The Practicality of Computer-Based Electrolyte Fisher to Develop Problem-Solving Skill of Students on Electrolyte and Nonelectrolyte Solution

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Abstract. The aim of this research was to get the Electrolyte Fisher game on electrolyte and nonelectrolyte solution topic which was practical to develop students' problem-solving skills. This research was development research (R&D) with a 4D model including the stages of defining, designing, developing, and disseminating, but this research was only up to the development stage. The research subjects in the developmental testing were 16 eleventh grade students of science from several senior high schools in Nganjuk. The selection of research subjects was carried out randomly from several schools which were considered to represent the abilities of students from each district in Nganjuk. The instrument used was the student response questionnaire sheet and the student activity observation sheet. The results showed that the responses of students to the games that were tested obtained an average percentage of 89.6% with the very practical category, and the observation of students' activities during the developmental testing obtained an average percentage of 86.2% with the very practical category. Based on these results, it could be concluded that the Electrolyte Fisher game was practically or easily used in learning process for electrolyte and non-electrolyte solutions topic to develop problem solving skills.
Keywords: *The practicality of Electrolyte Fisher game, problem-solving skill, electrolyte and nonelectrolyte solution*

1. Introduction

The industrial revolution 4.0 which was marked by the rapid development of technology, information and communication brought social changes in society, especially in the education. 21st century educational innovation requires students to master 4C (communication, collaboration, critical thinking, and creativity), namely mastering information and communication technology, collaboration, critical thinking, and creative thinking. One of the skills that must be mastered in the 21st century is problem solving skills. Problem solving skills are a process of learning methods that require students to find their own answers without special assistance so that they can provide superior results because they encourage children to find solutions to problems with their own thoughts [1]. Students' problem-solving skills seen from the 2018 Programme for International Student Assessment (PISA) data showed that Indonesia was ranked 75th out of 80 countries [2]. This showed that the problem-solving skill of Indonesian students in learning was still low. There were 4 components in the problem solving skills that were developed, namely (1) identify the problem; (2) formulate hypothesis; (3) collect and analyze data; and (4) evaluate hypothesis and make generalization [1].

The implementation of chemistry learning during the Covid-19 epidemic changed from offline to online. Online learning is learning that uses internet networks with accessibility, connectivity, flexibility, and ability to generate various types of learning interactions [3]. Some teachers have experienced difficulties in implementing this online learning. Applied distance learning requires a medium so that the matter presented by the teacher can be easily understood by students. This medium is in the form of digital learning media such as LMS, videos, face-to-face applications, and so on. In its implementation, online learning requires the support of mobile devices such as smartphones or Android phones, laptops, computers, tablets which can be used to access information anytime and anywhere [3].

The learning media for generation Z must be adapted to this era. Digital learning can be done via a computer or smartphone. However, computer-assisted learning is considered more suitable for use compared to smartphones because there are several high schools that do not allow their students to bring Android (smartphones) in teaching and learning activities. The policy to prohibit bringing smartphones to school is because there are students who abuse smartphones for negative things [4]. Visual-based media plays a very important role in the learning process. Visual media can facilitate understanding and strengthen memory. Visuals can also foster students' interest and can provide a relationship between the content of the subject matter and the real world [5]. One of the interactive visual learning media is game. Game can be a tool for teacher to motivate students to be interested in subject matter so as to increase their knowledge and skills [5].

The characteristics of chemistry subjects have a level of difficulty related to concept abstraction, chemical changes at the atomic level, and the use of symbols. There are three levels of representation used in chemistry learning, namely macroscopic, symbolic, and sub-microscopic representations. One of the topics in chemistry that requires these three representations is electrolyte and non-electrolyte solutions. Students are required to identify the type of solution macroscopically through observation, describe the occurrence of the ionization process sub-microscopically, and relate it to the strength of the conductivity of the electrolyte solution symbolically seen from the reaction equation and the degree of ionization. The characteristics of the matter are abstract, which lies in the ionization reaction of compounds in solution, so it takes a media that can illustrate concepts easily understood by students. [6]. In this research, a game was developed on electrolyte and non-electrolyte matter. Therefore, to determine whether or not the Electrolyte Fisher game is practical as a learning media that develops problem-solving skills, research must be carried out. In this research, the results of student questionnaires and observations of student activities will be reported. It was stated that the game Electrolyte Fisher was practically used in learning activities.

