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Implementation of 21st Century Learning: A Review of Teachers' Ability to Design and Implement Learning

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Abstract

This study aims to examine the alignment between the planning and implementation of biology learning based on the 2013 Curriculum in public high schools in Biringkanaya District, Makassar City, with a focus on the integration of 4C skills and Higher-Order Thinking Skills (HOTS). This study uses mixed methods involving four 11th grade biology teachers. Data were collected through analysis of lesson plans, observation of classroom teaching, and teacher questionnaires, then analyzed descriptively and inferentially using the chi-square test. The results showed that the quality of lesson plan preparation and biology teaching implementation was generally very low, especially in the formulation of Competency Achievement Indicators and learning objectives, which were still dominated by low-level thinking skills (C1–C2). The observation results also revealed limitations in the use of authentic stimuli, HOTS questions, and meaningful discussions, so that the development of students' 4C and HOTS skills was not optimal. The chi-square test showed a significant relationship between teachers' ability to design lesson plans and the quality of classroom teaching. These results emphasize the importance of strengthening teachers' pedagogical competencies in designing and implementing biology learning that is aligned with and oriented towards 21st-century skills.

Keywords: *lesson plans, learning implementation, biology.*

A. Introduction

International organizations and projects have identified several 21st-century skills that are considered important for the success of students in today's world and in the future. The Partnership for 21st Century Learning proposes that students develop digital literacy, creativity, critical thinking, and excellent interpersonal and social skills (Partnership for 21st Century Skill, 2019); (Pahlevi et al., 2020); *(Arsad et al., 2011)*. Much research has been conducted on 21st-century skills, including research on the problem-solving skills of students at public high schools in the Biringkanaya subdistrict of Makassar, which were found to be severely lacking (Susiati et al., 2020). Another study on the argumentation skills of students at public high schools in the Biringkanaya sub-district of Makassar city also found that these skills were in the very poor category (Bahri et al., 2021). This should be taken into consideration by all relevant parties to further improve the quality of education.

This condition indicates a gap between the skills required in the 21st century and the implementation of learning in schools. One factor that could potentially influence this condition is the quality of learning tools, particularly the Lesson Plan (RPP) prepared by teachers. The RPP is a very important learning tool in the context of 21st century education. The preparation of Lesson Plans (RPP) needs to take into account components that are in line with the applicable curriculum. In practice, many teachers experience difficulties in translating curriculum demands into concrete learning objectives, indicators, activities, and assessments that truly reflect 4C and HOTS. Currently, several schools in Indonesia still use the 2013 curriculum, in which the RPP must integrate elements that strengthen character education (PPK), communication skills, collaboration, creativity, critical thinking (4C), literacy, and higher order thinking skills (HOTS). In this study, the schools that were the subjects of the research were selected from schools that were still implementing the 2013 Curriculum, which at that time was in a transition phase towards the implementation of the Merdeka Curriculum. The integration of these elements is carried out in order to implement 21st-century learning (Mukarramah et al., 2021).

This study focuses on assessing the integration of 4C elements and HOTS in lesson plans. This is because of the basic needs of students in facing learning challenges in the modern era. Both aspects are prioritized in the current learning context, as they provide essential and relevant skills for students in an ever evolving era. Compared to other 21st-century competencies such as digital literacy or global awareness, 4C and HOTS were deliberately selected because they are directly embedded in instructional design, learning activities, and assessment processes, making them more observable and measurable within classroom practices. Through the integration of 4C and HOTS in lesson plans, teachers have the potential to create learning experiences that encourage active interaction, creativity, and analytical thinking, which are important for success in an ever-evolving world (Simanjuntak, 2019). Moreover, previous studies indicate that weaknesses in students' 21st-century skills are often rooted not in the absence of curriculum mandates, but in teachers' limited ability to translate higher-order cognitive demands into concrete learning objectives and classroom activities, positioning 4C and HOTS as critical entry points for identifying instructional gaps

The education revolution around the world has emerged from a constructivist perspective on teaching and learning. This change explicitly requires teachers to adopt different teaching strategies by shifting the focus from traditional text and memorization centered learning to exploration and inquiry based learning connected to real world phenomena. Within a constructivist framework, learning is understood as an active process in which students construct knowledge through problem solving, social interaction, and reflection, making the integration of 4C and HOTS not merely an instructional option but a pedagogical necessity. As the main actors in the implementation of classroom learning, teachers are tasked with planning, implementing, and evaluating changes or improvements in learning programs. Consequently, lesson planning must intentionally embed higher-order cognitive processes (C4–C6) and opportunities for communication, collaboration, creativity, and critical thinking, as these elements operationalize constructivist principles within classroom practice. Teachers must pay attention to the relevance of existing programs to the needs of students, improve program planning, select and deliver programs effectively, and evaluate changes made to learning programs (Pahlevi et al., 2020).T

To implement education that is integrated with 21st-century skills, innovation is needed in the curriculum, learning, and assessment, with teachers as the main actors in translating policy into classroom learning practices. Therefore, this study aims to analyze the integration of the 4C elements (communication, collaboration, creativity, and critical thinking) and Higher Order

Thinking Skills (HOTS) in biology lesson plans (RPP) and their implementation in classrooms at public high schools in Biringkanaya District, Makassar City.

B. Literature Review

1. The Lesson Plan

The Lesson Plan (RPP) is a plan for face-to-face learning activities that is prepared for one or more meetings. The RPP is developed based on the syllabus as a guideline for teachers in directing student learning activities to achieve Core Competencies (KD). Based on Permendikbud Number 65 of 2013 concerning Standards for Primary and Secondary Education Processes, the initial stage in the learning process is learning planning, which is realized through the preparation of an RPP. This document is designed for one or more meetings and is developed from the syllabus so that learning can be carried out in a focused and systematic manner to achieve the predetermined KD.

