Journal of Current Studies in SDGs
Homepage : https://journal.i-ros.org/index.php/JOCSIS
Email : jocsis@i-ros.org

e-ISSN 3089-7564
Vol. 1, No.4, December 2025

Curriculum Analysis to Evaluate Sustainable Learning in High School Physics Through AI-Based Learning Media for SDG 9

Rahmatta Thoriq Lintangesukmanjaya[1*], Wildan Fitroni[1], Binar Kurnia Prahani[1], Dwikoranto[1]

[1]Universitas Negeri Surabaya, Surabaya, Indonesia

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DOI : https://doi.org/10.63230/jocsis.1.4.92

Sections Info

Article history:
Submitted: September 4, 2025
Final Revised: December 4, 2025
Accepted: December 4, 2025
Published: January 10, 2025

Keywords:
AI;
Curriculum;
Evaluation;
K-13 Curriculum;
Merdeka Curriculum.

ABSTRACT

Objective: *The objective of this research is to analyze the implementation of the curriculum at SMAN 1 Cerme, Gresik, in order to identify the alignment of learning outcomes with applicable curriculum standards. This study also aims to contribute to achieving the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), which emphasizes inclusive and equitable quality education, and SDG 9 (Industry, Innovation, and Infrastructure), which encourages innovation in educational practices.* ***Method:*** *This research employs a qualitative descriptive method. Primary data were obtained from interviews and decisions issued by KOSP SMAN 1 Cerme, while secondary data were collected through observations and student response questionnaires.* ***Results****: The findings reveal that SMAN 1 Cerme applies the K-13 curriculum for grade XII and the Merdeka Curriculum for grades X and XI. The implementation demonstrates the importance of monitoring and evaluation to ensure the curriculum effectively supports the school's vision and mission.* ***Novelty:*** *This research's novelty lies in integrating curriculum analysis with the Sustainable Development Goals framework. By linking curriculum implementation to SDG 4 and SDG 9, this study highlights how curriculum transformation not only supports local educational objectives but also contributes to global efforts to promote quality education and foster innovation in learning infrastructure.*

INTRODUCTION

In a global world, humans will never be separated from development. In the era of society 5.0, technological developments play a significant role in driving change in increasingly sophisticated times. With today's technological development, society must maximize existing technology. Learning offerings in the 21st Century prioritize human resource professionalism in integrating technology, pedagogy, and operational content knowledge (Oktasari, 2020). One way to compete with current technology is to improve the education system so that the nation's generation becomes more empowered to utilize the technology that has developed. This is based on the objectives of the 1945 Constitution, making the nation's life intelligent is one of the contributions of the nation's generation to advance this country.

In addition, in the context of Sustainable Development Goals (SDGs), technology plays a crucial role in promoting SDG 9, which emphasizes resilient infrastructure development, sustainable industrialization, and innovation. The importance of digital technology and learning media interaction in today's education world not only improves access and effectiveness of the teaching and learning process, but also becomes an innovative instrument to support the achievement of SDG 9 targets, such as the availability of inclusive digital infrastructure and the use of innovative learning

e-ISSN 3089-7564
Vol. 1, No.4, December 2025

media that are adaptive to local and cultural contexts (Edbais & Hossain, 2025). Previous research also confirms that the use of technology can be an important catalyst in integrating Education for Sustainable Development (ESD) to support the achievement of SDG 4 and SDG 9, particularly by strengthening digital literacy, critical thinking skills, and learning innovation (Fitroni et al., 2025).

In simple terms, education is a human effort to realize the potential of innate abilities, both physical and spiritual, in accordance with the rules and norms of society (Angga, 2022). However, current educational standards still cannot guarantee students' future achievements. Indonesia has many factors that cause its education system to lag far behind those of other countries. Starting from the obvious things, such as equal distribution of school development, there are still many things that have not been fulfilled, especially the inadequate facilities and infrastructure. However, among the widely used learning methods today, the average achievement of learning objectives remains minimal, due to the implications of a communication process that is less functional and to the lack of learning effectiveness (Vhalery, 2022). In fact, apart from the teaching resources needed in schools, the more important thing to improve now is the learning system.

