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Development of Electronic Modules Based on the PQ4R Strategy Integrated Jigsaw Model to Improve Collaboration Skills of Grade XI Student

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A B S T R A C T

The research aims to develop electronic modules based on the PQ4R strategy integrated with the jigsaw model to improve students' collaboration skills. This research is development research using the ADDIE model. The test subjects were classes F2 and F5 at SMAN 6 Yogyakarta with each class consisting of 30 students. Data collection instruments used product feasibility validation questionnaires and collaboration skills observation questionnaires. The data analysis technique is one way anova test. The research results show that the electronic modules based on the PQ4R strategy integrated with the jigsaw model is effective in improving students' collaboration skills, according to the results of the ANOVA test which obtained a significance value of 0.001.

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INTRODUCTION

In modern times, 21st century skills are skills that are the main focus in the world of education. 21st century skills include critical thinking skills, communication, metacognition, problem solving, creativity, collaboration, literacy and other skills. Collaboration skills are one of the skills developed in learning chapter 21 (Indrawan et al., 2021). Collaboration skills are skills that encourage learning mechanisms, namely induction, deduction and associative learning. Having collaboration skills can help students in the world of work. Every individual must have collaboration skills, because in the world of work individuals will be required to work together with each other by collaborating (Sarifah & Nurita, 2023:23).

Interviews with Biology teachers showed that students' collaboration skills were still low, because in discussion activities students were less active and less focused on interacting with their group friends. This is also in accordance with the student needs questionnaire, namely that 51.51% of students did not agree that they were active in group discussions. Apart from that, students also prefer to depend on their group friends when completing group assignments so that students' sense of responsibility is still low. Activeness, cooperation and responsibility are indicators of collaboration skills, so it can be concluded that students' collaboration skills are still low (Firman et al., 2023: 85-88). This is confirmed by research by Sarifah & Nurita (2023:23), which obtained a percentage level of student collaboration skills of 39% and was included in the less collaborative category.

The problems presented will be a reference for developing human nervous system biology teaching materials that are effective in improving students' collaboration skills. Good teaching materials used for learning are materials that contain learning instructions, are multimedia, and can be accessed by students (Alperi, 2019: 103). One of the teaching materials that can be used to study the nervous system is an electronic module. Electronic modules are modules in digital format, in the form of text, images, or both, which contain digital electronic material and simulations that are suitable for use in learning. Electronic modules can be used independently by students anytime and anywhere, thus solving the problem of teachers and students who have limited time to study material on the human nervous system.

Collaboration skills in human nervous system material can be improved through learning strategies. One material that can be used is the PQ4R strategy (Preview, Question, Read, Reflect, Recite, Review). Students who have learned to use the electronic module independently with the PQ4R strategy are given the responsibility to share their learning experiences and share what they learn in the electronic module with their group friends in the next lesson. Sharing learning experiences with a group of friends has the potential to improve collaboration skills because it can train indicators of collaboration skills such as cooperation, flexibility, responsibility, compromise, and communication (Firman et al., 2023: 85 - 88).

Students learn independently using electronic modules based on the PQ4R strategy, then carry out learning using a jigsaw learning model on the human nervous system material. The Jigsaw learning model was developed with the aim of obtaining complete and systematic knowledge. The aim of dividing teaching materials or sub-materials into several parts is not only to divide teaching materials and make it easier for students to understand them, but also to help students understand the material as a whole more deeply and comprehensively (Suhirman, 2015: 5). Students will have basic knowledge regarding the human nervous system, and each student will be given the responsibility to master the material topic, which will then be shared with friends in their group. This allows students to solve complex material problems on the human nervous system. The jigsaw learning model can also improve collaboration skills because it trains students to actively participate in learning, share experiences, improve speaking and communication skills, and interact with each other (Sutarto, 2023: –1546). Based on the description of the background of the problem, the researcher will conduct research "development of electronic modules based on the PQ4R strategy integrated jigsaw model to improve collaboration skills of grade XI students."

THEORETICAL REVIEW

Electronic Modules

Electronic modules is modules in digital form consisting of text, images or both containing digital electronic material accompanied by simulations that are suitable for use in learning. Electronic modules is an innovative medium that can increase students' interest in learning (Herawati & Muhtadi, 2018: 182). Electronic modules can be used at any time, making them more practical for students to use. Electronic modules are also defined as independent teaching materials that are arranged systematically into the smallest learning units to achieve certain learning objectives presented in digital format (Hilda et al., 2023: 39).

