



MINISTRY OF HIGHER EDUCATION, SCIENCE AND TECHNOLOGY

University of Lampung

Faculty of Teacher Training and Education

Prof. Dr. Sumantri Brojonegoro Street No.1, Gedong Meneng - Bandar Lampung 35145

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**Undergraduate Programme in Biology Education
HANDBOOK**

MODULE

Module Name	STEM
Module Level, if Applicable	-
Code	KBO625106
Sub-Heading, (*if Applicable)	-
Classes, (*if applicable)	-
Semester	2nd
Module Coordinator	Dr Berti Yolida, M.Ed.
Lecturers	1. Dr Berti Yolida, M.Ed. 2. Rini Rita T. Marpaung, M.Ed.
Language	Bilingual (English and Indonesian)
Classification Within the Curriculum	Compulsory
Teaching Format/Class Hours Per Week During the Semester	Contact hours: 14 weeks x 100 minutes Structured learning: 14 weeks x 120 minutes Independent study: 14 weeks x 120 minutes
Teaching methods	Lectures (100 minutes)
Workload	Contact hours: 14 weeks x 100 minutes
Credit points	2 credits = $(1.28 \times 2) = 2.56$ ECTS
Prerequisite Courses	This course has no prerequisites
Course Outcomes (CO)	General Skill: - Able to apply logical, critical, systematic, and innovative thinking in the context of the development or implementation of science and technology that pays attention to and applies humanities values in accordance with their field of expertise; - Able to compile a scientific description of the results of the studies mentioned above in the form of a thesis or final project report, and upload it on the university's website; - Able to maintain and develop a network with supervisors and colleagues, both inside and outside the institution; - Able to document, store, secure, and retrieve data to ensure validity and prevent plagiarism.



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	Knowledge: - : Mastery of facts, concepts, principles, laws, theories, and procedures in STEM in depth and their implementation. - Possess sensitivity in identifying problems through STEM. - : Apply logical, critical, systematic, and innovative thinking in the context of problem-solving through STEM. - Communicate recommendations for problem-solving in STEM learning. Competencies: - Knowledge and understanding of STEM. - Ability to implement STEM in learning. - Ability to provide creative ideas for implementing STEM. - Strong problem-solving skills in STEM learning. - Ability to design engineering prototypes as visualisations of STEM.
Content	- STEM and its applications - STEM components in learning - Skills stimulated by STEM - Learning Strategies in STEM - Implementation of STEM
Study/Exam Achievements	Performance in theory (100%): ● Mid-term Exam (25%) ● Final Exam (25%) ● Team-based Project 40% ● Activity-based project 10%
Examination Methods	Written test and performance assessment
Forms of Media	Virtual Class (www.v-class.unila.ac.id) PowerPoint Presentation Materials quizizz.com
Literature	[1], [2], [3], [4], [5], [6], [7], [8], [9], [10] [1] A. Abdurrahman, H. Maulina, N. Nurulsari, I. Sukamto, A. N. Umam, and K. M. Mulyana, "Impacts of integrating engineering design process into STEM makerspace on renewable energy unit to foster students' system thinking skills," <i>Heliyon</i>, vol. 9, no. 4, 2023, doi: 10.1016/j.heliyon.2023.e15100. [2] S. M. Stehle and E. E. Peters-Burton, "Developing student 21st Century skills in selected exemplary inclusive STEM high schools," <i>Int. J. STEM Educ.</i>, vol. 6, no. 1, pp. 1–15, 2019, doi: 10.1186/s40594-019-0192-1. [3] H. O. Arslan and M. Genc, "The STEM Education Approach for Conceptual Learning," in <i>Transdisciplinary Approaches to</i>



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Learning Outcomes in Higher Education, IGI Global, 2024, pp. 43–73. Accessed: 20 November 2024. [Online]. Available: <https://www.igi-global.com/chapter/the-stem-education-approach-for-conceptual-learning/353044>

