Development of Constructivism-Based Pictorial Chemistry Cards on Electrolyte and Non-Electrolyte Solution Materials

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Abstract. Electrolyte solution is one of the abstract chemistry learning materials, which explains chemical phenomena mostly at the microscopic and symbolic representation levels. This can be an obstacle for students in learning and understanding the material so that it can result in low student learning outcomes. This research aims to develop Constructivism-Based Pictorial Chemistry Cards on Electrolyte and Non-Electrolyte Solution Materials that is valid in terms of instructional and technical content. The study employs a 4-D model. There were four stages of this investigation: (1) defining, (2) designing, (3) designing, and (4) disseminating. The data were collected via validity sheets by 3 chemistry lecturers. The result of this research is the validity of the Constructivism-Based Pictorial Chemistry Cards which is categorized as highly valid (88 %). The result indicates that the content quality, instructional quality, and technical quality of the Constructivism-Based Pictorial Chemistry Cards are valid for use as learning materials.

Keywords: Constructivism, development, pictorial card

1 Introduction

Chemistry is the study of matter and its interactions with other substances. This subject is a branch of science that investigates the content, structure, properties, and behavior of matter's constituent elements and the compounds made up of atoms, molecules, and ions, as well as the changes these entities undergo during chemical reactions [1, 2]. The definition of chemistry is in two forms: chemistry as a product and process. As a product, chemistry consists of knowledge in the form of facts, concepts, principles, laws and theories. While as a process, chemistry consists of a series of natural phenomena and events in nature[3]. There are three levels of chemical representation, namely macroscopic, microscopic and symbolic[4].

Electrolyte solution as one of the chemistry subject matter, studied in in 10th grade high school. This class of material is abstract, in the form of scientific descriptions of chemical phenomena that are mostly microscopic and symbolic[5]. This can be an obstacle for students in learning and understanding material at this level of representa-

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tion, so that it can result in low student learning outcomes. This is evident from the results of assessment atsolok, West Sumatera. The results of the observation showed the low learning outcomes of students on electrolyte and non-electrolyte solution material. During the observation in 10^{th} grade, it was found that 26 students (72.22%) had scores below the minimum completion score. This phenomenon is also in accordance with the results of Cahyana et al's research which states that the material of electrolyte and non-electrolyte solutions is abstract, making it is difficult to describe to students[6].

Observations also provide information that chemistry learning is dominantly teacher-centered with the lecture method. The tendency of teachers is to only teach material and the students in this situation are often referred to as "empty vessels" because they do nothing except listen and take in the material presented to them[7]. Although teachers used learning media in the learning process, the learning interaction carried out by the teacher is still one-way, because the source of information comes from the teacher so it does not accommodate students to be more active in the learning process[8]. The results of interviews with several students became reinforcements of researcher's observations. Most students are not very familiar with the material due to learning environment that is quite monotonous and presented with less interest. Therefore, it is necessary to develop learning media in accordance with the material and characteristics of students. However, most chemistry subject matters require learning media in the teaching process so that students can understand the lecture optimally[9, 10]. Learning media makes students to be actively involved in the learning process, thus making students' understanding of the material taught increases[11].

Referring to previous research, the use of chemical cards in the learning process is quite effective in improving student learning activities and outcomes[11, 12]. Chemistry card is in order to encourage active participation, motivate students during the learning by playing process, and effectively achieve the learning objectives[13]. The experimental results of the study conducted showed that the use of chemistry cards in learning outperformed the baseline in terms of excitement and pleasure of use, informative content, attractiveness of the application and encouragement of self-learning[14].

In schools, chemistry cards also can be used in tandem with other instructional resources to facilitate collaborative study[15, 16]. In addition, chemistry cards can also be developed with a constructivism approach. In this approach, the development of critical thinking, analytical and problem-solving skills can be done alone. Students can build their own knowledge through measurable, systematic and planned activities. It is intended that students are accustomed and trained to think in solving the problems they face, as well as independent, creative and able to be responsible for their thoughts rationally [17, 18]. This approach is one of the strategies to improve student's abilities by directing the learning process where students actively build their own knowledge (constructivism theory)[13].