Education is closely related to learning. Learning is an important and complex human endeavor (Zein, 2016). Learning is also directly proportional to students' cognitive development. Cognitive development is related to increased ability to think, solve problems, make decisions, and to intelligence and talent, as stated by Dariyo (Hanafi, 2019). One part of learning development is the learning curriculum. Curriculum development needs to be carried out in light of advances in science, technology, and the arts and culture, which align with changes in the social order at local, national, regional, and global levels (Kustijono, 2014). Currently, the curriculum used in Indonesia is the independent learning curriculum. The curriculum was developed to improve intellectual abilities and develop attitudes and skills (Bahri, 2018). Even though it is known that before there was an independent curriculum, Indonesia had implemented various curricula. One of the most significant factors influencing curriculum changes is the government's efforts to adapt education to current developments (Ardiawan, 2020). This is what makes the curriculum so important and a foundation in education today. However, the implementation of existing learning outcomes in the education sector still needs to be studied. When implementing independent and other curricula, there are always aspects that need to be evaluated. Especially in more advanced physics learning, it requires strong curricular support so that learning can be carried out optimally. Because physics does not rely solely on theoretical knowledge, it also requires mastery of several practical aspects.

Curriculum analysis research in schools aims to help identify learning outcomes in accordance with applicable curriculum standards. The aim of the national education

e-ISSN 3089-7564
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unit curriculum is specifically to provide absolute independence in choosing the curriculum appropriate to students in each school (Laeliyah, 2022). In line with this, this study specifically aims to analyze the achievement of SDG 9 in curriculum implementation in schools, particularly in relation to how the integration of digital technology, learning media, and the strengthening of educational infrastructure can support or hinder the achievement of targets such as innovation, equitable access to technology, and teacher readiness in utilizing innovative learning media.

SMA Negeri 1 Cerme is an upper secondary school that aims to improve its quality by providing competency-based training to students so they can continue to a higher level of education. Likewise, from the bureaucratic perspective, a good school is seen in terms of quantitative scores (NUN), while paying attention to qualitative scores (outcomes). SMAN 1 Cerme has achieved many achievements. In the last three years, this school annually graduated an average of 100% of its graduates. In both academic and non-academic fields, he has won championships in various competitions at the Gresik Regency, provincial, and national levels. Apart from these achievements, SMAN 1 Cerme also has other advantages. Every situation always has advantages and disadvantages. Due to society's demands and needs for student education, SMA Negeri 1 Cerme requires improvement and development in various aspects, for example, graduate competency, Independent Curriculum, learning process, educators and education staff, infrastructure, financing, management, and assessment development. Therefore, it is important to analyze the implementation of the curriculum at SMA Negeri 1 Cerme to understand the school's curriculum, standards, efforts to achieve student outcomes, and solutions to problems related to curriculum implementation at SMA Negeri 1 Cerme.

RESEARCH METHOD

The research to analyze the school curriculum at SMAN 1 Cerme used qualitative methods. Qualitative research, also known as naturalistic or natural research, emphasizes processes and meanings that are not precisely tested or measured with descriptive data (Strauss, 2003). Qualitative descriptive research involves averaging scores for each criterion of feasibility/validity of the assessment results, which is determined by the level of agreement (Percentage of Agreement) of the instrument (Habibullah et al., 2017). In this study, two types of research data were obtained: primary and secondary. Primary data was obtained through interviews and decisions from KOSP SMAN 1 Cerme.

Meanwhile, secondary data were obtained through observations and the distribution of questionnaires to students. According to Kusumastuti (2019), qualitative research is supported by interview data, observations, and document reviews. Therefore, the

research was designed to obtain a valid curriculum analysis with the following research activity roadmap.

