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The Effect of Electronic Modules on Self-regulated Learning and Cognitive Learning Outcomes on Chemical Bonding Material

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Abstract: This study aims to the effect of guided inquiry-based electronic modules on self-regulated learning and cognitive learning outcomes. The research design uses a quasi-experimental post-test only. This research was conducted on students of class X Natural Science in Yogyakarta using the cluster random sampling technique. The instrument used in this research is a self-regulated learning questionnaire and cognitive learning outcomes test. The data analysis technique uses Hotelling's T-Test to test whether there are differences in self-regulated learning and cognitive learning outcomes with the implementation of electronic modules. The results show that the significance value is 0.002 < 0.05. This means that there is a difference in self-regulated learning and cognitive learning outcomes between students who use the guided inquiry-based electronic module and those who do not use the electronic module.

Keywords: Chemical bonding; Cognitive learning outcomes; E-module; Guided inquiry; Self-regulated learning

Introduction

Students' capability to develop skills such as information and communication technology, critical thinking skills, problem-solving skills, and teamwork was emphasized in the 21st-century learning paradigm (Asman et al., 2022; Wrahatnolo & Munoto, 2018). To develop 21st century abilities by using learning techniques compatible with these resources and competencies. Using technology in the learning process is one of the learning approaches that can help students meet the criteria for 21st-century abilities (Chalkiadaki, 2018). In fact, there are still many teachers who have not utilized technology in the learning process due to lack of preparation, training, and guidance, so the learning process is still centered on the teacher using the lecture method and taking notes (Santosa et al., 2022). Thus, the teacher needs to master 21st-century skills such as passive learning into active learning.

Chemistry is one example of technology-assisted learning. Chemistry learning is a difficult and abstract process of learning about chemistry. Chemistry is a discipline of natural science that examines matter's structure, characteristics, transformations, and energy changes (Oreshkina & Gurov, 2019; Orgill et al., 2019). One of the materials in chemistry learning is chemical bonding which studies atoms starting from the structure and interactions between ions that form a chemical bond. However, many students find it difficult to understand chemical bonding material because it is electrostatic and has a great chance for misconceptions (Tsaparlis et al., 2021). In fact, students have difficulty studying intermolecular and intramolecular bonds, polar and non-polar bonds, ionic bonds, and covalent bonds (Julien et al., 2021; Tsaparlis et al., 2019). With these problems, there must be innovation in learning so that students understand learning, one of which is teaching materials, teaching materials can be in the form of electronic modules, audiovisuals or animations (Tsaparlis et al., 2021).

It is vital to modify or transition traditional teaching materials to electronic teaching materials to keep up with the times, science, and technology. Electronic modules are instructional tools that include materials,

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procedures, and questions that are presented engagingly and methodically to gain competency according to the 2013 curriculum (Handayani et al., 2021; Laili et al., 2019). Teachers' efforts to reduce student learning issues by using learning media such as films and learning animations, teaching content slowly and frequently, and presenting analogies from everyday life (Noer, 2020). Teaching materials that can answer these problems are IT-based teaching materials such as electronic modules with videos and learning animations. Educators can use electronic modules in and outside the classroom as learning resources for students (Asrial et al., 2021; Sofyan et al., 2020).

This study combined the electronic module with a guided inquiry learning model. Guided inquiry is a learning approach that involves students in finding and using various sources of information to improve their understanding (Margunayasa et al., 2019). The abilities that students must have in inquiry activities are asking questions related to investigations, designing and conducting investigations, using tools to collect data, then the data is used to explain the investigation results and then communicated or conveyed in understanding scientific inquiry (Gunawan et al., 2019). The importance of educators assessing the ability of guided inquiry for students is to assess the ability of students in learning with the inquiry model. But in reality, students still do not know about guided inquiry, making it difficult for students to learn chemistry (Arantika et al., 2019). Thus, it is necessary to apply a guided inquiry learning model in the learning process, so that students can recognize guided inquiry learning models.

