25 (2), 2024, 620-636

Jurnal Pendidikan MIPA

e-ISSN: 2685-5488 | p-ISSN: 1411-2531

http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

Development of Discovery-Based Nervourssy Media on the Topics of Nervous System to Improve Digital Literacy and Critical Thinking Skills

Purwanti*, & Agung Wijaya Subiantiro

Biology Education, Yogyakarta State University, Indonesia

Abstract: This research aims to determine the characteristics, feasibility and effectiveness of Nervourssy learning media based on discovery learning on the nervous system material to improve students' digital literacy and critical thinking skills. This research is Research and Development (R&D) research which refers to the ADDIE development model, which consists of 5 stages, namely: analysis, design, development, implementation and evaluation. The limited trial subjects were 22 students and the field test subjects were 65 students from two classes. The field test was carried out using a quasi-experiment with a pretest-posttest control group design. The data collection instruments used were interviews, observations, feasibility assessment sheets, digital literacy ability observation sheets and critical thinking ability test instruments. The results of the research show that: (1) The characteristics of Nervourssy learning media based on discovery learning have interactive content so that it becomes an attraction for students, an emphasis on group discussions, and a complete integration of the discovery learning model so as to encourage students to be actively involved in the learning process by searching, investigating and formulating their own findings; (2) Nervourssy learning media based on discovery learning on nervous system material is feasible and practical to use in the learning process; (3) Nervourssy learning media based on discovery learning on nervous system material is effective in improving digital literacy and critical thinking skills. Based on the paired-sample t-test, digital literacy skills in the control class did not experience a significant increase (P=0.888), while the experimental class experienced a significant increase (P=0.000). Meanwhile, critical thinking abilities in the control (P=0.022) and experimental (P=0.022) classes experienced significant improvement. Independent sample t-test results for digital literacy skills (P=0.001) and critical thinking skills (P=0.000)

Keywords: learning media, discovery learning, nervous system material, digital literacy, critical thinking.

▪ INTRODUCTION

The 21st-century industrial revolution 4.0 has prompted several countries to improve the quality of various sectors, including education. Education represents a dynamic manifestation of human culture and is essential for development. One of the potentials fostered through education is the academic abilities and students' skills in the learning process. The 21st century emphasizes students who have various skills known as the "4Cs" - creativity, critical thinking, communication, and collaboration (Thornhill-miller et al., 2023). These four skills are closely linked to digital literacy (Rahmadani, 2020).

Digital literacy focuses on enabling the younger generation to become critical, wise, safe, and ethical users of digital media (Pangrazio, 2020). Digital literacy is a form of ability to acquire, understand, and use information from various digital sources wisely, intelligently, accurately, and lawfully in order to foster communication and interaction in daily life (Naufal, 2021; Novitasari & Fauziddin, 2022). It refers to using digital technology effectively and leveraging technology with a critical mindset as a source of

Purwanti & Agung Wijaya Subiantiro
*Email: purwanti0989@gmail.com

DOI: http://dx.doi.org/10.23960/jpmipa/v25i2.pp620-636
Received: 18 August 2024
Accepted: 10 September 2024
Published: 25 September 2024

knowledge and information (Santos & Gomes, 2024). The ease of using technology has led many students to access the internet in digging up information about problem solving. This is in line with Kurniawati & Baroroh (2016) who stated that easily available sources of information can result in errors when gathering information from unreliable sources. Therefore, digital literacy is essential to avoid misinformation or hoaxes. Fitri et al (2023) found that the digital literacy skills of the millennial generation are generally low, with specific aspects such as comprehension scoring an index of 46.8% (moderate category) and collaboration skills scoring an index of 32.2% (low category).

The 21st-century paradigm includes students' abilities to think critically and master technology and information (Janah et al., 2019). The Regulation of the Minister of National Education Number 22 of 2006 (BSNP, 2006) emphasizes that critical thinking skills are needed for students to manage and utilize information to survive in ever-changing, uncertain and competitive circumstances. Tang & Chaw (2016) revealed that knowing the truth of the information sought or received requires good digital literacy skills, supported by strong critical thinking skills. The importance of high-level thinking skills is included in several points of junior high school students' ability criteria in the form of the ability to analyze, evaluate, conclude and solve problems. Critical thinking involves a systematic process of formulating and evaluating findings based on acquired knowledge with evidence, assumptions, and accountable logic. Therefore, critical thinking skills require habitual practice and training within the learning environment (Sari et al., 2021).

Critical thinking is the ability to solve problems, analyze facts, generate ideas, draw conclusions, and evaluate arguments. Over time, human critical thinking skills will develop when the individual faces new unsolved problems (Fitri et al., 2023). Ennis (2018) mentioned that indicators of critical thinking include providing elementary clarification, basic support, inferences, advance clarification, and strategies and tactics. The results of the PISA survey (2022) conducted by the Organization for Economic Cooperation and Development (OECD) which assessed 6,900 15-year-old students, showed that Indonesia ranked 68th out of 81 countries. This has increased by 5 positions compared to 2018, yet the international learning outcomes have decreased due to the pandemic. Indonesian students scored 379 in mathematics, while the international mathematics literacy score dropped by 21 points. The reading score was 371, while the average international reading literacy score fell 18 points. The science score was 398, with the international average score decreasing by 13 points (OECD, 2024). Overall, the PISA 2022 results can be categorized as low, comparable to the results obtained in 2003 for reading and mathematics, and in 2006 for science. These scores indicate that problem-solving and reasoning skills of students are still not optimal Lestari & Annizar (2020). Therefore, it is crucial to train students' critical thinking skills. According to (Hendi et al., 2020; Ridho et al (2020) critical thinking skills can be trained and developed using appropriate learning media and learning models.

Improving critical thinking skills cannot be separated from the appropriate learning model to support the learning process. The more intensive the learning experience, the higher the quality of the learning process. Discovery learning has a learning syntax that invites students to find their own understanding. Students find the targeted material themselves after formulating problems and hypotheses (Nurlaili et al., 2021). According to Agustini et al (2023) the discovery learning model is a learning process that creates a

problem-oriented learning situation, encouraging students to ask questions, find answers, and experiment. The discovery learning model can train logical thinking, reasoning skills, and problem-solving skills.