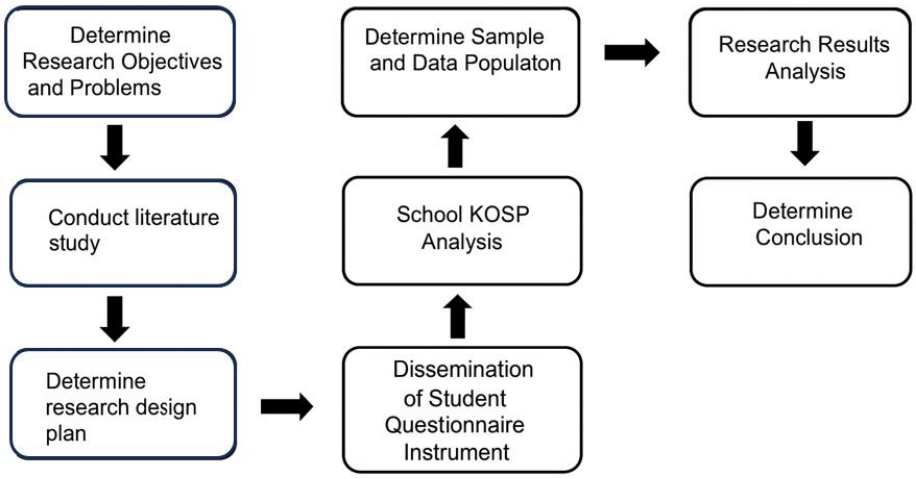

Figure 1. Research design (Kusumastuti, 2019)

In the questionnaire distribution instrument, the questionnaire was administered to two classes: class X and XI. The questionnaire results will be processed and adjusted to recapitulate the implementation of curriculum management in schools. Meanwhile, the results of the KOSP (School Operational Curriculum) analysis at SMAN 1 Cerme, conducted in the 2022/2023 academic year, reflect learning freedom and the application of the Pancasila Student Profile, providing accurate data on activities carried out at the school. Based on this data distribution, it will be known what evaluation and curriculum development are needed for the coming period at SMAN 1 Cerme.

RESULTS AND DISCUSSION

Results

In conducting curriculum analysis research that has been carried out with the entire population at SMAN 1 Cerme, in the process of implementing learning activities and supporting facilities and infrastructure, the results of the curriculum analysis, particularly for physics learning activities at SMAN 1 Cerme, are as follows:

a) Current Curriculum
   The curriculum implemented at Cerme 1 Public High School is the 2013 curriculum and the independent curriculum. The independent curriculum has been implemented at Cerme 1 Public High School since the 2022/2023 academic year. The independent curriculum is implemented at the 10th and 11th grade levels.
b) Curriculum Implementation
   In the implementation of the curriculum used by SMAN 1 Cerme, based on the results of observations, there are two curricula used. The independent curriculum is more widely used as a reference for teaching and learning activities certification. Judging from the content standards, the implementation ranges from the operational or specific curriculum to the independent curriculum (Amar, 2023).

Educators are already familiar with the independent curriculum. Before teaching, educators prepare learning tools that have been adapted to the independent curriculum based on the provisions of the Ministry of Education and Culture. The differences between the use of the independent curriculum and other curricula implemented at SMAN 1 Cerme are as follows:

1) The teaching tools used focus on student activities
2) There is a teaching module to replace the lesson plan

Integrate the Pancasila student profile into P5 (Pancasila Student Consolidation Project) activities as co-curricular activities. Given the developments in learning patterns at school, both parties (teachers and students) must be able to adapt gradually in order to produce the desired learning outcomes, especially in physics learning activities.

Learning Process Standards

According to Iskandar, learning is an effort to teach students. Learning is a process that involves a series of actions by teachers and students, based on a reciprocal relationship, that takes place in an educational setting to achieve specific goals (Ifan, 2019). The learning process always involves a series of learning activities to realize implementation standards. These standards will serve as guidelines for teaching staff in carrying out teaching and learning activities (KBM). In the independent curriculum, the recommended learning model is project-based learning. The learning methods used must involve two directions: between educators and students, and between groups and individuals. In the implementation of physics lessons, there has been no innovation from the school. The limitations of physics laboratory equipment restrict educators in designing learning activities, and students are unable to explore knowledge. These limitations are caused by inadequate facilities and infrastructure that have not been used for a long time, and a lack of attention to their maintenance. Ultimately, physics learning only focuses on conventional material deepening.