Self-regulated learning regulates the way of learning and attitudes of students related to time management with all learning activities of students at school and at home. Students who have high discipline in learning such as the accuracy of attendance and the number of attendance in class mostly have better academic achievements (Lai et al., 2018). Self-regulated learning is a method and philosophy in education in which students acquire their own knowledge and develop their ability to investigate and reflect critically (Huang et al., 2023). However, current learning is still centered on the teacher, so that students' self-regulated learning is still lacking in learning in class (Dignath & Büttner, 2018). It is a challenge for teachers to activate self-regulated learning by changing learning strategies integrated into the curriculum to encourage students to think, regulate their thinking processes and develop self-regulated learning to improve their abilities (Fazriah et al., 2021).

Cognitive learning outcomes are student self-assessments, changes that can be observed, proven, and measured in abilities or achievements experienced by students as a result of learning experiences (Tashiro et al., 2021). Cognitive learning outcomes are students' abilities after what they know and learn. The categories in cognitive processes are remembering, understanding, applying, analyzing, evaluating and creating (Muhayimana et al., 2022). However, students only hear and accept the learning delivered by the teacher, so students tend to be passive, this causes the cognitive learning outcomes of students to be low (Bely et al., 2019). Cognitive learning outcomes are influenced by the teacher, curriculum quality and current teaching methods, with this expected the development of new curricula and training programs for teacher so that they can affect the achievement of desired high-quality learning outcomes.

Thus, the purpose of the study is to test whether there is a difference between self-regulated learning and cognitive learning outcomes of class 10th high school students after using an electronic module based on guided inquiry on chemical bonding material.

Method

Research Design

The method used in this study is a quasi-experimental post-test only. This research was conducted for the 4th meeting in November 2021. This research was conducted hybrid learning process. The research design can be seen in Table 1.

Table 1. Desain Posttest Only

Group	Treatment	Posttest
Experiment	X_1	O_1O_2
Control	X_2	O_1O_2

Description:
X_1 = Learning using electronic modules
X_2 = Learning doesn't use electronic modules
O_1 = SRL questionnaire
O_2 = Cognitive learning outcome test

The sample used in this study was class 10th natural science, totaling 72 students in one of the Yogyakarta senior high schools. The sampling technique used is cluster random sampling. The cluster random sampling technique is selecting a sample that is done randomly with a specified population (Berndt, 2020; Sudria et al., 2018).

Techniques and Instruments

Data collection techniques used in this study was questionnaires and tests. The data on students' self-regulated learning on chemical bonding material was collected using this questionnaire approach. Then there's the test method employed in this study, which is based on cognitive learning results on chemical bonding materials.

This self-regulated learning questionnaire was created by combining different self-regulated learning journals (Awang et al., 2021; Oktari et al., 2020; Raković et al., 2022). The self-regulated learning questionnaire is made up of 26 statements, both positive and negative with 3 aspects such as self-regulation of behavioral aspects, self-regulation of motivational aspects, and self-regulation of evaluation aspects. The following is a grid of self-regulated learning questionnaires which can be seen in Table 2.

Table 2. Grid Self-regulated Learning

Aspects	Item	Total Item
Self-regulation of Behavioral	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	14
Self-regulation of Motivational	15, 16, 17, 18, 19, 20, 21, 22, 23	9
Self-regulation of Evaluation	24, 25, 26, 27, 28, 29, 30	7
Total	30	30

Then the following are aspects of cognitive learning outcomes according to Bloom's taxonomy in the cognitive domain: remember, understand, apply, and analyze (Muhayimana et al., 2022). Then there were 25 multiple choice questions on chemical bonding material with many sub-chapters such as atomic stability, ionic bonds, covalent bonds, metal bonds, molecular structures, compound polarity, and intermolecular forces, all of which were connected to cognitive learning objectives. The grid of cognitive learning outcomes can be seen in Table 3.

