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The Readiness of Science Teachers to Implement Differentiated Learning and Integrated STEM in Ecology Subject of the "Merdeka" Curriculum in Junior High School

Nikmatin Mabsutsah[1], Slamet Hariyadi[1], Jekti Prihatin[1]
[1] Master Program of Science Education, University of Jember, Indonesia

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ABSTRACT
Each student in the class has different abilities, readiness, and interests in learning. As the provider of materials and as a facilitator, the teacher must be able to adapt to curriculum changes, including enhancing students' creative thinking skills through differentiated and integrated STEM learning in the subject of ecology for grade 7 in junior high school. This research aims to analyze the readiness of science teachers to implement differentiated and integrated STEM learning in the "merdeka" curriculum of junior high school. The analytical method used is quantitative descriptive, employing a semi-open questionnaire consisting of 16 questions. The research subjects are 15 science teachers of grade 7 in junior high schools in Besuki. The questionnaire analysis results show that 66.7% of the teachers have implemented differentiated learning under the principles of the merdeka curriculum. However, they face several constraints, such as time, learning resources, facilities, infrastructure, and lack of training and experience teaching differentiated learning. 33.3% of science teachers who have integrated STEM into the ecology subject also encounter constraints such as time, availability of electricity, availability of materials, internet connection, and lack of training. 0% of science teachers have not yet used differentiated STEM-integrated ecology modules. Thus, 100% of the teachers agree with the development of differentiated STEM-integrated ecology modules, as teachers need learning media that can assist in implementing differentiated STEM-integrated learning.

Corresponding Author:
Slamet Hariyadi,
Master Program of Science Education, University of Jember
Jalan Kalimantan 37 Sumbersari, Jember 68121, Indonesia
Email: mailto:s.hariyadi.fkip@unej.ac.id

1. INTRODUCTION

The implementation of differentiated learning is an effort to adapt the learning process in the classroom to meet the individual learning needs of each student (Tomlinson, 2017). Students in the classroom show multi-level differences because they have different abilities, readiness, and interests in learning. A teacher is responsible for operating a learning process that aligns with each student's learning styles and needs. However, few teachers understand the basic concept of differentiated learning (Jamoliddinova & Kuchkarova, 2022). The heterogeneity of students remains a problem that receives insufficient attention and can impact the low learning outcomes of students (Purba et al., 2021). Currently, teachers are expected to implement differentiated learning and support each individual in improving their learning outcomes (Porta & Todd, 2022). Teachers' role is crucial in supporting curriculum changes (Jamjemah et al., 2022). Teachers can implement differentiated learning in content, process, product, and learning environment (Tomlinson, 2014). Content refers to the curriculum and learning materials. The process involves the way students learning the material according to their preferred learning styles and interests. The product refers to the learning outcomes that the teacher will assess. The learning environment refers to the classroom's concrete and abstract elements (Tomlinson & Imbeau, 2011).

In Indonesia, differentiated learning has been shown to improve student learning outcomes by 96.55% of the total students (Kamal, 2021). However, there are several challenges to the implementation of differentiated

learning. Firstly, teachers in Barabai, Indonesia, are still unsure of how to identify their students' learning styles and readiness for learning (Jatmiko & Putra, 2022). Secondly, teachers in Probolinggo tend to give assignments based on their preferences rather than considering students' learning characteristics (Balgan et al., 2022). Teachers should master adapting content, process, product, and learning environment to meet students' needs, which can positively impact the intended learning goals (Pratama et al., 2022). Research by Balgan et al. (2022) shows that differentiated learning is an educational approach that addresses students' personal needs and motivations for meaningful learning. Students with different learning activities will show different implementations in the classroom.

Differentiated learning aligns with the principles of the Merdeka curriculum, which aims to improve learning outcomes according to students' individual needs (Ngaisah et al., 2023). It is in line with the philosophy conveyed by Ki Hajar Dewantara regarding the purpose of education, which is to guide all the inherent potentials in children so that they can achieve the highest level of well-being and happiness, both as individuals and as members of society. Therefore, teachers can only guide the growth and development of the inherent potential in children to improve their behaviour and the growth of their potential (Kamal, 2021). The instructional materials in the "merdeka" curriculum are adjusted to the characteristics or needs of each student (Heryahya et al., 2022). The "merdeka" curriculum prioritizes character strengthening through the profile of Pancasila learners, one of which is creativity (Maulida, 2022).