Evaluation Process Standards

In line with the Ministry of Education and Culture's policy, operational evaluation of learning outcomes is conducted through summative assessment activities for students. This is also applied in physics learning. In addition, there is AKM, implemented as a substitute for the National Examination for students in grade 12. For classes, this independent curriculum report card is provided free of charge by the Ministry of Education and Culture for use by educational units that implement the curriculum.

c) Student Questionnaire Results

Table 1. Student questionnaire results

Question	Percentage Indicator				
How difficult do you find physics?	7,4 %	13,6 %	64,2 %	12,3 %	2,5 %
How interested are you in studying	9,9 %	34,6 %	45,7 %	6,2 %	3,7 %

Question	Percentage Indicator				
physics at school?					
How effective are teachers in explaining physics material today?	27,2 %	46,9 %	23,5 %	1,2 %	1,2 %
Do you agree with the implementation of physics lessons using the current independent curriculum?	8,6 %	60,5 %	25,9 %	2,5 %	2,5 %
Do you agree that future physics learning should prioritize student independence?	13,6%	49,4%	28,4%	2,5%	6,2%

d) Related Articles

Relevant articles were obtained by conducting a literature review of various journals and scientific articles using keywords identical to those used in the study.

Table 2. Results of student questionnaire distribution

Years	Tittle	Sample Characteristics	Findings
2020	Effectiveness in School Curriculum Implementation	Literature study through books, journals, and previous research.	The principles of exemplary and effective curriculum implementation are equal opportunities, with children at the center of the approach, and partnerships to provide policy and diversity in implementation. The curriculum must be adapted to the evolving needs and demands of society.
2022	Analysis of the Implementation of the Independent Learning Curriculum at State High Schools in Padangsidimpuan	Qualitative description through 3 teachers and 3 students.	The implementation of the independent learning curriculum at SMAN Sekota Padangsidimpuan has been carried out well in accordance with the Ministry of Education and Culture's regulations on school assessment, minimum competency assessment, lesson plans, and the acceptance of new zoned students. The curriculum adapts to the conditions of each educational institution to achieve national learning outcomes.
2022	Analysis of the 2013 Curriculum Changes on the Learning Outcomes of Grade X Students at MAN 1 Solok	The method of interviewing grade X students' learning outcomes was reinforced through a sample	The positive impact of the independent curriculum is that students are given the freedom to choose the learning materials they prefer, allowing them to spend more time understanding and enriching concepts and

Years	Tittle	Sample Characteristics	Findings
		of activity documentation.	strengthening their competitiveness. Teachers are given the freedom to use teaching methods and tools during the teaching and learning process at school.
2022	Analysis of the Implementation of the Independent Learning Curriculum to Prepare for 21st Century Learning	Literature Review	Various challenges in implementing the curriculum stem from a lack of digital literacy and understanding of the concept of independent learning.
2023	Development of the Merdeka Curriculum in Educational Units and Implementation of the Merdeka Curriculum in 21st Century Learning	Literature study through books, journals, articles, or research related to the topic being studied.	The implementation of the independent curriculum is consistent with the KKNI curriculum in terms of the principles of education technology, which are oriented towards students, and with the supporting systems necessary to realize quality education.
2023	Analysis of the Implementation of the Independent Curriculum (Case Study of SMK Al Huda Kedungwungu Indramayu)	A qualitative descriptive research method with a gradual data collection technique, namely observation and interviews, reinforced with documentation.	The improvement of the required competencies has become an obstacle to implementing the independent curriculum, and the infrastructure supporting the development of interactive learning methods has become a benchmark for creating a working atmosphere in educational institutions.
2023	Analysis of the Implementation of the Merdeka Curriculum in Overcoming Grade Retention in High Schools	Case study research method with qualitative analysis and questionnaires, questionnaire distribution, observation, and documentation.	Teachers, principals, teaching staff of related institutions, parents, and students play a key role in reducing the educational component in striving for curriculum success.
2023	Analysis of the Implementation of the Independent Learning Curriculum on	The population was taken from observations, documentation of conditions, and interviews with	The inhibiting factors in implementing the independent curriculum are the lack of learning facilities and the quality of teachers during the learning process, as the program is still in