The learning strategy that has been determined should be supported by media that aligns with the characteristics of the material, so that what has been learned can be meaningful to students. For instance, the nervous system is an invisible topic that can be challenging to understand, so the use of educational tools can facilitate learning, especially in computer-based instruction (Nisa et al., 2019). Learning media is a crucial component of the learning process and serves as an effective alternative to help achieve learning objectives. The significant role of media in the learning process requires educators to be more creative and innovative in utilizing learning media (Fitria et al., 2023). One of the learning media that can be used is interactive multimedia. Learning with interactive multimedia integrates various media components. Interactive multimedia is a learning media that combines various elements of text, images, photos, audio, video, and animations (Alberto et al., 2024). In addition, the use of multimedia can correct misconceptions and misinterpretations from previous learning experiences (Saselah, 2017). Iskandar et al (2023) state that the effectiveness of interactive media is higher than without applying the media so that the development of interactive multimedia is important.

▪ METHOD

Participants

The test subjects of the research and development activities of Nervourssy learning media based on discovery learning include students from grade XI MIPA and grade XII MIPA at SMAN 1 Gamping. The subjects for the limited trial were biology teachers and students from grade XII MIPA 1 at SMAN 1 Gamping, totaling 22 students. The subjects in the field trial were students from grade XI MIPA at SMAN 1 Gamping. The implementation was carried out in two classes, an experimental class and a control class, class XI MIPA 1 consisting of 35 students and class XI MIPA 2 consisting of 30 students so that the total sample was 65 students. The sampling technique used in this study was simple random sampling

Research Design and Procedure

This research used Research and Development (R&D) by developing Nervourssy learning media based on discovery learning. According (Sugiyono, 2016), Research and Development is a type of research used to develop a teaching material product by going through the step of testing the product to be developed so that it can be applied in various circles. The development model used in this study is the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. In the analysis stage, the researcher collects information or identifies the needs for the development of the learning media by analyzing several required needs. In the design stage, the researcher designs the product to be created. In the development stage, the design is transformed into an actual product. In the implementation stage, the product is tested on a number of respondents or research subjects. In the evaluation stage, the researcher evaluates the product.

Instrument

The data collection instruments in this study consisted of: (a) The feasibility of Nervourssy learning media based on discovery learning on the nervous system material was assessed using the following instruments; (1) media expert feasibility sheet with 14 items regarding the feasibility of learning media; (2) material expert feasibility sheet with 15 items regarding the feasibility of material in the media; (3) biology teacher response sheet with 20 items regarding biology teacher's feedback on the media. (b) The effectiveness of Nervourssy learning media based on discovery learning on the nervous system material was assessed using both non-test and test instruments as follows: (1) non-test instruments, a digital literacy observation sheet with 11 items, adapted from aspects from Kazakoff (2015), a digital literacy observation sheet was used to determine the level of digital literacy skills of students during the learning process using learning media; (2) instrument test, critical thinking assessment conducted through pre-test and post-test, each consisting of 10 questions based on aspects adapted from Ennis (2018), critical thinking test instruments was used to measure students critical thinking skills after using Nervourssy learning media based on discovery learning on the nervous system material.

Data Analysis

The data analysis technique is the method used after data collection following the learning process. The data analysis techniques for research and development used in the development of the Nervourssy learning media based on discovery learning are as follows: First, the quality assessment of the media, which is conducted before the implementation in the learning activities. The Nervourssy learning media based on discovery learning is assessed by material experts, media experts, biology teachers, and students. The feasibility assessment instrument uses a Likert scale (Sugiyono, 2016), which includes: (1) not very good; (2) not good; (3) pretty good; (4) good; and (5) very good. The interpretation of each aspect's data is categorized according to the value categories provided by Riduwan (2013). The level of product feasibility is determined based on Table 1.

Table 1. Criteria for media feasibility assessment

No.	Score Range (%)	Category
1.	81-100	Very Feasible
2.	61-80	Feasible
3.	41-60	Fair
4.	21-40	Less Feasible
5.	≤20	Very Less Feasible

The Nervourssy learning media based on discovery learning is categorized as Feasible if the score obtained form validation is ≥61 and can be applied as a learning resource. Second, the effectiveness data, in the form of pre-test and post-test that has been obtained by the researchers during the learning process is analyzed using the N-Gain. The Gain score is calculated using the equation developed by (Purwanto, (2002) as follows:

$$Gain\ (g) = \frac{\bar{X}\ Posttest - \bar{X} pretest}{\bar{X} - \bar{X}\ pretest}$$

Table 2. Gain score category

No.	Interval	Criteria
1.	g > 0.7	High
2.	0.7 > g > 0.3	Medium
3.	g > 0.3	Low

Data on the effectiveness of Nervourssy learning media based on discovery learning was assessed using paired sample t-test and independent sample t-test using SPSS 23 software. Data analysis of digital literacy and critical thinking skills tests collected in the form of pre-test and post-test results from control and experimental classes To determine the effectiveness of the media, a hypothesis test or preliminary assumption test is conducted. Hypothesis testing will be carried out if it meets the requirements of normal distribution and homogeneity. If both requirements are satisfied, parametric testing can be carried out.

▪ RESULT AND DISSCUSSION

Product Characteristics Description

The learning media developed in this research is the Nervourssy learning media based on discovery learning, designed to address the problems and needs of students and educators. This Nervourssy learning media based on discovery learning can be installed on smartphones (Android). It includes various menus to assist students in understanding biology, specifically the nervous system material. The features provided include a user guide, Exploration Room 1, Exploration Room 2, evaluation, and developer profile. The prototype results of the application development can be seen in Figure 1.