Creative thinking skills are recognized as crucial for facing current challenges and are a core objective at all levels of education (Huerta et al., 2022). Creative thinking is essential in problem-solving and generating new ideas (Suherman & Vidakovich, 2022). Some aspects of creative thinking skills indicators, according to P. E. Torrence, are fluency, flexibility, originality, and elaboration (Nurzulifa & Dwijanto, 2021). Several studies have shown that the creative thinking skills of junior high school students are still categorized as low. For example, the average creative thinking ability in Sidoardjo is 13.59, categorized as not creative (Santoso & Wulandari, 2020), while in Maumere, the average is 56.96, categorized as moderately creative (Jandu & Mago, 2020). The research by Laksono et al. (2021) proves that students' creativity can be improved through module development.

A learning module is a complete instructional medium that students can study individually (Ananda & Amiruddin, 2019). Modules can enhance students' learning outcomes without direct assistance from the teacher (Fattahillah et al., 2023)). Modules make science learning more comprehensive in understanding scientific concepts (Nyhout & Ganea, 2022). Teachers who use modules cover more material than those who do not (Century et al., 2020). As stated by (Kurniawan & Susanti, 2021), some characteristics of an attractive module are self-instructional, stand-alone, user-friendly, self-contained, and adaptive. One factor that can enhance the quality of learning is the development of learning media according to the needs of teachers and students (Najuah et al., 2020). Each module can have agreed-upon competency levels based on students' backgrounds (Cole et al., 2022). Modules can be managed to guide students step by step through the content, thus facilitating the learning process (Haderer & Ciolacu, 2022). One module that can enhance students' creative thinking skills is a module on "energy" integrated with STEM (Science, Technology, Engineering, and Mathematics) (Othman et al., 2022). Hence, a module can be developed for independent learning and integrated STEM to enhance students' creative skills.

STEM aims to connect various disciplines to solve real-life problems, motivate students to prepare for future careers, and equip them with knowledge and skills (Le et al., 2021). Integrated STEM should address critical global issues (such as climate change and energy sources) and develop design skills through practical technology and engineering activities, focusing on theory-based design. Examples of ecological problems threatening biodiversity include global warming, climate change (Hermawan & Svajlenka, 2022), water pollution (Liu et al., 2022), habitat loss, pollution, invasive species, monoculture, and overfishing or illegal hunting (Zaitegi et al., 2022). Students can solve problems in their daily lives by integrating STEM approaches with knowledge and skills (Ku et al., 2022). The social constructivism theory can serve as the foundation for the STEM approach, where children collaborate in groups to seek solutions, engage in the design process to generate creative ideas and construct their knowledge (Octaviyani et al., 2020). According to the studies, integrated STEM in teaching Ecology can teach students to overcome ecological problems in everyday life.

Based on the background, differentiated learning and integrated STEM developed into a module have great benefits as a learning media. It aligns with Balgan et al. (2022), who stated that differentiated learning in STEM is crucial to achieving the desired learning outcomes in developing countries. Besides, it is essential to understand how secondary school teachers comprehend and implement differentiated learning and explore their perceptions of the challenges in effectively implementing it (Porta & Todd, 2022). Therefore, the researchers aimed to analyze the readiness of teachers to implement differentiated learning and integrated STEM in the "merdeka" curriculum for the ecological topic in 7th-grade SMP.

2. RESEARCH METHOD

The method used in this research is quantitative descriptive. This study provides an overview of teachers' preparedness as educators and facilitators to meet all students' needs to achieve learning objectives. The research

subjects were 15 science teachers in Besuki, East Java, Indonesia. The data collection techniques involved observation and semi-open questionnaires. The observation technique focused on the teachers' "merdeka" activities in implementing the Merdeka curriculum in the classroom. The questionnaire was applied by providing questions through a Google Form distributed via WhatsApp. Data were collected using the questionnaire results, which consisted of 16 semi-open questionnaire questions. The instrument consisted of several indicators covering various aspects, such as curriculum, learning resources, ecology materials, integrated STEM, differentiated learning, modules, creative thinking skills, and student learning outcomes.

3. RESULT AND DISCUSSION

The readiness of strategies and approaches by science teachers towards the students' learning process in the subject of ecology.

The questionnaire results from 15 science teachers in the Besuki Residency, East Java, Indonesia, regarding the curriculum show that more science teachers use the 2013 curriculum than those who use the Merdeka curriculum. 66.7% of science teachers in East Java still use the 2013 curriculum, while 60% use the Merdeka curriculum (Figure 1). No more science teachers have been using the emergency curriculum since the completion of the COVID-19 pandemic.