The preparation of lesson plans in the 2013 Curriculum has a legal basis, including Regulation of the Minister of Education and Culture Number 22 of 2020 concerning Process Standards and Permendikbud Number 103 of 2020 concerning Learning in Primary and Secondary Education. In its implementation, teachers can use various learning models, such as Discovery Learning (DL), Problem-Based Learning (PBL), and Project-Based Learning (PjBL). The selection of these learning models needs to consider several aspects, including the learning objectives to be achieved, the characteristics of the learning material, the conditions and needs of the students, and other non-technical considerations.

In designing lesson plans, teachers are also required to integrate various elements of 21st-century learning. Permendikbud Number 23 of 2016 concerning Education Assessment Standards explains that the 2013 Curriculum accommodates 21st-century skills, which include Character Education Strengthening (PPK) with elements of religion, nationalism, independence, and cooperation; 4C competencies, which include communication, collaboration, critical thinking, and creativity; higher-order thinking skills (HOTS), which include the ability to analyze, reason, and evaluate; and basic literacy skills (Mukarramah et al., 2021). The integration of these elements emphasizes that the achievement of learning competencies must be balanced between attitude (ethics and morals), knowledge (cognitive), and practical skills of students (Andanty & Nabhan, 2022). In the context of this study, HOTS and 4C competencies are the main focus of the study.

2. 4C skills (Communication, Collaboration, Critical Thinking, and Creativity) as 21st century skills

The Partnership for 21st Century Learning (P21) identifies that students need to master communication, collaboration, critical thinking, and creativity skills, known as The 4Cs, in order to successfully face the challenges of the 21st century (Partnership for 21st Century Learning, 2019). In line with this, the OECD describes three dimensions of 21st-century learning, namely information, communication, and ethics and social influence, which emphasize the ability of individuals to work effectively in diverse teams, be open to different ideas and values, set and achieve goals, manage projects responsibly, demonstrate ethical practices, and contribute positively to themselves and the wider community (Ananiadou & Claro, 2009).

The 4C skills are the main competencies targeted in the 2013 Curriculum. Communication skills include the ability to convey ideas clearly and persuasively, both verbally and in writing, as well as the ability to interact meaningfully in a learning context. Collaborative learning allows students to work together, share ideas, and build collective understanding, which has been proven to improve learning outcomes (Bialik et al., 2015; Scott, 2015; Partnership for 21st Century Learning, 2019). In addition, critical thinking is a fundamental skill in 21st-century learning that involves the ability to access, analyze, synthesize, and evaluate information as a basis for decision-making and action, and is closely related to information literacy and metacognitive skills (Partnership for 21st Century Learning, 2019; Ananiadou & Claro, 2009; Bialik et al., 2015). Problem solving in the 21st century context requires the ability to find solutions to complex problems through effective collaboration, management of diverse information, and the integrated application of critical thinking, innovation, and creativity (Scott, 2015; Partnership for 21st Century Learning, 2019).

In addition to critical thinking, creativity and innovation are important skills that need to be developed from an early age. Creativity includes the ability to think divergently, generate new ideas, be flexible, and produce original solutions. Students need to be given space to think openly, express ideas, ask unusual questions, and try various possible answers as part of the

learning process (Center, 2010; Bialik et al., 2015; Scott, 2015). In the context of the 21st century, which is marked by rapid developments in information and communication technology, the world of education is required to adapt the learning process to the characteristics of today's students. Teachers and students need to have relevant skills and knowledge to be able to face challenges and take advantage of opportunities in the information age, so that students are prepared to face life and future challenges from the early stages of formal education (Simanjuntak, 2019).

In the context of biology learning, educational efforts are directed at equipping students with basic science literacy, namely the ability to be sensitive to phenomena, examine and filter information, and apply knowledge responsibly. Biology learning also aims to shape individuals who are able to contribute to the development of science and technology and improve the welfare of society (Adnan et al., 2021).

In line with global demands, 21st century students need to be prepared to become global citizens who have the skills and knowledge of science and technology to make decisions and solve everyday problems based on scientific attitudes and moral values (Redhana, 2019). Therefore, biology education in the 21st century emphasizes the development of digital literacy, critical and creative thinking skills, and interpersonal and social skills as the main provisions for students in facing future challenges.

C. Methodology

1. Research Design

This study used the mixed methods design because the analysis was conducted in two stages, namely quantitative descriptive analysis to describe the level of conformity between planning and implementation of learning through scores and percentages, and inferential analysis using the chi-square (χ^2) test to examine the relationship between the two. This combination of approaches allows researchers to obtain a complete and complementary picture of the data from observations, document analysis, and statistical testing, as recommended in mixed methods research.

The research sample was selected purposively with the criteria of biology teachers who actively teach in grade XI and have at least 10 years of teaching experience. These criteria were established to ensure that participants had reached a relatively stable level of professional competence, given that previous studies have shown that teaching expertise generally develops after 5–7 years of teaching experience and student learning achievement tends to reach a plateau after that period (Berliner, 2004). Based on these criteria, four biology teachers were selected as the research sample, as presented in Table 1.

Table 1. Research Sample

No	School	Sample Code
1.	SMAN 7 Makassar	SGB1
2.	SMAN 15 Makassar	SGB2
3.	SMAN 18 Makassar	SGB3
4.	SMAN 22 Makassar	SGB4

2. Instruments

The research instruments involved lesson plan assessment sheets, learning implementation observation sheets, and teacher questionnaires using a Guttman scale. The Guttman scale was used because the questionnaire aimed to determine whether the learning practices were actually implemented or not, rather than to measure teachers' perceptions. With yes or no answer options, this scale produced clearer and more objective data that was consistent with the data from observations and document analysis. Data was collected through passive observation of learning implementation, analysis of learning implementation plans, and completion of questionnaires by teachers.

