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Development of an Adaptive Curriculum: Enhancing HOTS-Based Learning in the Classroom

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Abstract—*This research focuses on the development of an adaptive curriculum to enhance Higher Order Thinking Skills (HOTS)-based learning in the classroom. The aim of this study is to explore how adjustments to lesson materials, student-centered learning, the use of technology, and formative assessment can facilitate the development of HOTS in the context of secondary education. This study employs qualitative methods with a case study approach at SMAN 1 Glagah Banyuwangi. Data were collected through in-depth interviews, participatory observation, and document analysis. The findings indicate that an adaptive curriculum tailored to the needs and interests of students significantly improves student engagement and critical thinking skills. The use of technology and HOTS-based formative assessment also proved effective in supporting the development of higher-order thinking skills. These findings underscore the importance of a responsive approach to individual student needs in enhancing the quality of education. However, this study has limitations, including variations in participants and the context of the location. Therefore, further comprehensive research is recommended to expand the scope and validity of these findings. The implications of this research suggest that educational policies need to consider the implementation of adaptive curricula to more effectively and inclusively support the development of HOTS.*

Keywords— *Adaptive Curriculum, Higher Order Thinking Skills, HOTS-Based Learning*

1 Introduction

In the era of globalization, education has become one of the main pillars in building competent human resources ready to compete on the international stage [1]. Good education emphasizes not only mastery of material but also the development of critical, analytical, and creative thinking skills [2][3]. These skills are known as Higher Order Thinking Skills (HOTS), which are essential for solving complex problems in the real world [4]. However, the implementation of HOTS-based learning in the classroom still faces many challenges. One of the main challenges is the limitations of curricula that are unresponsive to the individual needs of students, resulting in many students not being able to reach their full potential in critical and creative thinking [5][6]. In this context, the development of an adaptive curriculum emerges as a potential solution to enhance the effectiveness of HOTS-based learning [7].

An adaptive curriculum is an approach that allows for adjustments in lesson materials and teaching methods according to the needs, abilities, and learning styles of students [8]. This is important because each student has unique characteristics and learns in different ways [9][10]. With an adaptive curriculum, teachers can be more effective in accommodating these differences and promoting the equitable development of HOTS among all students [11]. Constructivist learning theories proposed by Piaget and Vygotsky emphasize that students build knowledge through interaction with their environment and others [12][13]. In the context of an adaptive curriculum, this theory is relevant as it allows

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students to be more active in their learning processes, ultimately enhancing their higher-order thinking abilities [14]. Additionally, Tomlinson's differentiation theory supports the importance of curriculum adjustments to meet the varying learning needs among students [15].

Therefore, this research is particularly interesting as it offers the potential to address challenges in the implementation of HOTS-based learning through the development of an adaptive curriculum [16]. This study not only contributes academically to the field of education but also has practical implications for improving the quality of education in Indonesia and globally. While many studies have discussed HOTS and the importance of these skills in education, there remains a gap in understanding how adaptive curricula can be effectively implemented to enhance HOTS in the classroom [17]. The challenges of integrating adaptive curricula with HOTS learning have yet to be fully resolved. The primary focus of this research will be how the development of an adaptive curriculum can improve HOTS-based learning in the classroom. More specifically, this study will explore which methods are effective in adjusting the curriculum to meet diverse student needs and how these approaches can be practically applied in the context of education in Indonesia.

Previous research has extensively discussed HOTS and its significance in education. For example, one study identified that instruction focused on HOTS can enhance students' abilities to analyze, evaluate, and create solutions for complex problems [18]. However, this research remains general and does not specifically address the role of adaptive curricula in HOTS learning [19]. Furthermore, discussions on differentiation in education highlight the importance of curriculum adjustments to meet individual student needs [20]. emphasizing that effective differentiation can support HOTS learning; however, this research does not explicitly explain how adaptive curricula can be implemented in daily practice [21]. Other studies indicate that developing higher-order thinking skills requires a more dynamic teaching approach [22]. While this research provides a strong theoretical framework, it has not addressed how adaptive curricula can fill this gap [23].

Based on the literature review above, there is a gap in research regarding how adaptive curricula can be effectively applied to enhance HOTS-based learning in the classroom. Previous studies have recognized the importance of HOTS and differentiation in education, but there is still a lack of discussion on the direct relationship between adaptive curricula and the improvement of HOTS. This study aims to fill that gap by providing practical guidance for teachers in implementing adaptive curricula that support HOTS.