Years	Tittle	Sample Characteristics	Findings
	the Learning Outcomes of Grade X Students in Geography at MAN I Koto Baru	geography teachers at MAN 1 Koto Baru.	an adjustment phase. The advantages of this curriculum are that it is more flexible, that teachers have greater freedom to design learning concepts, and that students are more independent.
2023	Implementation of the "Merdeka Belajar" Curriculum in the Era of Industry 4.0	This study involved the use of literature review and qualitative descriptive methods.	The independent curriculum is more straightforward than the 2013 Curriculum. The effectiveness of the 2013 Curriculum is quite good in giving students the freedom to choose their interests and talents. In addition, teachers do not explain the material thoroughly enough.
2023	Analysis of Student Diversity and Implementation of the Independent Curriculum in Physics	Qualitative descriptive research methods based on observation instruments, interviews, questionnaires, and written tests.	The implementation of the independent curriculum in the learning process has not yet led to differentiated learning. Learning is still teacher-centered, and assessments have not yet identified feedback provision to students.

Based on a review of articles, previous studies have analyzed curricula as a means of evaluating the implementation of learning. The emergence of new curricula as an update to old ones is influenced by several factors. The most important is the increasing demands of the times, which necessitate the development of existing learning curricula. The curriculum is a vital tool for achieving educational goals because a competent curriculum will facilitate the attainment of desired objectives (Jufrida et al., 2021). Therefore, the principle of learner-oriented educational technology, with its supporting systems to ensure quality education, is a requirement for implementing an effective curriculum. The positive impact of the independent curriculum is that students are given the freedom to choose the learning materials they prefer, allowing them to spend more time understanding and enriching concepts and strengthening their competitiveness (Hutabarat, 2022). This is often found in related articles; at least, the independent curriculum has provided students with learning independence.

Overall, each curriculum implemented in an educational unit has its own advantages and disadvantages. School support in providing infrastructure and teaching resources is one of the factors for curriculum success. The identification of learning assessments also influences the evaluation of student learning. The government has made every effort to improve the quality of education through the current education curriculum.

Discussion

Curriculum analysis requires an understanding of the implementation needed in learning procedures. The more meaningful the learning, the more evident the contribution of the curriculum in that learning. The questionnaire was distributed to 100 students in grades X and XI at Cerme 1 Public High School. This was based on the fact that at Cerme 1 Public High School, the new independent curriculum is still being implemented in grades X and XI.

The questionnaire stated that students at SMAN 1 Cerme tended to consider physics as a medium subject. Based on the questionnaire results on students' interest in physics, students at SMAN 1 Cerme were found to be quite interested in physics. This is evident in the percentage of students who considered physics easy to learn, which was higher than the percentage who considered it difficult, as reflected in their interest in learning. It is known that the current implementation of the independent curriculum tends to optimize student learning activities (Student Center). In stage F, physics learning must allocate 30% of the total lesson hours per year to projects (Makarim in Mairizwan, 2022). Because students have independence and motivation to improvise in learning activities, learning becomes more enjoyable. In addition, teachers are expected to draw on all their creativity to increase students' interest in physics learning, primarily through the use of interactive media and teaching materials during learning activities.

Based on a questionnaire on the effectiveness of teachers' teaching methods in explaining physics material, students at SMAN 1 Cerme find that teachers' explanations are adequate. Students tend to feel that the methods teachers currently use make learning more effective. The implementation of the learning system used by physics teachers has achieved learning objectives, even though only minimal teaching facilities and media are used. Effective learning is learning with a high learning achievement index. One of the roles of teachers is to implement and deliver the curriculum and design classes to improve the quality of learning, especially in physics (Supriatna, 2023). Based on the questionnaire results and supported by other external factors, the effectiveness of learning at SMAN 1 Cerme is undoubtedly part of the contribution of teachers who can enliven learning and motivate students.

