JURNAL PENDIDIKAN KIMIA (JPKIM)
ISSN: 2085-3653| e-ISSN: 2549-3116

J. Pendidik. Kim 2023, 15(3), 235 – 242
DOI 10.24114/jpkim.v15i3.49819

Research Article

Development of a reaction rate of chemistry module through a scientific approach to science

Tiurlina Siregar

Master of Science Education, Faculty of Teaching and Education, Cenderawasih University, Jayapura-99351, Indonesia

Received 14 August 2023 ♦ **Revised** 31 October 2023 ♦ **Accepted** 16 November 2023

Citation: Siregar, T. (2023). Development of a reaction rate of chemistry module through a scientific approach to science. Jurnal Pendidikan Kimia (JPKIM), 15(3), 235–242. https://doi.org/10.24114/jpkim.v15i3.49819

Keywords

Chemistry
Module
Reaction rate
Scientific approach

Corresponding author:
E-mail: tiurlina.siregar@gmail.com
(Tiurlina Siregar)

Abstract

Module development is very important in chemistry learning. The lack of modules as teaching materials is an obstacle in learning chemistry, especially the reaction rate material. Therefore this study aims to develop and validate the feasibility of the chemistry module on the reaction rate material through a scientific approach, as well as to assess how students and teachers respond to the product being developed. The research and development (R&D) method is the method used and ADDIE is the development model applied as the methodology. The sample in this study was 15 students. The sampling technique is saturated samples. Modules are validated by material and media validators and then validated by teachers and asked for responses from students. Data is processed using SPPS Reaction rate as the subject of this research. The developed module is very feasible to be applied in chemistry learning on reaction rate material, according to the results of the data analyzed. The material validator gave an average score of 91.77% (very feasible), the media validator 90.48% (very feasible) and the teacher's response was 99.07% (very good) and the students' response to the developed module was 97.50% (Very good).

Introduction

Online and offline learning requires skills that demand students to be active in solving problems creatively and innovatively. Face-to-face learning students receive full guidance from educators. However, during distance learning, students must be accustomed to independent learning. Increasing the independence of students in learning can occur due to stimulus factors from within and from outside (Siregar, 2021). Distance or online learning requires that a teacher must master science and technology so that online or distance learning can run effectively.

The implementation of online and offline learning must pay attention to the role of the world of education in improving the quality of human resources to face the era of society 5.0. Entering the current era of society 5.0, it is time for students to be allowed to choose their way and style of learning, where students can determine where and when they will study. The desire or emotional mood for one's learning can appear anytime and anywhere, so if this happens, students need to be accommodated so that they can learn immediately, including regarding the provision of learning resources, learning media and learning environment. Under these conditions, it is possible for students to learn in various scenarios, in formal or informal conditions, in the classroom or outside the classroom, individually or in groups/socially. Digital and non-digital media, as well as the physical environment and virtual environment (Sudarmanto et al., 2021).

The application of the 2013 curriculum uses a scientific approach or scientific process-based approach in learning. The scientific approach can use several strategies such as contextual learning. The scientific approach is intended to provide understanding to students to know, understand, practice what is being studied scientifically. Therefore, in the learning process it is taught that students find out from various sources through observing, asking, trying, processing, presenting, concluding, and creating for all subjects (Sudarwan, 2013).

One of the subjects that must be taught in the 2013 curriculum at the high school level is chemistry. Chemistry subjects study the science that examines the properties of substances and how these substances react with other substances. One of the goals of chemistry subjects is to apply chemical concepts to solve problems in everyday life and technology (Kemendikbud, 2013). A teacher should be total in the chemistry learning process delivered.

The totality of the teacher in the learning process is shown by the use of varied and appropriate teaching materials. Teaching materials that are varied and precise can increase motivation to learn in the learning process (Islamiyah et al., 2022; Asmi et al., 2023). The rapid development of technology today has affected all areas of life, including education. We can take advantage of technological developments to improve the quality of education by providing teaching materials that are easy to obtain, easy to understand and attract readers such as modules. Modules area. Teaching materials in the form of modules can be combined with teaching materials.