The novelty of this research lies in its unique focus on the integration of adaptive curricula with HOTS-based learning in the classroom. This study not only seeks to explain the importance of HOTS and differentiation but also provides practical solutions for teachers to implement effective adaptive curricula. This approach has not been widely discussed in existing literature, making this research highly innovative in the context of modern education.

The objective of this research is to explore and develop effective methods for the development of adaptive curricula that enhance HOTS-based learning in the classroom. This study will analyze various approaches that teachers can use to adjust curricula according to the diverse needs and abilities of students and evaluate the effectiveness of these approaches within the context of education in Indonesia. Thus, this research is expected to make a significant contribution both theoretically and practically in the field of education.

2 Method

This research employs qualitative research methods with a case study approach to deeply explore how the development of an adaptive curriculum can enhance Higher Order Thinking Skills (HOTS)-based learning in the classroom. The qualitative approach was chosen because this study focuses on understanding processes, dynamics, and individual experiences within the context of complex learning environments. The case study approach was selected as it allows for in-depth analysis of specific phenomena within a particular educational setting.

Table 1. Research Informants

Participants	Gender		Education		Informant Code
	Male	Female	Bachelor	Masters	
Principal School	1	1	-	2	PT, UT
Vice Principal	3	1	2	2	RA, RD, FR, US
Teacher	4	2	4	2	AM, RA, SA, DS, UR, TU
Student	1	2	3	-	ZN, HS, AM

The data collection techniques used in this study include in-depth interviews, participatory observation, and document analysis. In-depth interviews were conducted with teachers, students, and the principal to gain rich perspectives on the implementation of the adaptive curriculum in the classroom. Participatory observation was carried out in classes that had implemented the adaptive curriculum to directly observe the interactions between teachers and students, as well as the dynamics of HOTS-based learning. The research location was SMAN 1 Glagah Banyuwangi, chosen for its ongoing implementation of the adaptive curriculum. Data were also collected through document analysis, including curricula, lesson plans (RPP), and evaluation results used by teachers.

For data analysis techniques, this research employs thematic analysis developed by Braun and Clarke [24]. This technique was chosen as it allows for the systematic identification, analysis, and reporting of patterns or themes that emerge from the data. The data obtained from interviews, observations, and document studies were analyzed through several stages: initial coding, theme searching, theme reviewing, and theme naming [25]. This process aims to identify key themes that explain how the adaptive curriculum affects HOTS learning, as well as the challenges and opportunities faced in its implementation. Additionally, data triangulation was used to ensure the validity and reliability of the research findings by comparing data obtained from various sources and methods.

3 Findings And Discussion

The results of this study indicate that the development of an adaptive curriculum has a significant positive impact on enhancing Higher Order Thinking Skills (HOTS)-based learning in the classroom, particularly in the context of secondary education in Indonesia. These findings align with research conducted by Tohet, which shows that curriculum adaptations responsive to student needs can increase student engagement and foster the development of critical thinking skills [26]. However, this study also reveals several challenges in implementing the adaptive curriculum, such as resource limitations and teachers' skill gaps, which were not explicitly addressed in previous studies [27]. Therefore, this research not only reinforces previous findings but also expands the understanding of how adaptive curricula can be effectively integrated to support the development of HOTS in various educational contexts.

Adjusting Content to Student Needs

The adaptive curriculum allows learning materials to be tailored to students' levels of understanding and abilities. This enables students who grasp foundational concepts more quickly to transition to more challenging activities that require critical thinking, analysis, and evaluation—core elements of HOTS. The study found that aligning content with student needs significantly impacts the development of Higher Order Thinking Skills (HOTS). Interviewed teachers stated that when lesson materials are adapted to students' abilities and interests, they become more engaged in the learning process and are better able to apply higher-order thinking skills.

