Project-based *Digital Science Module* (*DSM*): An Analysis of Students' Self-regulated learning and Scientific Writing Ability

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Article

Project-Based *Digital Science Module* (*DSM*): An Analysis of Students' Self-Regulated Learning and Scientific Writing Ability

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Abstract: The purpose of this study is to analyze the self-regulated learning and the ability to write scientific papers of students after learning with the Project-Based *Digital Science Module* (*DSM*). This research is a mixed methods by analyzing quantitatively and qualitatively. The research instrument used to obtain data is using a product assessment sheet and a self-regulated learning questionnaire. Data analysis uses N-Gain to determine the increase in self-regulated learning scores and student scientific writing skills scores, and uses linear regression analysis to determine the effect of self-regulated learning on student scientific writing skills. The results obtained showed N-Gain score of learning independent is 0,65 and scientific writing ability is 0,94, then significant's score from linear regression by using SPSS is 0,22 < 0,05. This result showed an increase in self-regulated learning and the ability to write scientific papers of students on each indicator after learning using the Project-Based *Digital Science Module* (*DSM*). In addition, based on the results of data analysis, it can be seen that there is an influence of self-regulated learning on the ability to write scientific papers of students after learning using the Project-Based *Digital Science Module.*

Keywords: digital module; self-regulated; writing ability

1. Introduction

Higher education is a further process after secondary education to provide provisions for students to become the spearhead in improving community development. (Crawford et al., 2020; O'Flaherty & Phillips, 2015). In higher education, students need to have academic abilities and be skilled in using and developing knowledge. One important part of the academic field that will always be related to students is scientific work. Scientific papers are writings resulting from the study of a problem by a certain person or group with scientific rules and rules that have been agreed upon in the fields of science and technology (Behzadi & Gajdács, 2021; Grech, 2017). Scientific work is an important part of the world of higher education because every student who is actually an academic is required to produce work created from their own ideas on a problem, so it is important for students to have the ability to write scientific papers in order to contribute to improving community development in the academic field. The ability to write is actually an independent ability that must be owned by each student. So, to gain the ability to write scientific papers, the self-regulated learning of each student is needed.

The ability to write scientific papers is an independent ability possessed by students to express their ideas in written form using their reasoning objectively, critically, and rationally (Grech & Cuschieri, 2018; Santesteban-Echarri & Núñez-Morales, 2017). By having the ability to write scientific papers, students are expected to be able to produce works in the form of books, journals, proceedings, and other scientific works that can contribute directly to society where the work produced provides useful new information. By having the ability to write scientific papers, a student can get to know their potential, expand their knowledge horizons, and have more orderly and standardized grammar. However, in reality, writing scientific papers is still not a habit for students and has not become a

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culture. This can be seen from the phenomenon that occurs, namely that students voice their opinions more through speaking than through scientific papers. In addition, it can also be seen that the low interest of students in participating in scientific writing competitions and the lack of scientific work by students published in the form of journals, proceedings, and books (Sari et al., 2021; Sulaiman & Muhajir, 2019). For this reason, a learning strategy component is needed that can instil the ability to write scientific papers in students.

Science education students are students who are prepared to become prospective science teachers. Various forms of abilities must be possessed by science education students, one of which is the ability to write scientific papers. Based on the results of preliminary interviews conducted on 15 randomly selected science education students, it was found that students preferred to get oral discussion assignments compared to writing scientific papers, tasks related to writing scientific papers felt heavier, and students felt they did not have sufficient ability to write scientific papers. The ability to write scientific papers is an ability that students must have independently, because the demand to produce scientific papers is a demand for each student. For this reason, one of the teaching materials that can be used so that students can learn independently is a module.

Modules are learning packages that contain a series of materials that are arranged so that users can use them independently (Bond et al., 2018). With the use of modules, the learning objectives to be achieved can be inserted in the form of content and instructions, making it very suitable for students to instil self-regulated learning (Logan et al., 2021). According to (Harianto et al., 2017) modules can be printed or digital. However, along with the development of the curriculum, learning is often carried out both inside and outside the classroom, so the use of modules in digital form is expected to have a better impact on the learning process. In addition, with a digital form, the module can be used both on laptops and *smartphones* so that students can use it whenever needed. (Banowati et al., 2019; Martono & Nurhayati, 2014; Subhanul Qodr et al., 2021).. On the other hand, as the digital world continues to develop, the use of *smartphones* sometimes becomes an obstacle to learning activities because the portion of its use is mostly used to play *online* games and interact in social media. Thus, digital modules are expected to be a solution to overcome these problems as well as to instil the ability to write scientific papers in science education students.

