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SCIENCE TECHNOLOGY ENGINEERING AND MATH (STEM) BASED LEARNING MODEL IN BIOLOGY LEARNING AT ISLAMIC SENIOR HIGH SCHOOL

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Abstract

The purpose of this study was to analyze the percentage level of STEM occurrence in biology textbooks. The population used in this study was two biology teachers. The sample was taken using a purposive sampling technique. This data collection instrument is a human instrument. The approach uses STEM, and the type of research is descriptive qualitative. The data were analyzed descriptively; the data sources used in this study came from the curriculum, KI/KD lesson plans, and biology textbooks. Data analysis techniques using STEM indicators. The results showed the percentage of STEM occurrence rate in biology textbooks class X semester II by validator I had 17,5% Science components, 5,7% Technology, 25,6% Engineering, and 5,0% Mathematics; validator II had 17,5% Science components, 50,5% Technology, 26,0% Engineering, and 5,8% Mathematics; validator III had 17,5% Science components, 51,7% Technology, 25,6% Engineering, and 5,0% Mathematics. The average occurrence of STEM components is science as much as 17,5%, Technology as much as 51,3%, Engineering as much as 25,7%, and Mathematics as much as 5,2%. The assessment of the validator received a very suitable category with an assessment of 99,8% in the biology textbook at MAN 1 Medan class X semester II.

Keywords Biology, MAN 1 Medan, STEM, Textbooks.

INTRODUCTION

Biology learning includes concepts, phenomena, and life processes around us, which are closely related to daily life, both in the context of humans, animals, plants, microorganisms, and the environment. Usually, biology learning is carried out conventionally, where teachers convey biological concepts, facts, and processes orally to students, although this method is not in line with the Merdeka Curriculum currently in effect. In the curriculum, students are expected to be more active (student-centered) in solving problems and drawing conclusions from the material learned during learning. The STEM approach is one way to integrate learning with the Merdeka Curriculum to prepare students for the challenges of life in the 21st century.

The STEM approach in biology learning can be applied through several learning models, such as discovery learning (finding concepts or principles through problem-solving), inquiry learning (solving given problems), and problem-based learning (solving problems with various thinking skills) (Yulia, 2021). The main goal of the STEM approach is to integrate the four disciplines of science, technology, engineering, and mathematics with biology learning, where biology itself is also related to these four disciplines. According to (Bybee, 2010), the goal of STEM in primary and secondary education is to form STEM literate students with the knowledge, attitudes, and skills necessary to identify life questions and problems, draw conclusions based on relevant evidence, explore STEM issues, understand the characteristics of STEM disciplines as a form of knowledge, explain natural phenomena, develop human ideas, and realize how STEM disciplines shape the material, intellectual, and cultural environment, or engage in research on STEM. Research also shows similar impacts to these objectives.

Based on the interview with the biology teacher of class X at MAN 1 Medan, it is known that the learning process begins with an observation interview and a review of the Curriculum, lesson plans, KI/KD, and textbooks used. From the interview, it was revealed that the teacher faced obstacles during the biology learning process in the classroom, especially related to the lesson hours and time that were not conducive. This is due to the complexity of the biology material, which requires teachers to find solutions so that learning objectives can be achieved. Although the textbook at MAN 1 Medan has implemented the STEM approach in biology learning, the implementation has

not been optimal due to the limited technology owned by students. Teachers also have difficulty in overcoming this technology-related obstacle.

Research on STEM-based biology learning includes: First, Mia Mai Syarah's research (2021), which includes the results of the analysis of the application of the STEM approach to biology learning, can be integrated with appropriate learning models and materials. The application of the STEM approach can improve student learning outcomes, student critical thinking skills, student science literacy, student creativity, and scientific thinking ability. However, it has no effect in improving technological literacy and decision-making skills due to several factors, such as the placement of research subjects and inappropriate research time, so it has not had an effect. Second, research by Maisyarah Ayu Budi Ningrum (2021) shows that STEM literacy-based biology learning has been implemented, but students are still less enthusiastic about reading, students are more interested in learning related to technology, and teachers do not know the right evaluation formulation to determine students' STEM literacy achievement in biology learning. Third, Amalia Prabandani Halim's research (2021), with the results of the Basic Competencies of the 2013 curriculum in the field of class X biology studies that have been analyzed, have sufficient potential to apply STEAM learning with the qualification that 17 materials do not have STEAM potential because the material does not meet the indicator criteria needed to apply STEAM learning, 31 materials have sufficient potential to apply STEAM learning, and two materials have great potential to apply STEAM learning. The existing STEAM potential is expected to be used and developed optimally by teachers in teaching and learning activities.

The distinction between the author's research and previous research is that the author's research analyzes the suitability of STEM in biology learning with the subject of curriculum, lesson plans, and textbooks used at MAN 1 Medan. This research is important because it wants to prove whether it is appropriate to learn biology using the STEM learning model, how the learning methods are used, and what the obstacles to STEM in biology learning are. The research used descriptive qualitative research methods. The gap in this research is that the student learning book at MAN 1 Medan has implemented STEM in biology learning, and biology teachers have also implemented STEM. However, the application of STEM has not been maximized because the students have technological limitations. Teacher barriers cannot overcome these technological barriers.

METHOD

This research is a qualitative descriptive research. The main instrument in this research is (the human instrument) which plays a role in determining the focus of the research, selecting informants as data sources, collecting data, assessing data quality, analyzing data, interpreting analysis results, making conclusions, and reporting research results. The data analysis technique used in this research is content analysis. Content analysis is one of the data analysis techniques, not a data collection method. The instrument used was adapted from research conducted by (Agnezi et al., 2019) in the form of a questionnaire sheet for STEM component analysis. The analysis sheet is presented in Table 1 below.

Table 1. STEM Component Analysis Sheets

No.	STEM Components	Indicator	Yes	No	Statement
1.	*Science*	The textbook contains stimulation about the surrounding nature			
		The textbook invites students to actively participate.			
		The textbook stimulates students to ask questions.			
		The textbook invites students to explain an event.			
		The textbook invites students to make decisions.			
2.	*Technology*	Textbooks provide information on new technological developments			
		The textbook provides information on the use of technology in everyday life.			
		The textbook provides			

		information on the use of software in learning.	
		Textbooks are connected to the internet.	
3.	*Engineering*	Textbooks provide project assignments	
		Textbooks integrate biology with other sciences.	
		The textbook provides solutions to problems related to the material to be studied.	
4.	*Mathematics*	The textbook contains questions that require students to analyze	
		The textbook contains creative ideas.	
		The textbook guides students to interpret data correctly.	
		The textbook contains HOTS questions.	