Table 2. Interview Results

Interview Results	Coding	Sumber Informant
"I always start the school year with a diagnostic assessment to understand my students' skill levels. This helps me design lessons that meet their needs. For example, this year I found that many students struggled with basic math concepts, so I focused more on reinforcing those fundamentals."	Student Needs Analysis	Teacher
"Differentiated instruction is one of our main focuses. We provide training for teachers on how to manage heterogeneous classrooms, so that all students can receive instruction appropriate to their level of understanding."	Differentiated Instruction	Vice Principal
"We always encourage teachers to use active learning methods in the classroom. We find that students become more enthusiastic and engaged when given the opportunity to learn collaboratively and creatively."	Student Needs Analysis	Principal School
"I utilize various technological tools in my teaching, such as online learning applications and interactive presentations. This helps visual learners grasp the material more easily. Additionally, I assign tasks through online learning platforms so that students can study outside of school hours."	Use of Technology	Principal School
"I use various technological tools in my teaching, such as online learning applications and interactive presentations. This helps visual learners grasp the material more easily. Additionally, I assign tasks through online learning platforms so that students can study outside of school hours."	Use of Technology	Teacher

The interpretation of the interview results with several informants above indicates that teachers actively use various approaches to tailor learning to students' needs. They start by conducting diagnostic assessments at the beginning of the school year to understand students' skill levels, which are then used as a basis for designing lessons that are more relevant and suited to individual needs. Differentiated instruction becomes a primary focus, with teachers receiving intensive training to manage heterogeneous classrooms, ensuring that each student receives learning appropriate to their understanding and learning style. This allows teachers to provide suitable challenges for advanced students while offering additional support for those who need it. Furthermore, active learning methods are widely implemented to enhance student engagement, enabling them to learn collaboratively and creatively, which has proven to make students more enthusiastic and motivated. Technology is also effectively utilized in learning, with the use of online applications, interactive presentations, and online platforms that allow students to learn outside of school hours, providing a richer and more diverse range of learning resources. This approach not only helps visual learners grasp the material better but also offers flexibility in the learning process, allowing students to learn anytime and anywhere.

The results of the interpretation above show several indicators from the findings regarding the adjustment of materials to students' needs in enhancing HOTS-based learning in the classroom. The indicators will be explained in the following discussion: First, Student Needs Analysis. Student needs analysis is an important process carried out by teachers to understand the comprehension level, abilities, and specific needs of each student before starting the learning process [28]. This process typically involves diagnostic assessments, observations, and discussions with students to identify areas where they need further assistance or additional challenges [29]. The results of this analysis are used to design more

effective teaching strategies, ensuring that the material taught is relevant and aligned with each student's abilities and needs, allowing them to achieve optimal learning outcomes [30].

Second, Differentiated Instruction. Differentiated instruction is a teaching approach tailored to the comprehension levels, learning styles, interests, and individual needs of students in a heterogeneous classroom [31]. Teachers use various methods to adjust materials, tasks, and the way lessons are delivered so that each student can learn according to their capabilities [32]. This may involve assigning different projects to advanced students or providing additional guidance for those who need more help [33]. In this way, all students have the opportunity to learn maximally, without feeling overwhelmed or left behind.

Third, Implementation of Active Learning Methods. The implementation of active learning methods involves teaching strategies that encourage students to participate directly in the learning process rather than being passive recipients of information [34]. These methods include group discussions, collaborative projects, case studies, simulations, and hands-on activities that engage and motivate students more effectively [35]. Active learning aims to develop students' critical thinking, creativity, and problem-solving skills [36]. As a result, students are more likely to understand the material deeply and apply it in various contexts.

Fourth, Use of Technology. The use of technology in learning involves the application of digital tools and online platforms to support and enrich the teaching and learning process [37]. Technology can be used to provide interactive learning materials, give access to additional learning resources, and facilitate more flexible learning, both inside and outside the classroom [38]. Examples include the use of learning applications, digital simulations, and assignments delivered through online learning platforms [39]. Technology also allows teachers to personalize students' learning experiences, tailor materials to individual needs, and monitor learning progress more effectively [40].

Student-Centered Learning

An adaptive curriculum facilitates a more student-centered learning environment, where instructors act as facilitators. Students are encouraged to explore, ask questions, and find solutions on their own, thereby actively engaging in the learning process and developing higher-order thinking skills [41]. The findings of this research also indicate that student-centered learning plays a crucial role in enhancing HOTS (Higher-Order Thinking Skills). The teachers involved in this study consistently emphasized the importance of giving students greater control over their learning processes.

This explanation is supported by an interview with Muhyidin, one of the teachers, who stated, "When students are given the opportunity to explore and find answers on their own, they not only learn better but also develop stronger critical thinking skills." This interpretation suggests that student-centered learning encourages students to be more active and independent in their learning process, ultimately strengthening their HOTS. When students have the chance to explore and find answers themselves, they not only improve their understanding of the material but also develop stronger critical thinking skills. This exploratory process encourages students to think deeply and independently, honing their analytical abilities in facing challenges. Through this approach, students are more likely to grasp the core of the problems they encounter and find more creative and effective solutions. Furthermore, this experience builds confidence in their ability to solve problems independently, which is an essential skill for academic success and everyday life.

