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IMPLEMENTATION OF LOCAL WISDOM-BASED BIOTECHNOLOGY TEXTBOOK FROM TABAGSEL REGION ON CREATIVITY AND CRITICAL THINKING SKILLS OF STUDENTS AT UNIVERSITAS MUHAMMADIYAH TAPANULI SELATAN

Melvariani Syari Batubara[1*], Rafiqah Amanda Lubis[2], Elda Sari Siregar[3], Happy Sri Rezeki Purba[4], Ilmi Aulina Rahim[5]

[1,5] *Program Studi Pendidikan Biologi, Fakultas Keguruan dan Ilmu Pendidikan Universitas Muhammadiyah Tapanuli Selatan, Indonesia*

[2,3] *Program Studi Agroteknologi, Fakultas Sains dan Teknologi Universitas Muhammadiyah Tapanuli Selatan, Indonesia*

[4] *Program Studi Pendidikan Bahasa Inggris, Fakultas Keguruan dan Ilmu Pendidikan Universitas Muhammadiyah Tapanuli Selatan, Indonesia*

[*]Corresponding Author: melvarianisyari@um-tapsel.ac.id

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ABSTRACT

The objective of this study is to determine the implementation of a Tabagsel local wisdom-based biotechnology textbook on the creativity and critical thinking abilities of students at UMTS in the biotechnology course. The method employed in this research is PTK to assess the creativity and critical thinking abilities of students at UMTS. This PTK was conducted in 2 cycles, each consisting of stages: Analysis, Fact Finding, Conceptualization, Planning, Implementation, Additional Fact Finding, and Evaluation. The results of this study indicate that the highest score on the student creativity test in cycle I was 85 and the lowest was 54. The highest score on the student creativity test in cycle II was 95 and the lowest was 75. The increase in student creativity test scores was 10 points. The number of students who achieved mastery on the creativity test in cycle I was 12 students and in cycle II was 17 students, with an increase of 5 students. The conclusions of this study are: The PKK (Classical Mastery Percentage) on the student creativity test in cycle I was 50% and in cycle II was 70%, with an increase of 20%; The percentage of students who achieved mastery on the critical thinking test was 80%, while those who did not achieve mastery was 20%.

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INTRODUCTION

Biotechnology is a multidisciplinary science because it is related to other scientific fields, so teaching biotechnology material requires fundamental understanding from several related scientific fields, which makes biotechnology very complex to study. In addition, some materials studied in biotechnology are still abstract because they examine molecular-level phenomena. Therefore, to overcome this problem, teaching aids are needed to facilitate students' understanding of materials in the biotechnology course. Currently, there are no effective learning media available to help students understand materials in the biotechnology course, so it is necessary to develop and implement good learning media in the form of textbooks based on local wisdom (Batubara and Lubis 2022).

The Tabagsel region has a wide variety of fruits as its local wisdom, including salak (snake fruit) and coffee. Salak and coffee are fruits produced by plants native to Indonesia. Salak and coffee plants have many varieties, some of which possess superior characteristics in terms of taste and fruit appearance. Among those currently widely known to the public are Padangsidimpuan salak and Sipirok coffee, especially in North Sumatra (Burhanuddin et al. 2022). From literature studies, it was found that no textbooks are using this local wisdom as content and learning resources, so it is necessary to develop and implement media in the form of textbooks based on Tabagsel regional local wisdom that can increase learning interest, critical thinking abilities, creativity, learning outcomes, and students' understanding of the biotechnology course (Wanderi, Qurniati, and Kaskoyo 2019).

From discussions with biotechnology course lecturers, many concepts are very abstract for students, so students can only imagine what is being conveyed by their lecturers through lectures. Thus, this abstract knowledge does not rule out the possibility that students will experience misconceptions, for example in the concept of modern biotechnology. In order for all concepts in the material to be absorbed by students, the lecturer's role is very important in motivating students to be willing and able to absorb them.

