International Journal of Education, Information Technology and Others (IJEIT), June 2022, 5 (3), 31-46
DOI: https://doi.org/10.5281/zenodo.6673177
p-ISSN: 2654-2528 e-ISSN: 2623-2324
Accredited by Directorate General of Strengthening for Research and Development
Available online at https://jurnal.peneliti.net/index.php/IJEIT

The Development of Online Module to Improve Chemistry Learning Outcomes in High Schools

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Received: 8 Juni 2022
Revised: 12 Juni 2022
Accepted: 16 Juni 2022

Abstract

The objectives of this research are to determine the procedure for developing a suitable and effective Chemistry online module, as well as to know its feasibility and effectiveness in Chemistry learning in high schools. In order to achieve these objectives, the researcher use some research and development process by combining the Rowntree development model and the ILDF (Integrative Learning Design Framework). The Rowntree model is used to develop product in the form of draft module through preparation process, writing preparation and writing. The draft module is then designed and developed into an online module through the ILDF development model. ILDF consist of exploration, enactment and evaluation stages. The objects of this study are the students in Science class and the Chemistry teacher. Data were collected based on questionnaires, interviews, and student test results. Formative evaluation given by subject matter expert, learning design expert, media expert, as well as students shows that this module is suitable for learning. Furthermore, based on the T Test result on the students learning outcomes in the field test, there is significant difference between student learning outcomes before and after using the online module. The difference is indicated by the increase of the average learning outcomes up to 43.75 as the result of the online module use. Therefore, online module are very effective to improve student learning outcomes in Chemistry learning.

Keywords: *module, online module, Chemistry, Rowntree, Integrative Learning Design Framework (ILDF)*

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How to Cite: Rahayu, J., Solihatin, E., & Rusmono, R. (2022). The Development of Online Module to Improve Chemistry Learning Outcomes in High Schools. *International Journal of Education, Information Technology, and Others*, *5*(3), 31-46. https://doi.org/10.5281/zenodo.6673177

INTRODUCTION

Technological developments have had a major impact on the teaching and learning process. The integration of technology in learning has been shown to affect the learning process and student learning outcomes (Wai & Seng, 2013; Chauhan, 2017). One of the uses of technology in learning that is currently developing is *online*.learning *Online* is*learning*defined as "*environment that uses pedagogical tools, enabled by the Internet and Web-based technologies, to facilitate learning and knowledge building through meaningful action and interaction*" (Dabbagh & Ritland, 2005).learning *Online*, also known as *electronic learning* or *e-learning*, is the result of teaching delivered electronically using computer-based media (Smaldino, *et al*, 2012).learning environment *online* consists of two processes, namely: (1) students become active and reflective learners; (2) students and teachers

are involved in learning using *web* (Dobre, 2012). The key principle in *online* is that the learning process is student-centered and students have flexibility in achieving learning objectives (Dabbagh & Ritland, 2005). An absolute requirement in the presentation and *online* is the existence of components that support the context of independent learning, including (i) a clear formulation of learning objectives (general and specific); (ii) the formulation of the syllabus in accordance with the learning objectives/competencies; (iii) availability of learning programs such as various forms of materials, exercises, games, virtual labs and learning resources; (iv) developing the material into small segments by applying the principles of instructional design; (v) availability of a tutor to ask questions *online*, (vi) learning activity guide, (vii) learning assessment, (viii) assessment and improvement program (Prawiradilaga, 2014). Thus, learning resources are needed that can facilitate the presentation and online learning activities, especially those that can support the independent learning process in the form of online modules.

