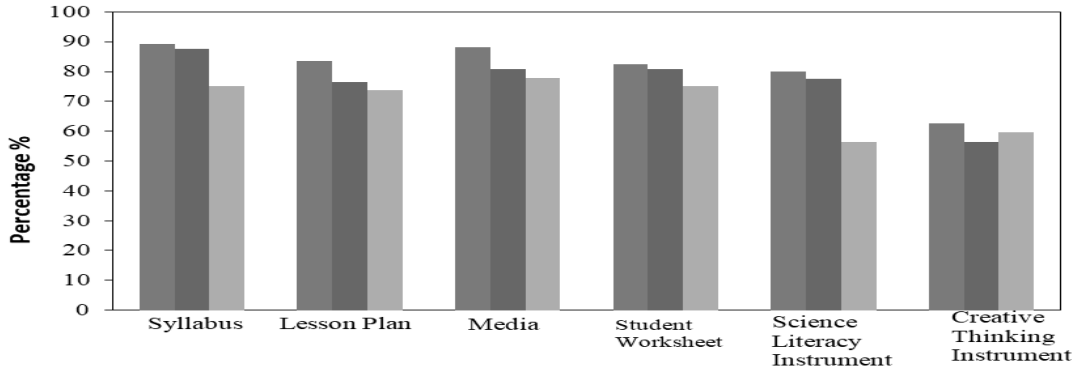

Figure 2.A validity test of green chemistry-based interactive multimedia
(three different intensity of black colors in block diagram indicate three experts)

Figure 2 shows the feasibility test of interactive multimedia products. The feasibility percentage of the syllabus was 85.53%, the feasibility percentage of the lesson plan was 78.67%, the feasibility percentage of the learning media was 81.08%, the percentage of feasibility of teaching material was 79.42%, the percentage of feasibility of scientific literacy instruments and creative thinking was 71.25% and 59.49%, respectively. The total percentage of all product items developed was 75.90%. Thus, it can be concluded that interactive chemistry based on green chemistry in the acid-basetopic is categorized as feasible to be applied. The results of research reinforce this finding by Sulistyono (2013) which states that interactive learning media developed using flash were categorized as feasible to be used in learning to administer servers in the network. This isalso supported by Priadana (2015) which states that interactive learning media assisted by Macromedia Flash software on basic competencies apply various basic logic circuit gates effectively to be used as learning media. In addition, research was conducted. Adawiyah et al. (2019) which states that interactive e-book can provide a positive response and increase students' learning interest as shown in the results of very high learning evaluations and excellent learning activities. Interactive multimedia that has been developed also has several drawbacks. The shortcomings in this study are as follows: (1) this research only arrived at the validation stage (2) this interactive multimedia has minimum computer specifications and requires users to install Adobe Flash software to run programs

4. Conclusion

The development of green chemistry-based interactive media on the topic of acid-basewas generally categorized as having high validity. This shows that the products developed can be used in the chemistry learning process. This research will continue to examine the practicality and effectiveness of this interactive media.

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