The results of expert assessment of the products that have been developed and implemented showed didactic validity of 3.43 (very valid), construction 3.62 (very valid), technical 3.75 (very valid), and creative and critical thinking abilities 3.69 (very valid) (Astriani, Fidaus, and Ardiawan 2019). The Discovery Learning Model-Oriented Student Worksheet that has been developed and implemented has the potential to develop students' creative and critical thinking abilities in biotechnology material (Agitsna, Wahyuni, and Friansah 2019).

The utilization of research results as learning media in the form of textbooks is carried out by considering requirements, organizational factors, and presentation of learning resources. Learning media in the form of textbooks in this case facilitate students in understanding abstract biotechnology substances, have attractiveness to be studied, and can motivate students to understand biotechnology material more deeply (Sobiruddin et al. 2022). The development and implementation of Tabagsel regional local wisdom-based biotechnology course textbook products need to be continued to ensure the quality of the developed textbook products (Nurramadhani 2019).

Research results conducted by (Nasution, Batubara, and Darwis 2019), Efforts to Increase Students' Biology Creativity Through the Application of Problem-Based Learning (PBL) Model in class XI IPA 4 at SMA Negeri 1 Sipirok in the 2018-2019 academic year on the topic "Cell Structure and Function". The research results obtained showed that the application of the problem-based learning model can increase student learning creativity, as can be seen from the creativity test results in cycle I obtaining a mastery percentage value of 71.97% and cycle II 93.75% (an increase of 21.88%).

Research results by (Batubaral and Sapitri 2020) showed that there was a 20% increase in students' biology learning creativity through the constructivist learning model on Biodiversity material during the pandemic at SMA Negeri 5 Padangsidimpuan with a mastery percentage reaching 50% in cycle I and 70% in cycle II, with a KKM (Minimum Mastery Criteria) value of 80.

The globalization era demands that students have an entrepreneurial spirit so that with creativity, innovation, leadership, and managerial skills, they can utilize their knowledge. The concepts learned in the Chemistry Practicum course are very close to students' lives. The CEP approach contains values such as pursuing opportunities, making innovations, daring to take risks, daring to be different, attracting attention, and being pro-growth so that students become logical, creative, forward-looking individuals oriented toward results. Lecturer assessment of the product produced an average score of 3.6 in the valid category, while student interest in entrepreneurship before and after using the product increased from an average score of 32 to 59. This also shows that the CEP-based chemistry practicum guidebook developed is in the good category and suitable for use as a learning resource for chemistry students at UMTS (Pohan and Lubis 2019).

Basic-level Arabic writing skills are included in the competency and conservation-based curriculum of the Arabic Language Education Study Program. Basic-level Arabic writing skills learning is provided through the taroqib wa takhawiljumal course. Basic-level Arabic writing skills learning based on local wisdom introduces our nation's culture and increases students' creativity in Arabic writing. This local wisdom-based basic-level Arabic writing skills learning introduces students to culture, encourages creativity in Arabic writing, and motivates better written language skills (Elmubarok, Qutni, and Nawawi 2019).

Based on interviews on March 4, 2023, with the Biotechnology course lecturer at Universitas Muhammadiyah Tapanuli Selatan, it was stated that in the learning process, lecturers have never used other learning models that can increase student learning creativity during the learning process, and the model applied by lecturers when teaching is the lecture method. From the observations, there was evident that during the learning process, students tend to be passive because the learning method used is still lecturer-oriented. Students only focus on lecturers as sources of knowledge. Students do not have opportunities to ask questions and express opinions, which lowers their learning creativity and makes them less active during teaching and learning.

If lecturers attempt to increase creativity, besides having to be able to activate students in learning, they must also create an interesting learning atmosphere for students (Yani, Sahriah, and Adiansyah 2017). In accordance with such an atmosphere, students can not only sharpen their cognitive abilities but also gain direct experience, so learning becomes more meaningful for students (Angraini, Fitri, and Darussyamsu 2022). Meaningful learning enables students to discover facts and concepts themselves and develop the values they hold (Almulla 2023).

