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Utilization of PjBL-STEM Based Interactive e-modules to Improve Visual Literacy: Teacher and Student Perspectives

Dini Andriani[1], Marina Setyarini[1*], Dewi Lengkana[1], Kartini Herlina[1]

[1] Department of Science Education, University of Lampung, Bandar Lampung, Indonesia

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Corresponding Author:
M.Setyarini
m.setyarini@fkip.unila.ac.id

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Abstract: This research aims to describe the use of interactive e-modules based on PjBL-STEM activities to train students' visual literacy. This research uses mixed methods with *sequential explanatory design* to obtain quantitative and qualitative data. Quantitative data was obtained by administering questionnaires to 39 science teachers in Lampung province and 149 junior high school students and qualitative data was obtained from interviews with teachers. The research results show as many as 41.70% of teacher respondents were new to using e-module teaching materials. The e-module they use is not yet interactive and the activities in the e-module do not invite students to carry out projects. The results of the teacher questionnaire were only 15.3% of teacher respondents using the PjBL learning model. As many as 74.5% of teacher respondents stated that the e-modules used had not been used to train students' visual literacy. The results of the questionnaire and interviews of teachers responded positively to the existence of teaching materials that can train students' visual literacy.

Keywords: interactive e-modules, PjBL-STEM activities, visual literacy.

Introduction

Development in the 21st century have implications for information and communication technology. One of the impacts of technology that plays a role in learning is visual-based media. Various visual media have emerged with the dominance of images and messages that are conveyed very clearly. Visual media in various forms enters every area of human life and becomes an inseparable and inevitable part (Supsakova, 2020), including in the learning context. Learning resources such as textbooks, guidebooks, class presentations, and the latest educational technology are filled with various visual forms (Aulia & Pamelasari, 2016; Wusqo *et al*., 2021). Forms of visual representation such as images range from realistic photos, diagrams, graphs, to abstract images (Chyleńska & Rybska, 2019; Quillin & Thomas, 2015). On the other hand, concerns arise when students lack visual literacy. Students can see and read images, but cannot interpret and create images, or conversely students can create video clips but cannot create story scripts (Duchak, 2014). The results of research conducted by Susiyawati and Treagust, (2021) show that students experience difficulties in interpreting, understanding and creating visualizations from photos presented in plant anatomy material. Therefore, students need to develop skills to communicate by creating and utilizing various visual forms, namely visual literacy (Lundy & Stephens, 2015).

Visual literacy helps students to show how to learn from images to understand concepts, images, and visual thinking, especially in science (Güney, 2019).

Students who have visual literacy are more critical in analyzing, interpreting, and understanding what they see (Damayana *et al*., 2018; Kędra & Žakevičiūtė, 2019). Students' skills in the 21st century need to be improved, so meaningful activities are needed so that the results meet expectations. Once learning model that can be used is *Project Based Learning* (PjBL). Learning using PjBL asks students to collaborate through in-depth interactions, conduct research, and create projects. This can be done by combining various students' knowledge and skills as well as the use of technology that influences complex problem-solving (Gary, 2015). In implementing

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the PjBL model, it can be assisted by a STEM approach that helps students integrate across disciplines for problem-solving (Aini *et al*., 2022)

Learning with PjBL-STEM can improve HOTS literacy skills, one of which is visual literacy. Research on PjBL-STEM has been carried out previously, including by Panggabean *et al*., (2021) stated that students were asked to create a visual image to explain the concept of static electricity. This is in line opinion with Li *et al*., (2021) which states that students are required to use the information they collect to apply it in developing models designed using symbols, arrows, labels, or other forms of representation. Furthermore, Jones, (2019) explained that project learning activities at the communication stage in making a product carried out by students can be presented in various forms of artifacts to be shared with the public.