Source; (Anggraini & Nurita, 2021)

The purpose of this study was to determine whether the textbooks applied were in accordance with STEM criteria in Biology learning at MAN 1 Medan. The subject in this study is the biology textbook for class X, semester II. To obtain the data, the researcher used observation, interview, and documentation instruments with the Biology subject teacher. The data was analyzed with several questions in accordance with the STEM criteria, which were filled in by the researcher and the validator team by filling in the check mark (✓) in the "Yes" and "No" columns, then entering the statement if any appears in the statement column.

The data used in this study are 10 lesson plans of biology teachers and biology textbooks of class X MAN 1 Medan, which will be reviewed for their suitability with the principles of STEM-based biology learning suitability. In this study, data were obtained from biology teachers of grade X MAN 1 Medan in the form of 10 lesson plans and biology textbooks that will be reviewed by researchers. Researchers used data collection techniques through documents. According to (Sugiyono, 2010), documents are records of events that have occurred. Documents can be in the form of text, images, or monumental works of a person. Examples of documents in the form of text include diaries, stories, biographies, rules, and policies. Meanwhile, documents in the form of images can be in the form of photos, videos, sketches, and the like. Documents in the form of works include works of art such as drawings, sculptures, films, and others. In addition, documentation techniques were applied to the analysis of the curriculum, lesson plans, and core competencies and basic competencies (KI/KD) of biology teachers.

The data obtained includes the suitability of textbooks analyzed based on STEM indicators. The process of analyzing the percentage of occurrence of STEM components was carried out using the following method (Anggraini & Nurita, 2021):

1. Calculate the percentage of occurrence of STEM components using the following formula:

Percentage=$\frac{Number\ of\ statements\ per\ component}{Total\ number\ of\ statements}$ x100%

2. Determine the average percentage of STEM components that have been analyzed from the textbook.

The results of the book analysis that has been carried out are measured for reliability using a checklist. The checking was carried out by a team of validators, namely Mrs. Ummi Nur Afinni Dwi Jayanti, M.Pd as validator I, Mr. Adi Hartono, M.Pd as validator II, and the author as validator III. Validators have a role in assessing the results of book analysis, namely by filling out the assessment sheet. The filling is done by filling in the check mark (✓) in the assessment column "Yes" if the statement that has been filled in by the researcher is appropriate and "No" if the statement is not in accordance with the STEM component on the STEM assessment sheet. The expert assessment sheet used is a modification of the research conducted by (Rezkiani, 2020) Which is presented in **Table 2** below.

Table 2. Validator Rating Sheet

STEM Components	Indicator	Statement	Assessment	
			Yes	No

The results of the validator's assessment that stated that it was included in STEM were taken as a percentage, and then the category was determined. Taking the percentage of validator assessment using the formula below:

$$\text{Percentage}=\frac{Number\ of\ statements\ including\ STEM\ components}{Total\ number\ of\ statements}\text{x}100\%$$

The percentage of validator assessment categories used is also a modification of the research conducted by (Rezkiani, 2020) Which is presented in **Table 3** below.

Table 3. Table of Validator Assessment Categories

No.	Intervals	Category
1.	81% - 100%	Very suitable
2.	61% - 80%	Suitable
3.	41% - 60%	Moderate
4.	21% - 40%	Unsuitable
5.	0% - 20%	Very Unsuitable

(Sugiyono, 2018)

The subjects analyzed were biology textbooks for class X semester II at MAN 1 Medan. The book sampling technique is analyzed with several questions that match the STEM criteria and will be adjusted to the validator's assessment category. The book is said to be valid if it is in the category of very suitable, suitable, or moderate.

FINDINGS AND DISCUSSION

Findings

The results of the Science Technology Engineering and Math (STEM) analysis at MAN 1 Medan seen from the results of biology teacher interviews at MAN 1 Medan through transcription of interview data, biology teacher lesson plans for class X semester II, and textbooks used at MAN 1 Medan semester II can be seen in Tables 4,5,6,7,8,9 and Figures 1,2,3 as follows:

Table 4. Comparison of Biology Teacher Interview Analysis Results

No	Question	Teacher 1	Teacher 2	Conclusion
1.	What are the approaches, strategies, methods, and learning models that you often use in the biology learning process in class?	Approach: Scientific If learning biology must be related to understanding learning strategies, methods, and models in schools using the SKS system, so is using the UKBM module. The UKBM module must be completed by students in one semester, so usually, during learning, it is always applied to how students learn the UKBM. The strategies used are sometimes group discussions or just the tutor.	Approach: Scientific Method: Discussion, question, and answer Model : • Cooperative learning, where students tend to learn in groups • PBL • PJBL • Literacy	Based on the information obtained from the two respondents, it was found that the approach used was the scientific approach. The learning methods and models used by respondent one and respondent 2 are different.
2.	Has your learning been linked to 21st-century learning and utilized biology?	Of course. One of them is in the UKBM; they are told to search for websites or click on the links that have been provided. Later, from the links, they can get information to answer the worksheets in the module / UKBM.	Of course, I link biology learning with analytical and critical thinking so that students' ability to analyze and think critically increases.	Based on the information obtained from 2 respondents, there are similarities, namely that it has been linked to 21st-century learning.
3.	What are the obstacles you faced during the biology learning process in class?	Usually, the obstacles are, in general, a less conducive class situation and time because the biology material is very dense and complicated, but we are clever as teachers so that the learning objectives can be achieved.	Students' abilities and learning styles are very different, making it difficult for teachers to facilitate all types of learning styles in the classroom at one time in a short and compact biology lesson.	Based on the information obtained from 2 respondents, it is found that teachers face obstacles during the biology learning process in class.
4.	Do you often direct students toward problem-solving skills?	Of course. As a teacher, we must overcome the problems that exist if the problem is material if there is a problem. Usually, we must find a solution.	Of course, my classroom learning must be linked to the problems at the beginning of the lesson.	Based on the information obtained from 2 respondents, it was found that the teacher directed students toward problem-solving skills.
5.	Is it important to use learning models that are varied and appropriate to the subject matter?	In my opinion, the learning model is very important, and the goal is that with the learning model, the learning atmosphere in the	Very important because each material needs/needs a different learning model.	Based on the information obtained from 2 respondents, it is found that it is very important