Table 3. Grid of Cognitive Learning Outcomes

Sub Chapters	Indicator				∑
	(C1)	(C2)	(C3)	(C4)	
Atomic stability	1	2, 3, 4, 5			5
Ionic bonds		9	6, 7, 8		4
Covalent bonds		13	10, 11, 12		2
Metal bonds		14, 15			2
Molecular structures			18	16, 17	3
Compound polarity	19	20	21		3
Intermolecular forces		23	22, 24,25		4
∑	2	10	11	2	25

Data Analysis Technique

Validity and reliability

All instruments used were tested for validity and reliability before being used for research. The validation used is theoretical and empirical validation. Theoretical validation was carried out by expert judgment related to self-regulated learning questionnaires and questions about cognitive learning outcomes.

Table 4. Criteria Item Response Theory

Value	Category
>0.94	Excellent
0.91 – 0.94	Very Well
0.81 – 0.90	Well
0.67 – 0.80	Average
< 0.67	Deficient

The results of the expert judgment are suggestions and input related to the instruments used to make them even better. While the empirical validity is done by testing the instrument to students outside the sample class. Instruments that use empirical tests are self-regulated learning questionnaires and cognitive learning outcomes tests. The empirical test of cognitive learning outcomes test is given to students who have received chemical bonding material. The empirical validity test of the students' results was analyzed using item response theory analysis with the QUEST program. An item is said to be good if the item has an INFIT MNSQ coefficient value of 0.77-1.33 (Rizbudiani et al., 2021; Syarif & Kuswanto, 2019).

Then the reliability of each instrument is determined. The reliability test on the self-regulated learning questionnaire instrument and the cognitive learning outcome test used item response theory analysis with the QUEST program. The criteria for response theory items can be seen in Table 4.

Research Data Analysis

Before data analysis, hypothesis testing was conducted. Several assumptions that must be met for data analysis are as follows: (1) having two or more dependent variables; (2) having independent variables consisting of two or more; (3) there is no relationship between groups; (4) adequate sample size; (5) the absence of outliers in univariate and multivariate; (6) have normality; (7) there is a linear relationship between

the dependent variable; (8) matrix homogeneity; (9) there is no multicollinearity. Then after the hypothesis prerequisite test is met, a multivariate test is carried out. In this study, the multivariate test used was hotelling's t test.

Multivariate Test

The hypothesis test carried out in this study is the multivariate analysis that aims to determine whether there are differences in learning independence and cognitive learning outcomes between students who use the guided inquiry-based electronic module compared to those who do not use the electronic module. In this study, the multivariate test used was Hotelling's t test.

Result and Discussion

Validity and Reliability Results

The empirical test carried out involved 680 students for a self-regulated learning questionnaire. Meanwhile, the cognitive learning outcomes test involved 324 students for package A, and for package B cognitive learning outcomes questions involved 364 students. Then the results of the empirical test are analyzed in item response theory using the Quest program to determine the validity and reliability of each item. Items are declared valid if the INFIT MNSQ value is in the range 0.77 to 1.33 (Rizbudiani et al., 2021; Syarif & Kuswanto, 2019). The validation results showed that the 30 items of the self-regulated learning questionnaire had several items that were outside the range of 0.77 to 1.33 so that the item was declared invalid. Invalid items are numbers 4, 17, 18, and 21.

Then for the question of cognitive learning outcomes in packages A and B, it shows that there are several items outside the range of 0.77 to 1.33 so the question of cognitive learning outcomes is declared invalid. The question of cognitive learning outcomes in package A that is not valid is number 23, while in package B the invalid is number 4, 5, 13, and 23. Then 45 questions are declared valid, 30 items are taken to be used as post-test cognitive learning outcomes. Already represents all the existing sub-materials.

The reliability test results on the self-regulated learning questionnaire obtained a value of 0.84. Then on, the question of cognitive learning outcomes obtained a reliability value of 0.99 for package A while for package B obtained a value of 0.99. The results of the reliability of the self-regulated learning questionnaire and the question of cognitive learning outcomes can be seen in Table 5.