To achieve maximum learning outcomes, students must always focus their attention on increasing knowledge (Muhlisin et al. 2020). The development of the teaching and learning process occurs through the cognitive domain (Nihlah, Ristanto, and Kurniati 2024). Students must be able to build their own understanding and accept others' understanding. Students can participate in group learning and are able to form groups in the learning process through the affective domain. Then, from the cognitive and affective domains, students must also have the ability to create innovative and creative ideas in the learning process (Arwita et al. 2025).

Despite the growing body of research on both local wisdom integration in education and biotechnology teaching innovations, significant gaps remain in the literature that this study addresses (Wei 2024). First, while numerous studies have explored local wisdom integration in primary and secondary education, relatively few have systematically examined its implementation and effectiveness in biotechnology courses, particularly for pre-service biology teachers who will become future educators. The unique challenges and opportunities of integrating local wisdom in university-level biotechnology education, where content complexity and cognitive demands are substantially higher, remain underexplored.

Second, although research has documented the general benefits of contextual and problem-based learning in biotechnology, there is limited

empirical evidence specifically examining how local wisdom-based textbooks impact the development of creativity and critical thinking skills two essential 21st century competencies that are particularly relevant for biotechnology students who must navigate complex, interdisciplinary problems requiring innovative solutions. Most existing studies focus primarily on knowledge acquisition and general learning outcomes, with insufficient attention to the specific mechanisms through which local wisdom contexts facilitate higher-order cognitive skill development. The assessment of creativity and critical thinking in biotechnology education context, particularly using validated instruments aligned with Bloom's taxonomy at C4 (Analyze) and C5 (Evaluate) levels, remains limited in the literature.

Third, methodological gaps exist in terms of systematic intervention studies employing rigorous research designs such as Classroom Action Research (PTK) to investigate the implementation process, challenges, and iterative improvements in local wisdom-based biotechnology teaching. While Classroom Action Research has been recognized as a catalyst for innovation in biology education in Indonesia, its application specifically for developing and implementing local wisdom-based biotechnology materials remains understudied. The systematic documentation of implementation cycles, reflection processes, and continuous improvement strategies through PTK methodology would provide valuable insights for practitioners and researchers seeking to replicate or adapt such interventions.

Fourth, regional specificity in local wisdom integration presents both opportunities and gaps. The Tabagsel region, with its distinctive agricultural products and traditional biotechnology practices, represents an underutilized context for biotechnology education research. While studies have explored local wisdom from various Indonesian regions, the specific potential of Tabagsel's agricultural biodiversity particularly Padangsidimpuan salak and Sipirok coffee as pedagogical resources for biotechnology education has not been systematically investigated. Understanding how region-specific local wisdom can be effectively transformed into pedagogically sound teaching materials that meet both local relevance and international scientific standards requires dedicated research attention.

This research offers several significant novelties that distinguish it from previous studies and contribute to the advancement of biotechnology education scholarship (Syamsidah and Suryani 2018). First, this study represents a pioneering effort to develop and systematically evaluate a comprehensive local wisdom-based biotechnology textbook specifically designed for higher education contexts in Indonesia, with particular focus on the Tabagsel region's distinctive agricultural products and traditional knowledge systems. Unlike previous studies that have explored local wisdom integration in a fragmented or ad hoc manner, this research provides a holistic textbook development framework that integrates didactic, constructive, and technical considerations while maintaining rigorous alignment with biotechnology curriculum standards and learning objectives.