Based on the phenomena described above, researchers are interested in developing a chemical learning media in the form of picture cards on electrolyte and non-electrolyte solution materials. The purpose of this research is to develop valid Constructivism-Based Pictorial Chemistry Cards on Electrolyte and Non-Electrolyte Solution Materials that can be used in chemistry learning.

2 Method

The type of research used is R. This type of research aims to develop a product, which in this study is a constructivism-based pictorial chemistry card on electrolyte and non-electrolyte solution material. The model used is a 3D model. The 3D development includes 3 main stages, namely, defining, designing, and developing stages.

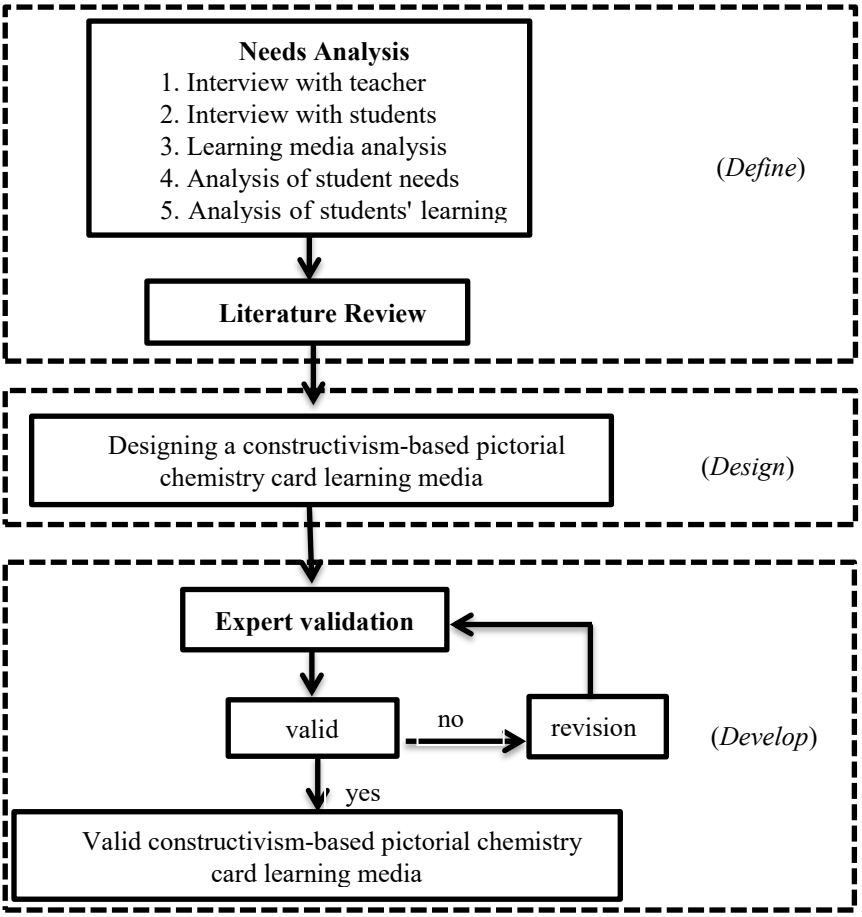

Fig. 1. Schematic of development stages

The development of pictorial cards is based on the problems found at Senior high school 2 Solok during chemistry learning of electrolyte and non-electrolyte solutions. The pictorial cards will be tested to validate the media involve as many as 3 chemistry lecturers. The instrument used for the validity test was a validation sheet. The validation sheet was divided into 3 aspects which include aspects of content quality, instructional quality and technical quality.

The data analysis technique was done by describing the results of media development. The data obtained through the validation sheet in the form of quantitative data was converted into qualitative data. Based on the results of the validator's assessment, the feasibility of the module that has been made can be known. Instrument assessment categories use the following categories:

Table 1. Validity Category

Interval	Category
0%-20%	Invalid
21%-40%	Less Valid
41%-60%	Quite Valid
61%-80%	Valid
81%-100%	Highly Valid

3 Results and Discussion

3.1 Define stage

The first stage in making picture cards is the defining stage. This stage was carried out to find out the conditions in the field through a series of needs analyses. This analysis was carried out as a reference and framework in formulating how pictorial chemistry cards was developed. Based on the needs analysis, it is known that the learning media used during learning is still limited to certain materials and has not been able to foster student's interest in learning and has not been able to make students active during the learning process. For electrolyte and non-electrolyte materials there is no learning media. However, there are learning resources such as books, but they are rarely used. Students complain that the size of the book is large and heavy.