Hilda et al., (2023: 59) stated that electronic modules have the following characteristics:

1. The electronic modules file size is relatively small and can be studied anywhere and at any time as long as you have a cellphone, laptop and computer.
2. There are links to browse the material linearly or linearly so as to direct students to certain information.
3. Electronic modules are equipped with animations and practical simulations and students can find out their learning completion through interactive self-evaluation.

PQ4R Strategy (Preview, Question, Read, Reflectly, Recite, and Review)

The position of PQ4R (Preview, Question, Read, Reflectly, Recite and Review) in this research is as a strategy. According to Erita (2016: 9), learning strategies are components of a set of material including activities before learning and student participation in the learning procedures used subsequently. In Setiawati's research (2017: 40), PQ4R acts as a learning

strategy, namely helping students effectively memorize information from reading, activating previous knowledge and connecting reading information with previous knowledge, thereby producing information.

PQR4 learning is student-centered learning, so that students build their own knowledge (Setiawati & Corebima, 2018: 98). The PQ4R strategy is easy to apply at all levels of education, thereby helping students to increase their knowledge. The PQ4R strategy stages consist of six stages, namely as follows (Taher & Alshuon, 2023: 838).

1) Preview, the preview stage is the speed reading activity stage. Speed reading activities by examining important points in the reading will stimulate students' critical thinking skills (Setiawati & Corebima, 2017: 3523).
2) Question, the activity carried out by students in the question stage is to ask themselves questions. Students create questions based on the reading material they have read in the preview stage. Questioning activities can stimulate students' activities to think at a higher level (Setiawati & Corebima, 2017: 3523).
3) Read, the reading stage is the entire activity of reading the material that has been given. The aim of this activity is to find answers to questions at the Question stage. In the reading stage, students carry out a critical thinking process. The reading process helps students measure their understanding and reinforce the material they have studied (Setiawati & Corebima, 2017: 3523).
4) Reflectly, at the reflection stage, students' activities are to connect the knowledge they have obtained from the Read stage activities with the knowledge they previously had. This activity encourages the development of critical thinking skills. The thinking process occurs when there is interaction between the reader, text, and understanding (Setiawati & Corebima, 2017: 3524).
5) Recite, in the Recite stage, students answer the questions that have been asked. This activity involves the senses and improves understanding and writing down the information obtained in diagrams or other forms. This stage involves students' critical thinking skills to summarize information, formulate concepts, explain the relationship between concepts and rewrite using their own sentences (Setiawati & Corebima, 2017: 3524).
6) Review, the Review Stage is the activity of making a summary or formulating the essence of the material read. At this stage students are able to formulate conclusions as answers to the questions they ask (Setiawati & Corebima, 2017: 3524).

Jigsaw Model

The jigsaw model is a cooperative learning model. The cooperative learning model prioritizes learning innovations that can improve students' cognitive, social and affective learning outcomes. Cooperative learning contributes to the idea that students who study together and are responsible for their teammates are able to motivate themselves to study as well as their

teammates. Students who study together and help each other in small groups will develop communication skills and improve collaboration and critical thinking skills. Jigsaw is a cooperative learning model that can be used to improve students' critical thinking and collaboration skills (Bialangi et al., 2016: 2). The Jigsaw model can develop relationships between groups, acceptance of classmates who are weak in academics, with lower academic levels and increase students' self-esteem (Karacop, 2017: 431). The characteristic of Jigsaw is that there are expert groups and home groups. After students study and understand the material in the expert group, they will return to their original group. Moving group members makes students active from one group to another. This will make learning not boring (Walad et al., 2019: 334).

The jigsaw model consists of two forms of discussion, including expert group discussions and home group discussions. Members of the original group who have a topic or material meet and discuss in expert groups, and help each other in understanding the material discussed. The teacher is tasked with facilitating and motivating members of the expert group in understanding the material discussed. After discussion in the expert group, each group member returns to their home group and teaches the material discussed in the expert group. Each student has responsibility and cooperation to obtain information and solve the problems given (Karacop, 2017: 431). According to Fahruddin (2022: 16) the syntax of the jigsaw learning model is as follows:

1. The teacher presents the essence of the subject matter to be studied.
2. Students study in groups according to each topic of material from their home group.
3. Students in the home group are grouped into expert groups based on material topics for in-depth discussions on the material.
4. Students from the expert group are returned to their original group to help their fellow group members to explore and teach material that is their expertise.
5. The teacher gives quizzes individually and the quiz material covers all lesson material. The score obtained by each group member from the quiz results will determine the group's score.
6. The teacher gives awards to the original group that has the highest score.