Science learning currently emphasizes understanding, *skill,* and student character education. The efforts to maximize the science learning process to run well are not only supported by an appropriate learning system but require adequate learning resources and materials, and interesting media. One effort that can be made by using teaching materials that suit current needs is in the form of modules. The module contains directions and instructions so that it can help students learn independently (Purwanto *et al*., 2020), and can be adjusted to the speed of understanding according to the level of ability of each student (Padwa & Erdi, 2021). With the development of the current technological era, modules that are usually in printed form are now presented in electronic and interactive form, namely electronic modules (e-modules). The e-module includes images and animations *flash*, and videos, as well as interactive quizzes that can provide feedback, which will make students enthusiastic about learning (Karnia *et al*., 2022; Sintawati & Margunayasa, 2021).

The use of e-modules as learning media can facilitate independent and flexible learning and can be integrated with various conditions. Moreover, its use can increase student involvement in learning so as to create an effective and relevant learning environment in the digital era including in PjBL-STEM-based science learning. At junior high schools in Lampung Province, not all schools implement PjBL-STEM-based learning using e-modules while their usefulness helps students to master the material. The non-use of e-modules in all schools in Lampung Province is due to limited internet access or lack of digital learning support for students. On the other hand, e-modules require technology because they are online-based with relevant digital tools. This situation shows that it is necessary to further study the importance of using e-modules based on PjBL-STEM activities in Lampung Province, precisely at the junior high school level.

Research that examines PjBL-STEM activity-based interactive e-modules includes: Agung *et al*.,(2022) concluded that the science e-module with STEM-PjBL is very valid, practical, and effective for use in learning to improve student learning outcomes. Apart from that, the application of the PjBL-STEM e-module can improve students' creative thinking abilities and learning motivation (Millen, 2023). Research conducted by Wandani *et al*., (2023) stated that PjBl-STEM-based e-modules can improve students' mathematical communication skills. However, there has been no research that examines interactive e-modules based on PjBL-STEM activities to improve students' visual literacy.

Therefore, this research was conducted to describe the use of interactive e-modules based on PjBL-STEM activities to improve students' visual literacy.

Method

The participants in this research consisted of 39 science teachers and 149 junior high school students for the 2022/2023 academic year. This research uses an adapted mixed method (Creswell & David, 2018) with strategy *sequential explanatory design* which combines two stages of data collection, namely the first stage collecting quantitative data, analyzing the results, and the second stage collecting qualitative data through interviews. First, researchers conducted a literature study by analyzing interactive e-modules, learning with PjBL-STEM activities, and visual literacy. Then the researchers developed a needs analysis instrument in science learning, especially mixed separation material. Next, the questionnaire was distributed to 39 science teachers and 149 students. Quantitative data was obtained by filling out a questionnaire that had been developed by researchers and distributed via *google form*. The questionnaire results were analyzed by grouping the answers based on the questionnaire statements, and giving scores to the answers according to the scoring criteria, calculating the percentage score using the Formula 1 (Sudjana, 2005).

$$\%Jin = \frac{\sum Ji}{N} \times 100\ \% \quad (1)$$

Information:
$\%\ J_{in}$ = Percentage of answer choices-i
$\sum J_i$ = Number of respondents who answered answer-i
N = Number of all respondents

After analyzing the results of the questionnaire continued with qualitative research, where three of the 39 science teachers were selected for further interviews

after being given a questionnaire taking into account their written responses. Figure 1 is a schematic of the research design in this study.