Table 5. Reliability of Self-Regulated Learning Questionnaires and Cognitive Learning Outcomes

	Summary of item estimates	Summary of case estimates
Self-regulated learning	0.84	0.78
Cognitive learning outcomes package A	0.99	0.76
Cognitive learning outcomes package B	0.99	0.78

Data Analysis Results

The data analysis used in this study is multivariate, before multivariate analysis is carried out, it must meet the following multivariate prerequisite assumptions test: (1) The independent variable used is a guided inquiry learning model with an electronic module based on guided inquiry; (2) The dependent variable are self-regulated learning and cognitive learning outcomes; (3) The sample used consisted of two classes, namely the experimental class and the control class. The experimental class used an electronic module based on guided inquiry, and then for the control class without using the module. These two classes are not related to each other; (4) The sample used is 72 students with 36 students in the experimental class and 32 students in the control class; (5) There are no univariate or multivariate outliers in the study; (6) The normality test in this study used the Kolmogorov-Smirnov. The normality test results showed that self-regulated learning and cognitive learning outcomes were normally distributed with a significance value > 0.05. The results of the normality test can be seen in Table 6.

Table 6. Normality Test Results

Variable	Group	*Kolmogorov-Smirnov*[a]			Distribution
		Statistic	*df*	*Sig.*	
Self-regulated Learning	Experiment	.110	36	.200*	Normal
	Control	.088	36	.200*	Normal
Cognitive Learning Outcomes	Experiment	.128	36	.143	Normal
	Control	.130	36	.131	Normal

(7) There is a linear relationship between self-regulated learning and cognitive learning outcomes; (8) The homogeneity test used in the study used the box's M test with a Box's M value of 4.702 with an F value of 1.519 and a significance value of 0.207; (9) The correlation test in this study uses person correlation. The results of the

pearson correlation value of 0.405 with a significance value of 0.000 < 0.05 show a positive relationship between self-regulated learning and cognitive learning outcomes because the significance value is < 0.05. The results of the correlation test can be seen in Table 7.

Table 7. Correlation test Results

		Self-regulated Learning	Cognitive Learning Outcomes
Self-regulated Learning	*Pearson Correlation*	1	.405**
	Sig. (2-tailed)		.000
	N	72	72
Cognitive Learning Outcomes	*Pearson Correlation*	.405**	1
	Sig. (2-tailed)	.000	
	N	72	72

Multivariate Test

Multivariate analysis in this study used hotelling's t-test. The results of the multivariate test analysis obtained a significance value of 0.002 < 0.05. It can be concluded that there are differences in self-regulated learning and cognitive learning outcomes between students who use the guided inquiry-based electronic module compared to students who do not use the electronic module. The results of the multivariate test using hotelling's t-test can be seen in Table 8.

Table 8. Multivariate Test Results

Effect		Value	F	Hypothesis df	Sig.
Group	Hotteling's Trace	.202	6.959[b]	2.000	0.202

Discussion

Research on the use of guided inquiry-based electronic modules on chemical bonding materials for class X high school students that has been developed was carried out to find out the differences. The sample in this study were students of class X natural science at senior high school Yogyakarta. This study used 2 classes, namely the experimental class and the control class where each class consisted of 36 students. The sample selection in control and experimental classes used the cluster random sampling technique.

The research was conducted in 4 meetings using the guided inquiry learning model in the experimental and control classes using the direct instruction learning model. Aspects of guided inquiry used in learning include introduction, problem formulation, hypotheses, data collection, data analysis, and conclusions. The self-regulated learning questionnaire developed in this study includes several aspects such as self-regulation of behavior, self-regulation of motivation, and self-regulation of evaluation.

Learning in the experimental class begins with the delivery of learning objectives at each meeting to direct students to the material to be taught. The learning process is carried out by discussions in groups consisting of 4 members. Then students ask questions and write hypotheses in the problem formulation phase. In the data collection phase, students are presented with materials and videos.

Students work on the exercises that have been provided in the process of analyzing the data. In the final stage of the guided inquiry process, students make conclusions regarding the material studied. After completing all steps, educators re-explain the material studied to strengthen understanding and avoid misconceptions. In the learning process using the inquiry syntax, students look active in group discussions to discuss material, solve problems, and ask questions about material that has not been understood. (Fauzi et al., 2019). Guided inquiry-based electronic modules can help educators and students in the learning process (Ash-Shiddieqy et al., 2018).