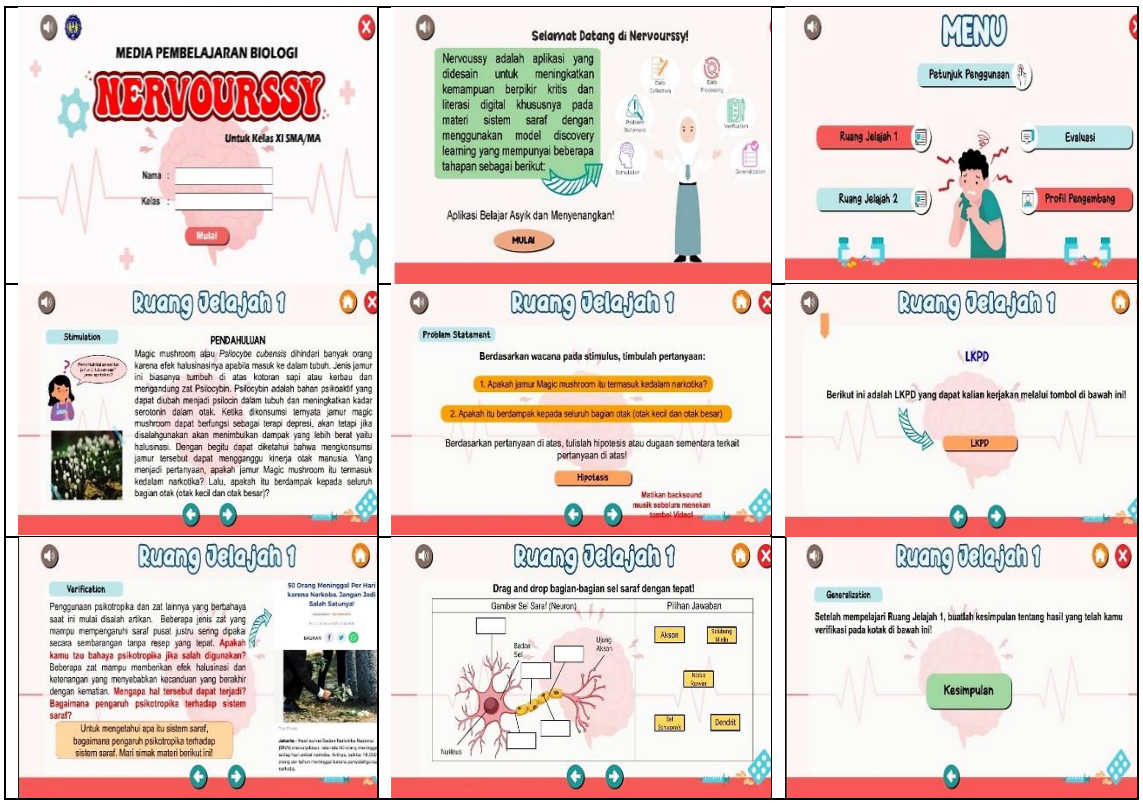

Figure 1. Display of the nervourssy learning media

Interactive Content: Nervourssy, based on discovery learning, presents engaging and interactive content to enhance students' motivation and engagement through the use of interactive multimedia elements, such as interactive simulations, animations, videos, and images. Interactive content can help students to be more actively engaged in learning and to gain a deeper understanding of the nervous system material. With the Nervourssy learning media based on discovery learning, students can use interactive simulations, also known as drag-and-drop activities, to manipulate and test their knowledge, determining the correctness of their understanding. This is in line with research by Pramuji et al (2020), which suggests that multimedia media, presenting text, images, animations, sound, and video, enhances the effectiveness of the learning process and the delivery of educational content. According to Rejekiningsih et al (2021), interactive media will assist students in comprehending the information presented during learning activities.

Authentic Problems: The Nervourssy learning media based on discovery learning presents authentic and relevant problems related to students' everyday lives. These problems can stimulate students' thinking skills and encourage them to apply their knowledge in daily situations. This approach helps to enhance students' critical thinking skills and strengthen digital literacy. According to (Septiaahmad et al., 2020), the discovery learning effectively improves critical thinking skills. Discovery learning is a teaching model that emphasizes active student engagement in exploring and investigating concepts. Rather than receiving information passively, students engage in problem-solving, experimentation, and inquiry. This model encourages students to discover knowledge for themselves, fostering critical thinking and a deeper understanding of the material. By actively engaging with content, students develop skills in analysis, synthesis, and evaluation, which are essential for applying their knowledge in real-world contexts and enhancing their ability to think critically and independently.

Integration of discovery learning model as a whole: learning media is designed by following the stages of the discovery learning model. Instruction is designed according to the syntax of discovery learning as an effort to improve digital literacy and critical thinking skills. This is because the discovery learning model is inquiry-based constructivism learning, where students are presented with problems and use available sources to discover facts and draw conclusions from the designed problems (Akbari Harahap & Setiawati, 2022; Septiaahmad et al., 2020). Students are required to be able to analyze problems and find solutions and facts from existing sources, one of which is by having digital literacy and critical thinking skills. This is in line with the research by Rajagukguk & Rambe (2022), which shows that interactive media based on discovery learning can improve critical thinking skills.

Product Feasibility

The feasibility of Nervourssy learning media based on discovery learning on the nervous system material was validated by two expert lecturers, a content expert and a media expert. The assessment of the material by the content expert lecturer includes two aspects, each of which has different indicators. The score obtained from the validator's assessment was 74 out of a maximum score of 76, with an average score of 97 in the "very feasible" category, so that the media is suitable for use. The highest feasibility score was 100 in the learning aspect, while the lowest was 95 in the content aspect. The learning aspect received the highest score of 100, indicating that the Nervourssy learning media based on discovery learning aligns with the concepts of the nervous system materials, objectives, and learning outcomes. This is consistent with Amrulloh et al., (2013), who state that feasible learning media must align with the content or learning material and the learning objectives to be achieved.

Assessment of the media by media expert includes four aspects, namely aspects of learning, aspects of ease and flexibility in access, aspects of presentation, and aspects of interactivity. In terms of the overall score obtained from the validator's assessment, the media received a validation score of 78 out of 80 as the maximum, with an average score of 96 in the "very feasible category", indicating that the media is suitable for use in trials. Meanwhile, when viewed from the value per aspect, the learning and the presentation aspect receive the highest scores of 100, while the interactivity aspect received the lowest score of 91.