The Guttman scale was used because the questionnaire aimed to determine whether the learning practices were actually implemented or not, rather than to measure teachers' perceptions. With yes or no answer options, this scale produced clearer and more objective data that was consistent with the data from observations and document analysis. Data was collected through passive observation of learning implementation, analysis of learning implementation plans, and completion of questionnaires by teachers.

3. Technique of Data Analysis

Data analysis techniques include data reduction, data presentation, and drawing conclusions. Data analysis is carried out in two stages, the descriptive analysis and the inferential analysis.

The first stage is descriptive analysis, which aims to describe teachers' abilities in designing lesson plans (RPP) and implementing biology lessons oriented towards 4C skills and Higher Order Thinking Skills (HOTS). At this stage, assessment scores are analyzed in percentage form using the following formula:

$$Average = \frac{\text{n}}{N}\ x\ 100\%$$

The percentages obtained are then categorized according to suitability criteria using the formula in Table 2.

Table 2. Five-Point Reference Assessment

Formula	Category	Score
Mi + 1,8 SDi< X ≤ Mi+3 SDi	Very Good	5
Mi + 0,6 SDi < X ≤ Mi + 1,8 SDi	Good	4
Mi – 0,6 SDi < X < Mi + 0,6 SDi	Fair	3
Mi – 1,8 SDi < X ≤ Mi – 0,6 SDi	Poor	2
Mi – 3 SDi < X ≤ Mi – 1,8 SDi	Very Poor	1

Source: Retnowati, Suprapto, Mohammad, Kristian, & Wagiron (2019).

The second stage of data analysis was inferential analysis, which aimed to examine the relationship between the suitability of the Lesson Plan (RPP) and the implementation of biology learning in grade XI at public senior high schools in Biringkanaya District, Makassar City. This inferential analysis was conducted using the chi-square (χ^2) statistical test, based on the results of score categorization obtained from the descriptive analysis stage.

The results of the categorized scores were then analyzed using the chi-square (χ^2) statistical test to determine whether there was a significant relationship between the suitability of the Lesson Plan (RPP) and the implementation of biology learning. The chi-square test was performed using SPSS Statistics version 28 with a significance level of $\alpha = 0.05$ (95% confidence level). Decision-making was carried out based on the following criteria:

a. If the calculated chi-square value is less than the critical chi-square value, the null hypothesis (H_0) is accepted.
b. If the calculated chi-square value is greater than or equal to the critical chi-square value, the null hypothesis (H_0) is rejected.

D. Findings and Discussion

1. Findings

This section describes the findings of research on the planning and implementation of learning with regard to communication skills, collaboration, creativity, critical thinking (4C) and High Order Thinking Skills (HOTS) in four public high schools in Biringkanaya District, Makassar City. The findings of the research related to each aspect of the study are presented as follows:

1) Teachers' Ability to Design Learning

The results were obtained using a lesson plan assessment instrument that had been validated by validators. The results of the analysis of lesson plans designed by four teachers can be seen in Table 3.

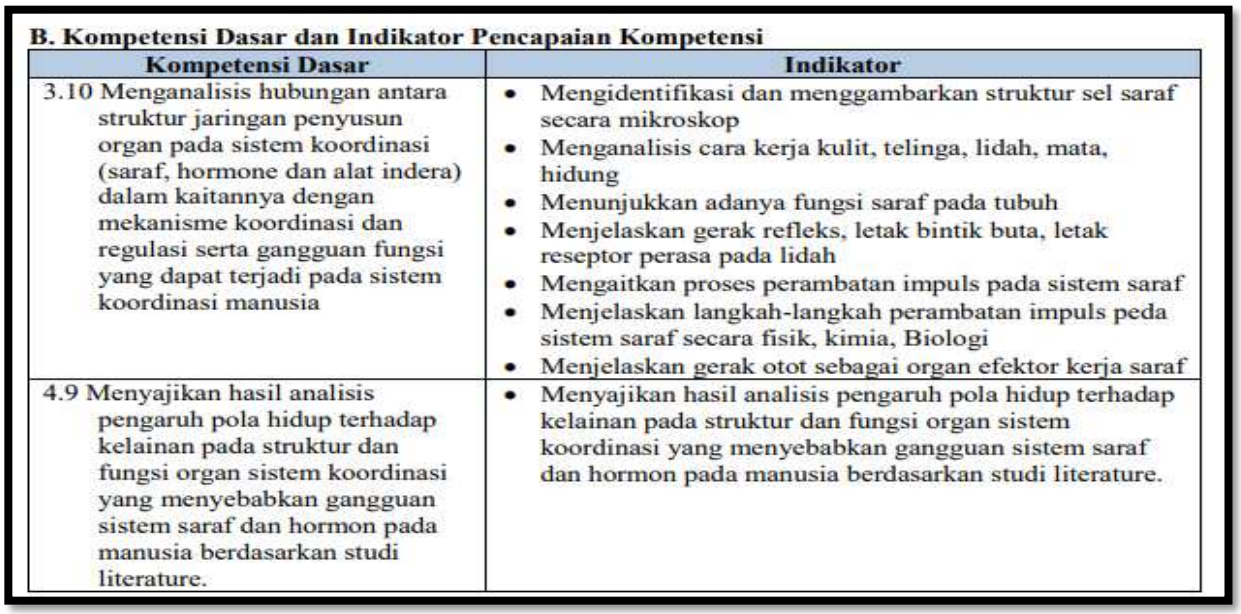
Table 3. Learning Planning Analysis Results