In an interview with another informant, Astutik, also a teacher, she mentioned, "I always try to give projects that allow students to work in groups and solve problems independently. As a result, they are more creative and able to think outside the usual boundaries of the classroom." This statement indicates that collaborative and independent learning is highly effective in developing higher-order thinking skills. Assigning projects that allow students to work in groups and tackle problems independently has proven effective in fostering creativity and critical thinking abilities. In groups, students learn to collaborate, discuss ideas, and seek solutions together, stimulating their creativity and encouraging thinking

beyond the conventional limits often present in the classroom. Such projects also emphasize the importance of independent problem-solving, helping students become more autonomous and resilient in facing challenges. This experience not only enhances academic skills but also builds essential social and communication competencies for daily life and future careers.

This aligns with the statement from Suryani, another teacher, who added, "When students feel that they have control over their own learning, they are more engaged and tend to think more critically about what they are learning." This statement reinforces the idea that giving students the freedom to control their learning processes not only increases engagement but also improves the quality of their thinking. When students feel they have ownership of their learning, their involvement in the learning process significantly increases, which in turn fosters the development of critical thinking skills. Ownership of learning gives students a sense of responsibility and intrinsic motivation to understand the material more deeply. They are more likely to actively explore various concepts and seek a better understanding rather than simply receiving information passively. This heightened engagement enables students to question, analyze, and critically evaluate information, leading them not only to learn more effectively but also to develop deeper and more enduring critical thinking abilities that will benefit them throughout their lives.

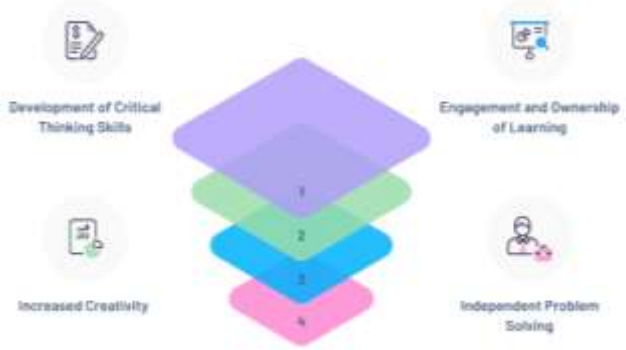

Figure 1. Thinking Skills

The development of critical thinking skills has become one of the main objectives in learning, which can be achieved when students are given the opportunity to explore and find answers on their own [42]. This process not only enhances their understanding of the material but also builds deep and independent thinking abilities, which are foundational to critical thinking skills [43]. Alongside this, creativity and independent problem-solving skills are also enhanced through projects that allow students to work in groups. In this environment, students learn to think beyond conventional boundaries, honing their creativity and becoming more autonomous in addressing challenges [44]. This collaborative process not only strengthens academic skills but also fosters important social competencies. Furthermore, when students feel they have control over their learning, their engagement significantly increases. This sense of ownership encourages students to be more active in the learning process, allowing them to develop their critical thinking skills more profoundly [45]. Thus, the development of critical thinking skills, creativity, and student engagement are interconnected and form a strong foundation for effective and sustainable learning.

These findings are consistent with constructivist theory, which asserts that effective learning occurs when students actively participate in the learning process. Vygotsky (1978) in his theory of the zone of proximal development (ZPD) also supports the idea that students learn more effectively when they are engaged in tasks that are slightly beyond their current capabilities, with appropriate guidance [46]. Therefore, student-centered learning not only enhances mastery of the material but also critical and creative thinking abilities, which are essential in HOTS.

Use of Technology and Digital Learning Tools

Technology can be used to support an adaptive curriculum, such as e-learning platforms that allow students to learn at their own pace and receive feedback tailored to their progress [47]. This technology can also provide simulations and scenario-based learning that require students to apply their knowledge in complex contexts, thereby enhancing their critical and creative thinking abilities [45]. The use of technology and digital learning tools in the classroom has proven effective in improving students' HOTS (Higher-Order Thinking Skills) [48]. Based on interviews, many teachers stated that technology helps provide more varied and challenging materials.