Figure 1. Curriculum Used by Science Teachers

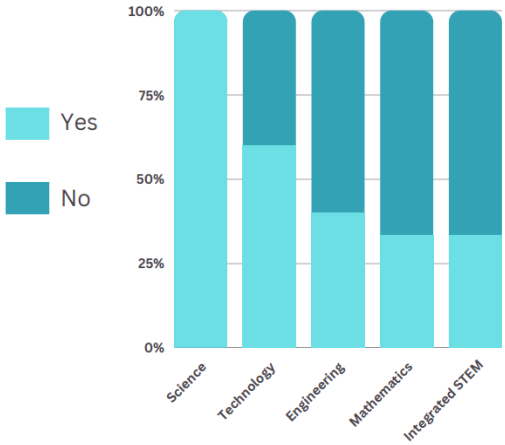

Figure 2. Science Teachers Implementing STEM and Integrated STEM Elements

The questionnaire on science teachers implementing STEM elements in ecology subjects in Figure 2 shows that 100% of science teachers have implemented the science element. However, STEM elements such as technology, engineering, and mathematics have not been well implemented. Teachers who have implemented the technology element are above 50%, while those who have implemented engineering and mathematics are below 50%. Therefore, less than 50% of science teachers have integrated STEM into ecology subjects. The questionnaire results in Table 1 indicate that some science teachers face challenges in implementing STEM elements and integrating STEM into ecology subjects. These challenges include the learning environment, time constraints, internet connectivity, LCD availability, lack of teaching aids and materials, lack of ideas, and insufficient training. However, most teachers' issues are related to their lack of confidence in integrating STEM within the given time, the availability of school facilities that support STEM integration, and the availability of teaching aids to support STEM integration.

Table 1. Challenges in Ecological Learning Process

Question	Answer	R
What challenges do you face in implementing the Science element in STEM for ecological topics?	The environment that supports ecological exploration near the school is inadequate.	R8, R11, R12, R13
	The time available for teaching is limited, and the internet network in my teaching area is very poor, even when using the best provider.	R10, R12, R13
	There is no LCD screen, so when I want to show pictures or videos using a laptop, I must place it close to the students.	R12, R7
	Some students rarely read about the presented material, and there are still many students who are unfamiliar with ecology.	R13
	The students find it difficult to understand the content of the teaching materials created or available at school.	R14, R8
	Lack of instructional media.	R2, R4
What challenges do you face in implementing the elements of Technology in STEM for ecology subjects?	The school infrastructure and facilities are not adequate to support the implementation.	R3, R5, R8, R10, R12, R14
	I have not found any innovative learning media related to ecology.	R4
	Lack of instructional time.	R1, R7, R13
	We have limited power sources. There are no electrical outlets in the classroom.	R9, R13
	Students face difficulties if additional learning media are not used.	R2, R15
What challenges do you face in implementing the engineering element in STEM for ecology topics?	Children find it difficult to find materials.	R1, R8, R12, R13
	They do not have ideas for creating supportive teaching aids. There are no examples of ecological products.	R9, R10,
	There are no supporting facilities available.	R7, R13
	The time for designing the product is insufficient.	R11
	There is a lack of supporting media, such as textbooks or modules.	R15
What challenges do you face in implementing the mathematics element in STEM for ecology topics?	Children sometimes struggle to count the number of grass organisms in one plot.	R1, R5
	Because students lack enthusiasm when given calculations.	R8, R13
	Lack of instructional time.	R7
	Lack of supporting instructional media.	R15
What challenges do you face in integrating Science, Technology, Engineering, and Mathematics (STEM) in ecology topics?	I don't understand how to apply STEM to ecology subjects. So far, what I have seen is STEM being used to teach physics.	R1, R15
	Difficulty in finding materials to implement STEM projects for creating tools like robots.	R1, R4
	There is no electricity connection available to implement STEM in the classroom.	R7, R8, R10
	I have never attended training specifically for implementing STEM. I have only received training for literacy and numeracy.	R1, R11
	The lack of class time is a challenge when implementing STEM projects that we have to create products.	R10, R12, R13
	There are no learning resources available to support the implementation of STEM.	R2, R4, R14
	I have not fully implemented the “merdeka” curriculum.	R3, R7
	When using differentiation, the challenges lie in preparing teaching materials and assessments.	R9
	If there is a wide variation in students' foundational skills, it can be challenging to implement differentiated instruction effectively.	R12
What challenges do you face in implementing the components of	I do not understand how to implement differentiated instruction.	R3
	The limitation lies in having limited plans and ideas for varied instruction.	R1, R4