- [4] S. Aslam *et al.*, “Identifying the Research and Trends in STEM Education in Pakistan: A Systematic Literature Review,” *SAGE Open*, vol. 12, no. 3, p. 21582440221118544, doi: 10.1177/21582440221118545.
- [5] C. E. Carter *et al.*, “Defining STEAM Approaches for Higher Education,” *Eur. J. STEM Educ.*, vol. 6, no. 1, p. 13, Nov. 2021, doi: 10.20897/ejsteme/11354.
- [6] U. Hasanah, “STEM Education for Critical Thinking Skills in Indonesian Science Education,” 2020.
- [7] M. Başaran and M. Erol, “Recognising aesthetics in nature with STEM and STEAM education,” *Res. Sci. Technol. Educ.*, vol. 41, no. 1, pp. 326–342, January 2023, doi: 10.1080/02635143.2021.1908248.
- [8] C. Carbonell-Carrera, J. L. Saorin, D. Melian-Diaz, and J. De la Torre-Cantero, “Enhancing creative thinking in STEM with 3D CAD modelling,” *Sustainability*, vol. 11, no. 21, p. 6036, 2019, doi: 10.3390/su11216036.
- [9] C. Conradty and F. X. Bogner, “From STEM to STEAM: How to Monitor Creativity,” *Creativity Research Journal*, vol. 30, no. 3, pp. 233–240, July 2018, doi: 10.1080/10400419.2018.1488195.
- [10] A. Abbott, “Chemical connections: A problem-based learning, STEM experience,” *Sci. Scope*, vol. 39, no. 7, p. 33, 2016, doi: 10.2505/4/ss16_039_07_33.



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Semester Learning Plan (SLP)

	UNIVERSITY OF LAMPUNG Faculty of Teacher Training and Education DEPARTMENT OF MATHEMATICS AND NATURAL SCIENCES BIOLOGY EDUCATION PROGRAMME			
Semester Teaching Plan (RPS)				
Course Name	Course Code	Credit Hours (sks)	Semester	Date of Preparation
Science, Technology, Engineering, and Mathematics (STEM)	KBO625106	2 (2-0)	2	June 2025
Authorisation	Name of Development Coordinator RPS	Field Coordinator Expertise (if applicable)	Head of Study Programme	
	 Dr Berti Yolida, M.Ed.	 Rini Rita T. Marpaung, M.Ed.	 Rini Rita T. Marpaung, M.Ed.	
's Learning Outcomes (LO)	CPL-PROGRAMME (Programme Learning Outcomes) Assigned to Courses			



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	1. Demonstrating scientific, educational, and religious attitudes and behaviours that contribute to improving the quality of life in society, nation, and state based on culture, norms, and academic ethics. 2. Integrating skills and innovation in the mastery of technology and information, career development, and life skills to become lifelong learners. 3. Applying logical, critical, systematic, and innovative thinking in the context of the development/implementation of science and technology that considers and applies humanities values appropriate to their field of expertise. 4. Mastering concepts, principles, theories, laws, and biological processes to solve problems in biology education.
	CLO (Course Learning Outcomes) 1. Analysing STEM and its applications 2. Analysing STEM components in learning 3. Analysing skills stimulated by STEM 5. Analysing learning strategies in STEM 6. Implementing STEM
Brief Description of the Course	This course examines STEM and its applications, STEM components in learning, skills stimulated by STEM, learning strategies in STEM, and the implementation of STEM.
Study Materials / Learning Materials	1. Introduction 2. STEM and its applications 3. STEM components in learning 4. Skills stimulated by STEM 5. Learning Strategies in STEM 6. Implementation of STEM
Main References:	Primary: [1 A. Abdurrahman, H. Maulina, N. Nurulsari, I. Sukamto, A. N. Umam, and K. M. Mulyana, "Impacts of integrating engineering design process into STEM makerspace on renewable energy unit to foster students' system thinking skills," <i>Heliyon</i>, vol. 9, no. 4, 2023, doi: 10.1016/j.heliyon.2023.e15100. [2] S. M. Stehle and E. E. Peters-Burton, "Developing student 21st Century skills in selected exemplary inclusive STEM high schools," <i>Int. J. STEM Educ.</i>, vol. 6, no. 1, pp. 1–15, 2019, doi: 10.1186/s40594-019-0192-1.