The results of the multivariate test with Hotelling's t-test data show that the significance value is 0.002 < 0.05, it can be interpreted that there are differences in self-regulated learning and cognitive learning outcomes between students who use guided inquiry-based electronic modules compared to those who do not use guided inquiry-based electronic modules. This is consistent with research which states that the learning outcomes of students who use chemical bonding electronic modules based on guided inquiry are significantly higher than students who do not use these electronic modules (Iryani et al., 2021). Modules developed in digital form such as electronic modules using technology and equipped with videos and animations make it easier for students to understand the material so that they can provide positive student learning outcomes. The electronic modules influence self-regulated learning and cognitive learning outcomes (Nurhayati et al., 2022; Pohan & Maulina, 2022). Students who study using guided inquiry-based electronic modules find it easier to follow the lesson because the learning process has been equipped with steps in accordance with the guided inquiry learning model (Aulia & Andromeda, 2021).

Conclusion

Based on the research, a significance value of 0.002 < 0.05 was obtained, there were differences in self-regulated learning and cognitive learning outcomes between students who used the guided inquiry-based electronic module and those who did not use the electronic module. Guided inquiry-based electronic modules can be used in online and offline learning processes.

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The authors declare no conflict of interest.

References

Arantika, J., Saputro, S., & Mulyani, S. (2019). Effectiveness of guided inquiry-based module to improve science process skills. *Journal of Physics: Conference Series*, *1157*(4). https://doi.org/10.1088/1742-6596/1157/4/042019

Ash-Shiddieqy, M. H., Suparmi, A., & Sunarno, W. (2018). The effectiveness of module based on guided inquiry method to improve students' logical thinking ability. *Journal of Physics: Conference Series*, *1006*(1). https://doi.org/10.1088/1742-6596/1006/1/012001

Asman, Kumaro, M., & Barliana, M. S. (2022). Integration of 4Cs Skills into Learning by Using the Project Based Learning (PjBL) Model to Face the Challenges of the 21st Century. *Proceedings of the 4th International Conference on Innovation in Engineering and Vocational Education (ICIEVE 2021)*, *651*, 88–93. https://doi.org/10.2991/assehr.k.220305.018

Asrial, A., Syahrial, S., Kurniawan, D. A., & Zulkhi, M. D. (2021). The Relationship Between the Application of E-Modules Based on Mangrove Forest Ecotourism on The Peace-Loving Character of Students. *Journal of Education Technology*, *5*(3), 331. https://doi.org/10.23887/jet.v5i3.34043

Aulia, F., & Andromeda, A. (2021). The Effectiveness Of Ion Equilibrium And Ph Of Salt Solution E-Modules Based On Guided Inquiry Learning For Student's Learning Outcomes. *International Journal of Progressive Sciences and Technologies (IJPSAT)*, *27*(2), 700–705. Retrieved from http://ijpsat.es/index.php/ijpsat/article/view/3292

Awang, I. S., Serani, G., Prasetyo, Z. K., & Wangid, M. N. (2021). Pedagogical Content Knowledge (PCK) Based On Local Wisdom To Develop Students' Nationality Characteristics. *Journal of Educational Science and Technology (EST)*, *7*(1), 97–104. https://doi.org/10.26858/est.v0i0.18892

Bely, L. N., Bahri, S., & Mustari, M. (2019). Model Pembelajaran Advance Organizer: Dampak Terhadap Hasil Belajar Kognitif Peserta Didik. *Indonesian Journal of Science and Mathematics Education*, *2*(2), 150–161. https://doi.org/10.24042/ijsme.v2i2.4340

Berndt, A. E. (2020). Sampling Methods. *Journal of Human Lactation*, *36*(2), 224–226. https://doi.org/10.1177/0890334420906850

Chalkiadaki, A. (2018). A systematic literature review of 21st century skills and competencies in primary education. *International Journal of Instruction*, *11*(3), 1–16. https://doi.org/10.12973/iji.2018.1131a

Dignath, C., & Büttner, G. (2018). Teachers' direct and indirect promotion of self-regulated learning in primary and secondary school mathematics classes – insights from video-based classroom observations and teacher interviews. *Metacognition and Learning*, *13*(2), 127–157. https://doi.org/10.1007/s11409-018-9181-x