		classroom is more interactive because there are learning models that change but must also be conditioned by class conditions.		to use a variety of learning models.
6.	How are students' learning outcomes when using and without the learning model?	Automatically, the difference is very significant, which is that if you use a learning model, students are usually more enthusiastic about the learning model because the learning model makes them learn coolly and not monotonously, but if without a learning model, for example, answering questions or summarizing or just reading, it usually makes the class boring.	Differently, students understand biology subject matter better by using learning models compared to the conventional classroom atmosphere, which is also more lively.	Based on the information obtained from 2 respondents, it is found that student learning outcomes when teachers use models and do not use learning models are very different.
7.	What are the problems that arise when you carry out teaching and learning activities in the classroom? Both from students and from the situation and conditions faced?	If the problems that arise have been controlled, the same obstacles will be conducive to class and time. From the conditions faced, whatever the problem is, we as teachers must be able to make the class atmosphere better so that students are active in learning.	It's more about the different characters and learning styles of the students.	Based on the information obtained from 2 respondents, it is found that there are obstacles in carrying out learning activities in the classroom.
8.	How do you overcome obstacles and problems that arise during the learning process?	My efforts with the existence of learning strategies and models with this so that students are able to learn with their interactive learning styles or learning styles that are not monotonous. For example, for class presentations using PPT/video learning, they are automatically interested in learning, and they are not bored because of these variations.	Finding media/making learning media that makes it easier for students to learn	Based on the information obtained from 2 respondents, it is found that both teachers have efforts to overcome problems in the classroom.
9.	What do you think effective learning should be like?	Effective learning is actually learning that is able to make	Shows students' ability to understand the material.	Based on the information obtained from 2

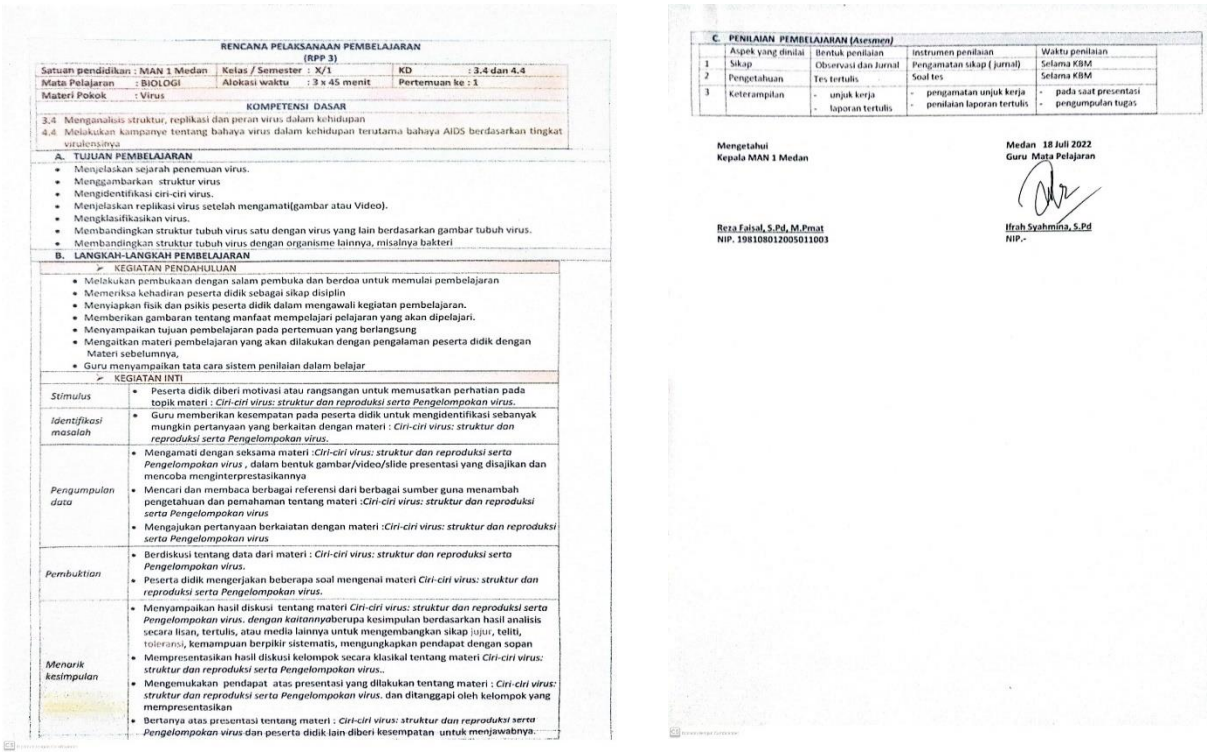
		students understand learning material. For example, effective learning is the kind of learning where the learning objectives to be achieved can be achieved properly.	There is an increase in understanding of the material.	respondents, there is a common opinion that effective learning must enable students to understand the learning material.
10.	Are there any co-curricular activities at school to strengthen and improve students' understanding?	There is usually every student who makes/follows Bimbel at school for students who want it / not forced. There are also extracurricular activities related to biology.	There is a KSM extracurricular activity, but only a select few students. Teachers usually provide enrichment as an additional facility to guide students.	Based on the information obtained from 2 respondents, there are similarities, namely that there are activities supporting subjects (co-curricular) at school.
11.	What do you think is your biggest challenge in learning in the era of evolving technology?	The toughest challenge is facilities; there are some students who may not have gadgets that can compete in the field of technology because there are some students who are sometimes economically different, some are well-off, and some are not well-off.	Students are very dependent on technology, especially cell phones. 1. Students find it very difficult to think/find solutions that are not available on the internet. 2. Students are very limited with instant answers and resources 3. Very often play cell phone	Based on the information obtained from 2 respondents, it is found that the toughest challenge is in technology, namely in the form of cell phones.
12.	What is one option that you can do with a STEM approach?	STEM is one of the scientific approaches, too, so I think one of the options is learning that is able to provide more understanding/has more focus to be able to provide lessons to students.	Many learning models support STEM, such as PBL and PJBL.	Based on information from 2 respondents, respondent 1 stated that the approach options that can be done with the STEM approach are scientific approaches while respondent 2 stated PBL and PJBL approaches.
13.	How do you incorporate STEM into your learning?	With this technology, many learning approaches/strategies/models can be created, one of which is with STEM.	Assisted by technology as a medium.	Based on the information obtained from the two respondents, there are similarities, namely, pouring STEM with the help of technology.