This is in line with the statement from Wahyudi, a teacher, who said, "By using digital platforms, I can provide simulations and scenarios that encourage students to think critically and seek innovative solutions." The teacher's comment on the use of digital platforms indicates that technology can be an effective tool for stimulating students' critical thinking skills. By providing challenging simulations and scenarios, technology allows students to explore various solutions and think innovatively. This emphasizes the role of technology in creating an interactive and dynamic learning environment where students are encouraged to think more deeply and creatively. In this context, technology is not just a tool for delivering content but also a means to facilitate deeper and more meaningful learning.

Additionally, Budiman, another teacher, expressed, "Technology allows me to provide faster and more personalized feedback, which helps students understand their mistakes and think more critically about how to correct them." Another teacher highlighted how technology accelerates and personalizes the feedback process, which is crucial in helping students identify errors and think critically about correcting them. Technology enables teachers to provide timely and specific feedback, which accelerates the learning process and encourages deeper reflection among students. This demonstrates that technology not only supports content delivery but also enhances the effectiveness of assessment, which is vital in developing Higher Order Thinking Skills (HOTS) among students.

Furthermore, Santoso reinforced the above statements by saying, "Through the use of applications and digital tools, I can make learning more interactive and engaging, which challenges students to think critically." This finding emphasizes that technology can serve as a catalyst in creating a learning environment that supports the development of HOTS. The third teacher's statement highlights that the use of applications and digital tools can make learning more interactive and engaging, thus encouraging students to think critically. Technology creates opportunities for more dynamic learning, where students actively participate and respond to material in ways that promote critical thinking. This underscores that technology plays a catalytic role in creating a learning environment that facilitates the development of higher-order thinking skills by making the learning process more engaging and challenging.

From the interpretations with several informants above, there are indicators that contribute to the development of the curriculum in enhancing HOTS-based learning in the classroom, which will be explained in the following discussion.

Use of Technology for Critical Thinking Simulations and Scenarios

This indicator demonstrates how technology can be utilized to create challenging simulations and scenarios for students, encouraging them to think critically and seek innovative solutions. By presenting situations that resemble the real world through digital platforms, students can sharpen their higher-order thinking skills, such as analysis, evaluation, and creation [49]. Technology provides a space for students to explore various possibilities and the consequences of their decisions, which is essential in the development of Higher Order Thinking Skills (HOTS) [50]. Thus, technology not only conveys content but also facilitates deeper and more contextual learning experiences.

Personalization and Enhancement of Feedback Processes

Technology also plays a crucial role in personalizing and accelerating the feedback process. With technology, teachers can provide fast, specific, and relevant feedback that students can receive immediately [33]. This feedback helps students understand where their mistakes occur and how they can correct them [51]. This process encourages students to think more critically and reflectively about their learning. The enhancement of feedback quality significantly contributes to the development of HOTS, as students become more aware and engaged in their learning processes and are better able to identify and address their weaknesses [52].

Increasing Interactivity and Challenge in Learning

This indicator emphasizes how technology can make learning more interactive and engaging. Through the use of applications and digital tools, learning becomes more dynamic, where students actively participate and face challenges that stimulate critical thinking [53]. This interactivity makes students more interested and engaged in the learning process, increasing their motivation to think more deeply and creatively [54]. By enhancing the challenges and interactivity in learning, technology significantly contributes to the development of HOTS, as students do not merely receive information passively but actively engage in a more complex and meaningful learning process.

However, this study also found that technology alone is not sufficient to enhance HOTS if not supported by appropriate pedagogical strategies. This aligns with findings that state that while technology plays an important role, human factors, such as teachers' abilities to facilitate learning, remain key to the success of developing HOTS [55]. Therefore, the use of technology should be viewed as part of a holistic approach that combines various teaching strategies focused on the development of HOTS.

HOTS-Based Formative Assessment

The development of an adaptive curriculum also includes formative assessments designed to measure higher-order thinking abilities. These assessments not only test basic knowledge but also the skills of analysis, evaluation, and synthesis of information. The findings of this research indicate that HOTS-based formative assessments play an important role in measuring and enhancing students' higher-order thinking skills. The interviewed teachers stated that assessments designed to measure HOTS provide deeper insights into the extent to which students can analyze, evaluate, and create solutions for complex problems.

From the findings, this is consistent with statements from several informants, including an interview with the principal who revealed that one teacher said, "I use formative assessments that require students to explain their thinking processes and how they reach conclusions. This helps me better understand their critical thinking abilities."

This is echoed by another teacher who added, "By using a rubric specifically designed for HOTS, I can provide more constructive and specific feedback that helps students develop their thinking abilities."