The module is a unit of learning program that is arranged in a certain form for learning purposes (Ibrahim, 2010). Another definition states that the module is a teaching material that is designed to be studied independently (Prawiradilaga, 2014) which consists of*learning materials*for students and guidance materials for tutors. In the learning materials there are instructional content, learning guidelines for students and self-study outcome assessment tools (Supratman, 2014). Modules are designed systematically based on a certain curriculum and packaged in the form of the smallest learning unit so that it is possible to study independently in a certain time unit (Purwanto et al, 2007). In addition, the module consists of learning units composed of theoretical and practical content sections and can be delivered to students using technological and computational resources (Barbosa & Maldonado, 2011). The theoretical content section can use books, papers, information from *the web*, *slides*, audio, video and so on. The practical content section includes learning and evaluation activities. Based on the definitions above, it can be concluded that the module is a unit of learning program that is designed systematically so that it can be studied independently for learning purposes by the learning participants. In the module there are*learning materials*, learning activities that will be carried out by students, guidance materials for tutors and self-study assessment tools. Modules can be delivered to learners using technology resources.

modules *Online* are a set of learning resources that focus on a topic and can be accessed via the internet (Hollingsworth & Lim, 2015). Another definition states that *online* modules are modules that are packaged on a *web* basis so that they can be studied anytime and anywhere through certain sites (Chaeruman, 2014), so the term *online* often confused with electronic modules and *web*.-based electronic modules *Web* can be interpreted as module teaching materials that are displayed using electronic devices in the form of a *web* (Suyoso & Nurohman, 2014).-based modules *Web* can be accessed by *users* with *web browsers, such as internet explorer, mozilla, opera, and google chrome* (Supriyono & Sugirin, 2014). Based on these understandings, it can be concluded that *online* is a set of learning resources that focus on a topic, consisting of learning content and student job descriptions, packaged and displayed on a web-based basis and can be accessed via

the internet so that it can be studied anytime and anywhere in the world. specific site.

modules *Online* can support interactive learning and challenge students to use active learning strategies where students can take control of their own learning and offer control over learning, control over learning speed, and learning time and place (Ikram, 2012).module *online* has the same components as the print module, including: brief descriptions, teacher guides, study guides for students, learning activities, objectives, material descriptions, exercises/assignments, self-tests/quizzes, summaries, and module final tests.module *online* not only limited to a combination of text and graphics but can also be in the form of multimedia such as video, audio, animation, simulation, *hyperlink* and *hypermedia* (Chaeruman, 2014).

Chemistry is a science that studies the properties of matter and is part of science (Indrawati, 2016). Science is a series of concepts and conceptual schemes that are interconnected and developed based on experimental and observational results and are suitable for subsequent experimentation and observation. Chemistry learning can be facilitated by dividing it into three categories, namely macroscopic, microscopic, and symbolic levels. The macroscopic level includes observable events, while the microscopic level includes the notions of molecules and atoms. The symbolic level is shown through the use of symbols, numerals, equations, and others (Kalla et al, 2013). The microscopic level is an abstract level but the phenomena can be observed at the macroscopic level. Macroscopic things can be observed when students carry out practical activities in the laboratory (Adlim *et al*, 2014). Chemistry learning should be developed based on how people learn through scientific practice and methods involving macroscopic phenomena, which can be observed as a basis for considering abstract (microscopic) phenomena and symbolic ideas. Therefore, it is necessary to apply*discovery/inquiry learning*in chemistry learning activities and use learning media to facilitate students in understanding abstract and symbolic concepts.simulations *online* able to improve understanding of the content of chemistry learning (Lamb & Annetta, 2013). In addition, the implementation of *online* in the calculus-based Physics program resulted in increased learning outcomes both on conceptual reasoning tests and representative reasoning (Hill *et al*, 2015).

This study aims to produce an *online* for class XI which consists of instructions for using the module, competency maps, student learning activities, material descriptions (consisting of text, images, animated videos/simulations), practice questions equipped with answer keys, evaluation of learning that equipped with an answer key and a guide for self-study results assessment as well as follow-up to the evaluation results. The formulation of the problem in this research are:

1. module *online* in Chemistry class XI Science?
2. What is the feasibility of the *online* in class XI Science Chemistry learning?
3. module *online* in class XI IPA learning Chemistry?