14.	How do you integrate and apply it in the learning process to students?	Many with PPT models, learning videos / presentations.	By asking problems, questions.	Based on information from 2 respondents, respondent 1 stated that the way the teacher integrates and implements it in the learning process to students is a lot with PPT models, learning videos / presentations. While respondent Two asked problems and questions.
15.	What do you think are the barriers to STEM in biology learning?	The obstacle is that the teacher must be able to create how the learning situation with the STEM approach can be applied properly. If the obstacles in terms of technology outside of that may not exist.	Preparation time to start learning should be maximized, and the media should be adequate.	Berdasarkan informasi dari 2 responden, responden 1 hambatannya dari segi teknologi, sedangkan responden 2 hambatannya waktu harus maksimal dan media harus memadai.

According to (Charmaz, 2006), focused coding entails making decisions regarding the most appropriate initial codes to provide deeper analytic meaning, so that data categories can be organized clearly and completely. At this stage, the researcher compares different codes. Some codes were combined because of certain similarities. For example, researchers put together codes such as approaches, strategies, methods, and learning models used.

The major themes that researchers found are as follows:

1. On the theme of the learning model used in MAN 1 Medan, coding: scientific.
2. On the theme of STEM obstacles in learning biology at MAN 1 Medan, coding: able to create learning situations, time, adequate media.



RENCANA PELAKSANAAN PEMBELAJARAN
(RPP 3)

Satuan pendidikan : MAN 1 Medan	Kelas / Semester : X/1	KD : 3.4 dan 4.4
Mata Pelajaran : BIOLOGI	Alokasi waktu : 3 x 45 menit	Pertemuan ke : 1
Materi Pokok : Virus		

KOMPETENSI DASAR

3.4 Menganalisis struktur, replikasi dan peran virus dalam kehidupan
4.4 Melakukan kampanye tentang bahaya virus dalam kehidupan terutama bahaya AIDS berdasarkan tingkat virulensinya

A. TUJUAN PEMBELAJARAN

- Menjelaskan sejarah penemuan virus.
- Menggambarkan struktur virus
- Mengidentifikasi ciri-ciri virus.
- Menjelaskan replikasi virus setelah mengamati(gambar atau Video).
- Mengklasifikasikan virus.
- Membandingkan struktur tubuh virus satu dengan virus yang lain berdasarkan gambar tubuh virus.
- Membandingkan struktur tubuh virus dengan organisme lainnya, misalnya bakteri

B. LANGKAH-LANGKAH PEMBELAJARAN

KEGIATAN PENDAHULUAN

- Melakukan pembukaan dengan salam pembuka dan berdoa untuk memulai pembelajaran
- Memeriksa kehadiran peserta didik sebagai sikap disiplin
- Menyiapkan fisik dan psikis peserta didik dalam mengawali kegiatan pembelajaran.
- Memberikan gambaran tentang manfaat mempelajari pelajaran yang akan dipelajari.
- Menyampaikan tujuan pembelajaran pada pertemuan yang berlangsung
- Mengaitkan materi pembelajaran yang akan dilakukan dengan pengalaman peserta didik dengan Materi sebelumnya,
- Guru menyampaikan tata cara sistem penilaian dalam belajar

KEGIATAN INTI

Stimulus	• Peserta didik diberi motivasi atau rangsangan untuk memusatkan perhatian pada topik materi : *Ciri-ciri virus: struktur dan reproduksi serta Pengelompokan virus.*
Identifikasi masalah	• Guru memberikan kesempatan pada peserta didik untuk mengidentifikasi sebanyak mungkin pertanyaan yang berkaitan dengan materi : *Ciri-ciri virus: struktur dan reproduksi serta Pengelompokan virus.*
Pengumpulan data	• Mengamati dengan seksama materi :*Ciri-ciri virus: struktur dan reproduksi serta Pengelompokan virus* , dalam bentuk gambar/video/slide presentasi yang disajikan dan mencoba menginterprestasikannya • Mencari dan membaca berbagai referensi dari berbagai sumber guna menambah pengetahuan dan pemahaman tentang materi :*Ciri-ciri virus: struktur dan reproduksi serta Pengelompokan virus* • Mengajukan pertanyaan berkaiatan dengan materi :*Ciri-ciri virus: struktur dan reproduksi serta Pengelompokan virus*
Pembuktian	• Berdiskusi tentang data dari materi : *Ciri-ciri virus: struktur dan reproduksi serta Pengelompokan virus.* • Peserta didik mengerjakan beberapa soal mengenai materi *Ciri-ciri virus: struktur dan reproduksi serta Pengelompokan virus.*
Menarik kesimpulan	• Menyampaikan hasil diskusi tentang materi *Ciri-ciri virus: struktur dan reproduksi serta Pengelompokan virus. dengan kaitannya*berupa kesimpulan berdasarkan hasil analisis secara lisan, tertulis, atau media lainnya untuk mengembangkan sikap jujur, teliti, toleransi, kemampuan berpikir sistematis, mengungkapkan pendapat dengan sopan • Mempresentasikan hasil diskusi kelompok secara klasikal tentang materi *Ciri-ciri virus: struktur dan reproduksi serta Pengelompokan virus.*. • Mengemukakan pendapat atas presentasi yang dilakukan tentang materi : *Ciri-ciri virus: struktur dan reproduksi serta Pengelompokan virus.* dan ditanggapi oleh kelompok yang mempresentasikan • Bertanya atas presentasi tentang materi : *Ciri-ciri virus: struktur dan reproduksi serta Pengelompokan virus* dan peserta didik lain diberi kesempatan untuk menjawabnya.