METHODOLOGY

This type of research is development research. According to Sugiyono (2016), the R&D method involves product development and testing its effectiveness. This development study was carried out using the ADDIE development model because it is a descriptive model that uses careful and clear steps to produce a product. The ADDIE development stage consists of analysis, design, development, implementation and evaluation. The subjects used in this research were students of XI SMAN 6 Yogyakarta, namely classes F2 and F5. Class F2 was used as an experimental class with a total of 30 students, and class F5 was used as a control class with a total of 30 students. The large-scale trial of this research was carried out from March 13 to March 28 2024. Data collection techniques include using questionnaires to collect expert, teacher and student

responses to electronic modules, interview forms to analyze teacher needs, and observation questionnaires on student collaboration skills. The validation technique for an instrument does not only involve material experts and media experts, but also direct evaluation by teachers and students. Data analysis techniques were carried out by one-way analysis of variance at a significance level of 0.05.

RESULTS

Results of Analysis Stages

The stages in the analysis stage include analysis of teacher needs, student needs, and curriculum. Analysis of teacher needs is done by conducting interviews with biology teachers. The results of interviews obtained with biology teachers are as follows:

1. Several high schools in Yogyakarta have started implementing the Merdeka Curriculum.
2. Many teachers still apply traditional teaching methods, such as group discussions, while a number of biology teachers use the Discovery learning approach.
3. The teaching strategies applied by the teachers consist of lectures, presentations, and practicums.
4. Biology teachers have never used the PQ4R approach and method in their teaching.
5. The tools used by the teachers in the learning process include PPT, LKPD, journals, and printed books.
6. The school has fairly good internet access for teachers and students.
7. The challenge faced by the teachers is the material on the human nervous system which is difficult to teach and understand for students, because it consists of three very complicated sub-materials.

The results of the student needs analysis were obtained based on the student needs questionnaire. Based on the student needs questionnaire, the following results were obtained:

1. About 36.36% of students strongly agree and 42.42% of students agree that the material on the human nervous system is quite difficult to understand.
2. About 30.3% of students strongly agree and 57.57% of students agree that biology material is very complicated.
3. As many as 51.51% of students do not actively participate in group discussions.
4. As many as 57.57% of students never provide explanations about the subject matter to classmates.

Analysis of the curriculum shows that the majority of high schools in Yogyakarta have implemented the independent curriculum system. SMAN 6 Yogyakarta is one of the educational institutions that has implemented the independent curriculum. From the results of interviews with Biology teachers, it was found that there were obstacles in the biology learning process, where the material was not delivered effectively to students. One of the topics in the independent curriculum that has not been delivered optimally is the Human

Nervous System. Therefore, an electronic module was designed based on the PQ4R strategy by integrating the jigsaw model, referring to the Biology Learning Outcomes in the independent curriculum.

Results of Design Stages

The product is produced through a design result that is designed in advance. The product design consists of several contents designed using the Canva application.

Results of Development Stages

The material and content about the human nervous system are designed in the form of electronic modules using the Canva application. After the electronic module based on the PQ4R strategy is designed, the next stage is to evaluate the feasibility of the electronic module by lecturers who master the material, media experts, and teachers.

Results of the Feasibility Assessment of Electronic Modules Based on Integrated PQ4R Strategy Jigsaw Model

The assessment of the feasibility of electronic modules using the PQ4R strategy integrated with the jigsaw model was carried out by experts in the fields of materials and media. Tatag Bagus Putra Prakarsa, S.Si., M.Sc., is a material expert who examines the feasibility of the material of the electronic module. Meanwhile, Ahmad Kamal Sudrajat, M.Pd., acts as a media expert who assesses the feasibility of the electronic module media. Table 1 below shows the percentage of results from the assessment of the feasibility of electronic modules based on the PQ4R strategy integrated with the jigsaw model.

Table 1. Recapitulation of the Feasibility of the Electronic Module Based on the Integrated PQ4R Strategy Jigsaw Model

Validators	Percentage (%)	Category
Subject Matter Expert	96,66	Very Feasible
Media Expert	100	Very Feasible

Results of Implemention Stages

The implementation that began was an evaluation of the practicality assessed by teachers and students at SMAN 6 Yogyakarta. Tables 2 and 3 below show the assessment of practicality from teachers and students.