Modules are teaching materials in the form of modules that are displayed which are expected to increase students' interest and learning motivation (Vaino et al., 2012; Fitri et al., 2023). This is because the e-module involves the display of images, audio, video and animation. In addition, e-modules can be used as teaching materials by students independently at school or at home. The use of teaching materials in the form of modules will greatly assist in the learner-centered learning process. Teaching materials can enable students to learn a basic competency in an orderly and systematic manner so that cumulatively they are able to master all competencies as a whole and integrated (Sudjana, 2010). Modules are learning materials that can be used by educators and students to expedite the learning process and understanding of chemistry subjects, especially the material on reaction rates. Teaching materials that can make students learn independently are needed in addition to learning in the classroom. This independent learning can be achieved by using problem-based electronic e-modules (Munthe et al., 2019; Asmi et al., 2023).

One of the essential chemistry materials to be taught is reaction rate materials to taught is reaction rate material. This reaction rate material at the high school education level is given in odd semester in class XI in odd semesters. Reaction rate material learns about how a chemical reaction is accelerated or slowed down, as well as changes in the concentration of reactants or products in a unit of time. Reaction rate learning which is an integral part of the science learning process. The process of learning science, in fact, emphasizes more on aspects of behavior and skills to acquire knowledge. Science learning has two important scientific dimensions in the science learning section, namely the first scientific content (content of science) which contains facts, concepts, laws, and theories that become scientific studies, while the second is the process of carrying out scientific activities and scientific attitudes (Silaban, 2017).

The process of learning chemistry on the reaction rate material in class is good. The teacher during the learning process uses a variety of learning methods. One of the methods used in learning chemistry about the rate of reaction is the practicum method, because according to the teacher himself the practicum method can make students active and this practicum method can make it easier for the teacher to deliver material that is abstract in nature. Modules have not been used as teaching materials at Madrasah Arabiyah Daru al Da'wah wa al Irsyad MA DDI Entrop Jayapura, the teaching materials used in chemistry learning so far are in the form of printed books, worksheets, slides and videos which have not been maximally and consistently used. This is because the teaching materials are not always used by the teacher in every subject matter. In addition, the printed books used do not display learning steps through a scientific approach and do not attract students to learn independently in discovering concepts. The module is expected to facilitate and facilitate students in the learning process, both during the pandemic and after the pandemic is over.

Method

This research is included in the type of research development or known as Research and Development (R&D) which was adapted from Dick and Carry (Sugiyono, 2019). This research development method uses ADDIE (Analysis, Design, Development, Implementation, Evaluation). The focus of the research is design, feasibility assessment, teacher responses and student responses to e-module development. The subject of this research is the reaction rate material. The module is a product of this study which was validated by 3 material validators and 3 media validators from Cenderawasih University (UNCEN) lecturers from the chemistry teacher MA DDI

Entrop Jayapura and responses from students. The instrument in the form of a questionnaire was distributed to 3 chemistry teachers and 15 students.

Table 1. Criteria for eligibility validation results (Rohmad et al. 2013)

Interval % score	Criteria
75% < score≤100%	Very feasible
50% < score ≤ 75%	Eligible
25% < score ≤ 50%	Less feasible
0% < score ≤ 25%	Not feasible

Table 2. Criteria for the percentage score of teacher responses and student responses (Sari and Alarifin, 2016)

% score intervals	Criteria
81% < score ≤ 100%	Very good
62% < score ≤ 81%	Good
43% < score ≤ 62%	Not good
0 % < score ≤ 43%	Not good

The data obtained is quantitative data resulting from the distribution of the Feasibility Questionnaire for the chemical module of the reaction rate material through a scientific approach that has been developed, then descriptive percentages are carried out. If the total percentage meets the eligibility criteria, then the chemistry module on the reaction rate material through a scientific approach is suitable for use as teaching material in learning. The validation carried out by the validator, namely material validation and media validation, was also carried out by teachers and students. The criteria for scoring the module assessment are the range of scores 2, 1 and 0. The data obtained is analyzed using a descriptive percentage, with the following equation (Sudjana, 2005):

$$P = \frac{n}{N} \text{ X } 100\%$$

Information: P = percentage of scores obtained, n = total scores obtained, N = total maximum score in each aspect. The validation criteria from the validator are in accordance with Table 1 and teacher response data and student responses to the module use the criteria in Table 2.