Second, the research makes a methodological contribution by employing a systematic two-cycle Classroom Action Research design that documents not only outcomes but also the iterative process of implementation, reflection, and refinement. This approach, involving seven distinct stages in each cycle (Analysis, Fact Finding, Conceptualization, Planning, Implementation, Additional Fact Finding, and Evaluation), provides detailed insights into the practical challenges and successful strategies for implementing local wisdom-based materials in biotechnology education. The systematic documentation of this process offers a replicable model for other educators and researchers seeking to develop contextually relevant teaching materials.

Third, this study provides unique empirical evidence regarding the dual impact of local wisdom-based biotechnology textbooks on both creativity and critical thinking skills simultaneously, using validated assessment instruments based on established creativity indicators (flexibility, originality, elaboration, and fluency) and Bloom's taxonomy-based critical thinking assessments. The simultaneous examination of these two interconnected but distinct higher-order cognitive skills, with specific attention to their differential

development patterns, offers theoretical insights into how contextual learning materials influence complex cognitive processes. The research establishes concrete benchmarks for improvement, with specific attention to the Classical Mastery Percentage (PKK) and individual student achievement trajectories.

Fourth, the study contributes to the practical knowledge base by providing a validated model of how specific local wisdom elements in this case, Padangsidimpuan salak and Sipirok coffee can be systematically integrated into biotechnology content covering topics such as plant breeding, genetic improvement, fermentation technology, and sustainable agriculture. The detailed documentation of content integration strategies, pedagogical approaches, and assessment methods provides actionable guidance for curriculum developers and educators in similar contexts. Additionally, the research offers insights into addressing the persistent challenge of biotechnology's perceived abstractness by demonstrating how familiar, culturally significant local contexts can serve as cognitive bridges to complex scientific concepts.

The research addresses four primary questions: (1) To what extent does the implementation of a Tabagsel local wisdom based biotechnology textbook improve students' creativity levels from Cycle I to Cycle II, as measured by creativity test scores and Classical Mastery Percentage (PKK)?; (2) How does the textbook implementation affect students' critical thinking abilities across the two instructional cycles, with specific attention to improvements in highest scores, lowest scores, average scores, and the percentage of students achieving mastery criteria?; (3) What are the specific implementation challenges, successful strategies, and refinements identified through the iterative Classroom Action Research process?; and (4) What differential patterns emerge in the development of creativity versus critical thinking skills through local wisdom based biotechnology instruction?

The objective of this research is to determine the implementation of the Tabagsel local wisdom-based biotechnology textbook on the creativity and critical thinking abilities of students at Universitas Muhammadiyah Tapanuli Selatan in the Biotechnology course. Also, through this South Tapanuli-based local wisdom biotechnology course textbook, it is expected to increase learning creativity and critical thinking abilities of students at Universitas Muhammadiyah Tapanuli Selatan. The research campus has never implemented a South Tapanuli regional local wisdom-based biotechnology course textbook, so researchers are interested in conducting research using this to increase learning creativity and critical thinking abilities.

The urgency of this research for science is expected to contribute to the development of knowledge related to the development and implementation of Tabagsel regional local wisdom-based Biotechnology course textbooks.

METHOD

In this research, the steps taken are classroom action research using a cycle model because the research object being studied is only one class. The implementation of this research consists of 4 stages: planning, acting, observing, and reflecting.

a. Planning: the researcher prepares learning scenario plans in the Lesson Plan (RPP) concerning learning activities to be implemented and expected behavior from research subjects.

b. Action: the researcher conducts learning according to the designed scenario.

c. Observation: the researcher observes student behavior/activities during learning.

d. Reflection: the researcher performs reflection or evaluation of action results, achievement of research objectives, weaknesses, and solutions to overcome these problems. If after the implementation of actions the results have not been optimal, revision and replanning are necessary to improve actions in the previous cycle for application in the next cycle.