Table 2. Results of Teacher Practicality Assessment

Aspect	Percentage (%)	Category
Effective	100	Very Feasible
Interactive	95	Very Feasible
Ease of operation	100	Very Feasible
Creative	93,75	Very Feasible
Total	96,6	Very Feasible

Table 3. Results of Teacher Practicality Assessment

Aspect	Percentage (%)	Category
Usefulness	84,35	Very Feasible
Convenience	87,7	Very Feasible
Satisfaction	84,67	Very Feasible
Total	85,37	Very Feasible

Results of The Effectiveness of Using Electronic Modules Based on Integrated PQ4R Strategy Jigsaw Modules

The analysis of the effectiveness of electronic modules based on PQ4R strategies integrated with the jigsaw model on improving student skills was carried out using the ANOVA test. To conduct an ANOVA test, the prerequisites for normality and homogeneity tests must be met. The following are the results of the ANOVA test obtained from the IBM SPSS Statistic 27 application:

Tests of Normality

Based on the normality test, the significance value in the experimental class and control class was <0.05, so it was stated that the pre-test and post-test data in the experimental and control classes came from a normally distributed population. This shows that the collaboration skills data meets the normality assumption test which can be seen in table 4.

Table 4. Tests of Normality

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelas	Statistic	df	Sig.	Statistic	df	Sig.
Skor	Pre Test Kelas Eksperimen	.155	30	.062	.941	30	.096
	Post Test Kelas Eksperimen	.140	30	.138	.934	30	.062
	Pre Test Kelas Kontrol	.126	30	.200*	.938	30	.080
	Post Test Kelas Kontrol	.118	30	.200*	.967	30	.448

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Test of Homogeneity of Variances

The homogeneity test table obtained the results of the homogeneity test significance on the collaboration skill score > 0.05. This shows that the collaboration skill data meets the homogeneity assumption test. The results of the homogeneity test on collaboration skills can be seen in table 5.

Table 5. Tests of Homogeneity of Variaces

Tests of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Skor	Based on Mean	.423	3	116	.737
	Based on Median	.375	3	116	.771
	Based on Median and with adjusted df	.375	3	111.426	.771
	Based on trimmed mean	.424	3	116	.736

Anova Test

After the prerequisite tests for normality and homogeneity are met, the next step is to conduct an ANOVA test. The results of the ANOVA test obtained a significance of 0.001 <0.05. The results of the ANOVA test can be seen in Table 6.

Table 6. ANOVA Test

ANOVA

Skor

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2010.692	3	670.231	177.409	<,001
Within Groups	438.233	116	3.778		
Total	2448.925	119			

Results of Evaluation Stages

The results of the study indicate that during the development stage, input and recommendations were obtained from the validator. The recommendation given by the material expert was the importance of including illustrative examples on the topics discussed, so that students can have a clearer understanding of the material. In addition, recommendations from media experts also include the need for an attractive and non-boring concept map page design, so it is highly recommended to add animated elements to the concept map page. In the evaluation of the practicality aspect, suggestions were also obtained to summarize the material in the electronic module more briefly, so that students can more easily understand its contents.

DISCUSSION

Product Quality

The electronic module based on the PQ4R strategy with the integration of the jigsaw model was developed using the ADDIE approach. This module includes several elements, such as an introduction, table of contents, image catalog, glossary, instructions for use, introduction, learning targets, concept maps, learning activities 1 and 2, summary, exercises, self-evaluation, assessment guides, and references (Widiastuti & Widayati, 2024). The process of developing this module includes analysis, design, development, implementation, and evaluation. This module has been validated by experts in the field of materials and media, and has been declared suitable for application in learning. In addition, this PQ4R strategy-based module has also been tested by teachers and students, which showed very good results for learning activities. The design of this electronic module was created using the Canva application. This module has attractive features such as animation, images, videos, and article links. Access to linked articles is very easy and improves students' understanding of the human nervous system. According to research by Anggraeni et al., (2021), effective teaching materials are those that can be accessed both at home and at school. With the concept of independent learning

in the education system, teaching materials are needed that enable students to learn independently.

Effectiveness of Electronic Module Based on PQ4R Strategy Integrated with Jigsaw Model on Collaboration Skills

Collaboration is a learning process that requires a combination of work ethics in students' efforts to collaborate and gain insights, ideas, and achieve educational goals (M et al., 2022). Aspects of collaboration skills in this study include cooperation, adaptability, responsibility, deliberation, and communication. This is in line with the findings of Nuraydah et al., (2024), which revealed that collaboration skills include the capacity to work with others, share knowledge and ideas, and achieve common goals. Meanwhile, the components of collaboration skills in the research of Nuraydah et al., (2024: 676), are cooperation, responsibility, respect for others, and flexible communication.