METHOD

The research conducted is categorized as *Research and Development (R&D)*. *Research and Development (R&D)* is the process used to develop and validate educational products. The steps of this process are usually referred to as the R&D cycle, which consists of studying the research findings related to the product to be developed, developing the product based on the findings, field testing in the setting where it will be used eventually, and revising it to correcting deficiencies found in the field testing phase (Borg & Gall, 1996). Richey and Klein use the term *Design and Development Research* (DDR) in the process of developing educational products. According to Richey and Klein, DDR is a systematic study of how to design a product, develop and evaluate the product with the aim of obtaining empirical data that can be used to create products, tools and models that can be used in learning or non-learning (Richey & Klein, 2007) .

This development research was conducted at the high school level in South Tangerang City. The research targets used as objects in this development are class XI students and Chemistry teachers at schools in South Tangerang City.

modules *online* is based on a product-oriented development model and can be applied in an *online*. The instructional development model chosen is a combination of Rowntree (Rowntree, 1994) and ILDF (Dabbagh & Ritland, 2005) development models. The selection of this development model is done to produce learning resources that can be implemented and used in the *online*. Rowntree's model consists of planning, writing preparation, writing and rewriting stages.

The Rowntree model was chosen for several reasons, namely: (1) specific for developing open, distance and flexible learning materials (modules); (2) is procedural and systematic and easy to understand; (3) provide clear instructions in conducting formative evaluations, and (4) involve experts *(expert review)* according to their academic level.

The ILDF model combines a systematic process of online learning design and development *learning* model *with an online*. The design and development process in the ILDF model consists of the exploration, *enactment* and evaluation stages. This design and development model intersects with *online* which include: (a) pedagogical models or views on learning and teaching, (b) learning strategies and activities that embody a particular view of learning, (c) learning technologies to implement the chosen learning strategies . The combination of the two development models is shown in Figure 1.

Development of *Draft* Module		
Phase 1 **Planning**	Stage 2 Writing Preparation	Stage 3 Writing and Rewriting

• **Describing student profiles** • **Formulate general and specific objectives** • **Outline the contents** • **Define media** • **Planning learning support** • **Considering existing materials**	• Considering learning resources and barriers • Sort writing ideas • Developing activities and feedback • Define related examples • Define graphics • Determine the equipment needed • Considering the physical format	• Drafting _ • Completing and editing *drafts* • Writing a study assessment

Developing *Draft* Modules Into *Online*

Exploration Stage

 Gather information about the learning context, learning process, content and *online* delivery Identify ways to present content and to engage students in *online*

Enactment Stage (*Enactment*)

 Mapping the information collected in the exploration stage Identify the characteristics of the pedagogical model of *online* learning Choosing a specific instructional strategy that fits the pedagogical model Implement instructional strategies using technology features

Evaluation Stage

 Conduct formative evaluation Improve products based on formative evaluation results

Figure 1. Module Development Model *Online*

Before the product was developed, the researcher first developed a research instrument in the form of a questionnaire using a *semantic differential*. Aspects that are assessed through the instrument include message clarity, relevance to students, clarity of procedures, influence on students, and feasibility. The instrument was further validated by an instrument development expert to evaluate the feasibility of the instrument in the *online*.

The results of the development in the form of a *draft* module at the development stage are carried out, evaluated first by a material expert. Furthermore, a readability test was carried out using the *Fog Index* (Sitepu, 2015). *The draft* module is then compiled into an *online* by considering how to present learning content in the context of *online* and by identifying the appropriate technology for the presentation.module development *online* are then evaluated by learning design experts and media experts. The results of the validation by learning design experts and media experts were then followed up by making improvements to the product in accordance with the suggestions and inputs given by each expert. After making improvements, the *online* reviewed by each expert (design expert and media expert) to provide an assessment of the *online*.