The classroom action flow can be seen in the diagram below:

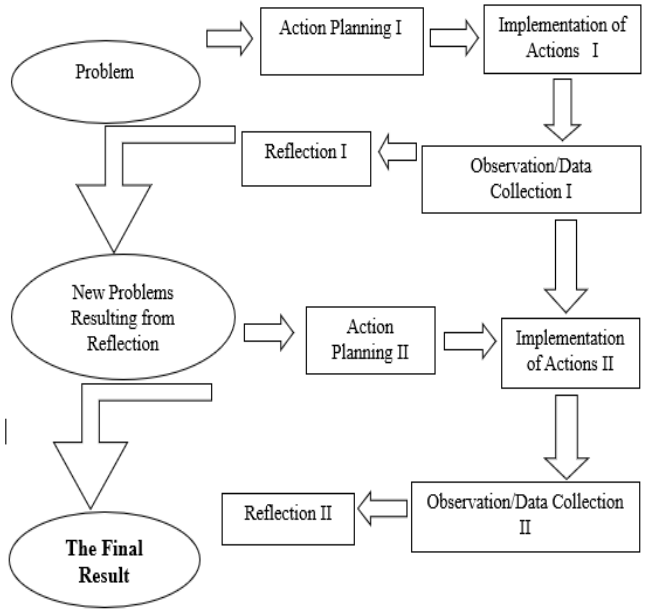

Figure1. Classroom Action Research (PTK) Procedure Diagram

Data collection techniques in this research are: first, providing questions and testing them on other students who have studied the material by entering the class's classroom group and distributing questions by sending the question file, and students answer the questions by photographing their answers and sending them back to the classroom; second, the results of the trial are calculated for test validity, reliability, difficulty level, and test discriminatory power. Next, valid questions are distributed to students who are research objects by entering the classroom and distributing questions by sending the question file, and students answer the questions by photographing their answers and sending them back to the classroom. As the learning process progresses in the classroom, student activities are also monitored to observe changes in their activities during teaching and learning.

Tests are questions that must be answered and completed by students being investigated, called respondents. In this test, researchers use creativity tests and critical thinking level tests to determine the development of students' creativity and critical thinking levels. The implementation of creativity tests and critical thinking level tests is conducted after learning is completed.

Table 1. Criteria for Creativity Test Scores and Critical Thinking Levels

No.	Score	Creativity Criteria	Critical Thinking Criteria
1.	90 – 100	Very Creative	Very Active
2.	80 – 89	Creative	Active
3.	70 – 79	Quite Creative	Quite Active
4.	60 – 69	Less Creative	Less Active
5.	≤ 59	Not Creative	Not Active

To obtain the data needed in this research, researchers use research instruments in the form of test sheets and questionnaire sheets.

Table 2. Grid for Writing Student Creativity Tests and Critical Thinking Levels

Indicator	Aspects Measured	Item Questions		
		Bloom's Taxonomy	Question Number	Time
Flexibility	1. Students are able to generate varied ideas, answers, or questions 2. Students can see a problem from different perspectives 3. Students are able to seek many alternatives or different directions	C4 & C4	2 & 7	1 Minute
Originality	1. Able to produce new and unique expressions 2. Students have strong determination to complete Biotechnology problems	C4 & C4	1 & 3	1 Minute
Elaboration	1. Students are able to respond to questions enthusiastically, actively, and energetically in completing tasks 2. Students dare to accept or carry out difficult tasks 3. Students enjoy finding practical methods in learning 4. Students are critical in examining work results 5. Students are aggressive in asking questions	C5 & C4	4 & 6	1 Minute
Fluency	1. Students generate many ideas, answers, problem solutions, or questions 2. Independent in learning Biotechnology	C4 & C5	5 & 8	2 Minute

To calculate the percentage of students' creativity and critical thinking levels individually, need to know : Calculating Scores, Calculating class average, Individual Mastery Percentage (PKI)and Classical Mastery Percentage (PKK)

Then, each student's learning mastery is determined, with student averages based on the KKM (Minimum Mastery Criteria) of 80.