To overcome the problems, researchers develop learning media. Learning media developed in the form of pictorial cards. The pictorial cards are clearly more interesting, cognitively stimulating, and easily evoke emotions during the learning process. Therefore, slow learners do not quickly forget the learnt material[19]. The developed pictorial cards are based on the constructivism approach. The constructivism approach emphasizes on student activity in building their knowledge[20].

3.2 Design stage

In this design stage, the first step is to create a storyboard. Storyboard is a general design of a media that is arranged sequentially and equipped with explanations and specifications of each image and text. Making a storyboard aims to identify what materials must be made or arranged so that the design process can run smoothly[21]. In making the storyboard, researchers compiled a layout of images, materials, and exercises. In addition to compiling layouts, researchers also adjust designs and attractive backgrounds so that students are interested in using this card media.

After the storyboard was completed, researchers began designing pictorial cards in accordance with the storyboard. The pictorial chemistry card contains a cover, bibli-

ography and contents that are in accordance with the constructivism approach. Constructivism-based pictorial chemistry cards have a size of 10 cm × 8 cm. The small size of the card aims to make this card media easy to carry around, so that students can use it wherever they are.

Fig. 2. Cover and content of pictorial chemistry card

3.3 Develop stage

The last stage of this research is the development stage. In developing this illustrated chemistry card, researchers conducted a validity test. The validity test is grouped into three aspects, namely, aspects of content quality, instructional quality, and technical quality.

Table 2. Results of validity test of Constructivism-Based Pictorial Chemistry Cards on Electrolyte and Non-Electrolyte Solution Materials

No	Aspect	Validator			Sum	Maximum score	%	Category
		1	2	3				
1	Content Quality	18	22	20	60	72	83	Highly valid
2	Instructional Quality	14	16	14	44	48	92	Highly valid
3	Technical Quality	43	45	42	130	144	90	Highly valid
	Sum	75	83	76	234	264	88	Highly valid

From the aspect of content quality, it was declared highly valid by the validator with a percentage of 83%. This indicates that the material on the pictorial card is easy to understand, and the pictorial card can encourage students to carry out investigative activities and discover the concepts learned themselves. The use of chemistry learning card media makes students enjoy the game, find it easy to play, and consider it a useful learning experience[22]. In addition, the results of the assessment of the three validators showed that the constructivism stages on the illustrated chemistry cards were in accordance with the existing theory.

In addition to the content quality aspect, it can also be reviewed from the instructional quality aspect. The results of the validator's score showed highly valid results with a fairly high percentage of 92%. This is because the developed pictorial chemistry cards are quite clear, both from the presentation of the cards, as well as the flexibility in their use which can encourage student's curiosity to use the cards.

In terms of technical quality, it was declared as highly valid by the validator with a percentage of 90%. This is because the pictorial chemistry cards have fulfilled the requirements for preparing good picture card media. Among them are all types of writing and the size of the writing on the card is easy to read, the language used is communicative, the sentences are in accordance with the intellectual abilities of heterogeneous students, the illustrations on the cover are in accordance with the material and cause attraction.

When viewed from the product produced, pictorial chemistry cards match students' characteristics, where students prefer media that contains lots of pictures. Students also enjoy the small size of the media so it is easy to carry and use. The most important thing is that pictorial chemistry cards are able to facilitate students to think in constructing their own knowledge, because in this media there are questions that are able to stimulate students' initial knowledge regarding the material to be studied. Having this initial knowledge will make students active during the learning process.

Overall, the validation results of constructivism-based pictorial chemistry cards were 88% with a highly valid conclusion. The higher the validity of the product developed, the better the conclusions, the level of meaningfulness, and the usefulness [23].

4 Conclusions

Based on the research results, it can be concluded that the Development of Constructivism-Based Pictorial Chemistry Cards on Electrolyte and Non-Electrolyte Solution Materials is highly valid. The outcome proves that the Constructivism-Based Pictorial Chemistry Cards are effective as a teaching tool in all three areas tested: content quality, instructional quality, and technical quality.

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