C. PENILAIAN PEMBELAJARAN (*Asesmen*)

	Aspek yang dinilai	Bentuk penilaian	Instrumen penilaian	Waktu penilaian
1	Sikap	Observasi dan Jurnal	Pengamatan sikap (jurnal)	Selama KBM
2	Pengetahuan	Tes tertulis	Soal tes	Selama KBM
3	Keterampilan	- unjuk kerja - laporan tertulis	- pengamatan unjuk kerja - penilaian laporan tertulis	- pada saat presentasi - pengumpulan tugas

Mengetahui
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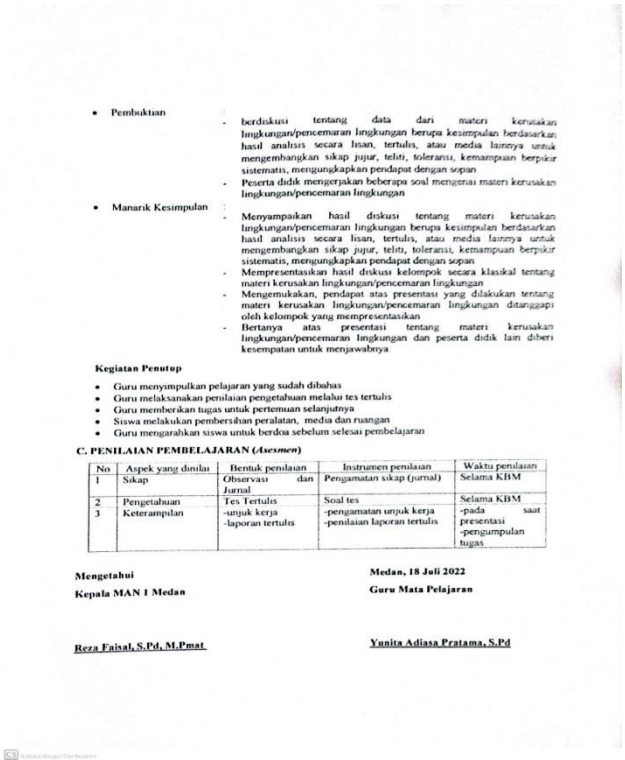

- Pembuktian
  - berdiskusi tentang data dari materi kerusakan lingkungan/pencemaran lingkungan berupa kesimpulan berdasarkan hasil analisis secara lisan, tertulis, atau media lainnya untuk mengembangkan sikap jujur, teliti, toleransi, kemampuan berpikir sistematis, mengungkapkan pendapat dengan sopan
  - Peserta didik mengerjakan beberapa soal mengenai materi kerusakan lingkungan/pencemaran lingkungan
- Manarik Kesimpulan
  - Menyampaikan hasil diskusi tentang materi kerusakan lingkungan/pencemaran lingkungan berupa kesimpulan berdasarkan hasil analisis secara lisan, tertulis, atau media lainnya untuk mengembangkan sikap jujur, teliti, toleransi, kemampuan berpikir sistematis, mengungkapkan pendapat dengan sopan
  - Mempresentasikan hasil diskusi kelompok secara klasikal tentang materi kerusakan lingkungan/pencemaran lingkungan
  - Mengemukakan, pendapat atas presentasi yang dilakukan tentang materi kerusakan lingkungan/pencemaran lingkungan ditanggapi oleh kelompok yang mempresentasikan
  - Bertanya atas presentasi tentang materi kerusakan lingkungan/pencemaran lingkungan dan peserta didik lain diberi kesempatan untuk menjawabnya

Kegiatan Penutup

- Guru menyimpulkan pelajaran yang sudah dibahas
- Guru melaksanakan penilaian pengetahuan melalui tes tertulis
- Guru memberikan tugas untuk pertemuan selanjutnya
- Siswa melakukan pembersihan peralatan, media dan ruangan
- Guru mengarahkan siswa untuk berdoa sebelum selesai pembelajaran

C. PENILAIAN PEMBELAJARAN (*Asesmen*)

No	Aspek yang dinilai	Bentuk penilaian	Instrumen penilaian	Waktu penilaian
1	Sikap	Observasi dan Jurnal	Pengamatan sikap (jurnal)	Selama KBM
2	Pengetahuan	Tes Tertulis	Soal tes	Selama KBM
3	Keterampilan	-unjuk kerja -laporan tertulis	-pengamatan unjuk kerja -penilaian laporan tertulis	-pada saat presentasi -pengumpulan tugas

Mengetahui
Kepala MAN 1 Medan

Reza Faisal, S.Pd, M.Pmat

Medan, 18 Juli 2022
Guru Mata Pelajaran

Yunita Adiasa Pratama, S.Pd

Figure 1. Biology lesson plan of Biology teacher of MAN 1 Medan class X semester II

The implementation of the Merdeka Curriculum is expected to help students develop the ability and readiness to face future challenges, become productive, creative, moral individuals, and be able to innovate and contribute to society, nation, and state. The STEM approach can be used as a tool to achieve this goal through various learning approaches, strategies, methods, and learning models.

STEM (Science, Technology, Engineering, and Math) Criteria through Biology Textbook Analysis at MAN 1 Medan

Biology textbooks of class X semester II at MAN 1 Medan obtained include the appearance of STEM components expressed in the form of percentages and assessments made by validators on the results of book analysis.

Occurrence of STEM Components in Biology Textbooks by Validator I

The appearance of STEM components in biology textbooks by validator I is presented in Table 5 as follows:

Table 5. Number and Percentage of Emergence of STEM Components in Biology Textbooks by Validator I

No.	STEM Components	Biology Textbook						
		BAB 6	BAB 7	BAB 8	BAB 9	Bab10	∑	%
1.	Science	15	13	25	15	12	80	17,5%
2.	Technology	34	61	76	18	47	236	51,7%
3.	Engineering	5	7	59	18	28	117	25,6%
4.	Mathematics	4	5	5	6	3	23	5,0%
	Amount	58	86	165	57	90		
								100%
	Total			**456**				

Based on **Table 5**, it can be found that the number of occurrences of STEM components in biology textbooks by validator I is very diverse. The percentages include *Science* as much as 17,5%, *Technology* as much as 51,7%, *Engineering* as much as 25,6%, and *Mathematics* as much as 5,0%.