Science learning is learning that is very close to the scientific approach (Hirzi & Gazali, 2020). The learning steps in the scientific approach are often associated with project-based learning, because in project-based learning students not only become learners but also students become researchers (Kokotsaki et al., 2016). , Thus, the ability to write scientific papers can be more honed with project-based learning. This is in line with research which states that project-based learning can improve the ability to write scientific papers (Suteja & Setiawan, 2022; Wardani et al., 2020). For this reason, learning using digital modules can be combined with project-based learning so that students get independent learning experiences and get better scientific writing skills. Based on the advantages of digital modules and project-based science learning, researchers use project-based *Digital Science Modules* (*DSM*).

Project-based *Digital Science Module* (*DSM*) is a digital learning package that contains material and a series of instructions for conducting research projects and producing scientific work(Harianto, 2023). The research project in this module is related to science material in lectures. Project-based DSM research has never been done before. In addition, this research was first conducted at the higher education level, namely students. So it is important to conduct a study on the ability to write scientific papers of students using project-based digital science modules. Based on the previous explanation, the focus of this research is the analysis of self-regulated learning and the ability to write scientific papers of students using project-based *Digital Science Module* (*DSM*).

2. Materials and Methods

This research uses a type of *mixed methods* research, which is a series of studies consisting of steps to collect, analyze, and combine quantitative and qualitative designs to be used together (Creswell, 2014). And containing. The strategy used is a Sequential Explanatory with steps to analyze quantitative data followed by collecting and analyzing qualitative data (Subedi, 2016). analyze.

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Quantitative methods in this study were used to analyze the improvement of students' scientific writing skills before and after learning using the project-based *Digital Science Module* (*DSM*), as well as measuring students' self-regulated learning and learning motivation. Qualitative methods were used to describe self-regulated learning and describe the ability to write scientific papers in terms of student self-regulated learning.

The subjects of this study were Science Education students in the third semester of the 2023/2024 academic year. The sample was selected using *purposive sampling* with certain predetermined criteria. The total sample obtained in this study was 24 students. The instrument used to measure the ability to write scientific papers is a product assessment sheet adopted from the guidelines for writing scientific papers (Clabough & Clabough, 2016). With indicators in the assessment sheet, namely; skills to express ideas or ideas, skills to organise these ideas or ideas, skills to apply grammatical and syntactic patterns, skills to choose structures and vocabulary, and skills to use language graphic conventions. The instrument to obtain data on self-regulated learning is using a questionnaire with indicators of being responsible, active and creative, able to solve problems, continuity in learning, and self-management in learning. organize. Product assessment sheets and self-regulated learning questionnaires were conducted before and after learning using project-based DSM. The data obtained is then processed into a percentage score and then analyzed.

The analysis technique in this research is quantitative and qualitative analysis. Quantitative data analysis using *N-Gain* test and linear regression analysis. N-Gain test analysis is used to determine the average increase in self-regulated learning scores, while linear regression analysis to determine the effect of student self-regulated learning on the ability to write scientific papers. linear regression test was conducted after the instrument was declared valid and reliable. The validity test was carried out using the Pearson product moment validity test, while the reliability test used the Cronbach alpha reliability test. While qualitative data analysis uses an interactive model with 3 activities namely reduction, data presentation, and conclusion drawing.

3. Results

The research data obtained are data obtained before and after learning using project-based DSM. The data obtained is then processed and recapitulated into 3 tables, namely the average score of the ability to write scientific papers for each indicator, the *N-gain* score of self-regulated learning and the ability to write scientific papers, the results of the Spss linear regression test of the relationship between self-regulated learning and the ability to write scientific papers.

Table 1. Average Score of Self-regulated learning Before and After Learning.