The next module was tested on three students by giving each student access to study the module. After the module is studied, each student is then interviewed using a questionnaire that has been given to find out the assessment and suggestions/comments from students on *online* the developed

After making improvements based on the opinions of the three students, a field test was carried out by involving 20 students in learning activities. Field tests were conducted to see the effectiveness of the module and to evaluate the feasibility of using the module among students. The overall procedure in the development of the online module is shown in Figure 2.

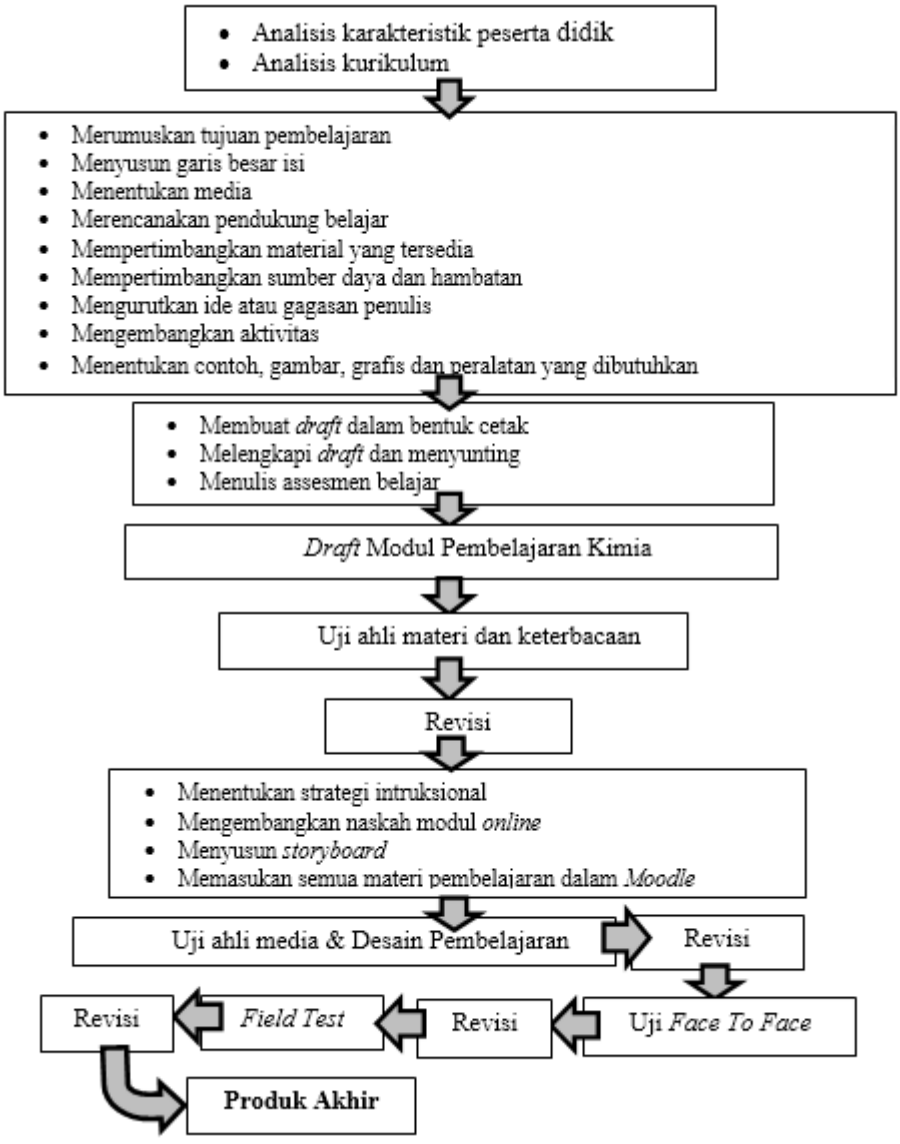

Figure 2. Module Development Procedure *Online*

RESULTS AND DISCUSSION

Results

Based on the research and development process that has been carried out, the following results are obtained:

1. Planning Phase

a. Analysis of Student Profiles

At the planning stage, preliminary research was carried out through the study of documents from students' daily test results to explore difficult material in Chemistry subjects and it was found that the average value of students' daily tests on the topic of Thermochemistry was 60. The average value was below the Minimum Completeness Criteria set by the school. namely 70. The research was continued to students and teachers in the field of study by compiling a preliminary research grid which was then developed into a questionnaire. Based on the questionnaire, it was obtained information that one of the obstacles faced by students in studying Chemistry was the absence of learning resources that could facilitate learning Chemistry optimally. So far, the explanations given by the books used are difficult for students to understand, while the time to participate in the learning process in class is very limited. The learning process is still teacher-centered because students wait for the teacher to give an explanation in order to understand the material contained in the textbook. On the other hand, the ability of students to concentrate when the teacher explains is very limited. Students are only able to listen to explanations with a duration of 15-45 minutes. Often students need a re-explanation from the teacher but are hesitant to say it.

Based on interviews with teachers of Chemistry subjects, it was also found that there were factors that became problems in learning, including the difficulty of teaching materials related to math, too much material being studied, the lack of teachers' ability to teach with different methods, the speed of students in learning. different and the time for teaching is limited. Time constraints make teachers less able to assist students who are slow in understanding the material. In addition, the books used for learning are also less able to facilitate the learning process. This makes it difficult for students to do independent learning at home.

b. Formulation of Learning Objectives

After mapping the profiles of students, the researchers then developed learning objectives based on existing curriculum documents. The learning objectives are translated into general and specific learning objectives related to thermochemical material in the form of a competency map.

c. Develop an Outline of the Contents of the Module

The outline of the contents of the module is then compiled based on the competency map.

d. Selecting Media

The selected learning media includes pictures of real events related to thermochemistry and relevant learning videos. In addition, the final media was determined in the form of an *online* designed and developed using Moodle.

e. Planning for Learning

Support Support for learning in the main module is facilitated through the interaction of students with learning content. Therefore, the availability of instructions for using the module, instructions for carrying out activities,*work samples*in the form of answer keys accompanied by how to work and an assessment rubric are provided to facilitate students in doing *online*.

f. Considering Existing Teaching Materials

Several teaching materials in the form of Electronic School Books published by the Ministry of National Education serve as reference materials in module development. In addition, textbooks from various publishers include Erlangga, Platinum, Quadra and University Basic Chemistry books.

2. Writing Preparation Stage

a. Considering Resources and Constraints

Resources owned by schools related to the development of *online* learning *online* are the availability of a computer laboratory consisting of 26 computers/laptops, LCD, *head set*, and internet connection. Constraints faced include the dependence of the module on the presence of a power source and network.

b. Sequencing Ideas and Writing Ideas The

outline of the content of the module that has been compiled in the previous stage is then developed into a description of the module material.

c. Developing Activities and Feedback

module *online* consist of scientific inquiry activities, links to relevant learning resources for conducting information searches, practice questions with answer keys and formative and summative tests. In each formative test, an analysis of learning outcomes is given so that students get recommendations for follow-up to be done based on the results of the formative test.

d. Determining Related

Examples Examples related to learning materials are concrete examples found in everyday life related to thermochemical topics including bomb blasting, photosynthesis, melting ice, metal welding and others. This is done in accordance with the literature review which states that students will be involved in online investigation and assessment if the learning unit is attractively designed by involving authentic and inquiry-based events and centered on real-world problems (Dwyer, 2016).

e. Determining Graphics

The process of determining graphics is mainly focused on *online* so as to create an effective perception of the message conveyed.

f. Determining the Equipment Needed

The equipment needed is a printer to print module designs (*drafts*), computers/laptops, internet networks, *domains* and *hosting* to put learning modules on a network (*online*).

g. Considering the Physical

teaching materials *online* and a guide to using the module for educators which is provided in printed form.