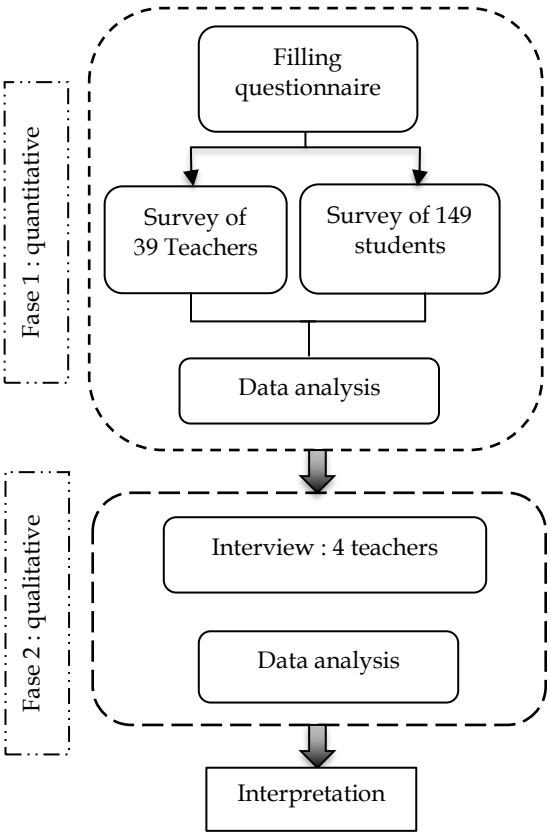

Figure 1. Research design scheme

Figure 2. Research Activities

Research activities were carried out by distributing questionnaires to students through google form and interviewing teachers related to interactive e-modules, PjBL-STEM activities, and visual literacy.

Result and Discussion

This section presents research findings and discussion based on the data collection and analysis carried out. The results of distributing questionnaires to 39 teachers are shown in Table 1, while the results of distributing questionnaires to 149 students are shown in Table 2.

Table 1. Result of Interpretation of Teacher's Perception Questionnaire

Question	Percentage (%)	
	Yes	No
Using teaching materials in learning mixture separation material	100	0
Using modules in learning	30.8	69.2
The module used by the teacher is already in the form of an e-module	41.7	58.3
there is a real phenomenon/problem on the e-module for mixed material separation	66.7	33.3
Using learning models in mixed separation material	100	0
Providing project assignments in learning	20.5	79.5
At the beginning of learning, the activity is to identify a problem	46.1	
Implement literature study activities and relevant information	38.5	
Applying activities to connect problems and information obtained to create product/solution designs	25.6	
Implement test activities for products/solutions created	15.4	
Implement presentation activities related to the solutions created	17.9	
The e-module used trains visual literacy	25.5	74.5
It is necessary to develop PjBL-STEM based interactive e-modules for visual literacy	92	8

Based on the survey results, Tabel 1 shows that all teachers in delivering learning materials, especially mixed separation, have used teaching materials. The teaching materials used by teachers in learning include printed books, student worksheet, modules, and internet sources to support the learning process. Printed books, student worksheet, and internet sources are widely used by teachers compared to modules, this is because these teaching materials are easier to find and access by teachers and students. As many as 30.8% of teacher respondents who chose the module said that the module helped them in their learning because it added a reference source for students, especially on material that was not found in books or the internet. The modules used by teachers can be adapted to the school environment, and provide more science content and activities in different ways so that students read more and practice scientific literacy for students (Angkowati *et al.*, 2018; Hsin & Wu, 2023). Part from that, according to teachers, using the module also helps them evaluate students' understanding because it contains practice questions. This is in line with the results research review of Yuliani *et al.*, (2021) which shows that the use of modules in learning can increase students' understanding, where to measure the level of

understanding students can use exercises and writing papers in the module.

Table 2. Result of Interpretation of Student's Perception Questionnaire

Question	Percentage (%)	
	Yes	No
Does the teacher apply various methods of learning?	81.2	18.8
Have you ever been assigned to create a tool on Mixture Separation material?	35.1	64.9
Does the teacher use interactive e-modules when teaching mixed separation material?	39.1	60.9
Does the e-module used contain discourse which is then assigned to convert information from reading into image form?	31.1	68.9
Does the e-module used contain two or more images and then you are asked to differentiate them?	36.5	63.5
Is the e-module used, students are assigned to observe and understand images?	39.2	60.8