No	Sample Code	Category	Score
1.	SGB4	Good	4
2.	SGB3	Fair	3
3.	SGB2	Poor	2
4.	SGB1	Poor	2
Average score			11
Category			Very Poor

The design of lesson plans that take into account the 4Cs and HOTS by biology teachers at public high schools in Biringkanaya District, Makassar City, is still in the category of very poor and in dire need of improvement. Further review revealed several important points, as described below:

a. Formulation of Competency Achievement Indicators (IPK)

Excerpts from the formulation of lesson plan indicators can be seen in Figure 1 to 4 below:



B. Kompetensi Dasar dan Indikator Pencapaian Kompetensi

Kompetensi Dasar	Indikator
3.10 Menganalisis hubungan antara struktur jaringan penyusun organ pada sistem koordinasi (saraf, hormone dan alat indera) dalam kaitannya dengan mekanisme koordinasi dan regulasi serta gangguan fungsi yang dapat terjadi pada sistem koordinasi manusia	• Mengidentifikasi dan menggambarkan struktur sel saraf secara mikroskop • Menganalisis cara kerja kulit, telinga, lidah, mata, hidung • Menunjukkan adanya fungsi saraf pada tubuh • Menjelaskan gerak refleks, letak bintik buta, letak reseptor perasa pada lidah • Mengaitkan proses perambatan impuls pada sistem saraf • Menjelaskan langkah-langkah perambatan impuls peda sistem saraf secara fisik, kimia, Biologi • Menjelaskan gerak otot sebagai organ efektor kerja saraf
4.9 Menyajikan hasil analisis pengaruh pola hidup terhadap kelainan pada struktur dan fungsi organ sistem koordinasi yang menyebabkan gangguan sistem saraf dan hormon pada manusia berdasarkan studi literature.	• Menyajikan hasil analisis pengaruh pola hidup terhadap kelainan pada struktur dan fungsi organ sistem koordinasi yang menyebabkan gangguan sistem saraf dan hormon pada manusia berdasarkan studi literature.

Figure 1. Excerpt from the Formulation of Competency Achievement Indicators (Sample Code SGMB1)

Based on Figure 1, it can be seen that the formulation of competency achievement indicators (IPK) is not yet fully aligned with basic competencies (KD). The formulated IPK tends to focus only on the aspect of knowledge, while the aspect of skills does not appear to be accommodated. This condition shows an imbalance between the aspects of knowledge and skills in the formulation of IPK.

B. Kompetensi Dasar dan Indikator Pencapaian Kompetensi

Kompetensi Dasar	Indikator
3.9 Menganalisis hubungan antara struktur jaringan penyusun organ pada sistem ekskresi dalam kaitannya dengan bioproses dan gangguan fungsi yang dapat terjadi pada sistem ekskresi manusia.	• Menjelaskan struktur dan fungsi organ pada sistem ekskresi pada manusia dan hewan (belalang dan cacing). • Menjelaskan proses ekskresi pada manusia. • Menjelaskan proses ekskresi pada hewan (belalang dan cacing). • Menjelaskan kelainan dan penyakit yang berhubungan dengan sistem eksresi. • Menjelaskan teknologi yang berkaitan dengan kesehatan sistem ekskresi.
4.9 Menyajikan hasil analisis pengaruh pola hidup terhadap kelainan pada struktur dan fungsi organ pada sistem ekskresi serta kaitannya dengan teknologi	• Menyajikan hasil analisis pengaruh pola hidup terhadap kelainan pada struktur dan fungsi organ yang meyebabkan organ yang meyebabkan gangguan gangguan pada sistem ekskresi serta kaitannya dengan teknologi.

Figure 2. Excerpt from the Error in Formulating Competency Achievement Indicators (Sample Code SGMB2)

Figure 2 shows that most IPKs are formulated at the C1 cognitive level. IPKs at the C4–C6 cognitive levels are very limited in number. These findings indicate that IPK formulations are still dominated by lower level cognitive abilities rather than higher-level thinking skills.

B. Kompetensi Dasar dan Indikator Pencapaian Kompetensi

Kompetensi Dasar	Indikator
3.9 Menganalisis hubungan antara struktur jaringan penyusun organ pada sistem ekskresi dalam kaitannya dengan bioproses dan gangguan fungsi yang dapat terjadi pada sistem ekskresi manusia.	• Menjelaskan jenis-jenis alat ekskresi pada manusia. • Menjelaskan struktur dan fungsi ginjal sebagai alat ekskresi • Menjelaskan struktur dan fungsi paru-paru sebagai alat ekskresi • Menjelaskan struktur dan fungsi kulit sebagai alat ekskresi • Menjelaskan struktur dan fungsi hati sebagai alat ekskresi • Menjelaskan penyakit/kelainan pada system ekskresi
4.9 Menyajikan hasil analisis pengaruh pola hidup terhadap kelainan pada struktur dan fungsi organ pada sistem ekskresi serta kaitannya dengan teknologi	• Menyajikan hasil analisis pengaruh pola hidup terhadap kelainan pada struktur dan fungsi organ yang meyebabkan organ yang meyebabkan gangguan gangguan pada sistem ekskresi serta kaitannya dengan teknologi.

Figure 3. Excerpt from the Competency Achievement Indicators Formulation (Sample Code SGMB3)

Figure 3 shows that there is a discrepancy between the basic competency requirements and the IPK formulation. The KD requires achievement at the C4 cognitive level, but the IPK is formulated using operational verbs at the C1 level. This indicates a decrease in the cognitive level of the IPK formulation compared to the core competence requirements.