Occurrence of STEM Components in Biology Textbooks by Validator II

The occurrence of STEM components in biology textbooks by validator II is presented in **Table 6** as follows:

Table 6. Number and Percentage of Emergence of STEM Components in Biology Textbooks by Validator II

No.	STEM Components	Biology Textbook						
		BAB 6	BAB 7	BAB 8	BAB 9	BAB 10	∑	%
1.	Science	16	15	24	14	12	81	17,5%
2.	Technology	33	60	75	18	47	233	50,5%
3.	Engineering	6	8	59	18	29	120	26,0%
4.	Mathematics	5	5	6	7	4	27	5,8%
	Amount	60	88	164	57	92		
								100%
	Total			**461**				

Based on **Table 6**, it can be found that the number of STEM component occurrences in biology textbooks by validator II is very diverse. The percentages include *Science* as much as 17,5%, *Technology* as much as 50,5%, *Engineering* as much as 26,0%, and *Mathematics* as much as 5,8%.

Occurrence of STEM Components in Biology Textbooks by Validator III

The appearance of STEM components in biology textbooks by validator III is presented in **Table 7** as follows:

Table 7. Number and Percentage of Emergence of STEM Components in Biology Textbooks by Validator III

No.	STEM Components	Biology Textbook						
		BAB 6	BAB 7	BAB 8	BAB 9	BAB 10	∑	%
1.	Science	15	13	25	15	12	80	17,5%
2.	Technology	34	61	76	18	47	236	51,7%
3.	Engineering	5	7	59	18	28	117	25,6%
4.	Mathematics	4	5	5	6	3	23	5,0%
	Amount	58	86	165	57	90		
								100%
	Total			**456**				

Based on **Table 7**, it can be found that the number of occurrences of the STEM component in biology textbooks by validator III also varies, and the results after being analyzed are the same as validator I. The percentages include *Science* as much as 17,5%, *Technology* as much as 51,7%, *Engineering* as much as 25,6%, and *Mathematics* as much as 5,0%.

Average STEM Occurrence

The average occurrence of STEM from biology textbooks is presented in Figure 2 as follows:

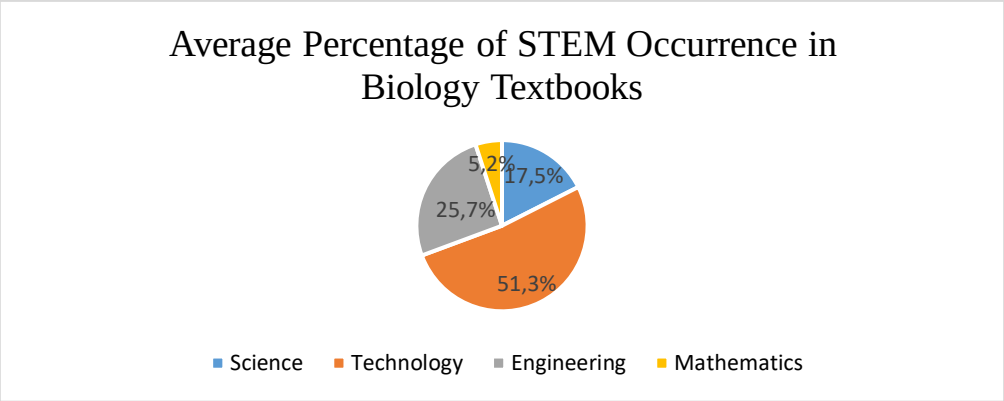

Figure 2. Average STEM Occurrence

Figure 2 states that the average percentage of STEM appearances in biology textbooks by three validators is *Science* as much as 17,5%, *Technology* as much as 51,3%, *Engineering* as much as 24,7%, and *Mathematics* as much as 5,2%.

Validator Assessment of Book Analysis Results

The results of the validator's assessment of the book analysis results are presented in **Table 8** as follows:

Table 8. Percentage of Validator Assessment

No.	Book Validator	Percentage Value	Category
1.	Validator I	99,8%	Very Suitable
2.	Validator II	99,8%	Very Suitable
3.	Validator III	99,8%	Very Suitable

Based on **Table 8**, it can be found that biology textbooks have a high percentage value with a very suitable category.

Discussion

After interviewing two 10th-grade biology teachers and collecting data, the researcher continued by analyzing the data. This analysis was done by coding. According to (Charmaz, 2006), coding is the process of categorizing or grouping research data using shorter labels that also show similarities with other data. Coding also shows how researchers separate, select, and sort research data to begin the analysis process.

According to (Charmaz, 2006), focused coding "entails decisions about the most analytically meaningful initial codes that can help clarify and complete the data categories." At this stage, the researcher compares different codes. Some codes that showed similarities were combined into one. For example, the researcher combined codes related to learning approaches, strategies, methods and models used.

The analysis conducted by the researcher using focused coding was considered adequate to identify theories that emerged from the data. By continuously comparing each code in the data, researchers can see the reciprocal relationship between the various codes (Adriany, n.d.). The major themes that researchers found are as follows:

Table 9. Focused Coding

Big Theme	Coding
The learning model used at MAN 1 Medan	Scientific
STEM barriers in biology learning at MAN 1 Medan	Able to create a learning situation Time Adequate media

In this research, the instrument used is the human being himself. Researchers are responsible for determining the focus of the research, selecting informants as data sources, collecting data, assessing data quality, analyzing data, interpreting the results, and concluding the research (Sugiyono, 2010). Lincoln and Guba suggested that using humans as data collection instruments offers advantages in the form of better flexibility and adaptability and utilizes all senses to deal with various situations (Aan Komariah & Satori, 2011).

Human Resources (HR) is the main indicator of educational success. Effective education will produce human resources that are qualified, competitive, and able to overcome various problems (Zo`bi, 2014). Basically, education is a conscious effort to develop the potential of students by encouraging and facilitating them in the learning process. Learning itself is a process of behavior change involving cognitive, affective, and skill aspects for self-improvement. Meanwhile, learning is a conscious effort to carry out the teaching and learning process between educators and students, with active involvement from both (Heru & Hidayati, 2017; Sumiati et al., 2018).

According to Indonesian Law No. 20/2003, the purpose of education is to develop the potential of students so that they become individuals who believe and fear God Almighty, have a noble character, are healthy, knowledgeable, skilled, creative, independent, and become democratic and responsible citizens in the implementation of educational activities (Vitasari & Rohayati, 2018). To achieve these educational goals, the government can improve the quality of education through providing textbooks and improving the curriculum (Festiyed, n.d.). To achieve educational goals, teaching materials are needed that can develop students' ability to think critically and solve problems.