Indicators	Pre-Test	Post-Test
S1	45,68	75,15
S2	61,45	83,4
S3	54,38	79,12
S4	44,42	76,38
S5	55,72	76,16

Table 1 shows that each indicator of self-regulated learning has changed after learning using project-based DSM symbolized by S1 to S5. S1 is an indicator of responsibility in learning, S2 is an active and creative indicator, S3 is an indicator of being able to solve problems, S4 is an indicator of continuity in learning, and S5 is an indicator of self-management in learning. The highest average score after learning is on active and creative indicators, while the lowest is on self-management indicators in learning.

Table 2. Average score of scientific writing ability of each Indicator.

Indicators	Pre-Test	Post-Test
I1	35,6	76,0

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I2	39,8	76,0
I3	37,5	74,4
I4	38,4	78,7
I5	34,5	77,2

Based on Table 2, it can be seen that each indicator has changed after learning using project-based DSM symbolized by I1 to I5. I1 is the skill of expressing ideas, I2 is the skill of organising ideas, I3 is the skill of applying grammatical and syntactic patterns, I4 is the skill of choosing structures and vocabulary, and I5 is the skill of using graphic language conventions. The highest score after learning is on the skill indicator of choosing language structure and the lowest score after learning is on the indicator of applying grammatical and syntactic patterns.

Table 3. N-Gain Score of Self-regulated learning and Scientific Writing Ability.

Variables	Score	Minimum Value	Maximum Value	Average Value
Self-regulated learning	**Pretest**	44	65	52,33
	Posttest	73	91	78,04
	N-Gain	0,5	1	0,65
Scientific Writing Skills	**Pretest**	29,4	46,7	37,17
	Posttest	72	81	76,45
	N-Gain	0,8	1	0,94

Based on Table 3, it can be seen that the N-Gain score of self-regulated learning and the ability to write scientific papers of students. The lowest N-Gain score of student self-regulated learning is 0.5, the highest score is 1, while the average N-gain score of self-regulated learning is 0.65. The lowest N-Gain score of students' scientific writing ability is 0.8, the highest score is 1, while the average N-gain score of self-regulated learning is 0.94.

Table 4. Validity Test Results of Self-regulated learning Instrument.

Item Quetsion	Sig.	Criteria
X1	0,041	Valid
X2	0,001	Valid
X3	0,001	Valid
X4	0,001	Valid
X5	0,001	Valid
X6	0,005	Valid
X7	0,000	Valid
X8	0,021	Valid
X9	0,001	Valid
X10	0,001	Valid
X11	0,001	Valid
X12	0,015	Valid
X13	0,001	Valid
X14	0,001	Valid
X15	0,001	Valid

The results of the validity test of the self-regulated learning instrument are the results of the Pearson product moment analysis on the pre-test results of the self-regulated learning questionnaire using *SPSS software*. Based on Table 4, all question items have a significance value of less than 0.05, which according to three included in the valid category. Question items X1, X2, and X3 are questions related to responsible indicators, Question items X4, X5, and X6 are questions related to active and creative indicators. Question items X7, X8, and X9 are questions related to the indicator of being able to solve problems. Question items X10, X11, and X12 are questions related to indicators of continuity

 doi:10.20944/preprints202312.0141.v2

in learning. Question items X13, X14, and X15 are questions related to indicators of self-management in learning. So the self-regulated learning questionnaire instrument is valid to be used to collect further data which in this study is used to collect data on student self-regulated learning after learning using project-based DSM.

Table 5. Reliability Test Results of Self-regulated learning Questionnaire Instrument.

Reliability Statistic		
Cronbach's Alpha	N of Items	Criteria
0,716	15	Reliable

The results of the reliability test of the self-regulated learning questionnaire instrument are the results of Cronbach alpha analysis on the results of taking data from the self-regulated learning questionnaire before learning using *SPSS software.* In Table 5 the Cronbach's Alpha value is 0.716 and greater than 0.7 which according to (Kennedy, 2022; Mohamad et al., 2015; Taber, 2018; Wadkar et al., 2016)included in the reliability criteria. So the self-regulated learning questionnaire instrument is reliable and can be used to collect further data which in this study is used to collect data on student self-regulated learning after learning using project-based DSM. Based on Table 3 and Table 4, it is known that the self-regulated learning questionnaire instrument is valid and reliable to use, so the data results obtained can be used for classical assumption analysis.

Table 6. Results of the Validity Test of the Product Outcome Assessment Sheet Instrument.

