

UTILIZATION OF ARTIFICIAL INTELLIGENCE IN DEVELOPING TEACHING MATERIALS AT THE BIOLOGY SUBJECT TEACHERS' WORKING GROUP

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Abstract. Online learning, which has been on the rise since the COVID-19 pandemic, continues to present various challenges for biology teachers in Gresik Regency, particularly in conducting laboratory experiments, maintaining student motivation, and developing innovative teaching materials aligned with the Merdeka Curriculum. This community service activity aims to enhance the capabilities of biology teachers who are members of the Gresik Regency Private High School Teachers' Working Group (MGMP) in utilizing Artificial Intelligence (AI) to develop instructional materials. The activity was conducted based on the TPACK (Technology, Pedagogy, and Content Knowledge) model, which comprises four stages: understanding, observation-instruction, instructional practice, and reflection. During the training, participants were guided in developing Instructional Modules, Student Activity Sheets (LKPD), and assessment instruments using AI applications such as ChatGPT, Quizizz, and iNaturalist. The results showed that 90% of participants rated the training as highly relevant, while 10% rated it as relevant to their school's learning needs. In addition, 28 out of 30 participants (93%) completed all assigned tasks. Participants also reported that the use of AI helped them develop assessment tools based on Higher Order Thinking Skills (HOTS), which they had previously found quite difficult. These findings suggest that the use of AI in training for instructional material development can help teachers work more effectively while producing higher-quality learning resources.

Keywords: artificial intelligence, higher order thinking skills, technological pedagogical content knowledge

Abstrak. Pembelajaran daring yang berkembang sejak pandemi Covid-19 masih menyisakan berbagai tantangan bagi guru Biologi di Kabupaten Gresik, terutama dalam pelaksanaan praktikum, menjaga motivasi belajar siswa, serta menyusun bahan ajar yang inovatif dan selaras dengan Kurikulum Merdeka. Kegiatan pengabdian ini bertujuan meningkatkan kemampuan guru Biologi yang tergabung dalam MGMP SMA Swasta Kabupaten Gresik dalam memanfaatkan Artificial Intelligence (AI) untuk menyusun perangkat pembelajaran. Pelaksanaan kegiatan mengacu pada model TPACK (Technology, Pedagogy, and Content Knowledge) yang meliputi empat tahapan, yaitu pemahaman, observasi-instruksi, latihan instruksi, dan refleksi. Selama pelatihan, peserta didampingi menyusun Modul Ajar, Lembar Kegiatan Peserta Didik (LKPD), serta instrumen evaluasi dengan memanfaatkan aplikasi AI, seperti ChatGPT, Quizizz, dan iNaturalist. Hasil kegiatan menunjukkan bahwa 90% peserta menilai pelatihan sangat relevan dan 10% menilai relevan dengan kebutuhan pembelajaran di sekolah. Selain itu, 28 dari 30 peserta (93%) berhasil menyelesaikan seluruh tugas yang diberikan. Peserta juga menyampaikan bahwa pemanfaatan AI membantu mereka menyusun instrumen evaluasi berbasis Higher Order Thinking Skills (HOTS), yang sebelumnya dianggap cukup sulit. Temuan ini menunjukkan bahwa pemanfaatan AI dalam pelatihan pengembangan bahan ajar dapat mendukung guru bekerja lebih efektif sekaligus menghasilkan perangkat pembelajaran yang lebih berkualitas.

Kata Kunci: kecerdasan buatan, keterampilan berpikir tingkat tinggi, pengetahuan konten pedagogis teknologi

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INTRODUCTION

Digital transformation in education has significantly changed how teachers design and deliver learning materials, particularly after the rapid development of generative artificial intelligence (AI) technologies following the launch of ChatGPT in late 2022. AI in education now extends beyond supporting personalized learning to automating administrative tasks, facilitating self-directed learning, and improving the accessibility and interactivity of



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educational experiences. Collaboration between AI and teachers also has the potential to enhance the overall quality of education (Resnawita & Karmanita, 2024).

This potential is further supported by the results of an AI-based interactive learning design training program for Madrasah Ibtidaiyah teachers, which demonstrated significant improvements in teachers' competencies and high levels of student enthusiasm toward the learning media produced (Utami et al., 2025). Nevertheless, teachers' readiness to adopt this technology remains a challenge, as their knowledge of digital and AI literacy is generally still limited. Therefore, strengthening such literacy is an essential prerequisite for ensuring that AI can be optimally utilized in the development of teaching materials (Pambudi et al., 2025).

This need has become increasingly urgent as national education policies move toward a deep learning approach, which requires teachers to adopt instructional strategies such as problem-based learning and project-based learning to promote students' conceptual understanding and critical thinking skills. This paradigm shift is also highly relevant to Biology teachers in designing teaching materials that can connect diverse concepts in meaningful and contextual ways (Nurhidayah et al., 2026).