2. Research Method

This type of research was development research by adapting the 4D model developed by Thiagarajan et al [7]. The 4D development model was divided into four stages, namely define, design, develop, and disseminate, but the stages carried out in this research were only until the developmental testing (development stage). In this research, the learning media for electrolyte and non-electrolyte matter was tested in the form of the Electrolyte Fisher game to develop students' problem-solving skills. The subjects of this developmental testing were 16 students of grade 11 Science in Nganjuk. Students who participated in this developmental testing were obtained randomly from several high schools in Nganjuk.

The research instrument used was in the form of student response questionnaire sheets and student activity observation sheets. Student response questionnaires were filled in by 16 students after using games in learning. This questionnaire contained a statement regarding the practicality of the Electrolyte Fisher game to find out what students thought about the learning media being developed. Student response questionnaire data were obtained by giving a Guttman scale score as in Table 1 below.

Table 1. Guttman Scale Criteria

Alternative Answers	Score	
	Positive	Negative
Yes	1	0
No	0	1

[8]

The formula used to calculate the practical percentage of each indicator was used as follows:

$$\text{Percentage of practicality (\%)} = \frac{\text{total score per statement}}{\text{number of respondents}} \times 100\%$$

The results of the student response analysis were used to determine the practicality of the developed media, namely by interpreting the percentage of assessment shown in Table 2.

Table 2. Interpretation Criteria for Practicality Score

Percentage (%)	Criteria
0 – 20	Not practical
21 – 40	Less practical
41 – 60	Enough
61 – 80	Practical
81 – 100	Very practical

[8]

The Electrolyte Fisher game was said to be practical if the percentage of practicality from the total average of students' response assessment results reached a percentage of ≥ 61% in practical or very practical criteria.

The observation instrument of student activity was used to determine the activities of students during the game. The observation sheet was filled in by observer who observe the students' activities during the developmental testing as a support for student response questionnaires. In this research, observer of student activity was only one person because of adjusting health protocols during the Covid-19 pandemic.

The questionnaire compiled by the researcher referred to the Guttman scale which was expressed in the form of "yes" and "no" answer choices as shown in Table 3.

Table 3. Guttman Scala

Answer	Score
Yes	0
No	1

[8]

The calculation of the percentage of student activity could be calculated with the following formula:

$$P\ (\%) = \frac{\Sigma \text{ frequency of activity appears}}{\Sigma \text{ overall activity frequency}} \times 100\%$$

The percentage results were obtained, then converted into criteria divided in Table 2. Based on the criteria, the Electrolyte Fisher game was considered practical if it got a score of ≥ 61% in practical or very practical criteria.

3. Research Results and Discussion

The developmental testing aimed to obtain data on the effectiveness and practicality of the game. The effectiveness was obtained from the test results in the form of learning outcomes of students before and after using the Electrolyte Fisher game as a learning media. The practicality was obtained from response questionnaires and observations of students' activities when using games. The subjects of this developmental testing were 16 students who had studied electrolyte and non-electrolyte solution material from several high schools in Nganjuk.

3.1. Student Response

Student response data were obtained from a response questionnaire sheets given to 16 students after using the Electrolyte Fisher game as a learning media. Following were the results of the student response questionnaire presented in Table 1.

Table 1. The Results of Student Response Questionnaire

Nu.	Aspect	Statement	Response		P(%)	Criteria
			Yes	No		
1	Students' interest in the Electrolyte Fisher	a. I am happy to use this learning media.	16	0	100	Very practical
		b. I am bored of Electrolyte	3	13	81,2	Very