differentiated instruction?	Sometimes, no LCD, power source, and Wi-Fi in the classroom.	R7
	It is not easy to implement in large classes due to the varied profiles of students.	R8, R9, R10
	There are no instructional media available to provide examples of differentiated instruction implementation.	R12, R15
	There is no training specifically focused on differentiated instruction; it is limited to creating teaching modules.	R14
What challenges do you face in enhancing students' creative thinking skills?	Students are not able to freely search for simple materials around the school.	R1, R11
	The students' understanding of the description and explanation of the steps is still low.	R15
	There are no examples provided to address ecological issues.	R8, R13, R14
What challenges do you face in improving students' learning outcomes?	The limitations lie in time constraints and skills.	R1, R3, R11, R7
	There are limitations in terms of facilities.	R14
	Lack of student motivation.	R4
	Lack of learning media.	R1, R5, R8, R10, R13, R15

The notation R = Respondent.

The results of the questionnaire from science teachers regarding differentiated learning in ecology subjects show that more than 50% of science teachers have implemented differentiated learning (Figure 3A). However, the majority of science teachers only differentiate the products. More than 50% of science teachers have implemented product differentiation, while less than 20% have implemented differentiation in process, content, and learning environment (Figure 3B). Several constraints in implementing differentiated learning are mentioned in Table 1, including understanding differentiated learning, limited ideas for variation, lack of training, inadequate facilities, and teaching resources. However, the main challenge most science teachers face is the diversity or variation in student profiles within the same class.

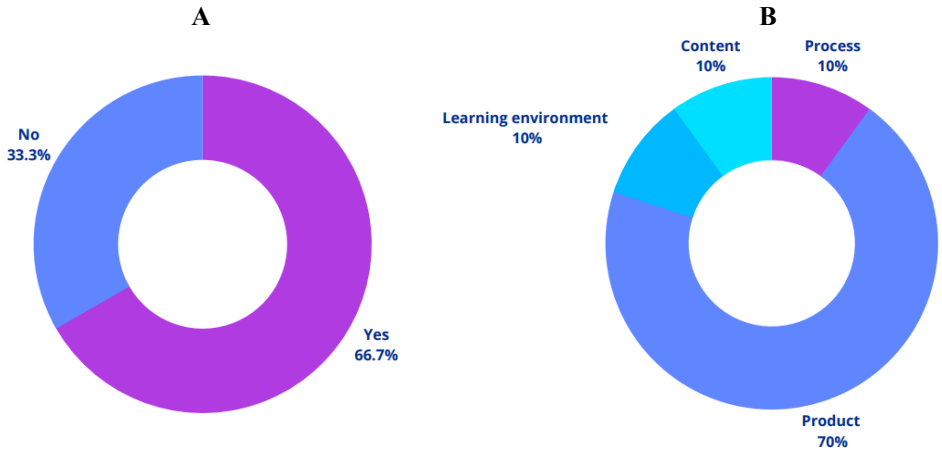

Figure 3. A. Science teachers who use differentiated learning, B. Components of differentiated learning implemented by science teachers.

The teachers' questionnaire results regarding the level of students' creative thinking skills show that most teachers rated the students' creative thinking skills as good and relatively good, with a percentage of 40% (Figure 4). Some teachers mentioned constraints in enhancing students' creative thinking skills, such as the lack of resources, students' weak understanding of the steps of the scientific method, and the lack of examples in creating ecological products (Table 1). However, the primary constraint mentioned by most teachers is the lack of examples of products to address ecological issues.

The questionnaire regarding students' learning outcomes in ecology subjects reveals that most teachers stated that the students' learning outcomes were categorized as good, with a percentage of 53.3% (Figure 4). Some science teachers faced challenges in improving students' learning outcomes, such as limited time, school facilities,

teaching resources, and teaching abilities. However, most science teachers mentioned that their main challenge was limited time (Table 1).