Table 3. Teacher Interview Results

Question	Answer
What do you know about interactive e-modules?	Only the module is in digital form, which can be accessed via a computer or laptop. Teaching materials that can be accessed easily through electronic media which include images, animations, audio, and interactive quizzes. An interactive teaching material that provides feedback to users, can be accessed via electronic media.
What do you think about learning using interactive e-modules?	Very helpful. Digital interactive e-modules are more practical and also more interesting because they contain images, videos or animations. I have used it, especially during the Covid-19 pandemic. Very helpful because it makes it easier for teachers and students. However, the e-module used is not equipped with an interactive quiz, there are only images and video links for supporting material that can be accessed on the internet. The use of e-modules is quite practical, and easy to access, especially now that many gadgets are sophisticated.
What activities do you provide using PjBL-STEM?	Presents problems related to the separation of mixtures; discuss and carry out simple practices of separating mixtures with economical tools and materials; writes down what they observe; students are asked to present the results of their discussions and practices. Carrying out experiments; students make observations and process data; discuss in groups; prove the experiment; conclude, Determine fundamental questions, design project plans, test results, evaluate experience
What do you know about visual literacy?	Visual literacy is a person's ability to read and interpret images. the ability to understand, analyze, and interpret images or visual media with a deep understanding a person's ability to convert information into a visual form or vice versa.
Do you agree that an interactive e-module based on PjBL-STEM activities was developed to train visual literacy?	Agree, because the multimedia added to the e-module raises student interest and participation in learning with PjBL-STEM activities I agree because it can support student involvement in learning

Along with the development of communication and information technology, modules can be presented in digital form and equipped with text, images, videos and interactive quizzes. e-module is a module packaged in electronic or digital form that contains various interactive media (Asrizal *et al*., 2022; Sidiq & Suhendro, 2021). In practice, 41.66% of teachers have used e-modules. Even though the module used is in digital form, the results of further interviews mean that the e-module is not yet equipped with images, video, audio, animation, and interactive quizzes simultaneously, so the e-module used is not yet interactive. Teachers stated that it was difficult to find interactive e-modules on internet sources, apart from that, some teachers felt that additional efforts and adjustments were needed in using technology so teachers preferred to use conventional teaching methods, namely lectures. In fact, the us of technology-based media such as e-modules which can be accessed via smartphone or laptop is a form of innovation carried out by teachers to attract students' interest in learning. Students are interested in learning because the forms of learning are more varied (Darmaji *et al*., 2020). The research conducted (Christina Ismaniati & Baroroh Iskhamdhanah, 2023; Kadek *et al*., 2021; Sintawati & Margunayasa, 2021) stated that the use of

interactive e-modules in learning can increase student motivation.

As many as 74.5% of teacher respondents who used e-modules had not trained in visual literacy. This is because the e-modules currently used by teachers are more focused on delivering the main content or lesson material and do not add visual elements. Most people still tend to think in words rather than using visual images (Stokes, 2002). Apart from that, they felt that students would have difficulty converting information into visual form and this activity would require relatively more time. Visual literacy is defined as the ability to understand, use, think, and learn using images (Ratheeswari, 2018). There are eleven indicators of visual literacy (Avgerinou, 2009), including the visual literacy indicators measured, namely visual thinking, visualization, visual discrimination, and visual reasoning. The results of the percentage of teachers who have trained each visual literacy indicator can be seen in the graph in Figure 3.

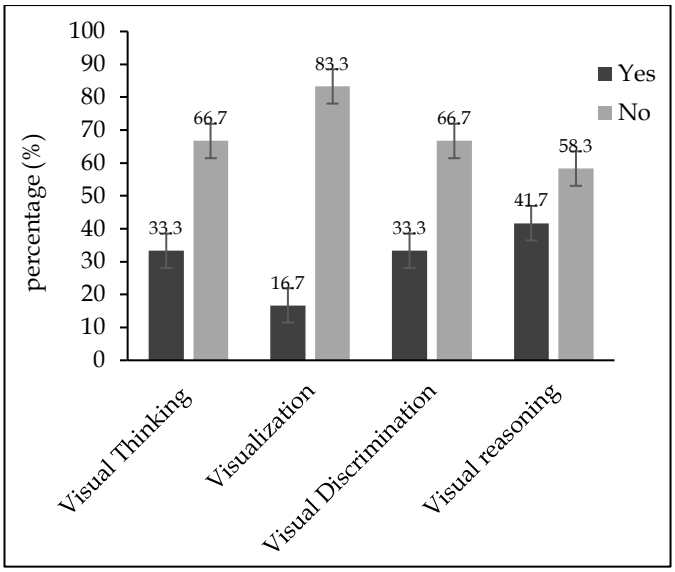

Figure 3. Percentage of visual literacy indicators

The graphic results show that of the four visual literacy indicators, the visualization indicator is the one that teachers train the least. According to Thronton in Mudaly & Rampersad,(2010) the decline in visualization is due to the dominance of traditional teaching methods compared to approaches that use verbal logic to emphasize logical and sequential steps in solving problems and computing in teaching.

