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The Development of Guided Inquiry-Based Solubility Equilibrium E-Module

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Abstract:
Solubility equilibrium is a basic material of chemistry that involve an abstract concept. The visualization of abstract concept can be presented using the electronic media in the form of pictures, videos, and animations. The guided inquiry is one of the right strategies to teach about solubility equilibrium. The purpose of this research was to develop, determine the validity and the eligibility of the guided inquiry-based solubility equilibrium e-module. This research used Borg and Gall's development model with 5 stages, which were the product analysis, the initial product development, the expert validation and revision, the field trial, the trial result analysis, and the product revision. The product validity has a very valid criteria in terms of the material, media, and language expert assessment with the average percentages were 96,11%, 83,18%, 90,61%. The students' response to the product showed that the product was very proper to used in the learning based on the average percentage of 90,61%. That meant the developed guided inquiry-based solubility equilibrium e-module could be one of the teaching materials for basic chemistry course.

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Introduction

Solubility equilibrium is one of the materials that should be mastered by the students who take the basic chemistry course. The material involves an abstract concept, such as dissolving and deposition processes. Beside of that, it also involves mathematic calculation, such as the value determination of the solubility equilibrium constant. The result of some research inform that the material is quite difficult to be learned (Quilez, 2004; Raviolo & Garritz, 2008; Kelly et al., 2010; Naseriazar, et al., 2011). The difficulty to understand the material has an impact on the occurrence of misunderstanding. The misunderstanding that always occur continuously can lead to the misconception, as reported by Onder & Geban (2006).

The fully understanding to the solubility equilibrium requires students to understand it on three representation sectors which are macroscopic, microscopic, and symbolic. Just as the chemists use the three representation levels to describe and explain the chemical phenomenon. The macroscopic representation is a concrete form that observed by sense (such as dissolving and deposition). The microscopic representation is an abstract form that describes a chemical process that involve atom, molecule, and ion interaction. The symbolic representation involves the use of symbols from the abstract object so that can be observed and understood such as the reaction equation, the mathematic equation, and graphic (Chandrasegaran, et al., 2007; 294).

Based on the one of the abstract solubility equilibrium material characteristics, thus it needs a right way to deliver. The abstract concepts can be visualized with two dimensions form such as picture or three dimensions form such as videos/animations. Gilbert (2005) stated that the conceptual visualization is very important in science. This is very important to be done to prevent the misconception.

A good understanding to the solubility equilibrium material is also can helped through the guided inquiry learning. The used of inquiry learning can improve students' understanding (Walker & Warfa, 2017). The guided inquiry learning can involve students directly in learning with giving a chance to explore the learning experience that has been owned before, also analyze the existing relationship with the new knowledge, so the learning becomes valuable. The advantages of the guided inquiry are, (1) in the learning demands cognitive, affective, and psychomotor aspect, (2) learning appropriate to each characteristic, (3) giving a long-lasting experience, (4) can provide students with high, medium, and low ability (Depdiknas, 2008).

The learning process that demands students' activity in the guided inquiry learning should be facilitated with the teaching material. One of the teaching materials that can be used is module. The module that used should be the guided inquiry-based, where in the module contains the stages in the guided inquiry learning model. Some of the research showed that the used of the guided inquiry-based teaching material can improve the learning result (Furqan, et al 2016; Novianty, et al, 2013).

The rapid development of the information and communication technology has been widely integrated in the process of learning. One of it is in the form of the teaching material innovation in the form of e-module. e-Module is an electronic module. e-Module can be accessed using computer/laptop and smartphone so it can be accessed whenever and wherever. In the e-module, various tools are presented, such as animations, chart pictures, and laboratory virtualization where the user can directly interact with practical tool should be at the laboratory (Pratama & Masykuri, 2018).

Based on the explanation above, then the research is done to develop, determine the validity, and know the eligibility of the guided inquiry-based solubility equilibrium e-module that can be used in the basic chemistry learning.

Research Method

The guided inquiry-based solubility equilibrium e-module product was developed by adopting the procedure of Borg & Gall's development research (2003). This development model was chosen because the process of testing and revising to the product was done gradually until the final product was obtained. The research procedure was simplified until only consist of 5 stages.

The first stage was the product analysis to determine which media type that is suitable with the material and students' characteristics. The second stage was the development of e-module product and the device to validation and trial process. The third stage was validation and revision, in the form of the validity assessment toward the e-module, in terms of material aspect, the appropriateness with the guided inquiry model, the accuracy as the learning media, also the rightness and clearness of language. In this stage, the revision as what the validators gave was also done.