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Lecturer's Name Lecturer	Dr Berti Yolida, M.Ed. Rini Rita. T. Marpaung, M.Ed.
Prerequisite Courses (if any)	-



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Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assessment		
							Criteria & ; Forms	Indicators	Percentage
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
1	Introduction	Course contract and Introduction to STEM: Concepts, urgency, and implementation in education.	Sharing of lecture agreements and lecture contracts		Offline 2 x 50 minutes	Discussion about agreements and expressing opinions	Activities and Q&A	Ability to express opinions in academic agreements	0
2	STEM and its applications	Science Components in STEM: Basic concepts, scientific methods, and their applications.	Lectures and Discussions Learning Resources: articles: and online learning resources	Media: Learning Resources: e-books	Offline 2 x 50 minutes	a. Discussion on scientific concepts, working scientifically by analysing the STEM b. Presentation of discussion results with strong arguments c. Question and answer session and confirmation of the accuracy of the discussion results by comparing the discussion results with the group that gave the presentation	Activities and Question and Answer	Able to analyse the Science components in STEM: Basic concepts, scientific methods, and their applications.	2
3	STEM components in learning	Technology components in STEM: Utilisation of digital devices, software, and learning media.	Lectures and Discussions Media: Source Learning:	Media: Videos Learning Resources: e-books	Offline 2 x 50 minutes	a. Discussion on technological components in STEM b. Presentation of discussion results with strong arguments c. Question and answer session and confirmation of the accuracy of the discussion results by	Activities and Question and Answer	Ability to analyse technological components in STEM: Utilisation of digital devices, software, and learning media.	2



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Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assessment		
							Criteria & Forms	Indicators	Percentage
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
			e-books, articles: 12-15 and online learning resources			comparing the discussion results with the group that gave the presentation			
4	STEM components in learning	Integration of Science and Technology in problem solving.	Lectures and Discussions Media: Video Learning Resources: e-book 3 and online learning resources	Media: Videos 4 and 5 Learning Resources: e-book 3	Offline (TM) 2 x 50 minutes	a. Discussion on the integration of Science and Technology in problem solving. b. Presentation of discussion results with strong arguments c. Question and answer session and confirmation of the accuracy of the discussion results by comparing the discussion results with the group that gave the presentation	Activities and Question and Answer	Ability to analyse and integrate Science and Technology in problem-solving.	2
5	STEM components in learning	Integration of Engineering and Mathematics for product innovation.	Lectures and Discussions Media: Video Learning Resources: e-book 1 and online learning	Media: Videos 4 and 5 Learning Resources: e-book 1	Offline (TM) 2 x 50 minutes	a. Discussion on the integration of Engineering and Mathematics for product innovation. b. Presentation of discussion results with strong arguments c. Question and answer session and confirmation of the accuracy of the discussion results by the , comparing the discussion results with the presenting group	Activities and Question-Answer	Ability to integrate Engineering and Mathematics for product innovation	3



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Week	Sub-CPMK (Planned final competency)	Course Content (Learning Materials)	Forms and Methods of Learning [Media & Learning Resources] (4)		Estimated Time	Student Learning Experience	Assessment		
							Criteria & ; Forms	Indicators	Percentage
(1)	(2)	(3)	Offline	Online	(5)	(6)	(7)	(8)	(9)
			resources						
6	Skills that can be stimulated with STEM	21st-century skills in STEM: Critical thinking, creativity, collaboration, communication.	Lectures and Discussions Media: Video Learning Resources: e-book 4 and online learning resources	Media: Videos 4 and 5 Learning Resources: e-book 4	Offline (TM) 2 x 50 minutes	a. Discussion on 21st-century skills in STEM: Critical thinking, creativity, collaboration, communication b. Presentation of discussion results with strong arguments about analysis of conservation strategies and techniques c. Question and answer session and confirmation of the accuracy of the discussion results by comparing the discussion results with the presenting group	Activities and Question and Answer	Able to analyse 21st-century skills in STEM: Critical thinking, creativity, collaboration, communication.	3
7	Learning Strategies in STEM	Primmer Model in STEM	Lectures and Discussions Media: Video Learning Resources: e-books 10 and 11 and online learning resources	Media: Videos 4 and 5 Learning Resources: e-book	Offline 2 x 50 minutes	a. Discussion on the Primmer Model in STEM b. Presentation of discussion results with strong arguments related to Community-Based Conservation analysis c. Question and answer session and confirmation of the accuracy of the discussion results by comparing the discussion results with the presenting group	Activities and Question and Answer	Able to analyse the Primmer Model in STEM	3