Fauzi, H., Farida, I., Sukmawardani, Y., & Irwansyah, F. S. (2019). The making of e-module based in inquiry on chemical bonding concept with representation ability oriented. *Journal of Physics: Conference Series*, *1402*(5). https://doi.org/10.1088/1742-6596/1402/5/055059

Fazriah, S., Irwandi, D., & Fairusi, D. (2021). Relationship of self-regulated learning with student learning outcomes in chemistry study. *Journal of Physics: Conference Series*, *1836*(1). https://doi.org/10.1088/1742-6596/1836/1/012075

Gunawan, Harjono, A., Hermansyah, & Herayanti, L. (2019). Guided inquiry model through virtual laboratory to enhance students' science process skills on heat concept. *Cakrawala Pendidikan*, *38*(2), 259–268. https://doi.org/10.21831/cp.v38i2.23345

Handayani, D., Elvinawati, Isnaeni, & Alperi, M. (2021). Development Of Guided Discovery Based Electronic Module For Chemical Lessons In Redox

Reaction Materials. *International Journal of Interactive Mobile Technologies*, *15*(7), 94–106. https://doi.org/10.3991/ijim.v15i07.21559

Huang, C. L., Wu, C., & Yang, S. C. (2023). How students view online knowledge: Epistemic beliefs, self-regulated learning and academic misconduct. *Computers and Education*, *200*, 104796. https://doi.org/10.1016/j.compedu.2023.104796

Iryani, Bayharti, Iswendi, & Putra, R. F. (2021). Effect of Using Guided Inquiry-Based Chemical Bonding Modules on Student Learning Outcomes. *Journal of Physics: Conference Series*, *1788*(1). https://doi.org/10.1088/1742-6596/1788/1/012022

Julien, M., Liégeois, M., Höhener, P., Paneth, P., & Remaud, G. S. (2021). Intramolecular non-covalent isotope effects at natural abundance associated with the migration of paracetamol in solid matrices during liquid chromatography. *Journal of Chromatography A*, *1639*, 461932. https://doi.org/10.1016/j.chroma.2021.461932

Lai, C. L., Hwang, G. J., & Tu, Y. H. (2018). The effects of computer-supported self-regulation in science inquiry on learning outcomes, learning processes, and self-efficacy. *Educational Technology Research and Development*, *66*(4), 863–892. https://doi.org/10.1007/s11423-018-9585-y

Laili, I., Ganefri, & Usmeldi. (2019). Efektivitas Pengembangan E-Modul Project Based Learning Pada Mata Pelajaran Instalasi. *Jurnal Imiah Pendidikan Dan Pembelajaran*, *3*, 308. Retrieved from https://ejournal.undiksha.ac.id/index.php/JIPP/article/download/21840/13513

Margunayasa, I. G., Dantes, N., Marhaeni, A. A. I. N., & Suastra, I. W. (2019). The effect of guided inquiry learning and cognitive style on science learning achievement. *International Journal of Instruction*, *12*(1), 737–750. https://doi.org/10.29333/iji.2019.12147a

Muhayimana, T., Kwizera, L., & Nyirahabimana, M. R. (2022). Using Bloom's taxonomy to evaluate the cognitive levels of Primary Leaving English Exam questions in Rwandan schools. *Curriculum Perspectives*, *42*(1), 51–63. https://doi.org/10.1007/s41297-021-00156-2

Noer, A. M. (2020). Content Needs Analysis and Development of the E-Module Reaction Rate in School Chemistry. *Journal of Physics: Conference Series*, *1655*(1). https://doi.org/10.1088/1742-6596/1655/1/012069

Nurhayati, N., Linda, R., & Anwar, L. (2022). E-module Using FlipHTML5 Application on Chemical Bond Material. *Jurnal Pendidikan Kimia Indonesia*, *6*(2), 133–141. https://doi.org/10.23887/jpki.v6i2.49542