The fourth stage was the filed trial with giving the product to 15 students to used it in the individual learning. Then, the students were asked to assess through a questionnaire. The last stage was the analysis of product trial and revision, where the researcher analyzed the result of product trial and revision questionnaire based on the trial activity suggestion.

Results and Discussion

Based on the result of the product analysis, the guided inquiry-based solubility equilibrium e-module product was developed in the ePUB (electronic publication) format. The e-module was developed using Sigil software which was the open source. The e-module could be only opened using the ePUB reader application. Here is the initial display of e-module when it was accessed using a laptop/computer with Azardi application (the left Figure 1) and using the Smartphone with the Moon+ Reader application (the right Figure 1).

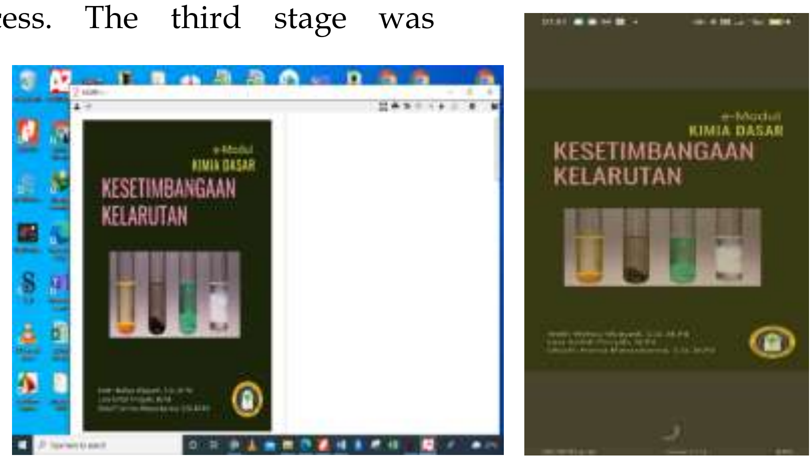

Figure 1. The Display of e-Module Accessed using Laptop/Computer (left) and Smartphone (right)

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According to Hanson (2005), e-module has the guided inquiry learning stages. The first stage was orientation, which is the activity to prepare students to learn. In this stage, the students were given a phenomenon that include in three represnetation. The macroscopic representation ws presented using picture and video. Mitra, et al (2010) stated that a video could help improve the understanding to the material taught. The microscopic representation was presented in the form of atom, molecule, and ion interaction based on the macroscopic phenomenon. The symbolic representation was presented using the reaction equation based on the phenomenon that observe macroscopically and presented in the microscopic representation. The phenomenon presentation in the three representations were done to ease students to understand the chemistry concepts (Maden, et al., 2011; Mayasari, et al., 2012; Yakmaci-Guzel & Adadan, 2013; Thomas, 2017) that showed in Figure 2.