Moreover, a third teacher stated, "Formative assessment allows me to identify students' weaknesses in critical thinking and provide appropriate interventions to help them improve."

From these interview results, it can be interpreted that formative assessment functions not only as an evaluation tool but also as a learning tool that helps students develop higher-order thinking skills. The first interview reveals that using formative assessments, where students are asked to explain their thinking processes and how they reach conclusions, is highly effective in understanding students' critical thinking abilities. Through this assessment, teachers can see how students approach problems, the steps they take, and the logic they use, providing deep insights into their critical thinking skills. This is reinforced by another teacher's statement who uses a specific HOTS rubric to provide more

constructive and specific feedback. With this rubric, teachers can accurately assess and guide students in developing their critical thinking abilities, highlighting areas for improvement and providing concrete guidance for enhancement. The last statement from the third teacher emphasizes the importance of formative assessment in identifying students' weaknesses in critical thinking, allowing teachers to provide timely interventions. These interventions aim to address identified weaknesses and assist students in better developing higher-order thinking skills. Overall, formative assessments and the use of specific HOTS rubrics significantly contribute to enhancing students' critical thinking abilities through specific feedback and timely interventions.

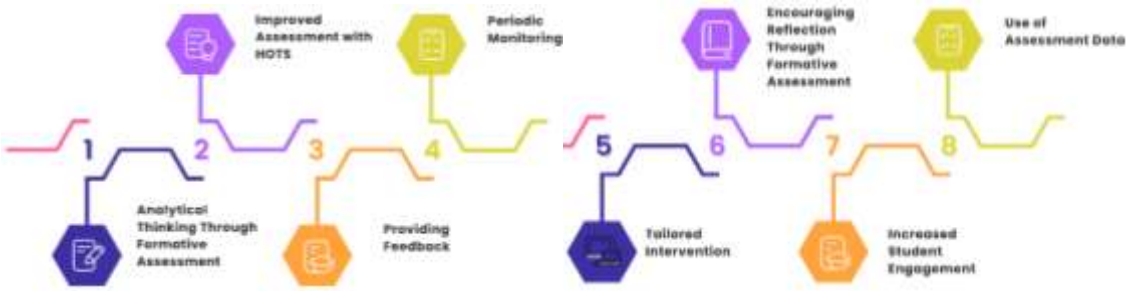

Figure 2. HOTS-based Formative Assessments

From the findings above, the development of an adaptive curriculum focused on formative assessment based on Higher Order Thinking Skills (HOTS) is an important strategy for improving the quality of classroom learning [56]. HOTS-based formative assessment aims to develop students' critical, analytical, and creative thinking abilities through in-depth and relevant feedback [57]. Through regular monitoring and the use of accurate assessment data, teachers can implement interventions tailored to the needs of each student [58]. These interventions assist students who are experiencing difficulties and encourage them to reflect on their learning process. Furthermore, timely and specific feedback promotes increased student engagement, as students understand the areas that need improvement and are motivated to achieve better outcomes [59]. The use of assessment data also plays a role in planning more effective teaching, ensuring that learning activities align with students' development [60]. Thus, HOTS-based formative assessments serve not only as evaluation tools but also as learning means that encourage students to engage more actively and think deeply, thereby enhancing the overall quality of education.

4 Conclusion

The conclusion of this study highlights the importance of developing an adaptive curriculum to enhance Higher Order Thinking Skills (HOTS) in the classroom. The most significant finding from this research is that aligning materials with students' needs and interests directly contributes to increased engagement and critical thinking abilities. Student-centered learning, along with the use of technology and HOTS-based formative assessment, has also proven effective in supporting the development of higher-order thinking skills. The key takeaway from this research is that a responsive approach to the individual needs of students not only improves the quality of learning but also prepares students to face complex challenges in the real world with better analytical and creative skills.

This research makes a significant contribution to the field of education by updating the perspective on how adaptive curricula can be effectively integrated into learning to support HOTS. The proposed approach in this study, which combines personalized materials, student-centered learning, and technology, offers methods that can be more widely adapted in diverse educational contexts. Nevertheless, this study has limitations that need to be considered, such as the case limitation conducted in only one school and the constraints

regarding the age and gender diversity of participants. Therefore, further comprehensive research is needed, involving variations in gender, age, and using broader survey methods to obtain a more representative picture. Such further research is crucial for ensuring that the results can serve as a basis for more targeted and inclusive educational policy.

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