2. Kompetensi Dasar (KD) Indikator Pencapaian Kompetensi (IPK)

No	Kompetensi Dasar	No	Kompetensi Dasar
3.2	Menyajikan hasil analisis pengaruh pola hidup terhadap kelainan pada struktur dan fungsi organ yang meyebabkan gangguan pada sistem ekskresi serta kaitannya dengan teknologi	4.2	Menyajikan hasil analisis pengaruh pola hidup terhadap kelainan pada struktur dan fungsi organ yang meyebabkan gangguan pada sistem ekskresi serta kaitannya dengan teknologi
Indikator Pencapaian Kompetensi		Indikator Pencapaian Kompetensi	
3.2.1	Menganalisis struktur dan fungsi alat – alat ekskresi pada manusia (ginjal)	4.2.1	Membandingkan kandungan zat pada urin normal dengan penderitadiabetes melitus model transpor pada membran sel dengan menggunaan bahan-bahan yang mudah didapatkan.
3.2.2	Menguraikan proses pembentukan urine dan zat produk yang terkandung dalam urin		
3.2.3	Menganalisis struktur nefron yang dilalui urine mulai proses pembentukan hingga dikeluarkannya urine dari dalam tubuh.		
3.2.4	Menganalisis faktor yang mempengaruhi pengeluaran urin		
3.2.5	Menjelaskan gangguan fungsi yang dapat terjadi pada system ekskresi		

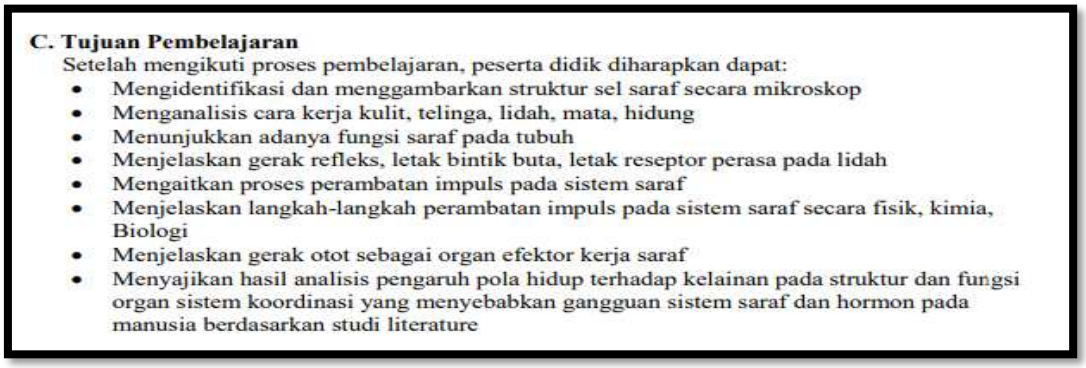
C4 C4 PS

Figure 4. Excerpt from the Competency Achievement Indicators Formulation (Sample Code SGMB4)

Figure 4 shows that teachers have formulated IPK that is in line with core competence. IPK includes indicators at cognitive levels C1 and C2 as supporting indicators, as well as IPK at cognitive level C4 as the main indicator. These findings indicate that there are variations in cognitive levels in the formulation of IPK in accordance with basic competency requirements.

b. Formulation of Learning Objectives

The image excerpt shows that the formulation of indicators is not in line with the learning objectives. The inconsistency between the IPK and the learning objectives formulated by the teacher can be seen in Figure 5.



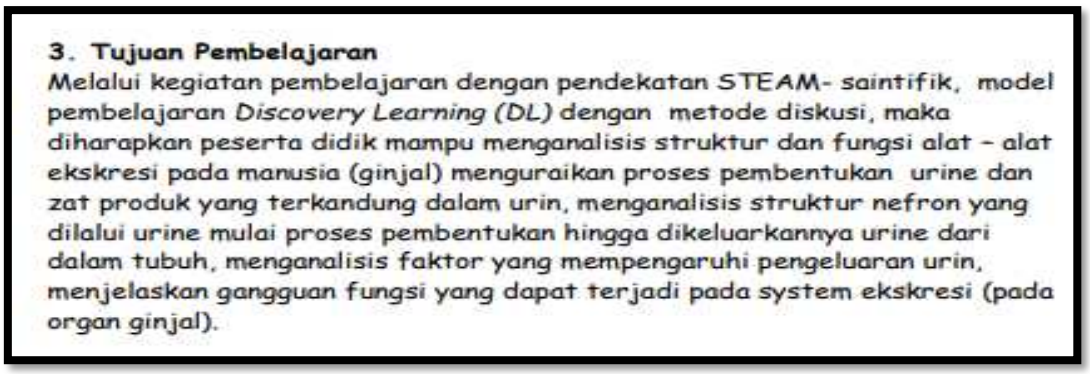
C. Tujuan Pembelajaran

Setelah mengikuti proses pembelajaran, peserta didik diharapkan dapat:

- Mengidentifikasi dan menggambarkan struktur sel saraf secara mikroskop
- Menganalisis cara kerja kulit, telinga, lidah, mata, hidung
- Menunjukkan adanya fungsi saraf pada tubuh
- Menjelaskan gerak refleks, letak bintik buta, letak reseptor perasa pada lidah
- Mengaitkan proses perambatan impuls pada sistem saraf
- Menjelaskan langkah-langkah perambatan impuls pada sistem saraf secara fisik, kimia, Biologi
- Menjelaskan gerak otot sebagai organ efektor kerja saraf
- Menyajikan hasil analisis pengaruh pola hidup terhadap kelainan pada struktur dan fungsi organ sistem koordinasi yang menyebabkan gangguan sistem saraf dan hormon pada manusia berdasarkan studi literature

Figure 5. Learning Objectives Excerpt (Sample Code SGMB1)

Figure 5 shows that the learning objectives in the lesson plan indicate that students are still guided only towards mastering prerequisite knowledge, such as explaining, demonstrating, identifying, and other activities that fall under the category of low-order thinking skills (LOTS).