Results and Discussion

Assessment of chemical materials for reaction rates was carried out by the validator. The recapitulation of the results of the assessment by the validator can be seen in Table 3.

Table 3. Product evaluation recapitulation results from the validator

No	Assessment Indicator	Score %			Average
		Validators I	Validators II	Validators III	
Content Eligibility Aspects					
1	Adequate Material (KS-KD) is appropriate	91.67	100.00	100.00	97.22
2	Material accuracy	95.00	95.00	85.00	91.67
3	Material support	91.67	95.83	95.83	94.44
4	Material update	87.50	93.75	87.50	89.58
Average		91.46	96.15	92.08	93.23
Aspect of feasibility of presentation					
1	Presentation technique	87.50	100.00	87.50	91.67
2	Supporters of presentation	97.22	91.67	94.44	94.44
3	Presentation of learning	87.50	93.75	81.25	87.50
4	Healence With Language Rules	75.00	93.75	100.00	89.58
Average		86.81	94.79	90.80	93./75
Validity aspects					
1	Straightforward	83.33	91.67	100.00	91.67
2	Communicative	100.00	75.00	75.00	83.33

No	Assessment Indicator	Score %			Average
		Validators I	Validators II	Validators III	
3	Dialogical and interactive	87.50	100.00	75.00	87.50
4	Conformity with the development of students	87.50	87.50	100.00	91.67
5	Conformity with language rules	87.50	100.00	75.00	87.50
Average		89.17	90.83	85.00	88.33
Average presentation		89.15	93.92	89.29	91.77
Average overall presentation		90.79			
Criteria		Very decent			

From Table 3, the feasibility results of module chemical material reaction rate by validator material the average feasibility of the module material is in Table 4.

Table 4. Recapitulation results of module feasibility aspects (Material)

No	Aspect	Validator I	Validator II	Validator III	Average	Information
1	Feasibility of content	91.46%	96.15%	92.08%	93.23%	Very decent
2	Feasibility of presentation	86.81%	94.79%	90.80%	93.75%	Very decent
3	Language feasibility	89.17%	90.83%	85.00%	88.33%	Very appropriate module
Average		89.15%	93.92%	89.29%	91.77%	Very decent

Based on Table 4 shows that the results of the feasibility assessment of the chemical module of the reaction material obtained an average of 91.77% have a very feasible assessment criteria. The module is very feasible to use it in the field without revision, but there are some things that need to be improved based on some input from the validator.

Content Feasibility Aspect

The feasibility of the chemical module material for the reaction rate through a scientific approach can be seen that the average results of the percentage of content feasibility aspects are 93.23%, including very feasible categories. According to (Setiawan, 2020) the learning process stage uses a scientific approach (1) see, (2) asking, (3) combining data, (4) reasoning, and (5) communicating.

Although the feasibility of content has a very decent category, there are several aspects of modules that need to be improved, namely the quality of print writing, the terms in the module are clarified so that there is no concept, and the module display is made more attractive and the revision of the module is carried out. A person's learning experience is obtained from the eye senses (75%), 13% through hearing, and 12% through other hearing, interesting images and illustrations will help students understand the lessons, spirituality (Pan and Garmston, 2011). Analysis of Assessment of Chemical Module Material Reaction rates from the aspect of content feasibility can be seen in Fig.-1.