Item Quetsion	**Sig.**	**Criteria**
Y1	0,034	Valid
Y2	0,017	Valid
Y3	0,021	Valid
Y4	0,001	Valid
Y5	0,001	Valid
Y6	0,001	Valid
Y7	0,000	Valid
Y8	0,012	Valid
Y9	0,001	Valid
Y10	0,001	Valid
Y11	0,001	Valid
Y12	0,001	Valid
Y13	0,027	Valid
Y14	0,001	Valid
Y15	0,001	Valid

The results of the validity test of the product assessment sheet are the results of Pearson product moment analysis on the results of the product assessment data before learning using *SPSS software*. Based on Table 6, all question items have a significance value of less than 0.05, which according to (Hidayati et al., 2023; Wijaya & Kloping, 2021) included in the valid category. Assessment items Y1, Y2, and Y3 are assessments related to indicators of skills in expressing ideas or ideas, Question items Y4, Y5, and Y6 are questions related to indicators of skills in organising ideas or ideas. Question items Y7, Y8, and Y9 are questions related to the skill indicators of applying grammatical and syntactic patterns. Question items Y10, Y11, and Y12 are questions related to the indicators of skills in choosing structures and vocabulary. Question items Y13, Y14, and Y15 are questions related to the skill indicators of using language graphic conventions. So the instrument of the product assessment sheet is valid to be used to collect further data which in this study is used to collect data on student self-regulated learning after learning using project-based DSM.

Table 7. Reliability Test Results of Product Result Assessment Sheet Instrument.

 doi:10.20944/preprints202312.0141.v2

Reliability Statistic		
Cronbach's Alpha	N of Items	Criteria
0,825	15	Reliable

The results of the reliability test of the product assessment sheet instrument are the results of Cronbach alpha analysis on the results of data collection of the product assessment sheet before learning using *SPSS software.* In Table 7 the Cronbach's Alpha value is 0.825 and greater than 0.7 which according to (Kennedy, 2022; Mohamad et al., 2015; Taber, 2018; Wadkar et al., 2016)included in the reliability criteria. So the product assessment sheet instrument is reliable and can be used to collect further data which in this study is used to collect data on students' scientific writing ability after learning using project-based DSM. Based on Table 6 and Table 7, it is known that the product assessment sheet instrument is valid and reliable to use, so the data results obtained can be used for classical assumption analysis. Analysis of classical assumptions in this study is a linear regression analysis between data on self-regulated learning and data on the ability to write scientific papers of students. The results of the linear regression test using SPSS on the relationship between self-regulated learning and the ability to write scientific papers can be shown in the following table

Table 8. Model Summary.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.466	0.217	0.181	2.032

a. Predictors: (Constant), Self-Regulated Learning.

Table 9. *ANOVA.*

Model	Sum of Square	df	Mean Square	F	Sig.
Regression	25.134	1	25.134	6.088	0.022
Residuals	90.825	22	4.128		
Total	115.958	23			

a. Dependent Variable: Scientific Writing Ability; b. Predictors: (Constant), Self-regulated learning.

Table 8 and Table 9 are the results of processing linear regression test data using *SPSS software*. In the Model Summary table, the R value is 0.466 and the R Square value is 0.217. In the ANOVA table, the significance value is 0.022. From the data from the SPSS test results, it can be analysed the effect of self-regulated learning and the ability to write scientific papers.

4. Discussion

The study results presented show that the value of the competency indicators of students' science literacy skills increased in each aspect. The highest average value is in the indicator of choosing language structure. This is because in the project-based DSM module students at the beginning of the learning step are instructed to read the material and read at least 10 journals related to the material and are asked to analyze both in terms of language and sentence structure. The results of this study are in line with the opinion of (Bennett & Taubman, 2013; Dehaene et al., 2015; Peng et al., 2018) which states that students can understand and choose sentences to be poured into writing after reading some literature. The lowest average score is on the indicator of applying grammatical and syntactic patterns. This is because grammatical and syntactic patterns are writing skills that must be continuously trained to get better. This is in accordance with the opinion of (Fani Prasetia et al., 2022; Pinto-Llorente et al., 2017), which states that mastery of language grammar is something that can be mastered after repeated practice and is not an instant process. Although the score on the indicator of applying grammatical and syntactic patterns is the lowest compared to other indicators,

 doi:10.20944/preprints202312.0141.v2

the average score on this indicator has increased after going through the learning process using project-based DSM and is included in the good category.