The learning and presentation aspects received the highest scores, indicating that the layout, images, and animations effectively assist students in clarifying material, particularly abstract information. This aligns with Wiana et al (2018), state that interactive multimedia that contains various animations, images, videos, texts, and audio can create an enjoyable learning experience and effectively convey information.

The validation of the digital literacy observation sheet involved three aspects: content, construction, and language. The score achieved from the validator's assessment was 48 out of a maximum score of 48, with an average score of 100, indicating a "very good" category, so it can be used to measure digital literacy skills. Similarly, the critical thinking skills instrument also has three aspects: content, construction, and language, and received a validation score of 150 out of 150, with an average score of 100, categorized as "very good" category. The critical thinking test items were empirically tested with 32 students and analyzed using SPSS 23. The empirical test results showed that 10 questions were valid and reliable, making them suitable for assessing critical thinking skills. The critical thinking skills instrument was empirically tested on 32 students and analyzed using the SPSS 23 program. The results of the empirical test showed that there were 10 questions that were valid and reliable, so it can be used to measure critical thinking skills.

Product Practicality

The practicality measurement of learning media for biology called nervourssy which based on discovery learning implemented by a biology teacher was based on four aspects: material, language, media, and learning. Furthermore, the results of biology teacher practicality were material, language, media, and learning aspects. The measurement obtained was 96 of 96 with the average score 100 which categorized as very

practical. The results of students' responses to the Nervourssy learning media based on discovery can be concluded as suitable to be used in the field tests. Product readability is based on an assessment done by 22 students in a limited test by class XII MIPA at SMAN 1 Gamping by using a questionnaire. There are four aspects of product readability done by students for assessment which got an average score of 84% categorized as practical, therefore, the media can be used in field tests. Students' comments regarding Nervourssy learning media based on discovery learning was "very interesting, the application is very useful for learning but they are lazy to read books". This is in line with Leow & Neo (2014) that the use of multimedia elements in creating learning content affects students' learning experiences more meaningful.

The Effectiveness of the Product on Students' Digital Literacy Skill

Based on the descriptive analysis on the data obtained, it shows that both control and experimental classes experienced an increase at the average score in digital literacy skill scores. The difference of students' initial and final scores can be seen in Table 3.

Table 3. Descriptive data of digital literacy skill

Group		Min-Score	Max-Score	Average Score	*N-Gain*	Category
Control	Meeting 1	36	91	67.50	0.01	Low
	Meeting 2	36	91	68.07		
Experimental	Meeting 1	38	91	63.60	0.45	Medium
	Meeting 2	45	100	80.17		

Based on the results of students' digital literacy skills measurement in the control and experimental classes, it was found that the average score at the first meeting in the control class was 67.50, while at the second meeting was 68.07. Therefore, it obtained the N-gain score in the control class 0.01 which was in the low category. In the experimental class, the average score at the first meeting for digital literacy skills obtained by students was 63.60, while at the second meeting the average was 80.17. Thus, the N-gain score obtained was 0.45 which categorized as medium.

Learning utilized Nervourssy learning media based on discovery learning on nervous system material can facilitate digital literacy skills by looking at the results of analysis on the observation sheets. The results of digital literacy observations showed that the experimental class had a higher average score for each aspect than the control class. The comparison of the average scores for each aspect of digital literacy skills can be seen in Figure 2 below.

Based on the comparison graph, the average score of each aspect of the digital literacy skills between the experimental and control classes shows an increase in the experimental class compared to the control class. This is supported by Heryani et al (2022) which shows that the use of technology as a learning media can increase students' motivation, learning outcomes and digital literacy.

The ability aspect to utilize and understand digital devices of students in the experimental class was observed by looking at the students' ability to access Nervoursssy learning media based on discovery learning, such as they are able to open menus on the media, access students' worksheet (LKPD) and videos, able to carry out learning

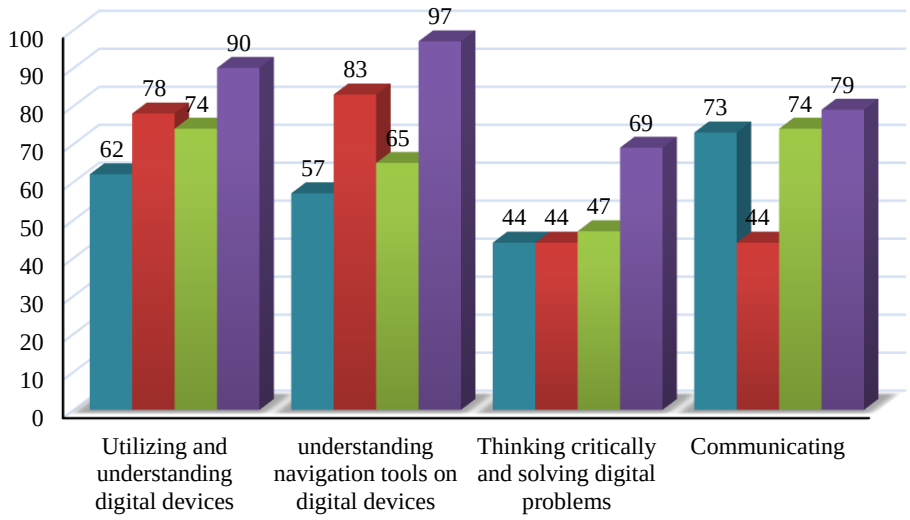

Figure 2. Comparison graph of the average score for each aspect of digital literacy skills

activities in Nervoursssy learning media based on discovery learning. The percentage of ability to use and understand digital devices at the first meeting for the experimental class was 73, this was because some students had not been able to install the application, had not brought a smartphone and had never used the application. Meanwhile, the control class got a score of 62, this was because many students did not understand how to fill in the LKPD on the live worksheet and there were many factors that caused the control class to be lower, this was because the class was not conducive. Furthermore, in the second meeting, the aspect of the ability to utilize and understand digital devices experienced an increase for the experimental class, the percentage gained was 90, while for the control class was 79.

