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The Development of Chemistry Electronic Module Based on Guided Discovery Learning on Teaching Chemical Bonding

Larah Maghfirotika, Muktiningsih Nurjayadi*, Fera Kurniadewi

Chemistry Education, Universitas Negeri Jakarta, Jl. Rawamangun Muka, Jakarta 13220, Indonesia

ORCID
Larah Maghfirotika: https://orcid.org/0000-0002-3541-8103
Muktiningsih Nurjayadi: https://orcid.org/0000-0003-1666-2263

Abstract.
The COVID-19 pandemic had many impacts on education. The teaching and learning process was done through distance learning and was carried out online through several online platforms and media. This study aimed to produce an independent learning media for students in the form of an online module based on the Guided Discovery Learning model in the class on chemical bonding of class X in senior high school. This study used the methods outlined in Research and Development by Borg and Gall (2003) and followed the descriptive quantitative method. The instrument used in this study was a questionnaire. The module was validated by three experts for content and language and also validated by three experts for media and graphics. The module was also trialled by 20 students in grade 10 science, 35 college students in the chemistry education program and 8 chemistry teachers. The ratings that were given by experts, students, and teachers from the validation and trial stages can be categorized as *good* and up to *very good*, so it can be concluded that the module is feasible to be used as a learning media on in the class on chemical bonding of class 10 in senior high school.

Keywords: online module, guided discovery learning model, chemical bonding

Corresponding Author:
Muktiningsih Nurjayadi; email:
muktiningsih@unj.ac.id

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1. INTRODUCTION

In the learning process, technology can be used in media and learning models. There are many learning models that can apply technology-based learning or learning models that are combined with technology and can be applied well in learning. M-learning has offered considerable benefits by building and supporting the creative, collaborative, interactive abilities and capacities inside the learning environments [1]. E-learning is an electronic learning system, using electronic media, internet, computers, and media files (sound, images, animation and video) [2].

Based on the results of the preliminary analysis that authors of this paper did, that was found 86.2% of students had laptops/computers and 95.4% of students had

smartphones, which showed that almost all students had products of technological development, and as many as 93.8% of students had Wi-Fi/Modem to access the internet. In addition, from the results of the preliminary analysis, 62.5% of students stated that reading chemistry textbooks was not interesting and not easy to understand.

Bonding material is one of the abstract chemical materials where the learning technique for abstract material is by imagining or creating pictures of abstract things. Chemical bonds describe the way atoms bond to form molecules or ions. This makes it difficult for students to understand the interactions that occur within molecules / between molecules [3]. To understanding chemical bonding material is very important first because understanding this material can be used as a basic for understanding other chemical materials, including the nature of chemical reactions, thermodynamics, chemical equilibrium, molecular structure, physical properties such as boiling point and organic chemistry [4, 5].

The electronic module is one of the teaching materials that can be used with electronic media and has several devices that make this teaching material interesting. The application of e-Module which utilizes technology and information that is developing rapidly and is believed to be able to improve the learning abilities of students [6] and allow two-way interactions which are expected to be able to improve the quality and effectiveness of learning. Chemical bonding materials are generally grouped into four sub-themes, namely ionic bonds, covalent bonds, metallic bonds, and intermolecular forces [7]. The problem in chemical bonding material is where students find it difficult to describe how the interactions that occur when atoms bond to form an ion or molecule. Chemical bonding materials that are more abstract are usually more difficult to understand, related to the relatively many previous understandings of material such as atomic structure, periodic properties of elements, so that they are less motivated to study them [8]. This difficulty can be overcome through learning media [9–11], one of which is an electronic module. In the electronic module, an interactive video will be presented that shows an overview of how the interactions between atoms when chemically bonded to form ions and molecules.

Then the product was developed during the Covid-19 pandemic, this condition is required students to independently learn from home and learning by online (from internet). Learning via online or distance learning (PJJ) makes it difficult for students to understand the material and reduces students' enthusiasm for learning. The researchers made a teaching material that hopes that students can learn anything, anywhere, anytime through the development of electronic modules that focus on modules that can be used in smartphones but can also be used through devices such as laptops.

Guided discovery learning is a learning model that aims to train students to find concepts independently [12]. In the guided discovery learning model, students are required to be more active and independent in solving cases and finding the right answer to the case, but still under teacher guidance / direction in understanding related cases with learning material. Also, the teacher presents examples, guides to find patterns in these examples, and provides conclusions when students have been able to describe the ideas that have been taught by the teacher. Therefore, this model can be applied well through electronic module teaching materials that utilize electronic media in its application. The development of an electronic module with the Guided Discovery Learning model is expected to be able to facilitate teachers and students in learning and can become teaching materials that can be used in the long term.

2. RESEARCH METHOD

The type of research used is Research and Development (R&D) which uses the Borg and Gall model with quantitative descriptive research methods. The subjects of this study were 5 high school chemistry teachers and 20 IPA high school students, and 35 students of Chemistry Education, UNJ Level 2. The study consisted of 9 stages, namely: preliminary analysis and needs, planning, early-stage module development, expert validation, revision of expert validation results, small-scale trials, revision of small-scale trial results, large-scale trials, and revision of large-scale result.