3. Writing and Editing

is produced *draft* in printed form. In addition, grids and learning outcomes assessment instruments were also produced which were developed based on learning objectives. Furthermore, instrument validation was carried out by involving instrument experts and practitioners.

learning *online* based on the ILDF model. The stages in this development model include exploration, *enactment* and evaluation. At the exploration stage, the characteristics of students who do not like Chemistry subjects have been determined and have difficulty learning them. In addition, information was obtained based on literature studies related to the characteristics of chemistry subjects that were microscopic, macroscopic, and symbolic. Microscopic nature means that Chemistry is an abstract subject but its symptoms can be observed (macroscopic) through investigations in the laboratory or in nature directly. These natural phenomena can be explained based on microscopic principles through symbols (symbols) that represent the elements or compounds involved.

Based on this information, *platform* learning *online* based on Moodle was created to transfer *the draft* module in print form to an *online*. Next, a script was prepared to develop *draft* module *online* using the features found in Moodle. In the script there are types of visualizations that will be presented *online* such as text, animation and video. The text contained in *the draft* module is designed to be delivered using technology such as *powerpoint* that are *embedded* sites *publisher* . In addition, several principles in thermochemistry are made in the form of videos in order to facilitate students to obtain information related to microscopic phenomena from natural phenomena that occur and other important principles. Making learning videos is done by first designing a *storyboard*.module *online* was further developed with an exploratory strategy. In this strategy, *online* facilitated through the interaction of students with learning content. Students carry out learning activities by exploring the content of *online*browsing information through links to other relevant learning resources.

At the evaluation stage, the research process is carried out through formative evaluation involving material experts, learning design experts, media experts as well as students and educators. Assessment criteria for formative evaluation are shown in Table 1.

Table 1. Assessment Criteria for Formative Evaluation Assessment

Criteria	
Score	**Description**
3.26 – 4.00	Very Good
2.51 – 3.25	Good
1.76 – 2.50	Enough
1.00 – 1.75	Less

The results of the evaluation by material experts indicate that the quality of the material contained in the module is very good. More clearly, the results of the assessment from material experts can be seen in Table 2 and Figure 3.

Table 2. Results of Module Assessment by Material Experts

Dimensions	Average
Message Clarity	3.78
Relation to Students	3.56
Clarity of Procedures	3.56
Influence on Students	4.00
Eligibility	3.70
Overall Assessment Average	**3.72**

Figure 3. Results of Formative Evaluation by Material Experts

Furthermore, a readability test was carried out on the text of *the draft* developed using the *Fog Index* (Sitepu, 2015). Based on the readability test, it is known that the readability of the module is relatively easy with a readability value of 5.05.

The modules are then evaluated by an instructional design expert. The results of the evaluation by the learning design expert showed that the module developed was very good. A summary of module assessments by learning design experts is shown in Table 3 and Figure 4.

Table 3. Module Assessment by Learning Design Experts

Dimensions	Average
Message Clarity	3.33
Relation to Learners	3.31
Clarity of Procedure	3.90
Effect on Students	4.00
Feasibility	3.86
Overall Assessment Average	**3.68**

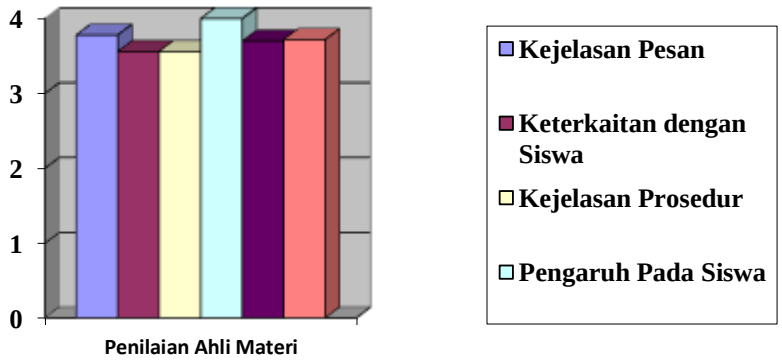

Figure 4. Results of Formative Evaluation by Learning Design Experts

The next formative evaluation process involves media experts. Based on the assessment by media experts, the quality of the module was stated to be very good. The results of the media expert's assessment are stated in Table 4 and Figure 5.