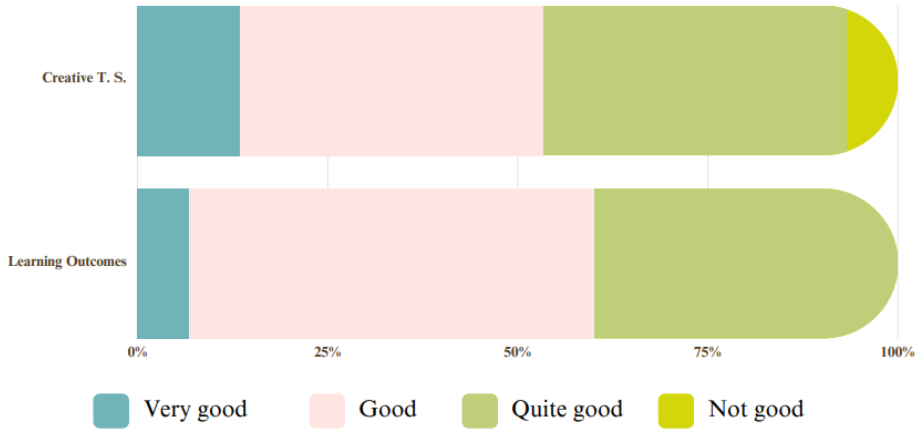

Figure 4. Creative thinking skills and learning outcomes.

The readiness of science teachers regarding instructional media in the subject of ecology.

Learning resources are used by 15 science teachers in implementing the "merdeka" curriculum. More than 90% of the teachers utilize textbook packages as their primary learning resource. Additionally, 60% of the teachers incorporate student worksheets into their teaching practices. However, less than 40% of the teachers utilize other learning resources, including modules, e-modules, and creating their modules. It suggests a reliance on traditional materials, such as textbooks and worksheets, with limited exploration of alternative resources for curriculum implementation.

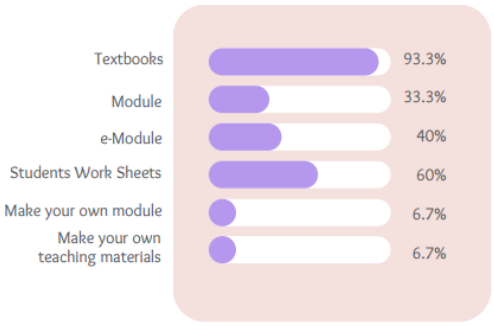

Figure 5. Learning Resources Used by Science Teachers

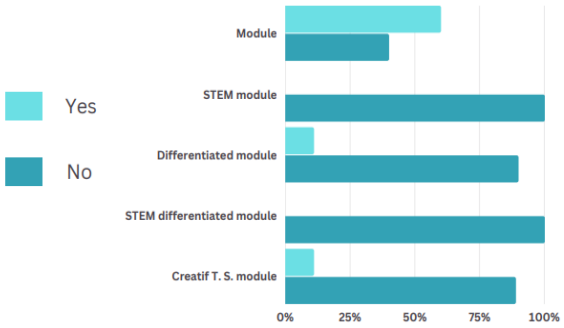

Figure 6. Science Teachers Using Modules

The questionnaire from 15 science teachers indicates that more than 50% of them have used ecology modules (Figure 6). However, 100% of the ecology modules used by science teachers have not been integrated with STEM. Furthermore, only 11.1% of the teachers have used differentiated modules, but none have utilized differentiated STEM-integrated modules. Some of the challenges reported by teachers in using modules include difficulty in understanding the modules, lack of attractiveness, practical examples in the modules requiring difficult-to-obtain materials and equipment, modules being in the form of teaching guides (lesson plans), and misalignment with student needs. However, most teachers state that the modules do not align with the principles of the "merdeka" curriculum, such as differentiated learning (Table 2).

More than 80% of the science teachers who have used modules to enhance students' creative thinking skills are above those who have not. Some teachers mentioned challenges in implementing modules, such as limited availability, lack of detail, mismatch with student needs, and high cost. However, most teachers state that the main challenge lies in the modules not meeting student needs regarding interests, learning styles, and backgrounds.

Table 2. Challenges in implementing the ecology module.

Question	Answer	R
What challenges do you face after using the ecology module?	The module is too difficult for 7th-grade students to understand.	R2, R10
	Students lack motivation to learn because the module is not engaging enough.	R6, R8
	Learning activities in the module require tools and materials that are difficult to obtain.	R11
	The module does not align with the "merdeka" curriculum that should cater to students' profiles and needs.	R1, R4, R13, R14
What challenges do you face after using the differentiated instruction module?	The module is in the form of a lesson plan, so it is difficult to provide it directly to students.	R2
What challenges do you face after using the ecology module to enhance creative thinking skills?	The module's content is limited and lacks detailed guidance for developing creative thinking skills, which does not align with the students' needs.	R1, R3, R7
	The main challenge is the cost involved, which requires printing materials for each session or meeting.	R11

The notation R = Respondent.