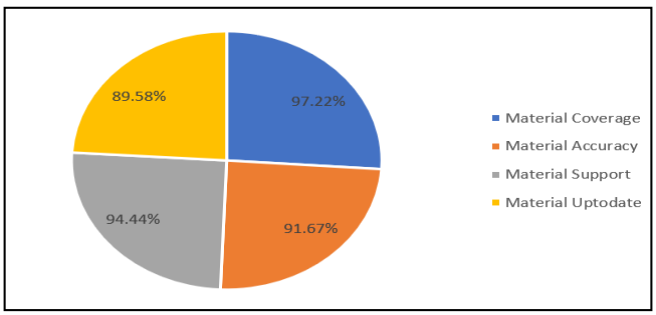

Fig.-1. Pie diagram Percentage of content feasibility aspects

The average of the equivalent shown in Figure 1 is known that, the results of the assessment of the feasibility aspects of the contents of the chemical module of the reaction rate of the validator of 89.58% to

97.22%. There are several aspects of assessment including adequate aspects of material that get an average value of 89.58%, aspects of the accuracy of the material that get an average value of 91.67%, aspects of supporting material that get an average value of 94.44%and aspects material that gets an average value of 89.58%.

Aspect of Feasibility of Presentation

The feasibility of the Material Chemical Module The reaction rate through a scientific approach can be seen that the average results of the percentage score of the feasibility aspects of the material presentation are 93.75%. The four aspects of the feasibility aspect of presentation are present, namely the supporting aspect of presentation (94.44%). Presentation techniques in learning need to be improved, so that students' participation in learning chemistry material reaction rate. Analysis of Assessment of Chemical Module Material Reaction rate from the feasibility aspect of presentation can be seen in Fig.-2.

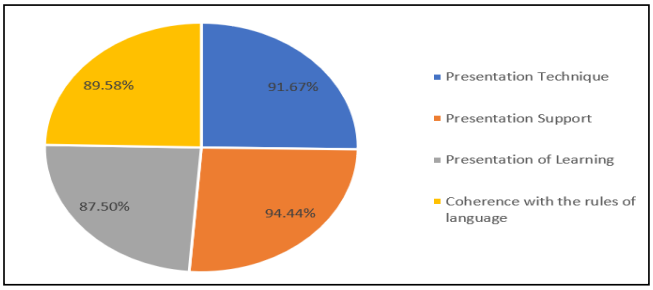

Fig.-2. Pie diagram percentage of presentation aspects of presentation

The average of the equivalent shown in Fig.-2 is known that, the results of the assessment of the feasibility aspects of the presentation of the chemical module of the reaction material from the validator of 87.50% to 94.44%. There are several aspects of the assessment including the aspect of presentation techniques that get an average value of 91.67%, the supporting aspects of the presentation that get an average value with the rules of language that get an average value of 89.58%.

Language Feasibility Aspect

The feasibility of the chemical module material for the reaction rate through a scientific approach can be seen that the average results of the percentage score of language feasibility aspects are 88.33%. The language feasibility aspect that gets the lowest research percentage is the communicative aspect, conformity with the level of development of students, and the use of terms, symbols, and icons in the chemical module of the reaction rate (91.67%). Item aspects that need to be improved are writing concepts/symbols that are clear so that it does not cause a double meaning and is easily understood by students. According to (Sari and Alarifin, 2016; Nisa et al. 2022; Silaban et al. 2022) states that grammar in making modules should use simpler grammar that can be understood. Some characteristics of the module teaching material, according to Prastowo in Siregar et al. (2022), namely: (1) Designed for independent learning, (2) is a whole and systematic learning, (3) contains goals, materials or activities, and evaluation, (4) presented communicatively, (5) is expected to replace several teachers' roles, (6) concerned with the activities of the user / user in learning. Analysis of Assessment of Chemical Module Material Reaction rate from the language feasibility aspect can be seen in Fig.-3.