Classroom action research is considered successful if it meets the following requirements: increased creativity and critical thinking levels of student learning in the biotechnology course, indicated by student learning mastery reaching 80% of students with a KKM of 80.

RESULTS AND DISCUSSION

In the implementation of research activities, the final stage has been reached (Utomo and Ratnawati 2018), having gone through several stages such as: (1) Research and Information Collection, including collecting initial data such as student learning outcomes, observational analysis, and interviews with students and lecturers; (2) Planning, including designing lesson plans based on stimulation with syntax and creating storyboards or scenarios for each material; (3) Dissemination and Implementation, including distributing the Tabagsel local wisdom-based biotechnology textbook to assess the creativity and critical thinking abilities of students at Universitas Muhammadiyah Tapanuli Selatan taking the Biotechnology course. This Classroom Action Research (PTK) was conducted in 2 cycles (Ikhlas 2018), each consisting of 7 stages: (1) Analysis, (2) Fact Finding, (3) Conceptualization, (4) Planning, (5) Implementation, (6) Additional Fact Finding, and (7) Evaluation, to achieve the expected results.

Table 3. Improvement of Student Creativity Test

No.	Descriptive Analysis	Cycle I	Cycle II	Improveme-nt
1.	Highest Score	85	95	10
2.	Lowest Score	54	75	21
3.	Average Score	69,5	85	15,5
4.	Number of Students	24	24	-
5.	Number of Students Who Achieved Mastery	12	17	5
6.	Number of Students Who Did Not Achieve Mastery	12	7	-
7.	PKK	50%	70%	20%
8.	Percentage of Students Who Did Not Achieve Mastery	50%	30%	-

From Table 3 above, it can be seen that the highest score on the student creativity test in cycle I was 85 and the lowest was 54. The highest score on the student creativity test in cycle II was 95 and the lowest was 75. The increase in student creativity test scores was 10 points. The number of students who achieved mastery on the creativity test in cycle I was 12 students and in cycle II was 17 students, with an increase of 5 students. The Classical Mastery Percentage (PKK) on the student creativity test in cycle I was 50% and in cycle II was 70%, with an increase of 20%.

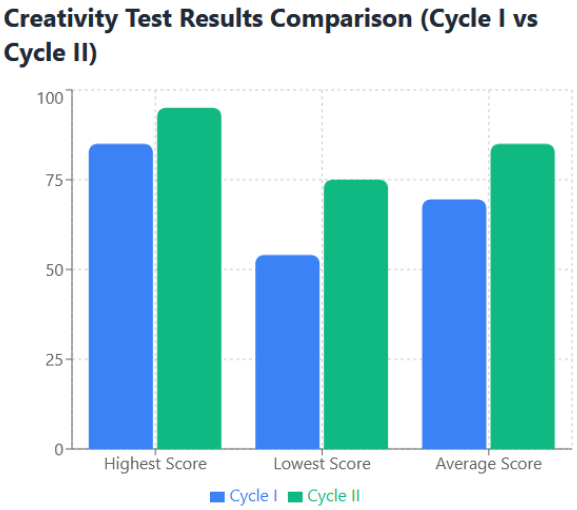

Figure 2. Graph of Improvement in Student Learning Creativity Test Results

The research findings demonstrate that the implementation of the Tabagsel local wisdom-based biotechnology textbook provides a significantly positive impact on improving student creativity. The Classical Mastery Percentage (PKK) increased from 50% in Cycle I to 70% in Cycle II, representing an improvement of 20%. The average creativity scores also experienced an increase from 69.5 to 85, or an improvement of 15.5 points (22.3%). The number of students achieving mastery increased from 12 students (50%) to 17 students (70%), indicating that more students successfully met the established Minimum Mastery Criteria (KKM) standard of 80.