Table 3. Suggestions for the development of the ecology module.

Question	Answer	R
Do you agree with the development of an ecology module based on STEM to enhance creative thinking skills and learning outcomes in a differentiated classroom according to the needs of each student? Please provide your suggestions:	Yes	R1-R15
	Easy to understand by students, both independently and in the classroom.	R1
	Not too difficult to implement.	R3, R5, R4, R8, R9, R10, R15
	Utilize affordable and easily accessible STEM activities.	R4, R4, R5, R8, R10
	Develop modules that meet the specific needs of students or differentiate instruction.	R6, R9, R10, R14, R15
	Enable teachers to save time in classroom instruction.	R8, R1
	Ensure the module is affordable and easily obtainable.	R10
	Provide clear instructions for independent learning to facilitate students' understanding.	R13

The notation R = Respondent.

The results of the questionnaire on the development of an integrated STEM ecology module in differentiated classrooms to enhance creative thinking skills and learning outcomes showed that 100% of science teachers agreed. Some suggestions from science teachers regarding module creation include ensuring it is not too difficult to implement, easily understood, differentiated to meet students' needs, utilizing low-cost STEM materials, and time-saving. However, most teachers suggested that the module should not be overly challenging, differentiated and use simple materials from the environment.

This study aims to determine teachers' preparedness in preparing learning approach plans and instructional media for the ecology topic in grade VII of junior high schools. Science teachers explained the challenges of implementing the "merdeka" curriculum in Indonesia as the desired media to facilitate classroom learning based on the "merdeka" curriculum's principles.

Science teachers who have implemented STEM elements in the "merdeka" curriculum face several challenges in the process of teaching Ecology, such as limited school environment, limited time, lack of LCD, low interest in literacy among students, difficulty finding innovative media, lack of electricity, limited materials for practical activities, and low students' mathematical skills. Furthermore, challenges in integrating STEM include a lack of understanding of how to apply STEM to ecological topics, lack of training, limited time for STEM implementation, and lack of learning resources. It aligns with the statement by Aminatun et al. (2022) that one of the challenges in the learning process is the uneven distribution of internet access in classrooms. Teachers

perceive various challenges in integrating STEM in the classroom, including time constraints for preparation and teaching, risks of failure in the engineering process, lack of confidence in their potential, and school facilities that may not be supportive (Bungum & Mogstad, 2022). Time and project management are significant challenges in integrating STEM in the classroom, as teachers face the challenge of producing high-quality products. The iterative testing of STEM design and emphasis on conceptual development for each student makes integrating STEM challenging (Wieselmann et al., 2022).

Teachers who face time constraints in integrating STEM should use simple STEM activities to design tools to address ecological issues, such as creating bird nests, building aquaponics systems, and creating bird feeders using recycled bottles and natural materials. Designing simple tools does not consume much time; if there is not enough class time for the design process, teachers can assign homework. Regarding time constraints, according to Kamarudin et al. (2022), teachers should take several steps, including considering all factors that affect student growth and development, ensuring that each teaching session has sufficient and appropriate time for preparation and teaching, and ensuring that teachers have enough preparation and teaching time.

Teachers who face power supply constraints should seek assistance from the school in providing the necessary facilities and infrastructure in the classroom. Teachers should report any needs to improve the quality of the learning process. Furthermore, for internet access, teachers can use personal hotspots to connect to the internet or pre-download instructional videos in places with internet access. Additionally, teachers who lack confidence in implementing STEM should consider attending training or workshops on integrated STEM in the classroom. STEM is not as difficult as teachers may perceive. Increasing teachers' knowledge in implementing STEM can be achieved through online professional development training for STEM teachers (STEM-TPD) using the DECODE model (Wahono et al., 2022).