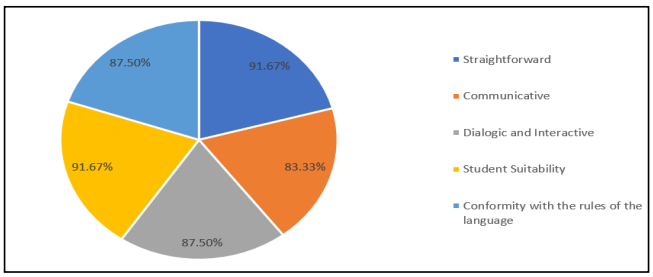

Fig.-3. Pie diagram percentage of language feasibility aspects

The average percentage shown in Fig.-3 is known that the results of the linguistic aspect of the chemical module of the reaction material from the validator of 83.33% to 91.67%. There are several straightforward aspects including adequate aspects of material that get an average value of 91.67%, communicative aspects that

get an average value of 83.33%, dialogical and interactive aspects that get an average value of 87.50%, aspects of suitability with the development of students who get an average value of 91.67%, and aspects of conformity with language rules that get an average value of 87.50%. The three aspects of validation by material experts are the feasibility aspects of the module content, the feasibility aspect of presentation and the language feasibility aspect obtained the average percentage of assessment of the overall aspects is 91.77%, including in the category very feasible to be used in learning activities by students. Very feasible in the sense, modules can be used as teaching material for students to improve scientific process skills and learning outcomes as a reference for success in the learning process.

Aspects of Media Feasibility

Validation of the feasibility of the preaching of the initial step that must be taken in the development of the module is to determine the design or plan. In this case the design and design of the chemical module of the reaction material is reviewed based on the assessment of the aspects of the crafting. In the validation process, there are several improvements and suggestions from the validators, namely the module cover page. The feasibility of the chemical module material for the reaction rate through a scientific approach that has been developed, then a descriptive percentage is carried out. If the total percentage meets the feasibility criteria, the chemical module of the reaction rate through a scientific approach is feasible to use as a teaching material in learning. The results of the analysis of the teacher's response questionnaire to the chemical module of the reaction rate through a scientific approach can be seen in Table 5.

Table 5. Recapitulation results of module feasibility aspects (material)

Response	The accuracy of the material									Amount	Percentage (%)
	1	2	3	4	5	6	7	8	9		
1	4	4	4	4	4	3	4	4	4	35	97.22
2	4	4	4	4	4	4	4	4	4	36	100.00
3	4	4	4	4	4	4	4	4	4	36	100.00
Amount	12	12	12	12	12	11	12	12	12	107	
Average	4.00	4.00	4.00	4.00	4.00	3.67	4.00	4.00	4.00	35.67	
Percentage (%)	100	100	100	100	100	92	100	100	100	99.07	
Strongly agree	3	3	3	3	3	2	3	3	3	26	96.30
Agree	0	0	0	0	0	1	0	0	0	1	3.70
Disagree	0	0	0	0	0	0	0	0	0	0	0.00
Disagree	0	0	0	0	0	0	0	0	0	0	0.00
Amount	3	3	3	3	3	3	3	3	3	27	100.00

Based on Table 5 Teacher's Response MA DDI Entrop Jayapura to the chemical module of the reaction rate through a scientific approach with an average shown in the table is 99.07%, with a very good category. The results of the analysis of the teacher's response questionnaire to the chemical module of the reaction rate can be seen in Fig.-4. Based on Fig.-4 the percentage of the value of the chemical module of the reaction material by teacher 1 is 97, 22%, teacher 2 and teacher 3 of 100%.

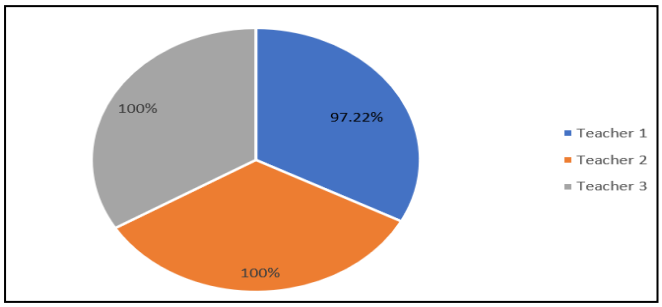

Fig.-4. Pie diagram of subject responses

The teacher response was given by three teachers, namely chemical teachers from MA DDI Entrop Jayapura. The three teachers gave an assessment by filling out the teacher's response questionnaire against the chemical module of the reaction rate. The average percentage of the results of the teacher's response to the chemical module of the reaction material is 97.07% (very good), the module is a very feasible category to be developed in

learning (Rahmatsyah and Dwiningsih, 2021). The three teachers gave their assessment responses. The response given by the teachers of Jayapura Entrop, suggestions and inputs is very helpful in improving the quality of the contents of the material, presentation and language arrangement of the chemical module of the reaction material, so that it is easier for students to understand in the learning process. With the appearance of modules and interesting content it is expected to affect students' understanding of learning. According to the student response questionnaire about the chemical module of the reaction material that is carried out in class XI, it was 95.83% and 98.33% (Table 6).