Table 4. Module Assessment by Learning Media Experts

Dimensions	Average
Procedure Clarity	3.50
Feasibility	3.65
Overall Rating Average	**3.58**

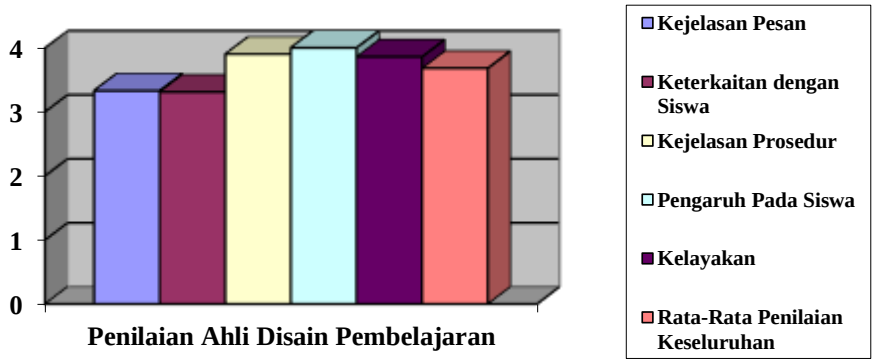

Figure 5. Formative Evaluation Results by Learning Media Experts

Opinions/suggestions from experts given at the formative evaluation stage are then followed up through improvement efforts in accordance with the directions given. After that, the module was tested on three students in the *Face to Face Tryout*. Each student is given access to an *online* to study the module. The three students were then asked to fill out a questionnaire and an interview was conducted to obtain more detailed input. From the three respondents, the module assessment data and opinions on the *online* are presented in Table 5.

Based on these data, it can be observed that the module's assessment of the message clarity aspect is 3.30; aspects of the relationship with students 3.37; aspects of procedure clarity 3.80; aspects of influence on students 3.89; feasibility aspect 3.65. The average assessment of the *online* at the *Face to Face Try Out stage is* 3.61.learning module *online* can be categorized as very good for use in learning activities.

Table 5. Results of *Face to Face Try Out*

Assessment Criteria	1	Student 2	tudent 3	Average
Clarity of Message	3.75	3.00	3.25	3.33
Relationship with Students	3.11	3.67	3.33	3.37

Clarity of Procedure	4.00	3.80	3.60	3.80
Effect on Students	4.00	4.00	3.67	3.89
Eligibility	3.74	3.79	3.42	3.65
Rating Average	**3.72**	**3.65**	**3.45**	**3.61**
Overall Recommendations and Comments Overall	module *online* is sufficient to facilitate students to study chemistry.	learning *online* makes it very easy for students to learn chemistry and of course this method is a good method for studying new chapters and *reviewing* them.	learning modules *online* presented are very good and suitable for students to learn. The presentation is also attractive and easy to understand.	

The next module is tested on 20 students. The trial begins with a *pre-test* and the average *pre-test* 35.00. After students learn to use the *online*, students do a *post test* and fill out a questionnaire. Based on the questionnaire, it is known that the quality of the *online* very good with an assessment of the message clarity aspect of 3.14; aspects of relationship with students 3.00; aspects of procedure clarity 3.45; aspects of influence on students 3.50; feasibility aspect 3.21. In addition, the *post test* showed an average value of 78.75. This shows an increase in the average learning outcomes before and after using the *online* by 43.75. This data is then analyzed through the T-test to determine whether there are differences in learning outcomes before and after using the module. Based on the results of the T test, it was obtained data that there were differences in the results of the *pre* test and *post* test in learning using the *online*.module *online* declared effective to improve student learning outcomes in Chemistry learning in high school. Subject teachers' responses to the *online* were obtained through interviews. From the interviews, information was obtained that this module can overcome difficulties in learning Chemistry, especially in the effort to find contextual and continuous events, where there are explanations of material and practice questions and their relevance in everyday life. In addition, teachers can also conduct independent learning on students and the time required is also more effective.modules *Online* can synergize with teachers and students in the midst of current technological developments, so *online* can be very helpful in learning and motivate students who are currently interested in technology.

