Green Chemistry Based Interactive Multimedia on Acid-Base Concept

M. Yustiqyar¹, G Gunawan², S Hadisaputra³

¹Magister Program of Science Education, Universitas Mataram.
²Physics Education Study Program, Universitas Mataram.
³Chemistry Education Study Program, Universitas Mataram,
Jalan Majapahit No. 62, Lombok, 83125, Indonesia

*E-mail: rizal@unram.ac.id, gunawan@unram.ac.id, ivalbrigde66@yahoo.com.

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 the acid-base concept was feasible to be applied in chemistry learning processes.

1. INTRODUCTION

Educators through the chemistry learning processes expect their students to need improved 21st-century skills [1]. Without skills such as collaboration and teamwork [2], creativity and imagination [3], critical thinking and problem-solving skills [4], students will not be able to participate in the global economy [5]. Additional skills that students must possess are skilled at using information and communication media [6]. The use of information technology in science learning was proven to be able to help improve problem-solving skills [7], and student creativity [8-9].

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 [10]. The use of interactive media that supports the chemical learning process is also very rarely used [11]. It causes chemical learning processes is less attractive [12]. 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 [13]. The use of interactive multimedia in learning has proven to improve learning outcomes [14], motivation [15], critical thinking skills, understanding concepts and learning activities [16].
2. METHOD

This type of research is Research & Development. The procedure of this study follows the 4D (define, design, develop and disseminate) development model developed by Thigaaranjan, Semmel, and Sivasailam [17] This research focuses on developing interactive multimedia products based on green chemistry on the acid-base material. The supporting products developed in this study include a 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:

\[ \text{Validity Percentage} = \frac{\text{Validator Total Score}}{\text{Maximum Score}} \times 100\% \]

The level of instrument validation [18] is depicted in Table 1.

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

3. RESULTS 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.
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 [19]. 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 [20]. 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 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-base topic is categorized as feasible to be applied.

The results of research reinforce this finding by Sulistyono [21] 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 is also supported by Priadana's research [22] 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.
Herjianto [23] which states that interactive media can provide a positive response and increase students' learning interest as shown in the results of very high learning evaluations and excellent learning activities.

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

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-base was 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.

5. **ACKNOWLEDGMENTS**

We express our gratitude to all those who have helped the research process, including a team of expert validators and IT teams that provided input on media design and development.

**REFERENCES**

[1] Jufri W 2015 *Belajar dan Pembelajaran Sains. Bandung*: Pustaka Reka Cipta
[2] Gunawan 2015. *Model Pembelajaran Sains Berbasis ICT*. FKIP Universitas Mataram
[3] Binkley M, Erstad O, Herman J, Raizen S, Ripley M, Miller-Ricci M, and Rumble M 2012 Defining twenty-first century skills. In *Assessment and teaching of 21st century skills* (pp. 17-66). Springer, Dordrecht.
[4] van Laar E, van Deurse A. J, van Dij J. A, and de Haan, J 2017 The relation between 21st-century skills and digital skills: A systematic literature review. Computers in human behavior. 72 577-588.

[5] Pekdağ B 2010 Alternative methods in learning chemistry: Learning with animation, simulation, video and multimedia. Journal of Turkish Science Education. 7(2) 111-118.

[6] Greenbowe T. J 1994 An interactive multimedia software program for exploring electrochemical cells. Journal of chemical education. 71(7) 555.

[7] Gunawan G, Harjono A, Sahidu H and Herayanti L 2017 Virtual Laboratory to Improve Students’ Problem-Solving Skills on Electricity Concept Jurnal Pendidikan IPA Indonesia. 6(2) 257-264

[8] Gunawan G, Sahidu H, Harjono A and Suranti N M Y 2017 The Effect of Project Based Learning With Virtual Media Assistance on Student’s Creativity in Physics Cakrawala Pendidikan 36(2) 167-179

[9] Gunawan G, Harjono A, Sahidu H and Nisrina N 2018 Improving Students’ Creativity Using Cooperative Learning With Virtual Media on Static Fluida Concept Journal of Physics: Conference Series. 1006 (1) 012016

[10] Agung S and Schwartz M S 2007 Students’ understanding of conservation of matter, stoichiometry and balancing equations in Indonesia. International Journal of Science Education. 29(13) 1679-1702.

[11] Coppola B P 2008 Selamat datang di Indonesia: Learning about chemistry and chemistry education in Indonesia. Journal of chemical education. 85(9) 1204.

[12] Ardac D and Akaygun S 2004 Effectiveness of multimedia-based instruction that emphasizes molecular representations on students’ understanding of chemical change. Journal of research in science teaching. 41(4) 317-337.

[13] Russell J W, Kozma R. B, Jones T, Wykoff J, Marx N and Davis J 1997 Use of simultaneous-synchronized macroscopic, microscopic, and symbolic representations to enhance the teaching and learning of chemical concepts. Journal of chemical education. 74(3) 330.

[14] Andayani Y, Hadisaputra S, and Hasnawati H 2018 Analysis of the Level of Conceptual Understanding. In Journal of Physics: Conference Series. Vol. 1095, No. 1, p. 012045. IOP Publishing.

[15] Ramandha M E P, Andayani Y, and Hadisaputra S 2018 An analysis of critical thinking skills among students studying chemistry using guided inquiry models. In AIP Conference Proceedings. Vol. 2021 No. 1, p. 080007. AIP Publishing.

[16] Cole R S and Todd J B 2003. Effects of web-based multimedia homework with immediate rich feedback on student learning in general chemistry. Journal of Chemical Education. 80(11) 1338

[17] Thiagarajan, Semmel and Sivasailam. 1974 Instructional Development for Training Teachers of Exceptional Children. Washington DC: National Center for Improvement Educational System.

[18] Arikunto, S. 2013. Prosedur Penelitian. Jakarta: Bumi Aksara

[19] Gunawan G, Harjono, A and Imran 2016 Pengaruh Multimedia Interaktif dan Gaya Belajar Terhadap Penguasaan Konsep Kalor Siswa. Jurnal Pendidikan Fisika Indonesia 12 (2)

[20] Morgil İ, Seçil, A R D A, Secken N, YAVUZ S and Oskay Ö Ö 2004 The influence of computer-assisted education on environmental knowledge and environmental awareness. Chemistry Education Research and Practice. 5(2) 99-110.

[21] Sulistiyono 2013 Pengembangan Media Pembelajaran Interaktif Berbasis Flash pada Standar kompetensi Mengadministrasi Server dalam Jaringan. Jurnal Pendidikan dan Pengajaran, 45(1)

[22] Priandana D F V 2015 Pengembangan Media Pembelajaran Multimedia Interaktif Berbantuan Software Macromedia Flash Pada Kompetensi Dasar Menerapkan Macammacam Gerbang Dasar Rangkaian Logika Di Smk Negeri 2 Bojonegoro. Jurnal Pendidikan Teknik Elektro. 04 (01)

[23] Herijanto B 2012 Pengembangan media interaktif pembelajaran IPS materi bencana alam. Journal of Educational Social Studies. 1(1)