The instrument that used in preliminary and need analysis is a questionnaire containing 27 statements to identify research problems that can be used to develop an electronic module (e-module) according to the needs of teachers and students both for the present and the future. Questionnaires also used in validation by expert. Table 1 shows the rating scale of the experts refers to the book rating scale by puskurbuk.

TABLE 1: Rating scale by puskurbuk.

Very Less		Less			Good		Very Good		
1	2	3	4	5	6	7	8	9	10

Table 2 shows the scale that used in this e-module trial instrument is a modified Likert scale which consists of four points.The criteria for each point presented in table 2:

TABLE 2: Likert scale.

Answer	Very Agree	Agree	Disagree	Totally disagree
Score	4	3	2	1

The research data were analyzed by using the percentage descriptive system. Data in the form of collected numbers are then processed by adding them, compared to the expected number and the percentage obtained. The formula used is as follows [13]:

Percentage (%) = $\frac{n}{N}$ x 100% (1)

Then, the resulting score is interpreted by the rating scale score based on the Puskurbuk by BSNP scale shown in table 3.

TABLE 3: Rating scale based on puskurbuk scale.

No.	Percentage	Interpretation
1	0% - 29%	Very Less
2	30% - 59%	Less
3	60% - 89%	Good
4	90% - 100%	Very Good

The research is successful if the interpretation results reach 60% to 100% or the interpretation is good or very good.

3. RESULT AND DISCUSSION

This research was started from December 2019 until June 2020. The development of this e-module is expected to be able to attract and help students learn to understand the Chemical Bond material independently. The steps in this study consist of 9 steps.

3.1. Preliminary and Need Analysis

The preliminary analysis phase and the need for teachers was carried out in December 2019-January 2020 at SMA Negeri 31 Jakarta and SMA Negeri 68 Jakarta. The total number of respondents who filled out the preliminary analysis questionnaire and these needs were 2 chemistry teachers and 65 students of class X SMA. This preliminary analysis of needs and needs was carried out by distributing questionnaires. The results of preliminary analysis and the needs of the teacher were chemistry teachers that the difficulty in teaching chemical bonding material was due to the fact that chemical bonding material had quite a lot of material and limited learning time, the teacher used printed books As the main source of information, the chemistry teacher stated that the chemistry textbooks used by students were not interesting and not easy to understand, chemistry teachers needed interesting teaching materials in addition to chemistry textbooks that students already had that were interactive, modern, and easy to understand.

The results of the preliminary analysis and the needs of students are that more than 80% of students have learning support facilities, namely laptops, smartphones, and Wi-Fi as supporting facilities for product implementation, as many as 53.8% of students stated that chemical bonding is a material that is difficult to learn. This difficulty is due to the chemical bonding material that has too much material to memorize (73.8%) and too much material (38.5%) with a limited learning time. Then as many as 95.4% of students expect to develop learning resources in the form of modules on chemical bonding material that are easy to understand (92.3%), short and clear material (86.2%), and display animation (76.9%).

3.2. Planning

The planning step is carried out by first analyzing the material and syllabus. The material that will be presented in the module is material obtained from the development of core competencies and basic competencies on the theme of chemical bonding. The chemical bonding material in the electronic module is arranged into 5 sub-themes based on the interactions between the particles. Basic Competence in chemical bonding material based on Regulation of the Ministry of Education and Culture No. 37 of 2018. From these basic competencies, indicators will be obtained that can determine the division of sub-themes in chemical bond material, which consists of elemental stability material, ionic bonds, covalent bonds, metal bonds, and intermolecular forces. Then the questions on each sub-theme used for formative tests and summative tests were also collected as material for evaluating students in understanding the material that had been studied.

3.3. Electronic Module Development

The development of the electronic module starts from compiling the components that will be presented in the module in the Microsoft Office Word 2016 application. The image components used in the module are edited with the Paint 3D application to tidy up the image and use the remove.bg web to remove the image background to become transparent. Meanwhile, for video editing, the InShot application on a smartphone is used. The application used to make reactions and Lewis structures presented in the module is the Chemsketch application. The main stage in making the electronic module is in designing and compiling the contents of the material and other components in the electronic module using the Adobe Illustrator 2020 application. The design and preparation stage of the module content produces a file in the .pdf format which will

then be imported into the final application, namely Flip PDF Professional. In the Flip PDF Professional application, you will get an electronic module with a flipbook display. In this final stage, a moving animation in .gif format is added and other components that can help the module application process.

3.4. Expert Validation

The experts validation of this e-module is divided into 2 aspects, there is material & language aspects and presentation & graphics.The material and language aspects of the module were validated by 3 expert lecturers from the Department of Chemistry, Universitas Negeri Jakarta. Table 4 shows the results of the study.

Table 4: Result of material and language validation assessment.