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Note:

1. Programme-Specific Learning Outcomes (PSLO) are the competencies possessed by each graduate of the programme, which are the internalisation of attitudes, knowledge mastery, and skills appropriate to the programme level, acquired through the learning process.
2. The CPL assigned to a course are several learning outcomes of the study programme (CPL-PRODI) used for the formation/development of a course consisting of aspects of attitude, general skills, specific skills and knowledge.
3. Course CP (CPMK) is the ability that is specifically described from the CPL assigned to the course, and is specific to the subject matter or learning material of the course.
4. Sub-CP Course (Sub-CPMK) is a capability that is specifically described from CPMK that can be measured or observed and is the final capability planned at each stage of learning, and is specific to the learning material of the course.
5. Assessment Criteria are benchmarks used as a measure or yardstick for learning achievement in assessment based on predetermined indicators. Assessment criteria are guidelines for assessment to ensure that assessment is consistent and unbiased. Criteria can be quantitative or qualitative.
6. Assessment indicators of student learning abilities in the learning process and outcomes are specific and measurable statements that identify student learning abilities or performance accompanied by evidence.

**MID-TERM EXAM QUESTIONS
ASSESSMENT OUTLINE**

Learning Outcomes (CP)	CPL-PRODI (Programme Study Graduate Learning Outcomes) Assigned to Courses
	1. Demonstrate scientific, educational, and religious attitudes and behaviours that contribute to improving the quality of life in society, nation, and state based on culture, norms, and academic ethics. 2. Integrate skills and innovation in the mastery of technology and information, career development, and life skills to become lifelong learners. 3. Applying logical, critical, systematic, and innovative thinking in the context of the development/implementation of science and technology, while considering and applying humanistic values appropriate to their field of expertise. 4. Mastering concepts, principles, theories, laws, and biological processes to solve problems in biology education.
	CPMK (Course Learning Outcomes)
	1. Analysing STEM and its applications



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	2. Analysing STEM components in learning 3. Analysing skills stimulated by STEM
Assessment Format	Written test in essay form
Aspects measured	COGNITIVE
Time Allocation	100 minutes

No	Sub-topics	Cognitive level measured						Number of items	Question number
		C1	C2	C3	C4	C5	C6		
1	Analysing STEM and its applications				√			1	1
2	Analysing STEM components in learning				√			1	2
3	Analysing the skills stimulated by STEM				√			1	3

ASSESSMENT INSTRUMENT

No	Learning Objectives	Cognitive	Questions	Score
1	Analysing STEM and its applications	C4	In the era of the Fourth Industrial Revolution, the integration of STEM is crucial in the workplace. Analyse the 21st-century skills that can be developed through STEM-based learning and provide examples of their application in everyday life!	10
2	Analysing STEM components in learning	C4	How can the integration of STEM components help students develop critical thinking and problem-solving skills? Provide examples of relevant classroom learning!	10
3	Analysing skills stimulated by STEM	C4	How can STEM learning stimulate students' critical and creative thinking skills in dealing with real problems in their environment? Provide examples of its application!	10