Nu.	Aspect	Statement	Response		P(%)	Criteria
			Yes	No		
	game	Fisher's media game. *				practical
		c. I prefer learning with this game media so that learning is not monotonous.	16	0	100	Very practical
		d. This game helps me to understand the concept of electrolyte and non-electrolyte solution matter.	16	0	100	Very practical
		e. I am not interested in playing again when the game is over. *	4	12	75	Practical
		f. I feel challenged when playing this game	15	1	93,8	Very practical
		g. I hope this game can be applied in the learning process.	16	0	100	Very practical
				Average	92,9	Very practical
2	The problem-solving skills of students after using the game	After using the Electrolyte Fisher game, it is easier for me to solve problems solving problems in electrolyte and non-electrolyte solution matter.	14	2	87,5	Very practical
3	The level of clarity of the language in the game	a. The explanation of matter in the Electrolyte Fisher game, make me easier to study the matter of electrolyte and non-electrolyte solution.	15	1	93,8	Very practical
		b. The questions in the game are easy to understand.	16	0	100	Very practical
		c. The language in the game is easy to understand.	14	2	87,5	Very practical
		d. The explanation of game rules is easy to understand.	15	1	93,8	Very practical
				Average	93,8	Very practical
4	The level of easiness in using the game	a. How to play this game is easy for me to do.	15	1	93,8	Very practical
		b. During the game, I experienced many distractions *	4	12	75	Practical
				Average	84,4	Very practical
				Total Average	89,6	Very practical

Infromation:
* = Negative statement

Based on Table 1, the results of the student response questionnaire analysis regarding the use of the Electrolyte Fisher game on electrolyte and non-electrolyte solution matter obtained an average percentage of 89.6% in very practical criteria. The first aspect, namely the students' interest in the games developed, obtained an average percentage of 92.9% in very practical criteria. Students felt interested and happy with the Electrolyte Fisher game. This could be seen during the developmental testing of game, students were very enthusiastic and show expressions of seriousness in playing the game. However, the fifth statement, which reads "I am not interested in playing again when the game is over" received the lowest percentage. The fifth statement received

a positive response of only 75% due to obstacles when playing level 3. Level 3 contained questions that were in accordance with the results of video observations at level 2. The video at level 2 contained an experiment of the electrical conductivity of several solutions. However, some students did not pay attention to the video because the video quality was low or the image was a little blurry so they could not answer the question at level 3 correctly. One of the identities of game was the presentation of information in the form of certain simulations needed so that students were able to apply all their learning experiences in solving the problem in questions [9]. Presentation of information on video displays with low quality could cause students to be unable to apply their learning experiences.

The second aspect was problem-solving skills of students which are developed to get a percentage of 87.5% with very practical criteria. In the game Electrolyte Fisher, there are question exercises that were repeated so that students could answer correctly. This is in accordance with the information processing theory which states that information from outside is captured by the senses, if the information attracts the attention of students it will be processed and stored in short-term memory. If this information is repeated, the information can be stored in long-term memory and can be recalled at any time [10]. Digital games in learning process are very useful in knowledge construction and train various thinking skills of students, especially problem-solving skill [11]–[14]. A well-designed game program can motivate students and improve their knowledge and skills [5].

The third aspect was the level of language clarity in the game which got an average percentage of 93.8% with very practical criteria. Based on this percentage, it means that students agree that the matter (text or video), question exercises, and explanation of the game rules were clear and understandable. In the game there were two language choices, namely Indonesian and English. However, during the developmental testing, all students chose to use Indonesian because the language used in the learning process and textbooks at school used Indonesian. The media is an medium or messenger for messages from the sender to the recipient of message so that one of the uses of media is to clarify the presentation of message so that it is not too verbalistic. [5].

Figure 1. The main menu of the Electrolyte Fisher game

The fourth aspect is the level of easiness in using game which got an average percentage of 84.4% with very practical criteria. This showed that the Electrolyte Fisher game was easy to use as a learning media because it is flexible to play anywhere and anytime according to the era. In the learning process, computer-based educational games are easy to use to review matter without being limited by space and time and can motivate students to acquire knowledge in interesting ways [15]. In addition, all button functions run properly according to the instructions given and the game operation runs smoothly without any interruptions or obstacles (no hiccups).

3.2. Observation of Student Activities

Data from observations of student activity were obtained from observation sheets that were observed by one observer when students used the Electrolyte Fisher game. The technique of collecting student activity data was carried out by observation because it was related to human behaviour, work processes and observed respondents were not too large [16]. One student was observed by one observer. The activity of developmental testing was carried out at different times

due to physical distancing rules. Following were the results of the student response questionnaire presented in Table 1.