Oktari, B., Susilawati, S., & Copriady, J. (2020). Implementation of Oriented Literated Science E-Module to Improve Critical Skills Thinking About in Hydrocarbon Material. *Journal of Educational Sciences*, *4*(2), 347. https://doi.org/10.31258/jes.4.2.p.347-356

Oreshkina, O., & Gurov, A. (2019). Solving the problem of limited content accessibility in Natural Science Disciplines for students with hearing impairments in Technical University. *2019 IEEE Global Engineering Education Conference (EDUCON)*, 345–351. Retrieved from https://ieeexplore.ieee.org/document/8725219

Orgill, M. K., York, S., & Mackellar, J. (2019). Introduction to Systems Thinking for the Chemistry Education Community. *Journal of Chemical Education*, *96*(12), 2720–2729. https://doi.org/10.1021/acs.jchemed.9b00169

Pohan, L., & Maulina, J. (2022). Blended Learning Integrated with Project-Based Learning: Its Effect on Learning Outcomes, Perception, and Self-Regulated Learning. *Jurnal Pendidikan Kimia Indonesia*, *6*(2), 97–106. https://doi.org/10.23887/jpki.v6i2.48213

Raković, M., Bernacki, M. L., Greene, J. A., Plumley, R. D., Hogan, K. A., Gates, K. M., & Panter, A. T. (2022). Examining the critical role of evaluation and adaptation in self-regulated learning. *Contemporary Educational Psychology*, *68*. https://doi.org/10.1016/j.cedpsych.2021.102027

Rizbudiani, A. D., Jaedun, A., Rahim, A., & Nurrahman, A. (2021). Rasch model item response theory (IRT) to analyze the quality of mathematics final semester exam test on system of linear equations in two variables (SLETV). *Al-Jabar : Jurnal Pendidikan Matematika*, *12*(2), 399–412. https://doi.org/10.24042/ajpm.v12i2.9939

Santosa, M. H., Harismayanti, I., & Jaya Putra, I. N. A. (2022). Technology in Action: Developing Gamification Handbook in English Teaching and Learning for the 21st Century Learners. *Tesl-Ej*, *26*(1), 1–25. https://doi.org/10.55593/EJ.26101A2

Sofyan, H., Anggereini, E., Muazzomi, N., & Larasati, N. (2020). Developing an electronic module of local wisdom based on the area learning model at Kindergarten Jambi city. *International Journal of Innovation, Creativity and Change*, *11*(2), 216–231. Retrieved from https://ijicc.net/images/vol11iss2/11215_Sofyan_2020_E_R.pdf

Sudria, I. B. N., Redhana, I. W., Kirna, I. M., & Aini, D. (2018). Effect of Kolb's learning styles under inductive guided-inquiry learning on learning outcomes. *International Journal of Instruction*, *11*(1), 89–102. https://doi.org/10.12973/iji.2018.1117a

Syarif, A. N., & Kuswanto, H. (2019). Developing an

Essay Test Instrument for Measuring Diagram Representation and the Capability of Argumentation on Newton's Law. *Journal of Physics: Conference Series*, *1227*(1). https://doi.org/10.1088/1742-6596/1227/1/012030

Tashiro, J., Parga, D., Pollard, J., & Talanquer, V. (2021). Characterizing change in students' self-assessments of understanding when engaged in instructional activities. *Chemistry Education Research and Practice*, *22*(3), 662–682. https://doi.org/10.1039/d0rp00255k

Tsaparlis, G., Pantazi, G., Pappa, E. T., & Byers, B. (2021). Using electrostatic potential maps as visual representations to promote better understanding of chemical bonding. *Chemistry Teacher International*, *3*(4), 391–411. https://doi.org/10.1515/cti-2021-0012

Tsaparlis, G., Pappa, E. T., & Byers, B. (2019). Proposed pedagogies for teaching and learning chemical bonding in secondary education. *Chemistry Teacher International*, *2*(1), 1–14. https://doi.org/10.1515/cti-2019-0002

Wrahatnolo, T., & Munoto. (2018). 21St Centuries Skill Implication on Educational System. *IOP Conference Series: Materials Science and Engineering*, *296*(1). https://doi.org/10.1088/1757-899X/296/1/012036