The ability aspect to understand navigation tools on students' digital devices was observed in all menus and buttons on the media, both the experimental and control classes experienced an increase. The results revealed that the percentage of the experimental and control classes is 97 and 83. In the aspect of being able to think critically and solve digital problems between the experimental and control classes showed a significant difference where the experimental class experienced an increase of 22% from the first meeting to the second meeting, while in the control class did not increase. It happened because the control class was not good at selecting a good quality information on the internet and is not good at solving problems using the information obtained. In terms of communication skills, all students in the experimental class are good at being able to upload the results of discussions on the Nervoursssy learning media based on discovery learning. Meanwhile, the control class experienced a decline because some groups did not collect the discussion assignments given and were less able to express their opinions.

The different test uses a paired sample t-test applied to determine the increase in students' digital literacy skills in both the control and experimental classes. The results of the paired sample t-test can be seen in following table 4.

Table 4. Paired sample T-Test results of digital literacy skills

Classes	Data	Average Score	(Sig, 2-tailed)	Category
Control	Meeting 1	67.50	0.888 (*P*>0.05)	Not Significant
	Meeting 2	68.07		
Experimental	Meeting 1	63.60	0.000 (*P*<0.05)	Significant
	Meeting 2	80.17		

Based on the results of field test Nervourssy learning media based on discovery learning on nervous system material, the researchers carried out a difference test on paired data to determine the differences that occurred because of the intervention in both control and experimental classes. It was carried out using the paired-sample t-test because the requirements for normality and homogeneity of the data were filled. Based on the paired-sample t-test, it revealed that digital literacy skills in the control class did not experience a significant average increase (P=0.888), while the experimental class experienced a significant average increase (P=0.000) in the pre-test and post-test data. Therefore, it can be concluded that Nervourssy learning media based on discovery learning can enhance digital literacy skills. According to Misir (2018) digital literacy competencies can be trained and formed in a classroom environment that requires students to actively participate during learning through the use of technology as a learning media which then practiced directly so that students' digital literacy increases. It is in line with Zulqadri and Nugrahaeni et al (2017) that web-based interactive multimedia is effective in increasing cultural literacy and digital literacy in students.

Hypothesis testing was carried out using an independent sample t-test which aims to determine the effectiveness of Nervourssy learning media based on discovery learning. The test aims to find out whether there is a difference in the average score of digital literacy skills on two unpaired samples. The independent data test was carried out using the independent sample t-test because the requirements for normality and homogeneity of the data population were filled. The summary of the results of the independent sample t-test on the post-test scores for digital literacy skills in the control and experimental classes can be seen in table 5.

Table 5. Results of the independent sample T-Test for digital literacy skills

Classes	Data	Average Score	(Sig, 2-tailed)	Category
Score of Meeting 1	Control	67.50	0.274 (*P*>0.05)	Not Significant
	Experimental	68.07		
Score of Meeting 2	Control	63.60	0.001 (*P*<0.05)	Significant
	Experimental	80.17		

Based on the results of the independent sample t-test, it found that there is no significant difference of students' digital literacy skills in the meeting 1 between the control and experimental classes (P=0.274). Thus, it can be concluded that the initial students' digital literacy skills of control and experimental classes are the same. Meanwhile, in the meeting 2, there was a significant difference in students' digital literacy skills score between the control and experimental classes (P=0.001). Therefore, it can be

concluded that the use of Nervourssy learning media based on discovery learning is effective in improving students' digital literacy skills.

Nervourssy media based on discovery learning is defined as a learning that uses multimedia which has the potential to create a high-quality learning environment, multimedia not only has meaning between text and simple graphics but it also equipped with animation and interaction, user control over the delivery of information and user interaction is one of the advantages in creating a good learning environment. This is supported by Budiarto et al (2021) which states that students have a positive impact on the learning process by using interactive multimedia.

The Effectiveness of the Product on Students' Critical Thinking Skills

The descriptive analysis on the data obtained shows that both the control and experimental classes experienced an increase in critical thinking skills scores. The difference in students' initial and final scores can be seen in table 6.

Table 6. Descriptive data on critical thinking skills

Group		Min-Score	Max-Score	Average Score	*N-Gain*	Category
Control	*Pre-test*	35	68	55.03	0.10	Low
	Post-test	43	83	59.93		
Experimental	*Pre-test*	38	65	55.03	0.52	Mediocre
	Post-test	68	93	78.71		

Based on the results of students' critical thinking skills measurement in the control and experimental classes, it was found that the average pre-test score for critical thinking skills in the control class was 55.03. Meanwhile, the average post-test score in the control class was 59.93. Thus, based on the pre-test and post-test scores, the N-gain score obtained in the control class was 0.10 and categorized as low. Moreover, in the experimental class, the average pre-test score for critical thinking skills was 55.03. Meanwhile, the post-test gained an average score of 78.71. Therefore, it obtained the N-gain score in the control class 0.52 which was categorized as mediocre category.

Learning using Nervourssy learning media based on discovery learning on nervous system material can facilitate critical thinking skills by looking at the results of critical thinking ability tests. The results of digital literacy observations showed that the experimental class had a higher average score for each aspect than the control class. A comparison of the average scores for each aspect of digital literacy skills can be seen in Figure 3 below.

