The Need Analysis of Augmented Reality-Based Chemistry Module Development on Electrolyte and Non Electrolyte Solutions at SMA Kristen 3 Kalabahi

Amehsti Mooli[1(✉)], Sentot Budi Raharjo[2], and Budi Hastuti[1]

[1] Faculty of Teacher Training and Education, Universitas Sebelas Maret, Surakarta, Indonesia
amehstimooli@student.uns.ac.id

[2] Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret, Surakarta, Indonesia

Abstract. This research was conducted with the aim of analyzing the need for augmented reality-based chemistry module development on electrolyte and non-electrolyte solutions at SMA Kristen 3 Kalabahi, in Alor Regency, East Nusa Tenggara. This study uses a survey methodology with a qualitative approach. Data obtained from interviews with chemistry teachers and the results of filling out questionnaires by 38 students. The instrument used has been supervised in advance by two professors of chemistry. The results of this study indicate that teachers have not developed technology-based teaching materials that can help students learn chemistry. The teaching material is a textbook containing writings and some two-dimensional pictures. Thus, it can be said that learning is still conventional and has not followed the development of the digitalization era. It is marked by a lack of the use of technology in the learning activities. The innovative and creative learning model is rare to use. In learning, the teacher relies only on lecture and discussion methods. Therefore, it can be concluded that the development of augmented reality-based chemistry modules needs to be applied to motivate students in learning and improve their understanding of chemical concepts independently. This module also can be used anytime and anywhere.

Keywords: Module development · Augmented Reality

1 Introduction

Rapid technological advances continue to change and transform teaching methods and learning process setting [1]. In this modern era, teachers must be able to apply technology and information in the learning activities. The application of technology in learning is a significant part of supporting current education, particularly in chemistry subjects. Chemistry deals with elements' structure, properties, and change [2]. It is one of the essential subjects taught to students because it can improve thinking skills and stimulate creative thinking [3]. A theoretical teaching concept in the learning activities tends to be difficult for teachers. Many students are struggling to study chemistry that considered a complex study. Because it is a complicated and tedious lesson for most students, chemistry has become one of the most disliked studies [4].

One part of the chemistry material taught in the 10th grade is electrolyte and non-electrolyte material. This section of material includes knowledge of concepts, facts and procedures [5]. In their learning process, students find it challenging to learn this material [6]. The electricity current material is less understood by students of 12th grade and first-year students [7, 8]. Students learning difficulty in electrolyte material is caused by microscopic material, so they cannot imagine it. Furthermore, students' low formal thinking skills cause difficulty in understanding the sub-microscopic aspects that lead to misconceptions.

Learning chemistry in high schools requires supporting tools such as media and suitable learning resources based on the material characteristic and students' development. The students need Media and learning resources to help them achieve the defined competencies [9]. The interactive learning media used so far is only observing and predicting. It cannot be integrated with the previous material [10]. The availability of various learning media will be more beneficial for students to meet their diverse learning characteristics. Material preparation is essential in learning, and the material contents should be relevant to the concept being studied [11].

The technology-assisted learning module becomes the learning media solution for teachers to transfer knowledge to learners. Learning can be more attractive by applying technology, information, and communication as constructive learning tools to improve motivation and stimulate students' curiosity [12]. One of the challenging topics for students to grasp and teachers in teaching is three-dimensional visualization (3D) of the molecules and their stereochemistry [13]. Visualizing 2D pictures into 3D in a module, teaching material, and textbook is a required competency to facilitate students grasping chemistry. The existence of conventional and limited learning resources is a different obstacle for students to get the material.

Moreover, the lack of various learning media makes learning activities unattractive, so students are bored and less motivated. In teaching and learning activities, teachers depend on the lecture method in delivering the material. Because students only listen and take notes, the result of the learning activities in the class is less than optimal. The existing modules are more conventional such as textbooks, so the additional illustration integrated with the web can improve the readability of a learning module [14].