3. Tujuan Pembelajaran

Melalui kegiatan pembelajaran dengan pendekatan STEAM- saintifik, model pembelajaran *Discovery Learning (DL)* dengan metode diskusi, maka diharapkan peserta didik mampu menganalisis struktur dan fungsi alat – alat ekskresi pada manusia (ginjal) menguraikan proses pembentukan urine dan zat produk yang terkandung dalam urin, menganalisis struktur nefron yang dilalui urine mulai proses pembentukan hingga dikeluarkannya urine dari dalam tubuh, menganalisis faktor yang mempengaruhi pengeluaran urin, menjelaskan gangguan fungsi yang dapat terjadi pada system ekskresi (pada organ ginjal).

Figure 6. Learning Objectives Excerpt (Sample Code SGMB4)

Figure 6 shows that the learning objectives designed by the SGMB4 teacher can be grouped into objectives that guide students' activities to develop their ability to analyze and correlate. The last learning objective uses the word “menjelaskan”, however it is related to the previous learning objective, it contains activities of analyzing and correlating, which are HOTS.

c. Formulation of Learning Activities

A comparison of the core learning activities obtained from the lesson plans used by teachers in teaching can be clearly seen in Table 4.

Table 4. Comparison of Core Learning Activity Formulations

Sample Code	Types of Activities	Reflected 4C content
SGMB1	Students ask questions about the material: The nervous system, the endocrine system, and the sensory system	Critical thinking
	Students present the results of their group discussions	Communication
	Students discuss and process information from the material on the nervous system, endocrine system, and sensory system	Collaboration
	Students create summaries	Creativity
SGMB4	Students identify problems related to bioprocesses occurring in cells based on the video they watched and formulate problems based on their observations from the video	Critical thinking
	One student from each group presented the results of their problem identification and problem formulation.	Communication
	Students are facilitated to discuss (ask and answer questions) in order to verify the results of the discussion	Collaboration

Sample Code	Types of Activities	Reflected 4C content
	with each other	
	Students collect information about the structure and function of the kidneys, the process of urine formation, and factors that influence urine formation, which is then recorded in the student worksheet	Creativity

SGMB4 teachers can formulate core activities that guide students to perform activities for mastering HOTS elements. The description of the core activity in question is that students identify problems related to bioprocesses that occur in cells based on the video they have watched and formulate problems based on their observations through the video, then the students discuss and verify each other's discussion results. The other three teachers also included discussion activities, but the activities prior to the discussion did not lead to analysis, but only to the creation of questions based on the material discussed.

2) Teachers' Ability to Implement Learning

The results were obtained by using learning implementation. The results of the analysis of learning implementation by considering the 4C and HOTS elements can be seen in detail in Table 5.

Table 5. Results of Learning Implementation Analysis

No	Sample Code	Category	Score
1.	SGB4	Good	4
2.	SGB3	Fair	3
3.	SGB2	Poor	2
4.	SGB1	Poor	2
	Average Score		11
	Category		**Very Poor**

3) The Relationship between Teachers' Ability to Design Learning and Learning Implementation

The results were obtained using the RPP assessment categorization score and learning implementation. The results of the analysis related to the relationship between teachers' ability to design and implement learning can be seen in Table 6.

Table 6. Chi Square Test Results

			Implementation of Learning			
			2.00 Poor	3.00 Fair	4.00 Good	***Total***
Designing lesson plans	2.00 Poor	Count	2	0	0	2
		Expected Count	1.0	.5	.5	2.0
	3.00 Fair	Count	0	1	0	1
		Expected Count	.5	.3	.3	1.0
	4.00 Good	Count	0	0	1	1
		Expected Count	.5	.3	.3	1.0
Total		Count	2	1	1	4
		Expected Count	2.0	1.0	1.0	4.0

Table 6 shows that the Chi-Square test results indicate a consistent correlation between teachers' ability to design lesson plans and their ability to implement learning. The data distribution objectively shows that two teachers with low lesson plan design abilities also showed low performance in learning implementation. Meanwhile, one teacher in the adequate category and one teacher in the good category showed identical levels of ability between the planning and implementation stages. Overall, these findings indicate that the quality of the lesson plans developed by teachers is directly proportional to the quality of instructional practices implemented in the classroom.

2. Discussion

1) Teachers' Ability to Design Learning

The cognitive downgrading phenomenon in competency achievement indicators design cannot be separated from the gap between the intended curriculum and the enacted curriculum. Curriculum enactment theory emphasizes that teachers act as curriculum interpreters, so the quality of implementation greatly depends on the conceptual and pedagogical understanding of the teachers themselves (Remillard & Heck, 2014). When the competency standards are at the HOTS level, but the competency achievement indicators is lowered to LOTS, this indicates a systemic cognitive simplification, not just a technical error. This condition is in line with recent research findings which show that teachers often find it difficult to maintain cognitive complexity when transforming curriculum standards into lesson plans (Voogt et al., 2013). As a result, biology lessons that should encourage scientific reasoning lose their challenge from the planning stage.