The results of the critical thinking skills test showed that the average score improved more in the experimental class than the control class. It is in line with the research conducted by Rajagukguk & Rambe (2022) that interactive media based on discovery learning is valid, practical and effective in increasing students' critical thinking skills. Based on the results of the critical thinking skills test in the aspect of giving a simple explanation (elementary clarification), which the students are measured in identifying problems, considering possible answers and providing a simple explanation, the control class had no significant increase with the pre-test score 53 and post-test score

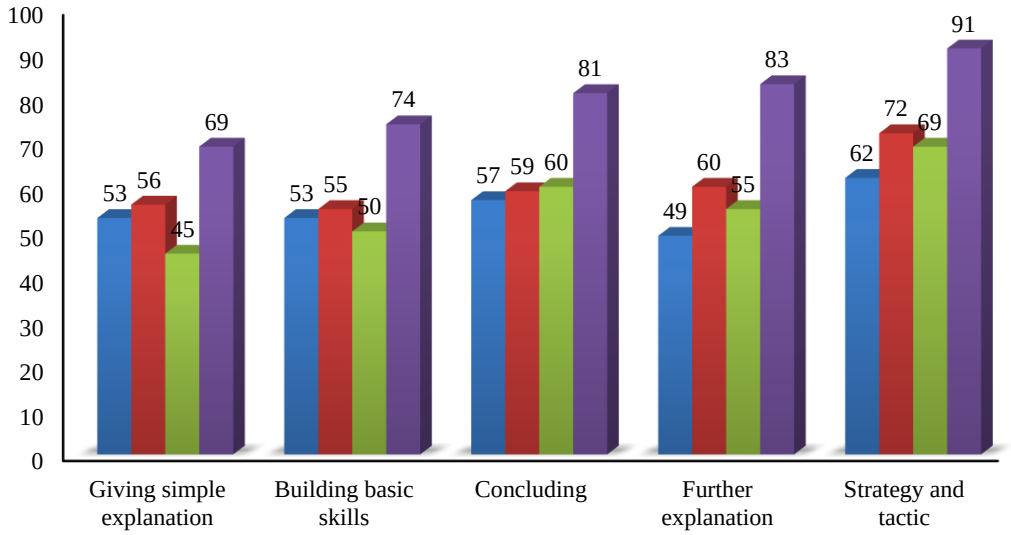

Figure 3. Comparison graph of the average score for each aspect of critical thinking skills

56. Meanwhile, there was a significant increase in the experimental class with the pre-test score 45 and post-test score 69.

The aspect of building basic skills is measured by considering the credibility of a source and the ability to provide reasons. The experimental class improved significantly more than the control class which gained a pre-test score 50 and post-test 74. Meanwhile, the control class obtained a pre-test score53 and a post-test score 55. In the inference aspect, the students were measured in making conclusions and hypotheses. Therefore, both the experimental and control classes experienced an increase with a higher increase in the experimental class. The pre-test score was 60 and the post-test score was 81. Meanwhile, the control pre-test score was 57 and the post-test was 59. This is because in the discovery learning model, the students are given opportunity to experience or do it by themselves, follow a process, analyze, prove and draw conclusions (Nugrahaeni et al., 2017).

In the aspect of advance clarification, students are measured on their ability to identify terms and consider definitions. The experimental class experienced an increase with the pre-test score 55 and the post-test score 83. Meanwhile, the control class gained pre-test score 49 and the posttest score 60. Even though both experienced an increase, the experimental class was gained higher improvement in critical thinking skills. In the aspect of strategy and tactics, students are measured in their ability to decide on taking an action where the results of both ability tests have increased significantly, the experimental class obtained a pre-test score 69 and post-test score 90. Meanwhile, the control class obtained a pre-test score 62 and post-test score 72. Based on Nugrahaeni et al., (2017) the discovery learning model has an effect on students' motor skills or skills, where during learning students can think critically with the teacher giving students the opportunity to learn actively, the teacher also gives students the opportunity to provide ideas, solving problems by developing analytical skills and processing the information obtained, so that students can be skilled in expressing their opinions. This is also in line with (Agustini et

who stated that interactive learning media based on discovery learning is effective in improving students' critical thinking abilities.

The paired data difference test was done by using the paired sample t-test. The paired sample t-test was carried out due to the requirements for normality and homogeneity of the population were met. Paired sample t-test used to determine the differences that occur due to intervention in both control and experimental classes. The summary of the paired sample t-test results can be seen in the following table 7.

Table 7. Paired sample T-Test results for critical thinking skills

Classes	Data	Average Score	(Sig, 2-tailed)	Category
Control	*Pre-test*	55.03	0.022 (P<0.05)	Significant
	Post-test	59.93		
Experiment	*Pre-test*	55.03	0,000 (P<0.05)	Significant
	Post-test	78.71		

In accordance to the results of the paired sample t-test, it was clear that the students' critical thinking skills in the control and experimental classes experienced a significant increase on the average score in both the control (P=0.022) and the experimental (P=0.000) classes. Nervourssy learning media based on discovery learning has an impact on students who are maximally involved in searching and investigating systematically, critically, analytically and logically so that students can formulate their own discoveries. In the context of discovery learning, students were given problems that require them to search and find their own solutions so that students can practice their critical thinking skills. The knowledge obtained by discovery learning revealed several advantages such as the knowledge that lasts a long time or is easier to remember compared to other methods. The discovery learning provides a reasoning effects and critical thinking skills. This is in line with Sukartiningsih et al (2019) who declared that the discovery learning model, syntactically invited the students to think from easy to difficult. Besides, discovery learning syntactically provides the students with problems, data collection, data processing, verification and generalization

Hypothesis testing was carried out using an independent sample t-test which aims to determine the effectiveness of Nervourssy learning media based on discovery learning. It aims to find out whether there is a difference in the average score of students' critical thinking skills of two unpaired samples. Meanwhile, the independent data test was carried out using the independent sample t-test due to the requirements for normality and homogeneity of the data population met. The summary of the independent sample t-test result on the post-test scores for digital literacy skills in the control and experimental classes can be seen in the following table 8.

Table 8. Independent sample T-Test results for critical thinking skills

Classes	Data	Average Score	(Sig, 2-tailed)	Category
Pre-test Score	Control	67.50	0.998 (P>0.05)	Not Significant
	Exsperimental	68.07		
Post-test Score	Control	63.60	0.000 (P<0.05)	Significant
	Experimental	80.17		

Based on the results of the Independent Sample T-Test, it revealed that there is no significant difference in average score (P=0.998) of students' critical thinking skills. Thus, it can be concluded that the initial abilities of students in the control and experimental classes are the same. In the post-test scores, there was a significant difference in average score (P=0.000) of students' critical thinking skills. Therefore, it can be concluded that the use of Nervourssy learning media based on discovery learning is effective in improving students' critical thinking skills. This is in line with research conducted by Djamas & Padang (2018) that interactive multimedia is effective in improving students' critical thinking skills.