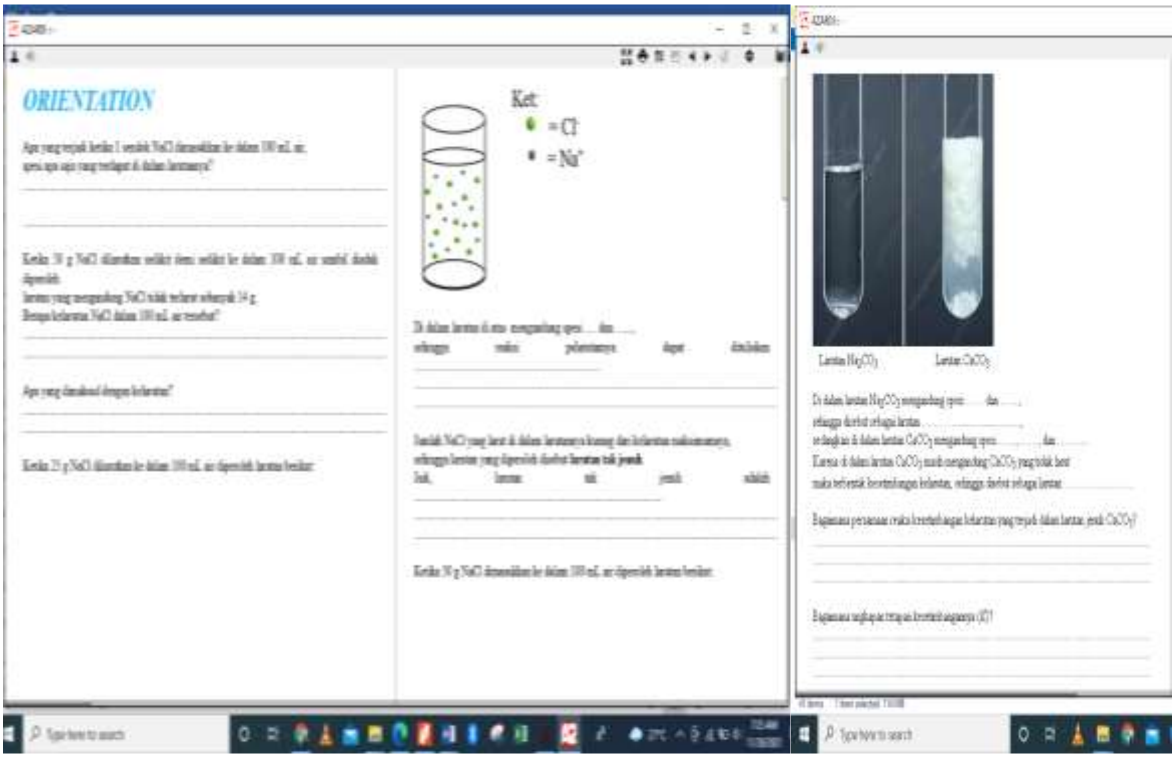

Figure 2. The Phenomenon Presentation in The Multiple Representation

The second stage was exploration, in this stage, the students did the experiment, starting with submit a hypothesis. The average age of the students who took the basic chemistry course is 17 years old. According to the Piaget's theory (Dahar, 2011) then the students could think abstractly and hypothesis-deductively, which mean the students were able to formulate a lot of hypothesis choices in responding a problem and checking a data to every hypothesis in order to make a decent decision. The using data should be obtained by practical activity. However, because of the limitation to do a practical activity at the laboratory, then the practical activity could be changed with ta practical video that present in this e-module, showed in Figure 3.

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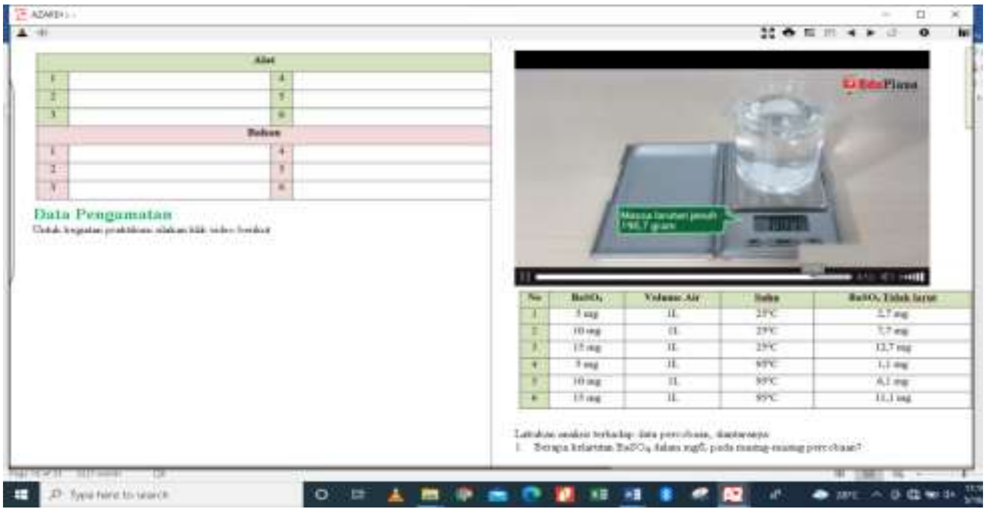

Figure 3. The Presentation of Practical Activity in The Form of Video

The third stage was the concept formation, in this stage, the concept was found. The concept finding process was designed by the questions that made the students to think critical and analytical related to the practical data that was obtained in the previous stage. From this stage, it was expected could practice students higher order thinking skill and motivate them. Blanchard, et al., (2010: 609) stated that the laboratory based guided inquiry learning tend to make the participants got a strong knowledge and generally saved in the long-term memory. In line with Bruner in Sund & Trowbridge (1973) who stated that one of the advantages in discovery learning, also include the guided inquiry was improve a memory.

The fourth stage was the application. In this stage, the students finished the exercise in the e-module that had been done to practice the ability of problem solving that relate to the concept that had been obtained. With the exercise, it would make an interaction, either the students' interaction with e-module or the social interaction between the students with the other and the students with the lecturers. Vygotsky in Eggen & Kauchak (2004) stated that the important thing in learning constructivist is the social interaction. The result of this stage was the students would know how the level of their understanding on the solubility equilibrium material.

Closure as the last stage was the process where the students did a reflection to the learning that had been done. It was same as Schunk, et al., (2008)'s statement that the constructivist learning made the participants to do a reflection in their way of thinking.