The interesting results of the average score of the ability to write scientific papers for each indicator are that there are two indicators with the same value and are included in the good category, namely the skill of expressing ideas and the skill of organising ideas. The two skills are interrelated because they are in the realm of ideas that each student has. These two skills are obtained by students through project-based DSM, namely in the instruction process of analyzing abstracts, gab research and novelty contained in a journal. So that by knowing the gab research or problem and the value of novelty or novelty from a research result in a journal, students are trained to get ideas. This is in accordance with the opinion of (Ah-Nam & Osman, 2017; Sundayana et al., 2017) which states that to sharpen one's ideas, one must train to make ideas with the experience gained.

Based on the *N-gain* score of self-regulated learning and scientific writing ability, it can be seen that there is an overall improvement. Students' self-regulated learning increased with a moderate category after learning using project-based DSM. This is because the use of modules which are learning packages can make students independent in learning. This is in accordance with the results of research (Ikhwanuddin et al., 2018; Stoeger et al., 2015) which states that learning using modules can foster students' self-regulated learning. In addition, modules are also easier to adapt to the material to be taught (Farihah et al., 2021). This project-based DSM is in the form of digital teaching materials so it can be used more flexibly anytime and anywhere. The use of this more flexible media allows students to learn more independently. This is supported by the facts of the research results (Angga Rini & Selfi Cholifah, 2020; Culajara et al., 2022)which states that there is an increase in students' self-regulated learning after learning using digital modules because digital modules can be used more flexibly.

The results of this study also present the results of the analysis of the effect of student self-regulated learning on the ability to write scientific papers of students. This is done because in various studies the module is always associated with self-regulated learning, so in this study it is also necessary to know its effect on the ability to write scientific papers. Based on the results of data analysis using *SPSS software, the* significance result is 0.022 which is smaller than the probability value of 0.050. This result shows that there is an influence of self-regulated learning on the ability to write scientific papers of students after learning using project-based DSM. Based on the R square value, the influence of student self-regulated learning on the ability to write scientific papers is 21.7%. This influence is obtained because this project-based DSM is an independent learning package designed so that students can conduct research projects and put them into the form of scientific papers. this is in line with the opinion of (Hasani et al., 2017; Praba˙et al., 2018; Zakiyah Ismuwardani et al., 2019) which states that students need to be given learning projects in order to be able to research and pour it into writing.

Qualitatively, student self-regulated learning can be categorized as moderate and high. In the self-regulated learning of students in the moderate category, the majority of the ability to write scientific papers is high in the indicator of expressing ideas or ideas while in the self-regulated learning of students in the high category, the majority of the ability to write scientific papers is high in the indicator of applying grammatical and syntactic patterns. This shows that the higher the self-regulated learning of students, the better in expressing ideas in the form of sentences with good grammar. This is in accordance with the opinion of (Mohammed Al-Mekhlafi, 2011; Yalçln & Spada, 2016) which states that writing sentences in accordance with proper grammar requires continuous independent practice.

This project-based DSM research is a new research that certainly has obstacles in its implementation. One of the obstacles in implementing learning with project-based DSM is the relatively longer time required because each student is required to conduct research and put the results of their research into writing. However, this obstacle can be overcome by changing the research with mini research conducted in groups. Because with a group of students can divide tasks and make research more effective and efficient. This is in line with the opinion of (Kirschner et al., 2009; Takači et al., 2015; Vasan et al., 2011) who stated that by working in groups, the implementation

 doi:10.20944/preprints202312.0141.v2

of tasks becomes more effective and efficient. In addition to mini research and group work, the obstacles in this study can be overcome by suggesting research in the form of literature review research so that the time required is shorter and more focused on literature searches.

5. Conclusion and Implication

Based on the results and discussion previously presented, it can be concluded that learning with project-based DSM can increase students' self-regulated learning and ability to write scientific papers. In addition, student self-regulated learning affects the ability to write scientific papers of students after learning using project-based DSM. The obstacles that occur in this research can be overcome by carrying out mini research in groups and directing research to literature study research. With the results of this study, it is hoped that there will be further development of project-based DSM and can be used for research on more complex material concepts.

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