STEM (Science, Technology, Engineering, and Math) Criteria through Analysis of Biology Textbooks at MAN 1 Medan

Qualitative research is understood as research that covers a broad scope (Samsu, 2017). This research emphasizes understanding and analysis from the perspective of the observed subject with a STEM approach. Researchers try to interpret and describe social phenomena in depth and clearly, not only based on the researcher's personal point of view (Hardani, Nur Hikmatul Auliya, Helmina Andriani, Roushandy Asri Fardani, Jumari Ustiawaty, Evi Fatmi Utami, Dhika Juliana Sukmana, 2020).

The STEM approach is a learning method designed to train students in solving problems relevant to teaching and learning activities. In the learning process, students are expected to be actively involved in classroom activities. Currently, teacher-centered learning often leads to a lack of active participation from students. Learning is the process of interaction between students and teachers to carry out learning activities in the classroom (Rahman et al., 2020).

The purpose of the STEM approach is to stimulate students' critical thinking (Puspitasari et al., 2015). Effective learning activities in ecology can produce excellent and virtuous students (Ulandari et al., 2018) And improve their understanding of the subject matter (Andika et al., 2020; Tamaela, 2016). This approach is very effective in improving student learning outcomes in the classroom (Putra et al., 2020). Therefore, the use of STEM-based teaching materials is very suitable to be implemented at the primary and secondary school levels.

Teaching materials are needed to support teaching and learning activities so that the learning process can run more purposefully. Teaching materials are designed as tools that make it easier for teachers and students to achieve more effective learning (Festiyed & Asrizal, 2019; Marsa, 2016). Teachers must ensure that students understand the physics concepts taught. With a good understanding of the concepts, students can analyze various exercise problems that are different from the example problems. The solution is to use teaching materials that can guide students in the learning process. This teaching material can help students understand concepts or subject matter effectively (Hardianti et al., 2020).

Previous research shows that the use of scientific-based teaching materials has a positive impact on students' competencies and skills (Alwi et al., 2020). In addition, these teaching materials can also improve mastery of lesson concepts among students (Oktaviani et al., 2017). The scientific approach affects the cognitive, affective, and psychomotor aspects of learners (Machin, 2014).

To achieve the desired learning objectives, an approach that is in accordance with the Merdeka Curriculum and effective in achieving the specified results is needed. One approach that can be used is the scientific (Tangkas et al., 2020). The STEM approach is a learning method designed to train students in solving problems related to teaching and learning activities. In the learning process, students are expected to be actively involved in activities that take place in the classroom.

One of the learning approaches that can be applied by educators is the STEM approach. STEM (Science, Technology, Engineering, and Mathematics) is a new method in education that integrates various disciplines. This approach connects real-world problems with problem-based learning, creating a link between the problems faced by learners and the phenomena in their lives (Torlakson, 2014). The STEM approach can be applied at all levels of education, from primary to tertiary, and can evolve by linking teaching materials with the surrounding environment and real-world situations of learners. STEM learning can effectively and efficiently improve learners' soft skills and shape their ability to think critically, logically, and systematically, which prepares them to face global challenges (Nessa et al., 2017). In general, the STEM approach can guide students to develop competencies that match 21st-century skills. This integration helps students in conducting a meaningful learning process. The implementation of STEM learning integration in the Indonesian

primary curriculum is very relevant to support the development of primary school students' skills in the 21st century (Lidinillah et al., 2019).

Today, the ever-evolving advances in technology and science present various innovations in education, which enrich our understanding of education itself. Technological developments have a positive impact by facilitating the learning process. Technological advances, both inside and outside the classroom, allow students to become more active learners (Saputri & Herman, 2022).

Biology textbooks for class X semester II at MAN 1 Medan obtained include the appearance of STEM components expressed in the form of percentages and assessments made by validators on the results of book analysis.

Occurrence of STEM Components in Biology Textbooks by Validator I

Based on **Table 5**, it can be found that the number of occurrences of STEM components in biology textbooks by validator I is very diverse. The percentages include *Science* as much as 17,5%, *Technology* as much as 51,7%, *Engineering* as much as 25,6%, and *Mathematics* as much as 5,0%.

Occurrence of STEM Components in Biology Textbooks by Validator II

Based on **Table 6**, it can be found that the number of STEM component occurrences in biology textbooks by validator II is very diverse. The percentages include *Science* as much as 17,5%, *Technology* as much as 50,5%, *Engineering* as much as 26,0%, and *Mathematics* as much as 5,8%.

Occurrence of STEM Components in Biology Textbooks by Validator III

Based on **Table 7**, it can be found that the number of occurrences of STEM components in biology textbooks by validator III is also diverse and the results after being analyzed are the same as validator I. The percentages include *Science* as much as 17,5%, *Technology* as much as 51,7%, *Engineering* as much as 25,6%, and *Mathematics* as much as 5,0%.

Average STEM Occurrence

Figure 2 states that the average percentage of STEM appearances in biology textbooks by three validators is 17,5% *Science*, 51,3% *Technology*, 25,7% *Engineering*, and 5,2% *Mathematics*.

Assessment of Book Analysis Results

Based on **Table 8**, it can be found that biology textbooks have a high percentage of values with a very suitable category.

This study also aims to analyze the percentage level of occurrence of STEM components in class X semester II biology textbooks. The following is a discussion of the results of research that has been carried out previously.

1. *Science* Component

Based on the research, the data shows that the *science* component by validators I, II, and III each obtained a percentage of 17,5%. The analysis of this *science* component includes five indicators, namely stimulation about the surrounding environment, encouraging students to play an active role, stimulating students to ask questions, encouraging students to provide an explanation of an event, and encouraging students to make decisions. The analysis showed that the book fulfills the *science* component. Among the five indicators, the most common one is the invitation to students to provide an explanation of an event. This is because the textbooks analyzed contain information that contains theories and concepts related to mechanisms or events that occur in nature (Purwadi, 2022).