Indicator		Percentage of Assessment			Interpretation
		Expert 1	Expert 2	Expert 3	
Electronic Module Cover Design	E-Module Cover Layout	81.4	87.1	75.7	Good
	E-Module Cover Typography	85	83.3	81.67	Good
	E-Module Cover Illustration	90	86.67	80	Good-Very Good
Electronic Module Content Design	E-Module Content Layout	82.67	86.67	75.3	Good
	Typography E-Module Contents	83.3	78.3	75.83	Good
	Illustration of E-Module Contents	80	70	77.5	Good

Then the interrater reliability calculations were carried out and the instrument reliability value was obtained at 0.93. Furthermore, the presentation and graphic aspects were validated by 2 expert lecturers and State University of Jakarta Chemistry Department and 1 expert lecturer from State University of Jakarta Educational Technology Department.Table 5 shows the results of the assessment of the three experts are as follows:

Then the interrater reliability calculations were carried out and the instrument reliability value was obtained at 0.96.

TABLE 5: Result of presentation and graphic aspects validation assessment.

Indicator		Percentage			Interpretation
		Expert 1	Expert 2	Expert 3	
Theory/ Material	Material Coverage	90	90	90	Very Good
	Material Accuracy	85	85	80	Good
	Skills	90	85	80	Good-Very Good
Language	Suitability with the Development of Students	80	80	70	Good
	Communicative	90	85	70	Good-Very Good
	Motivating Ability	90	80	70	Good-Very Good
	Discretion	80	80	80	Good
	Coherence and Sequence of Thought Plains	80	90	90	Good-Very Good
	Suitability with IndonesianLanguage Rules	80	80	80	Good
	Use of Chemical Terms and Symbols / Symbols	75	85	80	Good

3.5. Small-Scale Trial

This small-scale trial step includes small-scale trials on teachers and students. Table 6 and 7 shows the results obtained from the results of the small-scale trial on the teacher are as follows:

TABLE 6: Result of small-scale trial for teachers.

No.	Indicator	Acquisition Score	Maximum Score	%	Interpretation
1	Conformity of content substance with basic competencies	109	120	91	Very well
2	Clarity of information	53	60	88	Good
3	Language	32	40	80	Good
4	Audio and Visual Display	104	120	87	Good
5	Module Benefits	112	120	93	Very well
6	Benefits of Using *Guided Discovery Learning* Model	86	100	86	Good

Table 7: Shows the small-scale trial step for students is as follows.

No.	Indicator	Acquisition Score	Maximum Score	%	Interpretation
1	Quality of Material and Questions	522	640	82	Good
2	Language	125	160	78	Good
3	Audio and Visual Display	323	400	81	Good
4	Module Benefits	381	480	79	Good
5	Benefits of Using *Guided Discovery Learning* Model	390	480	81	Good

3.6. Large-Scale Trial

This large-scale trial step includes large-scale trials on teachers and students. The results obtained from of large-scale trials on teachers are showed in table 8 and rusults from large- scale for students trial stage showed in table 9:

Table 8: Result of large-scale trial for teachers.

No.	Indicator	Acquisition Score	Maximum Score	%	Interpretation
1	conformity of content substance with basic competencies	109	120	91	very well
2	clarity of information	53	60	88	good
3	language	32	40	80	good
4	audio and visual display	104	120	87	good
5	module benefits	112	120	93	very well
6	benefits of using *guided discovery learning* model	86	100	86	good

Table 9: Result of large-scale trial for students.

No.	Indicator	Acquisition Score	Maximum Score	%	Interpretation
1	Quality of Material and Questions	934	1120	83	Good
2	Language	347	420	83	Good
3	Audio and Visual Display	809	980	83	Good
4	Module Benefits	708	840	84	Good
5	Benefits of Using *Guided Discovery Learning* Model	688	840	82	Good

4. CONCLUSION

The results of the assessment obtained from the material and language validation as well as presentation and graphics show that the Electronic Chemistry Module Based on the Guided Discovery Learning Model has a good to excellent interpretation. The criteria for this excellent interpretation are seen as good material coverage, the language used in the module is communicative, able to motivate students, and illustrations from the cover of the electronic module are good. The validation results obtained were then calculated the instrument reliability value in each aspect and the result was 0.93 on the material and linguistic aspects, then in the presentation and graphic aspects the instrument reliability value was obtained at 0.96.

This value indicates that expert judgement on the instrument has a very good level of consistency. In the test of the electronic chemistry module based on the Guided Discovery Learning model on a small and large scale by students, good interpretation results were obtained, while the results of the interpretation of small scale and large-scale trials by the teacher obtained good to excellent results which indicate the substance of the content is appropriate. with basic competencies, the benefits of using a good electronic module. Based on the results of validation and the results of trials conducted on students and teachers, it can be concluded that the Development of Electronic Chemistry Modules Based on Guided Discovery Learning Models is stated to have good feasibility to be used in the learning process of chemical bonding materials and is able to help students understand the bonding material. chemistry independently, and can be used as interesting and interactive teaching materials.

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