The developed chemistry module will combine with augmented reality technology to motivate and facilitate students to grasp the learning contents. This technology-assisted chemistry module will be supported by markers and other interesting features so that it can encourage students to be actively involved in the learning process. This module will be combined with technology that can combine real and virtual situations. Augmented reality is a type of technology combination of 3D virtual things into a 3D natural environment [15]. This technology can lift a previously flat or two-dimensional object as if it became real together with the surrounding environment. The main characteristics of augmented reality are 1) combining virtual and real conditions 2) It is interactive in real-time 3) 3D registered. Augmented reality requires helping tools such as smartphones or tablets with android systems. Smartphone is a mobile device with high effectiveness and mobility compared to other mobile device. Through a smartphone, the augmented reality-based chemistry module will be more accessible, making it easier for students to learn chemistry even though they are not in school. Therefore, researchers developed

an augmented reality-based chemistry module that can be accessed anytime an any-where. Due to limited learning resources and the absence of innovative learning media, it becomes a solution.

This study aims to result in the augmented reality-based chemistry learning module in electrolyte and non-electrolyte solutions as one of the alternative learning media. It can be used in chemistry learning for high schools.

2 Methodology

This study is development research aiming to develop an augmented reality-based chemistry learning module. The development has been done by following Borg and Gall's procedures. The method used in this study is a qualitative descriptive method. Data is collected through interviews and questionnaires. The subjects in this study were chemistry teachers and 38 students at Kalabahi Christian high school who have learned about electrolytes and non-electrolyte in Alor regency, East Nusa Tenggara.

Data is obtained from the chemistry teacher interviewing results and questionnaires distribution to the students.

3 Result

The results of the needs of teachers and students obtained are presented in Tables 1 and 2.

Table 1. The Students' Needs Questionnaires

No	Statement	Answer Choice	
		Yes (%)	No (%)
1.	In the teaching and learning process, the teacher often uses the lecture method and discussion	100	0
2.	The learning activity in chemistry is writing more	89,2	10,8
3.	A learning module can improve student motivation to learning	86,8	13,2
4.	Besides chemistry textbooks, the teacher also used other books or teaching material in the teaching and learning process	23,7	76,3
5.	It is difficult for students to learn the chemistry material contained in textbook	81,6	18,4
6.	The student thinks chemistry is one of the complex subjects to be learned	89,2	10.8
7.	The teacher uses teaching material that is equipped with visual supporting tools to help the student understand the chemical concept	7,9	92,1
8.	An exciting and innovative learning module can improve student motivation to learning	97,4	2.6
9.	Student needs another learning media such as an interactive module or augmented reality-based module that can visualize the abstract material to be more simple, so the student can understand it easier	91,6	8,4
10.	The student has an android smartphone and sometimes brings it to school	97,4	2,6
11.	The student agrees with an innovative, engaging, and more understandable learning module like an augmented reality-based	89,2	10,8

Table 2. Chemistry Teacher Need analysis

No	Questions	Answers
1.	Based on the observation, what causes students' difficulty in learning chemistry? Is it an understanding concept or calculation?	The teacher thinks it is a concept of understanding the chemical concept related to ionization.
2.	How about students understanding related to chemistry, especially electrolyte and nonelectrolyte material?	In general, students can understand the material, but have not been able to classify it based on its ionization power and have not been able to connect relationship based on its type.
3.	What does the teacher think about the learning process during pandemic covid-19?	It becomes ineffective due to the limited time and material, so we will miss lots of material.
4.	What kinds of difficulties that the teacher and students face during chemistry learning?	Teachers' competencies are limited in using the learning tools. Then, limited resources for using the technology, and finally, the relationship between teachers, students, and parents is not integral yet.
5.	What efforts does the teacher make to overcome student learning difficulties?	By home visiting, they are conducting additional courses, then giving them assignments as often as possible so they can look for the material to answer the given questions.
6.	What is the most used method in the learning process? Is it effectively used in the classroom?	The teacher often uses lecture-discussion methods.
7.	Does the teacher use teaching material?	Yes, the teacher and the available books in the school library use it.
8.	Has the teacher ever done a module and shared it with the students?	The teacher has never done it. The teacher uses the teaching material from the publishers.
9.	Does the teacher often use learning media in class?	It is rare and has never been used.
10.	Does the teacher think the used learning resources have accommodated three levels of chemical representations?	Not yet.
11.	Can the used learning resources encourage and motivate the students to learn chemistry?	Based on the observation, due to the conventional learning resources, students are not encouraged and motivated yet.