Based on the creativity indicators measured in this study flexibility, originality, elaboration, and fluency the increase in creativity scores indicates that students are increasingly capable of generating varied ideas, producing new and unique expressions, responding to questions actively and enthusiastically, and generating multiple ideas in solving biotechnology problems. This indicates that using the Tabagsel local wisdom context (such as Padangsidimpuan salak and Sipirok coffee) as learning media can stimulate student creativity due to the relevance of the material to their daily life experiences and environment.

Research by OECD (2019) in "Fostering Students' Creativity and Critical Thinking" emphasizes that creativity and critical thinking are key skills for the complex and global 21st-century economy and society. OECD suggests that education systems must develop these skills through innovative and contextual pedagogical approaches. The implementation of local wisdom-based textbooks in this research aligns with these recommendations, where students are given opportunities to explore biotechnology concepts through the lens of their local culture and environment (Vincent-Lancrin et al. 2019).

The highest creativity scores also increased from 85 in Cycle I to 95 in Cycle II (an increase of 10 points), while the lowest score increased from 54 to 75 (an increase of 21 points). The greater increase in the lowest score compared to the highest score demonstrates that this intervention is highly effective in helping students who initially had low creativity levels. This indicates that using local wisdom-based textbooks provides effective scaffolding for students with diverse initial abilities.

Table 4. Classical Learning Mastery of Critical Thinking Test

No.	Descriptive Analysis	Cycle I	Cycle II	Improvement
1.	Highest Score	85	100	15
2.	Lowest Score	54	62,5	8,5
3.	Average Score	69,5	84,5	15
4.	Number of Students	24	24	-
5.	Number of Students Who Achieved Mastery	12	20	8
6.	Number of Students Who Did Not Achieve Mastery	12	4	-
7.	PKK	50%	80%	30%
8.	Percentage of Students Who Did Not Achieve Mastery	50%	20%	-

From Table 4, the results show that the highest score on the student critical thinking test was 100 and the lowest was 62.5, with a score increase of 37.5. The average score on the student critical thinking test was 84.5. The number of students who achieved mastery on the critical thinking test was 20 students, while 4 students did not achieve mastery, with an increase in the number of students of 16. The percentage of students who achieved mastery on the critical thinking test was 80%, while those who did not achieve mastery was 20%, with a percentage increase of 60%.

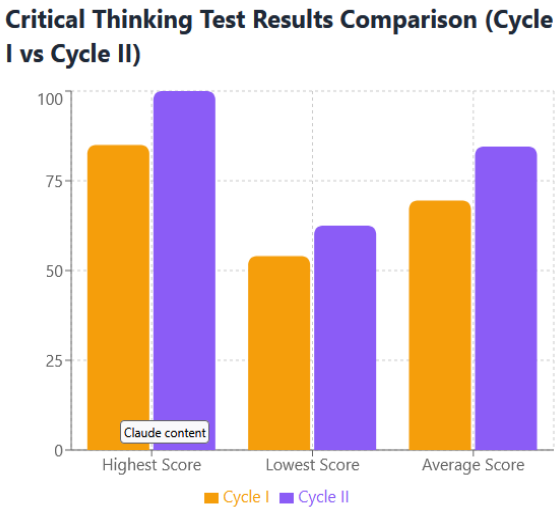

Figure 3. Graph of Improvement in Student Learning Critical Thinking Test Results

The research findings show a highly significant improvement in student critical thinking abilities. The PKK increased from 50% in Cycle I to 80% in Cycle II, representing an increase of 30%. The average critical thinking score increased from 69.5 to 84.5, or an increase of 15 points (21.6%). The number of students achieving mastery increased from 12 students (50%) to 20 students (83.3%), indicating that the majority of students successfully met or exceeded the established KKM.

The achievement of 80% PKK in critical thinking abilities has met the minimum target established in this research, demonstrating that the implemented intervention is highly effective. One student even achieved a perfect score of 100 in Cycle II, showing that the developed textbook can encourage students to reach the highest level of critical thinking.