This gap becomes even more apparent when viewed from the perspective of contemporary Pedagogical Content Knowledge (PCK), which emphasizes the integration of content, pedagogy, and understanding of how students learn (Kind, 2015). The low quality of HOTS competency achievement indicators indicates that teachers do not yet fully understand how biological concepts can be packaged into analytical, evaluative, and creative activities. Recent research shows that teachers with limited PCK tend to choose indicators that are procedural and easy to measure, even though they do not represent disciplinary depth of thinking (Halim et al., 2014). This condition explains why competency achievement indicators often stops at levels C1–C2, while core competence requires C4–C6. Thus, the problem of lesson plan planning is not only related to the structure of the document, but also reflects the limitations of teachers' professional knowledge.

These limitations in PCK have a direct impact on the failure to achieve the principle of constructive alignment, which requires harmony between learning objectives, learning activities, and assessment. In practice, competency achievement indicators that is not aligned with core comptence causes learning activities and assessments to fail to encourage higher-order thinking skills. This contradicts the backward design approach, which emphasizes that learning planning must begin with higher-order cognitive objectives and authentic assessments. Research over the past decade shows that failure to implement backward design often results in weak integration of HOTS and 21st-century skills in science learning (Darling-Hammond et al., 2020). Therefore, the low quality of lesson plan design is an indicator of weak pedagogical foundations in learning planning.

Furthermore, from the perspective of modern cognitive and sociocultural constructivism, learning design should facilitate the process of knowledge construction through cognitive challenges that are within the Zone of Proximal Development (ZPD) of students (Shabani et al., 2010). Competency achievement indicators dominated by LOTS does not provide space for concept exploration, discussion, or scientific argumentation, which are characteristics of HOTS-based biology learning. Recent research confirms that 4C skills, particularly critical thinking and collaboration, only develop optimally when students are presented with analytical and problematic tasks that are deliberately designed (Bellanca, 2014; Ananiadou & Claro, 2009). Thus, weaknesses in the formulation of IPK not only limit students' cognitive achievements but also hinder the holistic development of 21st-century competencies. These findings emphasize that improving the quality of biology learning must begin with improving cognitive design at the planning stage.

2) Teachers' Ability to Implement Learning

In general, the implementation of learning that integrates 21st century skills (4C) and Higher Order Thinking Skills (HOTS) in public high schools in Biringkanaya District, Makassar City, is still in the very low category. The results of observations show that learning activities in the classroom are dominated by individual assignments and low-level questions, so that students' cognitive involvement has not developed optimally. From a student-centered learning perspective, this condition reflects the failure of the transformation of the teacher's role from a center of information to a learning facilitator (OECD, 2018). Previous research confirms that learning oriented towards surface learning tends to hinder the development of HOTS and 21st-century skills (Biggs & Tang, 2009). Thus, the low quality of learning implementation has a direct impact on limiting students' opportunities to develop critical, creative, collaborative, and communicative thinking skills.

The weaknesses in implementation were apparent from the preliminary stages of learning, particularly in the activities of apperception and communication of learning objectives. Goal-oriented learning theory states that clear learning objectives serve as cognitive and affective anchors that prepare students for meaningful learning (Hattie, 2012). When learning objectives are not explicitly communicated, students tend not to understand the direction, relevance, and expectations of the learning activities. Recent research shows that a weak opening to learning contributes to low student motivation and participation in the learning process (Darling-Hammond et al., 2020). This condition shows that problems with learning implementation have begun since the early stages of learning.

This problem continues in the core stage of learning, which has not been optimized in utilizing initial stimuli and authentic problems as triggers for higher order thinking. Based on constructivism and experiential learning theories, meaningful learning should begin with cognitive conflict or a real context that is relevant to students' experiences (Kolb, 2015). However, the observation results show that the questions asked by teachers are still dominated by “what” questions, which are at a low cognitive level. When viewed from Bloom's Revised Taxonomy, this practice shows a mismatch between the cognitive demands of the curriculum (C4–C6) and the implementation of learning in the classroom, which is still at the C1–C2 level. This phenomenon indicates the occurrence of cognitive downgrading, as also found in previous studies in the context of science learning (Biggs & Tang, 2009; Ananiadou & Claro, 2009).

The limitations of this learning implementation are further reinforced by the low quality of group discussions, which tend to be procedural in nature. Within the framework of Social Constructivism, social interaction in learning should function as cognitive scaffolding that enables students to learn within the Zone of Proximal Development (ZPD). However, the group discussions observed were not directed towards encouraging scientific argumentation, negotiation of meaning, and conceptual reflection. Research over the past ten years shows that collaboration without cognitive structure and challenging questions does not have a significant impact on the development of critical thinking and communication (Bellanca, 2014). This explains why students' collaboration and communication skills have not developed optimally even though group work has been implemented.

The failure to develop 4C in this study is a direct implication of learning designs and implementations that are not yet authentic and dialogic. Critical thinking, creativity, collaboration, and communication skills can only be developed through real world problem based tasks, reflective discussions, and cognitively challenging decision making (OECD, 2018). When learning is dominated by individual tasks and rote memorization questions, students do not have the opportunity to develop these skills in an integrated manner. These findings are consistent with previous research stating that HOTS and 4C based science learning is highly dependent on the quality of stimuli, questions, and teacher scaffolding (Bellanca, 2014; Darling-Hammond et al., 2020). Therefore, the low achievement of 4C and HOTS is not caused by student characteristics but by limitations in teachers' pedagogical practices.