Nervourssy learning media based on discovery learning facilitates active learning that develops critical thinking skills. This is because the learning is framed by independent and group analysis and observation which is presented in a modern and interactive display so that it makes students more active and enthusiastic in learning. The more intensive the learning experience carried out by students, the higher the quality of the learning process. The use of the discovery learning model changes passive to active and creative learning conditions, teacher-oriented learning to student-oriented, and changes the expository mode of students who only receive information from the teacher into a discovery mode where students find information by themselves (Rajagukguk & Rambe, 2022).

▪ CONCLUSION

Based on the results and discussion, it can be concluded that the characteristics of the Nervourssy learning media based on discovery learning on the nervous system material developed have interactive content so that it becomes an attraction for students, an emphasis on group discussions, and a complete integration of the discovery learning model that encourage students to actively involved in the learning process by searching, investigating and formulating their own findings. Nervourssy learning media based on discovery learning on nervous system material is feasible and practical to be implemented in the learning process. This is because nervourssy learning media based on discovery learning on nervous system material is effective in improving students' digital literacy and critical thinking skills.

▪ REFERENCES

Agustini, P. D., Agustini, K., Bagus, I., & Pascima, N. (2023). *Pengembangan media pembelajaran interaktif berbasis discovery learning pada mata pelajaran bahasa inggris materi descriptive di smp negeri 4 singaraja.* Kumpulan Artikel Mahasiswa Pendidikan Teknik Informatika (KARMAPATI), 12(1), 95–106.

Akbari Harahap, N., & Setiawati, T. (2022). *Penerapan model discovery learning untuk meningkatan kemampuan berpikir kritis siswa.* Jurnal Pendidikan Indonesia, 3(6), 575–583. https://doi.org/10.36418/japendi.v3i6.1019

Alberto, C., Ospina, J. A., Luna-garc, H., Parra, J. A., Mauricio, G., Moreira, F., & Villalba-condori, K. O. (2024). Applied sciences work route for the inclusion of learning analytics in the development of interactive multimedia experiences for elementary education.

Amrulloh, R., Yuliani, & Isnawati. (2013). The feasibility theoritical of learning media of interactive multimedia in the topic of mutation for senior high school. Berkala Ilmiah Pendidikan Biologi, 2, 134–136.

BSNP. (2006). *Permendiknas RI No. 22 Tahun 2006 tentang standar isi untuk satuan pendidikan dasar dan menengah. badan standar nasional pendidikan.*

Budiarto, M. K., Rejekiningsih, T., & Sudiyanto, S. (2021). Students' opinions on the need for interactive multimedia development for entrepreneurship learning. International Journal of Evaluation and Research in Education, 10(4), 1290–1297. https://doi.org/10.11591/ijere.v10i4.21411

Djamas, D., & Padang, U. N. (2018). Development of interactive multimedia learning materials for improving critical thinking skills. 14(4), 66–84. https://doi.org/10.4018/IJICTE.2018100105

Ennis, R. H. (2018). Critical thinking across the curriculum: a vision. Topoi, 37(1), 165–184. https://doi.org/10.1007/s11245-016-9401-4

Fitri, A., Fathoni, M. I. A., & Ilmiyah, N. (2023). *Analisis komunikasi matematis siswa melalui soal model pisa pada era literasi digital pasca pandemi covid-19.* Journal of Mathematics Education and Science, 6(1), 75–84. https://doi.org/10.32665/james.v6i1.1589

Fitria, S. J., Biologi, P., Matematika, F., Alam, P., Surabaya, U. N., Biologi, P., Matematika, F., Alam, P., & Surabaya, U. N. (2023). *Pengembangan media pembelajaran powerpoint interaktif pada submateri peserta didik kelas x sma* development of interactive powerpoint learning media on environmental pollution submaterials to train critical thinking ability of 10 th Grade in Senior High Sc. 12(2), 440–451.

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. American Journal of Physics, 66(1), 64–74. https://doi.org/10.1119/1.18809

Hendi, A., Caswita, C., & Haenilah, E. Y. (2020). *Pengembangan media pembelajaran interaktif berbasis strategi metakognitif untuk meningkatkan kemampuan berpikir kritis siswa.* Jurnal Cendekia : Jurnal Pendidikan Matematika, 4(2), 823–834. https://doi.org/10.31004/cendekia.v4i2.310

Heryani, A., Pebriyanti, N., Rustini, T., & Wahyuningsih, Y. (2022). *Peran media pembelajaran berbasis teknologi dalam meningkatkan literasi digital pada pembelajaran ips di sd kelas tinggi.* Jurnal Pendidikan, 31(1), 17. https://doi.org/10.32585/jp.v31i1.1977

Iskandar, M. Y., Putra, A. E., Widia, D., & Efendi, R. (2023). Developing interactive multimedia for natural science in high school. 6, 128–135.

Janah, S. R., Suyitno, H., & Rosyida, I. (2019). *Pentingnya literasi matematika dan berpikir kritis matematis dalam menghadapi Abad ke-21.* PRISMA, Prosiding Seminar Nasional Matematika, 2, 905–910.

Kazakoff, E. R. (2015). Young children and families in the information age: Applications of technology in early childhood. Young Children and Families in the Information Age: Applications of Technology in Early Childhood, 1–292. https://doi.org/10.1007/978-94-017-9184-7

Kurniawati, J., & Baroroh, S. (2016). *Literasi media digital mahasiswa Universitas Muhammadiyah Bengkulu.* Jurnal Komunikator, 08(02), 51–66.

Leow, F. T., & Neo, M. (2014). Interactive multimedia learning: Innovating classroom education in a Malaysian university. Turkish Online Journal of Educational Technology, 13(2), 99–110.