The average percentage of *science* components in the book was recorded at 17,5%. This figure is in line with the research (Agnezi et al., 2019) Which shows an average percentage of *science* of 30%. Another study by. Another study by (Anggraini & Nurita, 2021) reported an average of 56,7%, while, (Purwadi, 2022) Found an average of 83.9% in the explanation of the material. According to (Anna Permanasari, 2016), the application of science in teaching materials should relate the material to everyday life because science is very relevant to the products used by society. In addition to the material, science is also related to students' abilities. One way to improve students' science skills is through experiences gained in the classroom and in the surrounding environment. This experience is expected to help students connect theory with reality in the surrounding environment (Agnezi et al., 2019).

2. *Technology* Component

Based on the research conducted, the data shows that the technology component in validator I reached a percentage of 51,7%, validator II 50,5%, and validator III 51,7%. The analysis of the *technology* component includes four indicators, namely information about new technological developments, the use of *technology* in everyday life, the utilization of software in learning, and internet connection. The *technology* component appeared more frequently than the other three components. Among the four indicators, the internet connection indicator shows the highest

frequency of occurrence. This indicates that the book is modern and in line with the times because it is connected to the internet. The existence of web links in textbooks makes it easier for students to find more complete information about the material being studied (Anggraini & Nurita, 2021).

The average *technology* component obtained from books reached 51,3%. This figure is similar to the results of research (Agnezi et al., 2019), which recorded an average *technology* percentage of 23%. On the other hand, research (Anggraini & Nurita, 2021) showed an average of 10,7%, while (Purwadi, 2022) recorded an average of 3,6% in the material explanation. The application of *technology* in teaching materials should also include an explanation of how the *technology* works (Purwadi, 2022). For example, in practicum activities, students are advised to understand how the tool works or the measurement of substances to be reacted. This application usually appears in practicum activities found in textbooks. As in the field of science, this application also relates the material to everyday life.

3. *Engineering* Component

Based on the results of the study, the data showed that the percentage of *engineering* components in validator I was 25,6%, in validator II was 26,0%, and in validator III was also 25,6%. The analysis of the *engineering* component involves three indicators, namely providing project tasks, integrating biology with other disciplines, and offering solutions to problems related to the material to be studied. Of the four indicators, the indicator that appears the most is the integration of biology with other sciences. This is evident from the appearance of physics, chemistry, and mathematics in several statements contained in the textbook. This shows that *engineering* can serve as a link that creates meaningful learning between science and other disciplines, such as mathematics (Shalikhah, 2016).

The average acquisition of the *engineering* component of the book is 25,7%, which is similar to research (Agnezi et al., 2019) Which recorded an average *engineering* percentage of 19%. On the other hand, research (Anggraini & Nurita, 2021) Showed an average of 16,2%, while Purwadi Purwadi (2022) recorded an average of 3,1% in the material explanation. (Anggraini & Nurita, 2021) Suggested that the application of *engineering* is more focused on project tasks, one of which is through practicum activities. This is in line with the application in the field of technology. The main difference lies in project tasks in *engineering*, which are carried out in groups to train student

communication and participation, while in technology, students are expected to understand how the tools used work so the two can complement each other.

4. *Mathematics* Component

Based on the research, the data shows that the *mathematics* component in validator I has a percentage of 5,0%, validator II is 5,8%, and validator III is also 5,0%. Analysis of the *mathematics* component includes four indicators, namely: questions that ask students to analyze, contain creative ideas, help students present data appropriately, and questions that test High Order Thinking Skills (HOTS). The *mathematics* component appears the least compared to the other three components. This is due to the lack of analysis indicators in the textbooks studied in accordance with the established STEM component criteria. Among the four indicators, the indicator that appears the most is related to data interpretation. This happens because the analyzed textbooks encourage students to solve problems by interpreting data based on their knowledge (Anggraini & Nurita, 2021).

For example, the analyzed book asked students to record the test results in a table. Meanwhile, the lowest number of occurrences was in the HOTS question indicator. Despite the small number of occurrences, the analyzed textbooks have prepared students to face the challenges of the 21st century. HOTS questions are very important in teaching materials because they help students think critically and creatively (Anggraini & Nurita, 2021). HOTS is the ability of students to connect subject matter in the classroom with material outside the classroom (Simarmata, J, Simanihuruk, L, Ramadhani, R, Safitri & Wahyuni, D & Iskandar, 2020).

The average result of the *mathematics* component of the book was 5,2%. This result is similar to research by (Purwadi, 2022), which recorded an average of 9,3% on the material explanation. On the other hand, research by (Anggraini & Nurita, 2021) Showed an average of 16,3%, while (Agnezi et al., 2019) recorded an average *mathematics* percentage of 28%.

5. The Importance of STEM in Textbooks

According to (Anggraini & Nurita, 2021), textbooks play an important role in improving learning effectiveness. When used during the teaching and learning process, coursebooks can help achieve learning objectives. In addition, they can also support less experienced teachers to create a better learning atmosphere. STEM-integrated coursebooks give teachers the opportunity to deliver materials on principles, concepts, and techniques in science, technology, engineering, and

mathematics. In addition, it can increase students' motivation to learn, strengthen critical thinking and problem-solving skills, and help students understand current technological developments. All of this can be achieved with proper planning and learning models (Agnezi et al., 2019).

CONCLUSION

In analyzing the application of the STEM approach in biology learning, it can be concluded that this approach can be integrated with various learning models, curriculum, lesson plans, and appropriate biology textbooks at MAN 1 Medan. The application of the STEM approach in biology learning has the potential to improve student learning outcomes, critical thinking skills, science literacy, creativity, and scientific thinking ability. The curriculum and lesson plans implemented at MAN 1 Medan have been adjusted to the principles of Merdeka Belajar. The biology textbook for class X semester II used at MAN 1 Medan has fulfilled the STEM component. The percentage of STEM occurrence rate in class X semester II biology textbooks by validator I has 17,5% *science* components, 51,7% t*echnology*, 25,6% *engineering*, and 5,0% *mathematics*; validator II has 17,5% *science* components, 50,5% *technology*, 26,0% *engineering*, and 5,8% *mathematics*; validator III has 17,5% *science* components, 51,7% *technology*, 25,6% *engineering*, and 5,0% *mathematics*. The average occurrence of STEM components is *science* as much as 17,5%, *technology* as much as 51,3%, *engineering* as much as 25,7%, and *mathematics* as much as 5,2%. The assessment from the validator received a very suitable category. In overcoming STEM barriers in biology learning at MAN 1 Medan, teachers need to create an effective learning situation to apply the STEM approach well.

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