Teachers who focus on differentiated products are more than those who focus on differentiated processes, content, and learning environments. Teachers also face challenges in implementing differentiated instructional processes based on the “merdeka” curriculum, such as time constraints for lesson and assessment preparation, a large number of students requiring more variations, lack of understanding of differentiated instruction, lack of ideas for meeting students' needs, lack of examples of differentiated instruction, and a lack of training or workshops. It aligns with the research by Porta & Todd (2022), indicating that teachers mention several challenges in effectively implementing differentiated instruction, such as lack of time and large class sizes. According to Jamoliddinova & Kuchkarova (2022), teachers rarely or never experience differentiated instruction in pre-service teacher education programs. To effectively implement differentiated instruction, pre-service teachers should receive efficient education before graduating from university, and experienced teachers should participate in in-service training. Teachers require more training for professional development in differentiated instructional processes. Another challenge is the learning environment, including sharing classroom space among several groups, limited workspace, storage cabinets, and a large number of students (Demircan, 2022)

Teachers with difficulty implementing differentiated learning based on its components can first learn about differentiation techniques in the process, content, product, and learning environment. According to Tomlinson and Imbeau (2011), in terms of content, teachers modify learning materials based on students' learning styles and their current abilities. The content is adjusted to fit the students' conditions and abilities. For example, reading materials of different levels (regular, remedial, and enrichment). Students who need remedial support are given concise reading materials, while those who do not need remediation are provided with more in-depth and extensive reading materials. Other forms of differentiated content include providing reading materials with different themes.

The following discussion is about the process aspects. Due to the variety of learning styles and preferences among students, the classroom needs to be modified to accommodate different learning needs effectively for example, delivering the material based on students' learning styles (using visuals, videos, and hands-on activities). Regarding product aspects, students' learning styles determine the products or learning outcomes. For example, teachers can ask students to create products based on their learning styles (drawings, videos, or three-dimensional models). In the learning environment aspect, differentiation can occur regarding time and space. For instance, students can be assigned tasks in different locations, such as inside or outside the classroom, and differentiation in the learning environment can be implemented during daytime or afternoon sessions.

Teachers can integrate differentiated STEM into ecology lessons by providing different themes to create STEM products. For example, in terms of content, students are asked to read about ecological components with different themes (rice fields, birds, and fisheries). Regarding process differentiation, teachers can modify the learning process by using modules, videos, or activities to deepen students' understanding of ecology. In differentiated STEM products, students can create products based on their learning styles, such as drawings, videos, or three-dimensional models. Differentiated learning aligned with the goals of the “merdeka” curriculum should not only be the responsibility of teachers but also require schools to provide supportive learning tools in

the classroom, such as providing laptops for students with audiovisual learning styles, tools and materials for students with kinesthetic learning styles, and pictures or reading books for students with visual learning styles. Teachers also need instructional media such as modules, teaching materials, worksheets, and textbooks to support differentiated learning in the classroom, enabling students and teachers to adapt to the new curriculum and achieve learning objectives.

The questionnaire results indicate that students' creative thinking skills are categorized as good and very good. However, after observing one teacher, it was found that creative thinking skills were not measured using specific indicators; only the concrete products of the students were evaluated. The teacher stated that students had difficulty finding materials and understanding the steps of the scientific method. If students have trouble finding materials, the teacher or the school should provide instructions on the availability and location of materials. There should even be assistance in providing the necessary tools and materials. Students who have difficulty understanding the steps of the scientific method visually can be helped by understanding them through audiovisual means via the Internet. Teachers can enhance students' creativity with the support provided, and they should have learning resources that can enhance students' creative thinking skills. According to Aini and Aini (2023) creative thinking skills are essential skills that students must possess in the 21st century to adapt to daily life. Therefore, students need to have experience in enhancing their creative thinking skills.

Low student creativity is due to an imbalance in the brain caused by the excessive restriction of ideas, so higher stimulation is needed to enhance student creativity (Duval et al., 2023). Research findings show that the causes of low creative thinking skills among students are: teacher-centred learning processes, inappropriate instructional models, low learning motivation, and traditional teaching methods. The problems presented in the supporting learning materials cannot measure students' mathematical creative thinking abilities, resulting in boring lessons and low creative thinking skills among students (Sitepu et al., 2023). Instructional media used by teachers to support creative thinking skills must be well-prepared, with different materials for students with different abilities, and provide a variety of learning methods that can stimulate students' creative thinking abilities (Utomo et al., 2020).

The teacher stated that the students' learning outcomes are categorized as good. However, after observing two teachers, even though the learning outcomes were good, the students could not solve problems at the analysis or C4 level. The teacher created questions with lower-order thinking skills, generating good student grades. It does not meet the learning objectives where students should be able to address ecological issues. The low learning outcomes are caused by the science learning process, which often only focuses on theoretical understanding and makes students unable to solve environmental problems (Lestari, 2020). Learning outcomes are typically seen as a final result predetermined and isolated from the learning process. However, learning outcomes can also be observed during the learning process when students are actively engaged (Skau & Lindstol, 2022).