DISCUSSION

modules *Online* on Chemistry subjects can be accessed anytime and anywhere via the link *learningchemistry.net*. In addition, the module presents Chemistry learning materials with interesting media including exothermic and endothermic reaction learning videos, calorimetric principles learning videos, learning videos on the principle of determining enthalpy changes based on bond energy data, *powerpoint slides* that can be seen directly in the module on the topic of thermochemical equations, laws Hess and determination of enthalpy change based on standard enthalpy of formation data. In the module there are also investigation activities in each learning activity so that students can learn to formulate hypotheses, conduct scientific investigations, communicate observations and draw conclusions. Scientific inquiry activities facilitated in the module can stimulate students to think critically and construct knowledge through inquiry activities. These things result in the microscopic, macroscopic and symbolic nature of Chemistry being facilitated. The module has also been facilitated with a discussion forum feature so that students can discuss *online* with other students or with the teacher. Learning content in online modules can be updated directly according to the needs and developments of the times so that students can get the latest information related to learning. This is also the difference between the online module and the print module, because the content in the print module is fixed (cannot be updated directly).

Based on the research results, it is known that the developed module has a very good feasibility level. These things are indicated by the assessment of material experts, learning design experts and media experts respectively at 3.72; 3.68; and 3.58. The results of the formative evaluation through the *Face to Face Tryout* also showed the module was classified as very feasible with a score of 3.61. At the field test stage, based on the questionnaire given to students, the module has a very suitable category for use in learning activities with a feasibility value of 3.26. In addition, student learning outcomes also showed an increase in student averages from 35.00 during the *pre-test* to 78.75 during the *post-test*.

The increase in learning outcomes in the use of online modules in this study is in accordance with several other research results, including: (1) *The Use of Online Modules and the Effect on Student Outcomes in a High School Chemistry Class* (Lamb & Anetta, 2013). In this study, it was proven that the use of *online* has a role in increasing students' understanding of the content of chemistry learning. (2) Development of Web-Based Electronic Modules as Physics Learning Media. In this study, it was concluded that a web-based electronic module with a mobile version format could improve student achievement. (Suyoso & Nurohman, 2014). (3) Development of Web-Based Teaching Materials Based on Student Learning Styles in Physics Subjects (Purmadi & Surjono, 2016). In this study, it was concluded that learning using web-based teaching materials was effective. This is indicated by an increase in the achievement of student learning outcomes after using web-based teaching materials by 31.87%. The mean value of the pretest was 52.03, and the posttest was 83.90. The percentage of student learning completeness is 97% (30 of 31 students), and the assessment of student responses when using shows a good

category. (4) Development of *Problem Solving* Using Moodle on Salt Hydrolysis Material for Class XI SMA Semester II. In this study the use of E-Modules showed better results than conventional learning (Nugroho, et al, 2017).

module *online* has several drawbacks, including: the module can only be accessed when connected to the internet, the module development has not been adapted to the use of a mobile phone so that the module display with the use of a cell phone is different from a laptop/computer, practice questions and formative tests in the form of HOTS questions in the module are still limited, this allows the module to be developed further.

CONCLUSION

modules *online* as independent learning materials is a solution to facilitate learning activities as an effort to improve student learning outcomes. Based on the results of research and development, the combination of Rowntree's development model with the *online* can be used to produce products in the form of *online* appropriate and effective

Based on formative evaluations from material experts, learning design experts and media experts, as well as students, the quality of *online* produced in this research and development is very good so it is suitable for use in learning Chemistry. In addition, the *online* has been proven to improve chemistry learning outcomes by increasing the average student learning outcomes before and after using the *online*.

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