This improvement aligns with research findings showing that active learning is an essential component in enhancing critical thinking abilities. Research demonstrates that student centered learning strategies significantly improve critical thinking skills both in the short term and long term. The implementation of the local wisdom based biotechnology textbook in this research actively involves students through exploration of material relevant to local contexts, analysis of real cases from their surrounding environment, and critical evaluation

of biotechnology applications in local cultural contexts (Crawford 2022).

Research in life sciences education also shows that using flipped classrooms with active learning activities such as process oriented guided inquiry learning, model building, case studies, and targeted critical thinking exercises can significantly improve critical thinking skills. Although this research does not explicitly use the flipped classroom model, the learning approach with local wisdom based textbooks facilitates similar activities where students engage in inquiry, case analysis, and contextual problem-solving (Thornhill-Miller et al. 2023).

The highest critical thinking score increased from 85 in Cycle I to 100 in Cycle II (an increase of 15 points), while the lowest score increased from 54 to 62.5 (an increase of 8.5 points). The more moderate increase in the lowest score compared to creativity indicates that critical thinking abilities may require a longer time to develop in students with low initial abilities; however, improvement still occurred and was meaningful.

Comparative analysis between creativity and critical thinking improvements reveals an interesting pattern. Critical thinking abilities experienced a greater PKK increase (30%) compared to creativity (20%), although the average scores of both increased with almost the same magnitude (creativity +15.5 points vs. critical thinking +15 points). This shows that more students successfully achieved mastery standards in critical thinking abilities compared to creativity.

This difference can be explained through the characteristics of both constructs. According to OECD literature, creativity and critical thinking are two different but interrelated higher order cognitive skills. Both require substantial mental effort and energy and represent cognitive challenges. Creativity aims to create new and appropriate ideas and products (novel and appropriate), while critical thinking aims to carefully evaluate and assess statements, ideas, and theories to reach competent conclusions (Vincent-Lancrin and Lowe 2024).

In the context of biotechnology learning with local wisdom-based textbooks, students face material requiring both types of skills. When analyzing biotechnology applications in Padangsidimpuan salak or Sipirok coffee, students need to think critically to evaluate appropriate biotechnology techniques, analyze the advantages and disadvantages of each method, and make evidence based decisions. Simultaneously, students need to think creatively to develop innovative ideas in biotechnology applications appropriate to local contexts.

The higher PKK increase in critical thinking may indicate that critical thinking assessment criteria are more structured and can be developed through systematic practice, while creativity may require a longer incubation time to develop optimally. However, both show significant positive trends, indicating the intervention's effectiveness (Mamun 2024).

Implementation of the Tabagsel local wisdom-based biotechnology textbook proved effective in improving student creativity and critical thinking abilities at Universitas Muhammadiyah Tapanuli Selatan. The PKK increase from 50% to 70% for creativity and from 50% to 80% for critical thinking demonstrates significant positive impact from this intervention. Using relevant local contexts, combination with student centered learning approaches, and implementation through systematic PTK design contributed to intervention success.

This research provides important contributions to pedagogical development in biotechnology learning and science education generally, particularly in the Indonesian context where local wisdom integration can be an effective strategy for improving learning quality. These findings also reinforce the importance of shifting from teacher centered to student centered learning and developing quality, contextual, and engaging teaching materials (Lucas 2022).

Practical implications of this research are that lecturers and curriculum developers are encouraged to integrate local wisdom into their learning designs, use PTK approaches for continuous improvement, and facilitate active learning that promotes student creativity and critical thinking development. Thus, higher education can be more effective in preparing students with 21st century skills needed to face future challenges (Styers, Van Zandt, and Hayden 2018).

CONCLUSION

The conclusions of this activity are: a) The Classical Mastery Percentage (PKK) on the student creativity test in cycle I was 50% and in cycle II was

70%, with an increase of 20%; b) The percentage of students who achieved mastery on the critical thinking test was 80%, while those who did not achieve mastery was 20%.

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