Weaknesses in the implementation of learning are also apparent in the closing stage, which has not been optimally utilized to strengthen students' conceptual understanding and metacognitive awareness. Research in the field of learning sciences emphasizes that reflection and formative feedback at the end of learning play an important role in deepening understanding and guiding learning improvement (Hattie, 2012). When assessment focuses only on task completion, students' opportunities to integrate knowledge and higher-order thinking skills become limited. Other studies show that reflective closing activities that are aligned with learning objectives can significantly improve students' critical thinking and communication skills (Darling-Hammond et al., 2020). Thus, the closing stage should be positioned as a strategic part of HOTS and 4C development.

Overall, the findings of this study indicate that the low implementation of 4C-based learning and HOTS is due to the lack of internalization of the constructivist paradigm, the inappropriate application of Bloom's Revised Taxonomy, and teachers' weak understanding of the characteristics of 21st-century skills. These findings are in line with previous studies that emphasize that the success of 21st-century learning is largely determined by the quality of teachers' design and instructional enactment. When learning is still viewed as a process of knowledge transmission, the demands of HOTS and 4C are difficult to realize in practice. Therefore, improving the quality of biology learning needs to be directed at strengthening teachers' pedagogical competencies in designing authentic stimuli, HOTS questions, and planned and reflective cognitive scaffolding.

3) The Relationship between Teachers' Ability to Design Learning and the Implementation of Learning

The results of the Chi-Square test in Table 3 show a consistent linear relationship between teachers' ability to design lesson plans and the quality of classroom learning implementation. Teachers with poor planning skills consistently display poor learning practices, while teachers with good planning skills demonstrate consistent implementation. These findings confirm that lesson planning is not merely an administrative activity, but rather a cognitive foundation for instructional practice. In this context, lesson plans serve as instructional blueprints that guide the flow of thinking, strategies, and learning interactions in the classroom. Therefore, the quality of learning implementation is largely determined by the depth and accuracy of the learning design created by teachers from the outset.

In terms of theory, this linear relationship can be explained through the Pedagogical Content Knowledge (PCK) framework, which places planning as the main manifestation of teachers' professional knowledge. PCK emphasizes that the effectiveness of learning depends on the teacher's ability to integrate content, pedagogy, and understanding of student learning characteristics. When teachers have limited PCK, the lesson plans they develop tend not to include HOTS and 4C strategies in an operational manner, resulting in minimal implementation in the classroom. Research over the past decade shows that teachers with strong PCK are able to translate abstract curriculum objectives into concrete and meaningful classroom practices (Shing et al., 2015; Sarkar et al., 2024).Thus, the low quality of learning planning and implementation reflects the limitations of teachers' PCK, not merely technical weaknesses in learning lesson development.

The relationship between planning and implementation of learning can also be understood through the principle of constructive alignment, which requires alignment between learning objectives, activities, and assessments. When lesson plans are not designed with indicators that are cognitively aligned with the requirements of the core competence, classroom learning activities tend to fall at the LOTS level (C1–C2). This phenomenon is in line with the concept of cognitive downgrading, where HOTS demands at levels C4–C6 experience a decline when translated into learning practices. Recent research shows that failure to maintain cognitive alignment from the planning stage has direct implications for the low quality of learning interactions the classroom (Biggs & Tang, 2009). Therefore, the linear consistency found in this study reinforces the position of the lesson plan as the main controller of learning quality.

The poor implementation of learning also shows that the view of learning as a process of knowledge construction has not been internalized. Constructivist learning requires teachers to design challenging, collaborative, and reflective learning experiences so that students can construct their own knowledge. However, when lesson plans do not include authentic stimuli, analytical questions, and meaningful discussion spaces, classroom learning tends to revert to a pattern of knowledge transmission. These findings are in line with recent research stating that teachers who have not fully adopted the constructivist paradigm will find it difficult to implement HOTS and 4C even though they have included them in their planning document. Thus, weaknesses in learning implementation are a direct consequence of the pedagogical paradigm underlying teacher planning.

The correlation between planning and implementation of learning also explains why 21st century skills have not developed optimally. The theory of 21st century skills asserts that critical thinking, creativity, collaboration, and communication can only grow through authentic tasks, reflective dialogue, and problem-based decision-making (OECD, 2018). However, research results show that although some lesson plans have included elements of 4C and HOTS, their implementation in the classroom has not been consistent. Research confirms that inconsistency between planning and implementation is one of the main causes of failure in 21st century learning. This shows that the success of 4C development is highly dependent on teachers' ability to realize learning plans in the classroom.

Overall, the findings of this study confirm that the low quality of 4C based and HOTS biology learning occurs due to weak synergy between learning planning and implementation. The linear consistency found shows that improvements in implementation cannot be made without simultaneous improvements in the quality of lesson plans. Recent research emphasizes that improving the quality of 21st century learning requires reflective teaching practices supported by data based feedback and continuous mentoring(Kim et al., 2019). Therefore, the necessary interventions are systemic in nature, including strengthening PCK, aligning competency achievement indicators cognition with core competence, and developing teachers' self efficacy in managing interactive learning. These findings reinforce that lesson plans are not merely

administrative documents, but strategic instruments that determine the quality of the student learning ecosystem in the modern education era.

E. Conclusion

The design of lesson plans and the implementation of biology learning in public high schools in the Biringkanaya sub-district of Makassar City are categorized as very poor and in need of improvement. Teachers' lesson plan design skills still need to be improved, especially in terms of formulating indicators that are in line with core competencies (KD) and the use of high cognitive level indicators (C4-C6). The implementation of learning, despite integrating the 4C and HOTS principles, needs to be more focused on optimizing learning conditions to train students' critical thinking, creative thinking, collaboration, and communication skills.

The results of the chi-square statistical test also concluded that there was a significant relationship between teachers' ability to design lesson plans and the implementation of biology learning. This shows that good lesson plan design can contribute to improving the quality of biology learning in the classroom.

F. References

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