Table 2. (*continued*)

No	Questions	Answers
12	Did the teacher know about augmented reality in chemistry learning? If the teacher does, has the teacher applied it?	No. It's never been applied.
13.	Does the teacher allow the students to use their smartphones in class?	Yes. The teacher often allows students if it is needed. Students can use it to look for information related to the material from other references.
14.	Does the teacher need a module that collaborates with technologically augmented reality to teach electrolyte and non-electrolyte solutions?	Yes, the teacher does need it. It must be done, considering that innovations in education are necessary to encourage students to learn chemistry.

4 Discussion

From the results of student questionnaires, 89.2% of students revealed that they wrote the most material during learning activities. The teacher only depends on the lecture and discussion method in delivering the material to the students. According to the interview result, the most used way is lecture-discussion. In addition to the method, the learning model used by the teacher is also still the old model and less varied. The use of the lecture method that is often done by teachers can have an impact on the lack of student activity in the classroom where students will only listen and take notes on the material presented, so thei skills are limited to a low level. The disadvantages of this method are that even though students will master the material, teachers will find it difficult to ascertain the extent of their understanding.

Furthermore, if a teacher does not have good communication, this method will be very tedious, and students will be discouraged from learning. Due to this reason, their chemistry score is below the minimum. Students' average quiz score evidences it in the academic year 2020/2021 is 67.

The learning process carried out is closely related to the use of learning media, for example teaching materials. Through interview data, it is known that the teachers in teaching chemistry always use textbooks as one of the teaching materials available in the school library. It is also known that the teacher has never made any teaching material. The used teaching material is conventional and not integrated with the technology. This is in contrast to learning in the 4.0 era which is synonymous with the use of technology in various fields including education. Teachers' limited competencies in using technology become a new challenge for them to create innovations in the learning process and to have an enjoyable learning atmosphere. Based on the results of the questionnaire, 23.7% of students answered that the teacher had other teaching materials used in learning, however, students still experienced problems in learning chemistry. Through a questionnaire, 89,2% of students stated that chemistry is a difficult material to learn.

One of the most challenging topics for students in learning chemistry is understanding. A teacher is visualizing 3D. According to Abraham et al., some identified factors that

cause this difficulty is that person's brain requires to imagine between the 3D structures of the molecule and the 2D pictures printed. Visualizing 2d into 3D in teaching material is a necessary competency for facilitating students in understanding the material. State that a static visualization can describe an unobservable level to facilitate students' understanding. Based on the interview result, the teacher reveals that students find it difficult to understand material about the ionized solution. Using conventional teaching material challenges the teacher in delivering the material and the students. The teacher did not use the collaborated technology teaching material yet. The questionnaire analysis result reinforces it, 92,1% of students stated that teachers did not use teaching material with visual tools. Argues that a conventional learning module requires additional illustrations and is integrated with webs so it can improve the readability of a learning module.

However, the current problem is the availability of learning resources that have not been integrated, still conventional and limited, like a textbook with only writings and 2D images. The lack of variety in the use of learning media also makes learning activities uninteresting and unattractive for students. Based on these, the researcher is developing an accessible augmented reality-based chemistry module as a solution to learn the material with the technical help that can visualize molecules.

This module enables students to learn actively because the visualization is displayed attractively. The integrated augmented reality technology in this module creates more interesting learning because it shows 3D alongside its animation that would exist in a natural environment. This module uses android devices, and 97,4% of the students also can bring smartphones to school.

5   Conclusion

From this research it is concluded that it is necessary to develop an augmented reality-based chemistry module that can assist teachers in creating more effective learning so that it can help students overcome the students' low understanding and interest in chemistry. Through this module, the submicroscopic material can be visual statically, so it also can facilitate the teacher in the teaching process. The students can achieve an understanding concept because it displays unobservable levels. It can also help teachers to conduct optimal learning by involving students actively in the learning activities.

Therefore, the research will conduct augmented reality-based chemistry module development on electrolyte and non-electrolyte material.

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