Based on a survey of students at SMAN 1 Cerme regarding the implementation of physics learning using the independent curriculum, students agreed with its implementation. Before using the independent curriculum, the K-13 curriculum was prioritized in building student literacy. Curriculum development always emphasizes improving mindsets, strengthening curriculum management, deepening and expanding material, strengthening the learning process, and adjusting the learning load to ensure consistency between learning objectives and outcomes (Kustijono, 2014). This is a benchmark in the development of an independent physics learning curriculum. Alignment between learning objectives and outcomes is one indicator of a curriculum's success (Hutabarat, 2022). This serves as basic evidence that, based on the questionnaire results, students at SMAN 1 Cerme feel that physics learning under the independent learning curriculum has produced good results.

The reason most students agree with the implementation of physics learning using the independent curriculum is that it allows students to explore the subject themselves and, in its implementation, presents them not only with material but also with practical work. Looking at the current development of the independent learning curriculum, students can feel the system of independence evident in its form. In implementing the Independent Curriculum, schools have the freedom to choose three alternatives independently. The first is the standard Independent Curriculum option, the second is the Independent Curriculum with innovation option, and the third is the Independent Sharing option (Harahap, 2023). Public schools provide an independent curriculum in accordance with the standard. However, in terms of students' experience with the character of Pancasila, or commonly referred to as the Pancasila Student Profile Strengthening Project (P5) program, it varies from school to school. Not only is the independence of the academic learning process measurable, but the independence of skills outside the classroom is also an output of the current implementation of the independent curriculum.

Students at SMAN 1 Cerme tend to agree that future physics lessons will prioritize independence. The dominant reason students tend to agree that future physics lessons will prioritize independence is that they believe independence in physics learning allows them to think critically and find solutions on their own. From the questionnaire, students need physics learning that is not monotonous, meaning that it is not focused solely on theory but also on practical work and direct application. Students also support the implementation of the current curriculum, namely the independent curriculum, because, according to them, in learning, students can explore their own knowledge, thereby becoming more critical individuals. Students also agree that physics learning prioritizes independence, which can be sustained through an independent curriculum that centers on students (student-centered). From this, the results of the analysis of obstacles and solutions can also be obtained.

a) Curriculum Barriers

When we look at the implementation of a curriculum, after the curriculum is applied, there is always an evaluation of the performance of the curriculum used in each school. Suryabrata states that factors that can influence learning outcomes consist of external and internal factors. External factors include the curriculum, programs, facilities and infrastructure, teachers (teaching staff), general physiological conditions, and sensory conditions. Internal factors include physiological and psychological factors such as interest, intelligence, talent, motivation, and cognitive abilities (Dewati, 2012). In adapting two different curriculum references, SMAN 1 Cerme clearly faced obstacles in its implementation. The obstacles listed below are based on observations at SMAN 1 Cerme, as well as additional information from teachers and curriculum representatives at SMAN 1 Cerme.

1) The culture of students who cannot actively participate in learning.

In learning activities, in addition to improving students' cognitive abilities, the curriculum must also be able to shape character and morals in the learning

process. The learning culture, which has long been affected by the Covid-19 pandemic, still influences students' behavior at school. Of course, this poses a major challenge for teachers in disciplining and reconstructing a culture that has not yet been properly instilled in their students.

2) School infrastructure does not yet fully support learning
   The large number of activities hampered by infrastructure issues in schools not only causes setbacks in the learning process, but also affects the efficiency of other activities in schools.
3) Parents of students who do not support school policies
   Many activities are not available at school, requiring students to learn outside of school, but in terms of permission, many parents are still reluctant to give permission for what the school has planned. In this case, the school has no right to interfere with the decisions of the students' parents.