Lestari, A. C., & Annizar, A. M. (2020). *Proses berpikir kritis siswa dalam menyelesaikan masalah pisa ditinjau dari kemampuan berpikir komputasi.* Jurnal Kiprah, 8(1), 46–55. https://doi.org/10.31629/kiprah.v8i1.2063

Misir, H. (2018). Digital literacies and interactive multimedia. International Online Journal of Education and Teaching (IOJET), 5(September), 514–523. http://iojet.org/index.php/IOJET/article/view/178/250

Naufal, H. A. (2021). *Literasi digital.* Perspektif, 1(2), 195–202. https://doi.org/10.53947/perspekt.v1i2.32

Nisa, L. L. A., Setyawati, S. M., & Norra, B. I. (2019). Increasing analytical thinking skills through a popup booklet development with digestive system. Journal of Physics: Conference Series, 1241(1). https://doi.org/10.1088/1742-6596/1241/1/012057

Novitasari, Y., & Fauziddin, M. (2022). *Analisis literasi digital tenaga pendidik pada pendidikan anak usia dini.* Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini, 6(4), 3570–3577. https://doi.org/10.31004/obsesi.v6i4.2333

Nugrahaeni, A., Redhana, I. W., & Kartawan, I. M. A. (2017). *Penerapan model pembelajaran discovery learning untuk meningkatkan kemampuan berpikir kritis dan hasil belajar kimia.* Jurnal Pendidikan Kimia Indonesia, 1(1), 23. https://doi.org/10.23887/jpk.v1i1.12808

Nurlaili, R., Zubaidah, S., & Kuswantoro, H. (2021). *Pengembangan e-module berbasis discovery learning untuk meningkatkan kemampuan berpikir kritis siswa kelas XII berdasarkan penelitian analisis korelasi kanonik dari persilangan tanaman kedelai.* 2013, 213–219.

OECD. (2024). PISA 2022 Technical report. https://www.oecd-ilibrary.org/education/pisa-2022-technical-report_01820d6d-en

Pangrazio, L. (2020). What is digital literacy ? A comparative review of publications across three language contexts. https://doi.org/10.1177/2042753020946291

Pramuji, L., Permanasari, A., & Ardianto, D. (2020). *Multimedia interaktif berbasis stem pada konsep pencemaran lingkungan untuk meningkatkan kemampuan berpikir kritis siswa.* Journal of Science Education and Practice, 2(1), 1–15. https://doi.org/10.33751/jsep.v2i1.1699

Purwanto.M. (2002). *Prinsip-prinsip & teknik evaluasi pengajaran.* PT Remaja Rosdakarya.

Rahmadani, H. (2020). *Profil keterampilan literasi digital: penelitian survey di SMA IT Al Bayyinah Pekanbaru.* Instructional Development Journal, 3(2), 96. https://doi.org/10.24014/idj.v3i2.11306

Rajagukguk, K. P., & Rambe, N. (2022). *Pengembangan media interaktif ipa berbasis discovery learning untuk meningkatkan kemampuan berpikir kritis siswa sekolah dasar.* Elementary School Journal Pgsd Fip Unimed, 12(3), 217. https://doi.org/10.24114/esjpgsd.v12i3.38261

Rejekiningsih, T., Budiarto, M. K., & Sudiyanto, S. (2021). *Pengembangan multimedia interaktif berbasis potensi lokal untuk pembelajaran prakarya dan kewirausahaan*

di sma. Kwangsan: Jurnal Teknologi Pendidikan, 9(2), 167. https://doi.org/10.31800/jtp.kw.v9n2.p167--185

Ridho, S., Ruwiyatun, R., Subali, B., & Marwoto, P. (2020). *Analisis kemampuan berpikir kritis siswa pokok bahasan klasifikasi materi dan perubahannya.* Jurnal Penelitian Pendidikan IPA, 6(1), 10–15. https://doi.org/10.29303/jppipa.v6i1.194

Riduwan. (2013). *Skala pengukuran variabel penelitian.* CV Alfabeta.

Santos, Im. R., & Gomes, M. M. F. (2024). Lifelong digital learning : " computer literacy ," " digital literacy ,"and " digital competence" as dimensions for digital skills. Teaching and Teacher Education, 1–16.

Sari, R., Sumarmi, S., Astina, I., Utomo, D., & Ridhwan, R. (2021). Increasing students critical thinking skills and learning motivation using inquiry mind map. International Journal of Emerging Technologies in Learning (IJET), 4–19.

Saselah, D. (2017). *Pengembangan multimedia interaktif berbasis adobe flash cs6 professional pada pembelajaran kesetimbangan kimia.* Jurnal Kimia Dan Pembelajaran Kimia, 2(2), 80–89.

Septiaahmad, L., Sakti, I., & Setiawan, I. (2020). *Pengembangan lembar kerja peserta didik (lkpd) fisika berbasis etnosains menggunakan model discovery learning untuk meningkatkan keterampilan berpikir kritis siswa sma.* Jurnal Kumparan Fisika, 3(2), 121–130. https://doi.org/10.33369/jkf.3.2.121-130

Sugiyono. (2016). *Metode penelitian kuantitatif, kualitatif, dan R&D.* Penerbit Alfabeta.

Sukartiningsih, S., Sarmini, S., & Jacky, M. (2019). What is discovery learning can grow critical thinking skills? The Indonesian Journal of Social Studies, 2(2), 87. https://doi.org/10.26740/ijss.v2n2.p87-94

Tang, C. M., & Chaw, L. Y. (2016). Digital Literacy: A prerequisite for effective learning in a blended learning environment? The Electronic Journal of E-Learning, 14, 54–65.

Thornhill-miller, B., Camarda, A., Mercier, M., Burkhardt, J., Morisseau, T., Bourgeois-bougrine, S., Vinchon, F., Hayek, S. El, Augereau-landais, M., Mourey, F., Feybesse, C., Sundquist, D., & Lubart, T. (2023). Creativity, critical thinking , communication , and collaboration : assessment , certification , and promotion of 21st century skills for the future of work and education.

Wahjusaputri, S., & Purwanto, A. (2022). *Statistika pendidikan: teori dan aplikasi.* CV. Bintang Semesta Media.

Wiana, W., Barliana, M. S., & A.Riyanto, A. (2018). The effectiveness of using interactive multimedia based on motion graphic in concept mastering enhancement and fashion designing skill in digital format. International Journal of Emerging Technologies in Learning, 5–20(02).