The average percentage of e-module validity developed result in terms of material and suitability aspect with the guided inquiry model based on the experts' assessment of 96,11%. This result could be categorized as very valid (Riduwan, 2013). It showed that e-module has contain the complete solubility equilibrium material and appropriate to the curriculum. The concepts in the solubility equilibrium material were presented correctly and precisely. The material presentation in the e-module also had been appropriate with the stages in the guided inquiry learning that stated by Hanson (2005), which were orientation exploration, concept formation, application, and closure. The summary of the material experts' assessment is presented on the Table 1.

Table 1. The Result of e-Module Validity in Terms of The Material and Suitability Aspect with The Guided Inquiry Model Data

The Assessed Aspect	Percentage (%)	Criteria
The material suitability	97,50	Very valid
The material depth and completeness	96,59	Very valid
The concept rightness	95,59	Very valid
The suitability with the guided inquiry model	93,75	Very valid
The average percentage	**96,11**	**Very valid**

The average percentage of e-module validity developed result in terms of the learning media aspect based on the experts' assessment of 83,18%. This result could be categorized as very valid (Riduwan, 2013). It showed that e-module has a completeness such the introduction part, the main part and the closing part, according to Purwanto, et al (2007)'s opinion. e-Module was presented with the interesting design and display by the precision video and picture arrangement in it. The summary of the material experts' assessment is presented on the Table 2.

Table 2. The Result of e-Module Validity in Terms of The Learning Media Aspect Data

The Assessed Aspect	Percentage (%)	Criteria
The e-module completeness	86,36	Very valid
The e-module design & display	80,00	Valid
The Average Percentage	**83,18**	**Very valid**

The average percentage of e-module validity developed result in terms of the language rightness and clearness, based on the experts' assessment of 90,61%. This result could be categorized as very valid (Riduwan, 2013). It showed that the using language in the e-module was very clear (does not lead to a double interpretation), easy to understand, the using illustration to explain the relevant material with the delivered message, the order among the topic, subtopic, and the writing of terms/symbols were appropriate with *Kamus Besar Bahasa Indonesia (KBBI)*. The summary of the material experts' assessment is presented on the Table 3.

Table 3. The Result of e-Module Validity in Terms of The Language Rightness and Clearness Data

The Assessed Aspect	Percentage (%)	Criteria
The communicativeness of material objective and evaluation	86,36	Very valid
Dialogue & interactive	86,36	Very valid
The material objective and evaluation straightforwardness	90,00	Very valid
The order among the topic, subtopic & paragraph	93,75	Very valid
The writing of terms/symbols	96,59	Very valid
The average percentage	**90,61**	**Very valid**

Based on the average percentage the experts' assessment result, then it could be said that e-module had a very valid validity so that it could be done to the trial stage. The trial result that was done to the students to know the

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appropriateness of e-module that seen from the material suitability, the delivery clarity, the language use, the display, the easiness to use, and the benefit of use, it is presented in the Table 4.

Table 4. The e-Module Trial Result Data

The Assessed Aspect	Percentage (%)	Criteria
The material suitability	91,88	Very proper
The delivery clarity	95,71	Very proper
The language use	86,87	Very proper
The display	91,88	Very proper
The easiness to use	88,00	Very proper
The benefit of use	89,29	Very proper
The Average Percentage	**90,61**	**Very proper**

The average percentage showed that e-module was very suitable to used in the learning. It showed that e-module had the content accuracy, the interesting delivery, the easiness to use, and the benefit of use in the basic chemistry course learning. The e-module appropriateness in this research was in line with the e-module appropriateness in the chemistry material that had been produced by other researchers, among of it were the chemical equilibrium material e-module (Asmiyunda, et al., 2018), the atomic structure material e-module (Wijayadi & Putra, 2019), and the natural chemical organic material e-module (Kasih, et al., 2021).

Conclusion

The research result showed that the guided inquiry-based solubility equilibrium e-module had a very valid validity based on the material, media, and language experts' assessment with the average percentage of 96,11%, 83,18%, 90,61%. The students' response to the product showed that the product was very proper to use in the learning with the average percentage of 90,61%. Therefore, e-module can be used in the basic chemistry learning.

The advantages of the development result e-module were: (1) the product was developed based on guided inquiry so that could practice the thinking skill in the inquiry process; (2) the product was completed with the visualization concept on the level of macroscopic, symbolic, and microscopic; (3) the product was completed with the test that automatically gave feedback to the user; (4) the product could be used whenever and wherever. The weakness of the product that had been developed was the product could not directly used without the ePUB reader application in laptop/computer or smartphone.

The suggestion that could be given based on the research result is the need of doing further research relate to the e-module implementation in the learning at class to know the level of effectiveness and the findings that occur. The potential of e-module development result as a teaching material in the e-learning should be studied in the further research.

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