Table 2. Observation Results of Student Activities

Nu.	Aim	Observed aspects	Implementation		P (%)	Criteria
			Yes	No		
1.	Knowing the interests of students when using games	a. Learners follow the rules of game	16	0	100	Very practical
		b. Students continue to play until the end of the game when they fail	16	0	100	Very practical
				Average	100	Very practical
2	Knowing the learning activities of students when using games	a. Students read the rules of game before playing game	13	3	81,2	Very practical
		b. Students read matter on the main menu	12	4	75	Practical
		c. Students answer the questions in the game	16	0	100	Very practical
		d. Learners play the game at level 1	16	0	100	Very practical
		e. Learners play the game at level 2	12	4	75	Practical
		f. Learners play the game at level 1	16	0	100	Very practical
				Average	88,5	Very practical
3	Knowing the clarity of how to use game	a. Students understand the procedures for playing Electrolyte Fisher	13	3	81,2	Very practical
		b. Students do not ask questions when playing	12	4	75	Practical
				Average	78,1	Practical
4	Identifying activities that are not relevant to the Electrolyte Fisher game	a. After the game is over, students do not play again	4	12	75	Practical
		b. Students do activities that are not relevant (such as playing smartphones, opening other applications on the computer, joking with friends, etc.)	3	13	81,2	Very practical
				Average	78,1	Practical
				Total Average	86,2	Very practical

Based on Table 2, the observation results of student activity when using the Electrolyte Fisher game on electrolyte and non-electrolyte solution matter obtained an average percentage of 86.2% in very practical criteria. The first aspect, namely the interest of students in the games developed, obtained an average percentage of 100% in very practical criteria. There were three elements that need to be considered to make the learning process with computer fun, namely challenging, fantasy, and curiosity [5]. The game Electrolyte Fisher fulfilled a challenging element, namely preparing question exercises with several levels of difficulty so that students were motivated to do

questions until the game was over. The fantasy element in this game was in the form of examples of sub-microscopic images or animations of the electrical conductivity of the solution that attracted and touched the emotion of students. The element of curiosity in this game was the presentation of phenomena on the main menu (before entering level 1) so that students could be led into surprising situations and could arouse their curiosity by playing games.

The second aspect, namely the learning activities of students when using games, obtained an average percentage of 88.5% in very practical criteria. Students followed the whole game flow starting from reading matter, game rules, and working on questions from level 1 to 3. This game was a type of Computer-Assisted Instruction (CAI) which presented messages and information in drill and practice format. its format was used with the assumption that a concept, rule, or procedure in this case electrolyte and non-electrolyte matter has been taught to students. This type of CAI could provide practice until a concept was completely mastered by students before moving on to other concepts and provided constant reinforcement of the correct answer. [5]. In the Electrolyte Fisher game, students had to answer the question exercises correctly in order to go to the next level. If the score did not fulfilled yet, the students had to repeat the level. In addition, there was reinforcement in the form of discussion of questions if students succeed in answering questions correctly.

The third aspect, namely the clarity of how to use game, obtained an average percentage of 78.1% in practical criteria. Most of the students understood how to play the game because at the time of the developmental testing activity, there were only 4 students who asked about how to operate the game. One of the main components in the game was the existence of the game rules [5]. Therefore, a good game had to have clear rules that were easy to understand for students. The fourth aspect was activities that were not relevant to the Electrolyte Fisher game obtained an average percentage of 78.1% in very practical criteria. There were 3 students who carried out irrelevant activities, namely playing smartphone when presenting the phenomenon monologue. This happened because they considered the presentation of the phenomenon to be insignificant so it is ignored.

4. Conclusion

Based on the result of research, it could be concluded that the Electrolyte Fisher game was stated to be very practical as a learning media to develop students' solving skills. This was based on the percentage of students' positive responses of 89.6% and the percentage of students' high activities when using the Electrolyte Fisher game of 86.2%. Both of these percentages were in very practical criteria so that it showed that the Electrolyte Fisher game could be used easily in learning activities for both teachers and students.

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