Table 6. Recapitulation results of student response to modules

No	Respondent	Display aspects (%)	Aspects of material presentation (%)	Benefit aspects (%)
1	A	100.00	100.00	95.83
2	B	91.67	95.83	100.00
3	C	95.83	97.92	95.83
4	D	100.00	97.92	100.00
5	E	95.83	95.83	100.00
Average		96.67	97.50	98.33
Overall average		97.50		
Criteria		Very good		

Table 6 shows that the results obtained in each aspect are averaged so that the results of the student response presentation in the chemical module of the reaction rate is 97.50% which has been categorized as high. Students' responses are very necessary to determine the interests and interests of students to learn by using the chemical module for the reaction rate, and from the point of view and response of students this chemical module of the reaction material will be developed (Fig.-5).

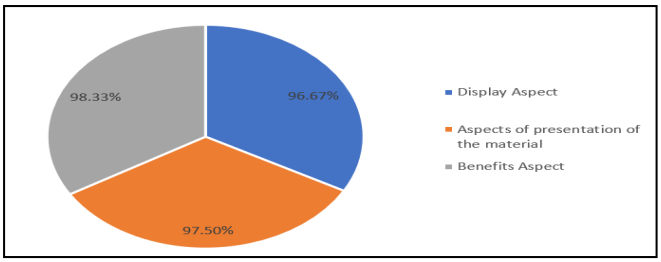

Fig.-5. Pie diagram Percentage of average questionnaire

The average small-scale equivalent shown in Figure 9 is known that, the results of the assessment of small-scale student response questionnaires in the chemical module of the reaction rate of the student rate of 96.67% to 98.33%. There are several aspects of the assessment including the appearance aspects that get an average value of 96.67%, aspects of presentation of material that get an average value of 97.50%, aspects of benefits that get an average value of 98.33%and cohendy aspects with language rules that get an average value of 89.58%.

After the questionnaire is distributed to students to find out the response of students to the readability of the module. Students who fill the questionnaire to students to the images in the module according to the reaction rate material. Steps of learning activities that are easy to understand, the existence of simple practicums that are fun, and exercises about crossword puzzles that are not boring and a summary of material that can make it easier for students to learn independently. Module assessment by material experts, media experts, chemical teachers and students with a very decent category, it can be concluded that the chemical module of the reaction rate through a scientific approach is very feasible to use in chemistry learning in class XI MA DDI Entrop Jayapura.

Conclusion

The chemical module on the reaction rate material through a scientific approach is very suitable for use as a teaching material module in schools. This is based on an average assessment of 91.77% material validator with a very feasible category, 90.48% media validator and 99.07% teacher response is very good. After being implemented in the 97.50% student response class, it is very good.

Conflict of Interests

The author (s) declares that there is no conflict of interest in this research and manuscript.

References

Asmi, A., Silaban, R., & Silaban, S. (2023). Problem based learning (PBL) chemistry E-module development for class X high school students. *Proceedings of the AISTEEL 2023, September 19, Medan, Indonesia*. http://dx.doi.org/10.4108/eai.19-9-2023.2340436

Fitri, D., Silaban, S., & Darmana, A. (2023). Implementation of interactive electronic books based on project based learning for class XI high school even semester on student motivation and learning outcomes. *Proceedings of the AISTEEL 2023, September 19, Medan, Indonesia*. http://dx.doi.org/10.4108/eai.19-9-2023.2340419

Islamiyah, K., Juwitaningsih, T., & Silaban, S. (2022). Implementation of contextual-based chemistry electronic textbook class x sma/ma semester II on learning outcomes and student's learning motivation. *Jurnal Pendidikan dan Pembelajaran Kimia*, 11(2), 44-51.