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RUBRIC

No	Learning Objectives	Question	Answer Key	Descriptor
1	Analysing STEM and its applications	In the era of the Fourth Industrial Revolution, the integration of STEM is crucial in the workplace. Analyse the 21st-century skills that can be developed through STEM-based learning and provide examples of their application in everyday life!	21st-century skills developed through STEM: - Critical thinking: analysing real-world problems, such as air pollution. - Creativity & innovation: designing new solutions, such as an air quality monitoring application. - Collaboration: working in cross-disciplinary teams to produce practical solutions. - Communication: conveying analysis results and products to the public. Application: the use of IoT (Internet of Things) sensor-based <i>smart farming</i> to increase agricultural productivity.	7-10 = write the answer correctly and completely 3-6 = writing the answer correctly but incompletely 1-3 = provide correct but incomplete answers 0 = incorrect answer
2	Analysing STEM components in learning	How can the involvement of STEM components help students develop critical thinking and problem-solving skills? Provide examples of relevant classroom learning!	Example: learning about simple water filtration systems. 1. Science: principles of filtration and properties of water. 2. Technology: selection of materials (sand, charcoal, gravel). 3. Engineering: designing a filter model. 4. Mathematics: calculating filtration capacity and rate. Analysis: Through STEM integration, students learn to analyse real-world problems, evaluate various alternative solutions, and develop critical thinking and problem-solving skills.	7-10 = write the correct and complete answer 3-6 = writing the answer correctly but incompletely 1-3 = writing correct but incomplete answers 0 = incorrect answer
3	Analysing skills stimulated by STEM	How can STEM learning stimulate students' critical and creative thinking	Stimulus for critical and creative thinking:	7-10 = write the answer correctly and completely



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		skills in dealing with real-world problems in their environment ()? Provide examples of its application!	- Critical thinking: students analyse the causes of flooding in the school environment by linking factors such as rainfall, drainage and waste. - Creative thinking: students design a "mini water absorption garden" using simple materials. Example of application: a project to create an environmentally friendly drainage system model that combines science (water flow), technology (use of humidity sensors), engineering (channel design), and mathematics (water discharge calculations).	3-6 = writing the answer correctly but incompletely 1-3 = writing the correct answer but incompletely 0 = incorrect answer
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**FINAL EXAM
ASSESSMENT GUIDELINES**

Learning Outcomes (CP)	CPL-PROGRAMME (Programme Learning Outcomes) Assigned to the Course
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	CPMK (Course Learning Outcomes)
	1. Analysing learning strategies in STEM 2. Implementing STEM
Assessment Format	Written test in essay form
Aspects measured	COGNITIVE
Time Allocation	100 minutes

No	Sub-topics	Cognitive level measured						Number of items	Question number
		C1	C2	C3	C4	C5	C6		
2.	Learning Strategies in STEM				√			1	1
3.	Implementation of STEM				√			1	2

ASSESSMENT INSTRUMENT



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No	Learning Objectives	Cognitive	Questions	Score
1	Learning Strategies in STEM	C4	Many teachers still teach science and mathematics separately. Analyse why integration into STEM learning is more effective, and evaluate which strategies teachers should choose so that students are able to connect cross-disciplinary concepts.	10
2	Implementing STEM	C4	In schools with limited resources, STEM implementation is often hampered by a lack of laboratory facilities and technology. Analyse strategic solutions that teachers can implement to ensure that STEM learning remains effective without compromising quality.	10

ASSESSMENT SECTION

No	Learning Objectives	Question	Answer Key	Descriptor
1	Learning Strategies in STEM	Many teachers still teach science and mathematics separately. Analyse why integration into STEM learning is more effective, and evaluate which strategies teachers should choose so that students are able to connect cross-disciplinary concepts.	1. STEM integration is more effective because the real world does not separate fields of study; students learn to understand the relationships between concepts (e.g., the laws of physics and mathematical calculations in designing a miniature bridge). 2. Strategies that can be chosen: Inquiry-Based Learning or Problem-Based Learning, which emphasise open-ended questions, investigation, and real-world problem solving. 3. With these strategies, students do not just memorise concepts, but also use them in real-world contexts.	7-10 = write the answer correctly and completely 3-6 = write the answer correctly but incompletely 1-3 = write correct but incomplete answers 0 = incorrect answer
2	Implementation of STEM	In schools with limited resources, the implementation of STEM is often hampered by a lack of laboratory facilities and technology.	Analysis of solutions to resource limitations: 1. Use simple tools and materials (low-cost materials), such as used bottles, cardboard, or natural materials as experimental media. 2. Implement digital simulations (PhET, GeoGebra, simple AR/VR applications) to replace expensive laboratory equipment.	7-10 = write the answer correctly and completely 3-6 = writing the answer correctly but incompletely 1-3 = writing correct but incomplete answers