b) Solutions and Problem Solving

1) Use a virtual lab or practice with simple tools and materials
   As an alternative to overcoming the lack of laboratories in schools, you can use virtual laboratories that are widely available on the web, both paid and free. This is especially true for physics, which requires more experimental activities for some of its material, both in the 2013 curriculum and the independent curriculum. The implementation of the Independent Curriculum can be said to create a learner-centered learning environment and equip learners with skills relevant to the 21st century (Tessalonika et al., 2022).
2) Accustoming students to using IT-based learning
   IT-based learning is always more optimal to use today. In addition, educators' participation in the curriculum development process is very important to ensure that the content of the Merdeka curriculum meets the needs of students in the classroom (Tessalonika et al., 2022). Developments certainly shape students' needs in the current era of IT globalization, enabling them to keep pace with technological advances. Technological developments must be utilized. Of course, the modules and teaching materials used are important for providing a small amount of material through digital technology. This way, facilities that cannot be used directly in the classroom or school can still be accessed through this technology.
3) Educators encourage students to explore and be more active in learning
   Exploration aims to make learning memorable and not monotonous only at school, but sometimes students need motivation through activities outside the classroom. As we know, the implementation of the "Curriculum" in schools requires the support of skilled, qualified, and competent human resources, starting from the principal, teachers, and other educational staff. Curriculum changes cannot be implemented without changes in the teachers themselves (Pratikno et al., 2022). Therefore, the seriousness of student learning is also influenced by educational staff in the same scope.

4) The school provides a letter of approval for each additional activity
   A letter of approval as valid permission for students to participate in activities outside of school that are still related to school. In addition, schools can also request assistance with infrastructure deemed necessary by submitting a proposal.
5) Guiding teachers to make learning more interactive
   Interactive learning can be achieved if teaching staff and teaching materials are ready to contribute. The preparatory steps include guidance for teaching staff, soft skills training, and much more. More active learning will leave a positive impression on the learning process and improve the cognitive abilities of students. The presence of educators with quality human resources is one of the determining factors for the successful implementation of the curriculum. Excellent and creative educators can minimize the impact of shortcomings, including a lack of infrastructure and management support (Pratikno et al., 2022). This explains that improving interactive learning also requires more competent teaching staff.

Based on what has been explained previously, the results of the questionnaire survey, and the analysis of the KOSP (Operational Curriculum for Education Units) curriculum that has been implemented, it needs to be developed to be applied more optimally in schools. In addition, many students still feel they are not yet an important part of the current education system. In fact, the entire teaching and learning process improves students' cognitive skills and knowledge. An evaluation is needed to improve the curriculum for the following semester. Facilities and infrastructure must also be provided so that teaching staff can maximize the use of teaching materials.

Based on the discussion, the application of digital learning media and innovation in school curricula has real potential to support SDG 9. The development of inclusive digital infrastructure (e.g., devices, connectivity, digital learning spaces), as well as curriculum adaptation that incorporates local innovations and cultural wisdom, can strengthen educational innovation and expand access to learning for students from diverse backgrounds (Navas-Bonilla et al., 2025). However, several challenges remain: infrastructure disparities in schools in remote areas, teachers' unpreparedness to use innovative technologies pedagogically, and a lack of policy support and adequate budget allocation for the maintenance and development of educational technology. Without concrete efforts to overcome these obstacles, achieving SDG 9 targets (access to affordable information and communication technology) and enhancing research and innovation will be difficult (Pappa et al., 2023; Dagli et al., 2025).

These findings imply that policymakers need to formulate a clear roadmap and action strategy for SDG 9 in the field of education. Examples include developing national/regional policies that provide specific funding for digital education infrastructure and learning media innovation, prioritizing ongoing technology training for teachers so they can adapt and develop digital media in line with local contexts, and monitoring and evaluating SDG 9 achievements at the school level. On the other hand, the concepts of Education 4.0 and decentralized learning offer innovative opportunities to modernize learning methods and expand access (Lintangesukmanjaya et al., 2025).

However, they require adequate security, regulation, and technological readiness to avoid widening the gap (Duarte et al., 2025). Furthermore, learning transformation through transformative approaches and innovative pedagogy is important for strengthening the awareness and capacity of educational institutions to promote sustainable development through education, rather than merely technological adaptation (Dagli et al., 2025; Lim et al., 2022).