There are several challenges regarding teachers' readiness to implement media in learning to support the “merdeka” curriculum. Teachers have not found an integrated STEM ecology module, which hinders some of them from implementing STEM. The lack of supporting facilities and time constraints also make teachers less confident using STEM modules. Furthermore, teachers face challenges in applying differentiated modules in the classroom because their understanding of modules is currently limited to teaching modules (lesson plan) rather than learning modules. Teachers state that differentiated modules are teaching modules that cannot be directly applied to students. They also encounter difficulties with existing ecology modules as they lack detail and do not meet the students' needs. Therefore, teachers require differentiated STEM-based ecology modules to implement the “merdeka” curriculum that aligns with the demands of the 21st century. According to (Mabsutsah & Yushardi, 2022), changes require teachers to adapt to the demands of the “merdeka” curriculum, including the additional teaching materials that support all criteria for authentic assessment in the learning process. Quality learning processes require good media or instructional models.

Teachers need modules that can support differentiated learning in the classroom, which are easy to implement and utilize simple facilities according to the students' and school's capabilities. According to Jamoliddinova and Kuchkarova (2022), differentiated learning is related to the teachers' experience, age, and grade level, while the length of teaching does not influence it. The responsibility for implementing differentiated strategies is not solely placed on the teachers; it requires joint and coordinated efforts from all stakeholders in the secondary school to make it a reality. Teachers find it challenging to implement differentiated learning due to classroom management issues. They need to dedicate their time and energy to meeting the needs of their students rather than focusing solely on themselves. Sharing ideas and communication, as well as independent task completion and group collaboration, should be encouraged according to students' interests to enhance their existing potential further and develop students who are more competitive in the future (Kamarudin et al., 2022).

Teachers need supporting media such as modules to integrate STEM into differentiated classrooms with confidence so students' creative thinking skills and learning outcomes can improve and learning goals on ecological topics can be achieved. It is to assist teachers in implementing the principles of the “merdeka”

curriculum that cater to the needs of each student and help students prepare for the future with STEM. Through the STEM approach, students not only memorize concepts but also understand how scientific concepts relate to everyday life. Students who learn through the STEM approach can also become independent and self-directed learners, gaining confidence and developing the ability to work within a specified timeframe (Sutarto et al., 2021). According to Balgan et al. (2022) teachers should employ different teaching methodologies as there is a strong relationship between intellectual abilities, learning styles, and students' personality types in STEM learning. STEM is an integrated learning approach that involves curriculum content, teaching activities, and educational policies. All four elements of STEM ultimately converge on technical problems and products (Hariyadi et al., 2023).

Differentiated modules effectively enhance students' skills according to their potential (Ulger & Cepnı, 2020) The modules are designed based on predetermined times and stages. They have specific objectives that focus more on a particular learning outcome. The development of differentiated modules within the context of solving everyday life problems considers the characteristics of potentially talented students. Based on teachers' readiness regarding process and media to implement the "merdeka" curriculum, teachers have utilized differentiated learning and integrated STEM into ecological topics. However, no teachers have yet to use differentiated integrated STEM ecology modules. However, they face several challenges; lack of confidence due to limited time, students' diversity, inadequate school facilities, infrastructure, and teacher training. Therefore, this study suggests to develop materials, lesson plans, and media regarding STEM and differentiated learning is worth further research, especially in ecology.

4. CONCLUSION

The readiness of science teachers in planning differentiated STEM-integrated ecological learning processes and media for implementing the "merdeka" curriculum is not fully prepared. Among the science teachers, 33.3% have integrated STEM, and 66.7% have implemented differentiated learning in ecological topics. However, they face several challenges; lack of confidence due to limited time, diverse student profiles within a single class, school facilities, and infrastructure, inadequate supporting media for differentiated STEM learning, lack of supportive teaching models for differentiated learning, and insufficient training. In the ecological subject, students require creative thinking skills to address ecological problems according to their interests and needs. Creative thinking skills can be enhanced through integrated STEM and the availability of supporting media. Therefore, 100% of science teachers agree that the development of STEM-based ecological modules is needed to enhance creative thinking skills and learning outcomes in the classroom within the framework of the "merdeka" curriculum.

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