The assessment carried out by material experts showed that the percentage of eligibility reached 96.66%, which indicates that the electronic module based on the PQ4R strategy is very suitable for achieving learning objectives, especially in improving students' collaborative abilities. The material contained in the electronic module with this strategy is very comprehensive and equipped with articles that enrich students' knowledge, so that they can understand the material well. This electronic module also provides content that is relevant to the objectives and learning outcomes that must be achieved by students, so that the electronic module based on the PQ4R strategy is very feasible and effective to be applied to students. This is supported by research by Anggraeni et al. (2021: 5237), which emphasizes that effective teaching materials are those that include materials that are in accordance with core competencies, basic competencies, and learning objectives.

The assessment conducted by media experts showed that the electronic module based on the PQ4R strategy achieved a feasibility score of 100%. This shows that the module is very suitable to support learning objectives, especially in terms of improving student abilities and cooperation. This electronic module referring to the PQ4R strategy is designed as flexible teaching material, allowing students to use it anytime and anywhere. The features in the module are very interesting, equipped with animations, images, videos, and article links. The article links are easily accessible, increasing students' insight into the topic of the human nervous system. Based on the explanation of Anggraeni et al., (2021), good teaching materials are materials that can be used at home and at school. In the current education system, the concept of independent learning is prioritized, and teaching materials are needed that allow students to learn independently. According to Bukit et al., (2022), a learning module is a tool that can train students' independent learning abilities. The electronic module developed in this study can be accessed independently by students, so that they can study the nervous system material which has complicated sub-materials in an efficient way.

The product implementation was carried out after the product was validated and improved. The implementation took place with large-scale

testing at SMAN 6 Yogyakarta, where class F2 was used as the experimental group and class F5 served as the control group. Learning achievement was measured based on the observation sheet from the experimental class that implemented the electronic module with the PQ4R strategy integrated with jigsaw, which resulted in a score of 100% for the first and second meetings. The control class also recorded identical results, namely 100%.

Based on the results of the ANOVA table, a significance value of 0.00 was obtained which is smaller than 0.05, indicating that the null hypothesis is rejected while the alternative hypothesis is accepted. Thus, it can be concluded that there is a difference in improving collaboration skills between students who take part in learning with electronic modules based on the PQ4R strategy integrated with the jigsaw model (experimental class) and students who learn in the traditional way (control class) on the human nervous system material, with a significance level of 5% simultaneously. The improvement in students' collaboration skills occurs because the jigsaw learning model encourages students to actively participate in the learning process, share experiences, improve speaking skills, and interact with each other (Sutarto, 2023). In addition, the PQ4R strategy also contributes to improving students' collaboration skills because at the Reflectly stage, PQ4R trains students to conduct group discussions in answering and solving problems contained in the module and expressing their opinions (Thei & Junita, 2021). Collaboration, discussion, and communication are important indicators of collaboration skills.

Electronic modules based on the PQ4R strategy integrated with the jigsaw model are very effective to be applied in the learning process. According to research conducted by Gardenia et al. (2018), there is an increase in communication among students who use the PQ4R learning strategy. This communication is one indicator of collaborative skills, so it can be concluded that the PQ4R approach has the potential to improve collaboration skills. Collaboration between peers in study groups can improve communication skills, allowing students to exchange information (Authary, 2018). In addition, the PQ4R strategy supports students in solving problems, helping them to express ideas to form new understandings and helping to build ideas collectively in groups (Gardenia et al., 2018). Structured discussions and division of responsibilities will stimulate the exchange of ideas among students, thus creating a cooperative and effective learning experience (Harianto, 2024).

CONCLUSIONS AND RECOMMENDATIONS

Based on the formulation of the problem, research objectives, research results, and discussions in the development of electronic modules using the integrated PQ4R strategy with the jigsaw model, the following conclusions can be drawn:

1. The electronic module based on the integrated PQ4R strategy with the Jigsaw model for the human nervous system material that has been developed shows very good feasibility criteria and positive effects in improving students' collaboration skills. The assessment from material experts recorded a percentage of 96.66% (very feasible), while the

assessment from media experts recorded a percentage of 100% (very feasible).
2. The electronic module with the integrated PQ4R strategy with the Jigsaw model has the ability to improve students' collaboration skills in the Nervous System lesson for grade XI SMA, which can be seen from the results of the ANOVA analysis showing a significance value of 0.000> 0.05, so that H0 is rejected and Ha is accepted.

FURTHER STUDY

The electronic module based on the PQ4R strategy integrated with the jigsaw model on the human nervous system material can only be used in schools that provide software and internet facilities, as well as students who use smartphones and laptops in learning.

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