In science learning, especially mixed separation material, as many as 66.7% of teacher respondents stated that they had presented real phenomena or problems in the e-modules used during their learning to students. Based on open questions, the teacher presents problems such as sulfur mining in the Ijen crater, salt-making process, and river pollution due to waste such as detergent waste, bleach waste, and other household waste. However, teachers have not followed up on the real phenomena or problems they present to students with learning in the form of projects to find designs and solutions. Seen79.5% of teacher respondents have not carried out project assignments, they prefer to give assignments such as working on practice questions, asking children to make presentations regarding mixture separation material, or carrying out simple experiments. These results are also supported by data from the use of learning models by those who support project learning which is still little used by teachers, namely learning models *Project Based-Learning* (PjBL). According to Latifah *et al*., (2020) this is because teachers need understanding and skills in implementing this model, and the time required is relatively long, and adequate facilities are required. The percentage of use of learning models by teachers can be seen in Figure 4.

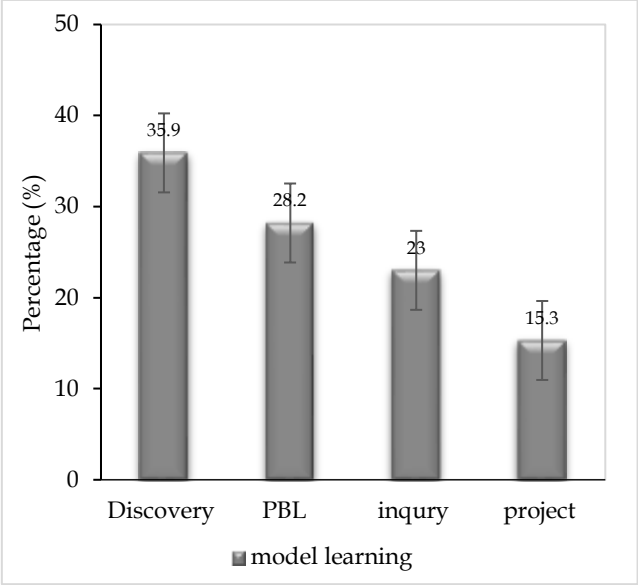

Figure 4. Percentage of learning model selection

Model *project based learning* involves students in contextual problems that exist in the real world and allows them to find solutions with the knowledge they already have or will acquire (Juuti *et al*., 2021). To overcome this problem, this learning model is often combined with a STEM approach. PjBL-STEM learning consists of five learning stages, namely *reflection, research, discovery, application*, and *communication* (Laboy-Rush, 2011). However, in practice teachers have not implemented activities that are in accordance with the PjBL-STEM learning syntax. This is shown in Figure 5.

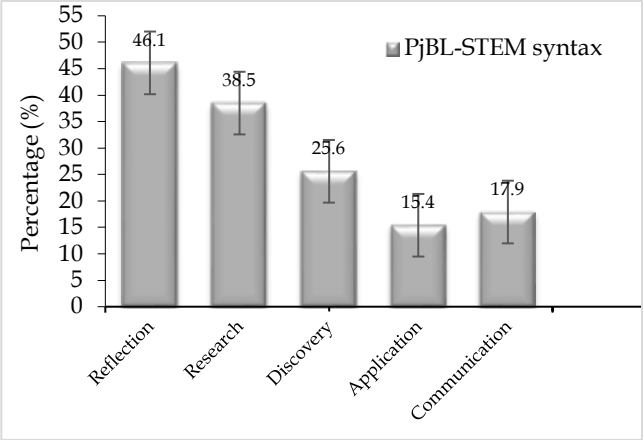

Figure 5. Percentage of PjBL-STEM activity

Based on Figure 5 above, it shows that the activity tendencies in each PjBL-STEM syntax are not the same. Based on further interviews, the teacher missed activities that had to be carried out in the syntax, for example the teacher did not carry out activities in the syntax *application* for testing products/solutions created by students.