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	Analyse strategic solutions that teachers can implement to ensure that STEM learning continues to be effective without compromising quality.	3. Use the flipped classroom model, where students learn concepts through videos at home, then perform simple practical activities at school. 4. This strategy ensures that STEM implementation remains contextual, affordable, and applicable.	0 = incorrect answer
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STEM PROTOTYPE DEVELOPMENT PROJECT ASSESSMENT TOOL

Aspects Assessed

1. Project Planning (Science, Technology, Engineering, Mathematics)
2. Process and Collaboration
3. Creativity & Innovation
4. Prototype Product
5. Presentation & Communication

Assessment Criteria	Score 4 (Excellent)	Score 3 (Good)	Score 2 (Satisfactory)	Score 1 (Poor)
Project Planning (STEM)	Planning is very detailed, with all STEM components (science, technology, engineering, mathematics) clearly and relevantly integrated.	Planning is quite detailed, with most STEM components integrated	Planning is still limited, with only a small portion of STEM components being used	No clear STEM integration in the planning
Process & Collaboration	All members actively contribute, demonstrating solid cooperation and joint problem solving	Most members are active, cooperation is fairly good	Only a few members are active, collaboration is limited	Group work is ineffective, most members are passive
Creativity & Innovation	The prototype is highly creative, unique, and demonstrates new innovations in problem-solving	Prototypes are fairly creative, with new elements although still simple	Prototypes are less creative, mostly imitating existing examples	No creative elements, merely a complete copy



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Prototype Product	The prototype functions very well according to its purpose, with a strong and aesthetically pleasing design	The prototype functions reasonably well, although there are minor flaws	The prototype does not function optimally, with many technical flaws	The prototype does not function and does not serve its purpose
Presentation & Communication	The presentation is very clear and systematic, with test data/results supported by mathematical analysis, and the communication is convincing	The presentation is fairly clear, and the data/test results are well presented	The presentation is unclear, and the data/test results are limited	The presentation is not coherent, there is no analysis or supporting data

Final Score

- 16–20 = Very Good
- 11–15 = Good
- 6–10 = Fair
- 1–5 = Poor

PROJECT WORK PROCESS OBSERVATION SHEET (ACTIVITY)

Identity

- Group Name:
- Member Names:
- Project :
- Observation Date:

Aspects Assessed

Process Aspect	Indicators Observed	Score 4 (Very Good)	Score 3 (Good)	Score 2 (Fair)	Score 1 (Poor)
Participation & Engagement	Every member is actively involved, contributes ideas, and carries out tasks	All members are active and balanced	Most are active	Only a few are active	Almost all are passive
Collaboration & Cooperation	Able to work together, respect opinions, share tasks	Solid collaboration, mutual support	Collaboration is quite good	Limited cooperation, frequent conflicts	No cooperation
Problem Solving	Ability to overcome technical/conceptual obstacles	Quickly finds creative solutions	Able to resolve most problems	Only some problems are resolved	Unable to resolve problems
Time management	Manage project stages according to schedule	Very organised, according to the timeline	Fairly organised, with some delays	Not very organised, often late	No time management



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Application of STEM Concepts	Integrating science, technology, engineering, and mathematics into the work process	All aspects of STEM are clearly applied	Most aspects of STEM are applied	Only a few aspects of STEM are applied	No visible integration of STEM
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Score & Interpretation

- 16–20 = Excellent (work process is highly optimal)
- 11–15 = Good (work process is fairly optimal)
- 6–10 = Fair (work process is inconsistent)
- 1–5 = Poor (work process is not functioning well)