Kemendikbud. (2013) Permendikbud No.64 tentang Standar Isi Pendidikan Dasar dan Menengah. Jakarta: Kementerian Pendidikan dan Kebudayaan

Munthe, E. A., Silaban, S., & Muchtar, Z. (2019). Discovery learning based e-module on protein material development. *Advances in Social Science, Education and Humanities Research*, 384, 604-607.

Nisa, S. A., Silaban, M. S., & Silaban, S. (2022). Development of chemic media (chemistry comic) based on problem based learning on chemical bond materials for class x students. *Jurnal Pendidikan Kimia*, 14(1), 39–46. https://doi.org/10.24114/jpkim.v14i1.32112

Pan, W. and Garmston, H. (2011) Enhancing project-based learning in sustainable building by incorporating learning technology. *Poster presented at the 9th VC's Teaching and Learning Conference*, University of Plymouth, Plymouth, UK, 7 July 2011

Rahmatsyah, S. W., & Dwiningsih, K. (2021). Pengembangan E-module interaktif sebagai sumber belajar pada materi sistem periodik unsur. *UNESA Journal of Chemical Education*, 10(1), 76–83. https://doi.org/10.26740/ujced.v10n1.p76-83

Rohmad, A., Suhandini, P., & Sriyanto, S. (2012). Pengembangan lembar kerja siswa (LKS) berbasis eksplorasi, elaborasi, dan konfirmasi (EEK) serta kebencanaan sebagai bahan ajar mata pelajaran geografi SMA/MA di kabupaten Rembang. *Edu Geography*, 1(2), 1-5.

Sari, A. T. W., & Alarifin, D. H. (2016). Pengembangan modul berbasis POE (predict, observe, explain) materi usaha dan energi ditinjau dari kemampuan kognitif. *Jurnal Pendidikan Fisika*, 4(2), 124. https://doi.org/10.24127/jpf.v4i2.531

Silaban, S. (2017). *Dasar-dasar pendidikan matematika dan ilmu pengetahuan alam*. Medan: Harapan Cerdas Publisher.

Silaban, M. S., Nisa, S. A., Silaban, S., & Sianturi, J. (2022). The development of sets-based chemic media on hydrocarbon material. *Jurnal Pendidikan Kimia*, 14(2), 85–96. https://doi.org/10.24114/jpkim.v14i2.32911

Siregar, T. (2021). Pengembangan modul kimia pada materi sistem periodik unsur berbasis budaya literasi. *Jurnal Ilmu Pendidikan Indonesia*, 9(1), 27–33. https://doi.org/10.31957/jipi.v9i1.1559

Siregar, T., Karubaba, M., Siallagan, J., & Inggamer, M. M. (2022). Development of chemical e-modules based on papua local wisdom on reduction and oxidation reaction materials to increase student learning outcomes. *Jurnal Ilmu Pendidikan Indonesia*, 10(3), 118–128. https://doi.org/10.31957/jipi.v10i3.2409

Sudarmanto, E., Mayratih, S., Kurniawan, A., Abdillah, L. A., Martriwati, M., Siregar, T., ... & Firmansyah, H. (2021). *Model pembelajaran era society 5.0*. Cirebon: Penerbit Insania.

Sudarwan, D. (2013). *Menjadi peneliti kualitatif*. Bandung: CV. Pustaka Setia

Sudjana N. (2005). *Metoda statistika*. Bandung: Tarsito.

Sudjana (2010). *Dasar-dasar proses belajar*. Bandung : Sinar Baru.

Sugiyono (2019). *Metode penelitian kuantitatif, kualitatif, dan R&D*. Bandung : Alphabet

Vaino, K., Holbrook, J., & Rannikmäe, M. (2012). Stimulating students' intrinsic motivation for learning chemistry through the use of context-based learning modules. *Chem. Educ. Res. Pract*, 13(4), 410–419. https://doi.org/10.1039/c2rp20045g