CONCLUSION

Fundamental Finding : The research findings show that SMAN 1 Cerme implements two types of curriculum: the K-13 curriculum for grade XII and the Merdeka Curriculum for grades X and XI. The main challenges encountered are the lack of active learning culture among students, limited school infrastructure, and insufficient support from parents. As an alternative, interactive learning and the use of digital learning materials have become essential strategies to maximize curriculum implementation. These efforts are aligned with SDGs 4 (Quality Education) and SDGs 9 (Industry, Innovation, and Infrastructure) by supporting equitable learning opportunities and promoting innovation in educational infrastructure. **Implication :** The study implies that strengthening digital literacy programs, enhancing teachers' competencies in utilizing innovative learning media, and establishing collaboration with parents and policymakers are crucial to improving curriculum implementation. This also indicates that curriculum transformation at the school level can serve as a strategic entry point to contribute to global development goals, particularly in ensuring quality and innovative education systems. **Limitation :** This study is limited by its scope, as the analysis only focused on one school, SMAN 1 Cerme, with data collected from interviews, observations, and questionnaires. The findings may not fully represent the diversity of curriculum implementation challenges in other schools or regions, especially those with different socio-cultural or infrastructural conditions. **Future Research :** Future studies should broaden the scope by including more schools and diverse contexts to provide a comprehensive picture of curriculum implementation in relation to SDGs. Comparative studies across regions or educational levels could also help identify best practices for integrating SDGs 4 and SDGs 9 into curriculum design and implementation, while exploring the long-term impact of digital innovation on student outcomes and school performance.

AUTHOR CONTRIBUTIONS

Rahmatta Thoriq Lintangesukmanjaya contributed to the conceptual framework, research design, and validation process; **Wildan Fitroni** was involved in methodology development, data analysis, sourcing references, and drafting the manuscript; **Binar Kurnia Prahani** handled data management; **Dwikoranto** was involved in project coordination. All listed authors have reviewed and approved the final version of this submission.

CONFLICT OF INTEREST STATEMENT

The authors confirm that there are no conflicts of interest, either financial or personal, that may have influenced the content or outcome of this study.

ETHICAL COMPLIANCE STATEMENT

This manuscript complies with research and publication ethics. The authors affirm that the work is original, conducted with academic integrity, and free from any unethical practices, including plagiarism.

STATEMENT ON THE USE OF AI OR DIGITAL TOOLS IN WRITING

The authors acknowledge the use of digital tools, including AI-based technologies, as support in the research and writing stages of this article. Specifically, Grammerly for a writing aid that offers various advantages, especially in terms of improving the quality and clarity of writing in English. All outputs generated with digital assistance were critically evaluated and revised to ensure academic rigor and ethical standards were upheld. The final responsibility for the manuscript rests entirely with the authors

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*__Rahmatta Thoriq Lintangesukmanjaya__
Universitas Negeri Surabaya
Departement of Physics Education, Universitas Negeri Surabaya,
Jl. Ketintang, Ketintang, Kec. Gayungan, Surabaya, Jawa Timur 60231
Email: 24031635011@mhs.unesa.ac.id

Wildan Fitroni
Universitas Negeri Surabaya
Departement of Mathematics Education, Universitas Negeri Surabaya,
Jl. Ketintang, Ketintang, Kec. Gayungan, Surabaya, Jawa Timur 60231
Email: wildanfitroni25@gmail.com

Binar Kurnia Prahani
Universitas Negeri Surabaya
Departement of Physics Education, Universitas Negeri Surabaya,
Jl. Ketintang, Ketintang, Kec. Gayungan, Surabaya, Jawa Timur 60231
Email: binarprahani@unesa.ac.id

Dwikoranto
Universitas Negeri Surabaya
Departement of Physics Education, Universitas Negeri Surabaya,
Jl. Ketintang, Ketintang, Kec. Gayungan, Surabaya, Jawa Timur 60231
Email: dwikoranto@unesa.ac.id