Further analysis of the results distributed questionnaires to 149 students which were used to strengthen the teacher questionnaire data shown in Table 2. Student responses to the use of electronic learning resources such as interactive e-modules showed that 60.9% of student respondents stated that teachers did not use interactive e-modules during learning, and as many as 39.1% of students stated that they had used interactive e-modules. The e-module given by the teacher mostly contains material and practice questions, while there are very few images and animations in the e-module. Furthermore, data from student questionnaires regarding the application of learning methods shows that teachers have used various learning methods in mixed separation material, such as lecture methods, demonstrations, experiments and project assignments. However, the project activities given by teachers to students are not optimal. As many as 64.9% of students stated that they had not been given the task of making a tool that is used to solve problems in life. The problems presented in project activities are problems and needs that must be resolved in everyday life (Hendriyani *et al.*, 2020). Project activities through PjBL-STEM activities provide benefits for students in understanding concepts through meaningful learning (Rahmania, 2021).

Furthermore, based on Table 3, the results of interviews conducted with three science teachers regarding the use of interactive e-modules, PjBL-STEM learning activities, and visual literacy show that the teachers already know about interactive e-modules. Interactive e-modules that teachers know are digital teaching modules that can be accessed via a computer which include images, animations, and interactive quizzes that can provide feedback to users. The use of e-modules that contain interactive multimedia provides a reading and learning experience for users and can raise enthusiasm because the information presented is not static (Febriani & Kustiyono, 2022). From the respondents' answers, it is known that the use of interactive e-modules is very practical because it makes it easier for teachers and students, which is supported by time efficiency and easily accessible teaching materials. According to Yulando *et al.*, (2019); Wijaya & Vidianti, (2020), students can first study the material contained in the interactive e-module by accessing it via smartphone or computer, so that teachers have time to provide more detailed explanations of the material that is considered difficult.

The combination of innovative learning media combined with appropriate learning is one of the needs that must be met to help students achieve competency (Habibi *et al.*, 2022). Next, learning with PjBL-STEM activities which involves students in understanding the subject matter through project assignments by connecting content and practices of various scientific disciplines. When PjBL-STEM activities ask students to find solutions to a problem, it requires the use of technology as a digital tool to assist in processing information, collecting data, analyzing data, and building models (Juuti *et al.*, 2021). This can unconsciously train visual literacy skills. The activities implemented in learning cause all students to be more active in visual activities(Winarni *et al.*, 2022). Previous research shows that students are required to use the information they collect to apply it in developing models designed using symbols, arrows, labels or other forms of representation(Li *et al.*, 2021). The results of the teacher questionnaire were 92% of teacher respondents and the results of teacher interviews responded positively to the development of teaching materials in the form of interactive e-modules based on PjBL-STEM activities to increase students' visual literacy.

Based on the description above regarding the results of the needs analysis, it appears that there has been no use of interactive e-modules based on PjBL-STEM activities to train students' visual literacy to support learning.

Conclusion

Based on the results and discussion, the importance of using interactive e-modules, PjBL-STEM activity-based learning models, and visual literacy by science teachers and junior high school students does not meet expectations. As many as 41.7% of teacher respondents

were new to using e-module teaching materials. The e-module they use is not yet interactive and the activities in the e-module do not invite students to carry out projects. This is supported by the results of the teacher questionnaire, only 15.3% of teacher respondents used the PjBL learning model. As many as 74.5% of teacher respondents stated that the e-modules used had not been used to train students' visual literacy. Based on the results of questionnaires and interviews, teachers responded positively to the existence of teaching materials that can train students' visual literacy. This research can be a basis for future teachers and researchers to be able to develop and implement interactive e-modules

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Conflicts of Interest
The authors declare no conflict of interest.

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