On the other hand, Biology teachers who are members of the MGMP of Private Senior High Schools in Gresik Regency still face several challenges in developing instructional materials. These challenges include difficulties in designing innovative and creative teaching materials, adapting learning content to the characteristics and local potential of students, and determining assessment indicators based on Higher Order Thinking Skills (HOTS). Difficulties in integrating local potential into teaching materials have also been reported in mentoring activities for the development of coastal potential-based local content teaching modules. The results of these activities indicated that teachers require continuous professional development to integrate local contexts into teaching materials in a systematic and coherent manner (Palalas et al., 2026).

This issue is a priority because teachers' limited time and resources for manually developing instructional materials often directly affect the quality and variety of learning materials provided to students. The use of Large Language Models (LLMs), such as ChatGPT, Gemini, and Claude AI, has the potential to revolutionize the way teachers prepare and develop teaching materials. Therefore, AI utilization training represents a more relevant and efficient solution than conventional training approaches, which require more time to achieve comparable outcomes (Ali et al., 2026).

Based on this rationale, the activity is grounded in the Technological Pedagogical Content Knowledge (TPACK) framework, which integrates technology, pedagogy, and content as the foundation for developing teachers' competencies. This framework was selected because it has been shown to have a significant influence on teachers' ability to implement digital-based learning (Silvester et al., 2024). In its implementation, the TPACK framework was adapted into four workshop stages: understanding, observation-instruction, instructional practice, and reflection. These stages were designed to ensure that teachers not only acquire theoretical knowledge about AI but also gain hands-on experience in developing teaching modules, student worksheets, and AI-assisted assessment instruments (Dogan et al., 2025). This approach is consistent with findings from a literature review indicating that the integration of ChatGPT and AI technologies can support the improvement of digital literacy, enhance critical thinking skills, and assist teachers in developing teaching materials and formative assessments more efficiently (Rhomadoni et al., 2025; Wae et al., 2025).

Based on the foregoing discussion, this community service activity aims to enhance the competencies of Biology teachers affiliated with the MGMP of Private Senior High Schools in Gresik Regency in utilizing Artificial Intelligence (AI) to develop innovative, efficient, and locally contextualized teaching materials, learning media, and assessment instruments. Specifically, the activity is expected to equip teachers with the skills to develop AI-assisted instructional resources that align with the demands of the deep learning approach, while also encouraging the establishment of a sustainable repository of Biology learning media and assessment instruments that can be utilized by the MGMP.

The expected benefits extend beyond improving teachers' work efficiency to enhancing students' learning experiences through more interactive, contextualized, and individually responsive learning.

METHOD

The solution offered by the community service team to address the partner's challenges is mentoring on the utilization of Artificial Intelligence (AI) in developing Biology instructional resources. Through this mentoring program, Biology teachers affiliated with the MGMP of Private Senior High Schools in Gresik Regency are introduced to several AI applications that can accelerate and simplify the development of syllabi, lesson plans, teaching materials, student worksheets, and assessment instruments, while maintaining alignment with students' characteristics and the requirements of the Merdeka Curriculum.

The approach adopted in this activity is based on the Technological Pedagogical Content Knowledge (TPACK) framework and is implemented through a participatory workshop. This approach was selected because it enables teachers not only to acquire theoretical knowledge of technology but also to directly apply it within the pedagogical and Biology content contexts that they encounter in their daily teaching practices. The participants were Science/Biology teachers affiliated with the MGMP of Private Senior High Schools in Gresik Regency. The activity was conducted through the following four stages.

Understanding Stage; The community service team conducted brief interviews with participating teachers to identify their initial conditions and challenges in developing instructional resources. This was followed by a presentation delivered by the resource person based on the needs identified through the initial assessment.

Observation-Instruction Stage; Participants discussed the instructional resources they had previously used with the resource person. They were then introduced to the procedures for developing AI-assisted instructional resources and received initial instructions before proceeding to the practical stage.

Instructional Practice Stage; Participants were guided in developing instructional resources based on local potential, including syllabi and lesson plans, the formulation of learning indicators, the development of teaching materials, and the preparation of Student Activity Worksheets (LKPD). At this stage, participants were divided into small groups of 4–6 members to facilitate more intensive mentoring and guidance.

Reflection Stage; The partner organization, community service team, and resource person jointly evaluated the overall implementation of the activity, including challenges encountered, solutions implemented, and outputs produced by the participants.

Throughout the program, the Biology MGMP of Private Senior High Schools in Gresik Regency played an active role from the preparation stage through the follow-up stage. During preparation, the principals of partner schools coordinated with the program coordinator to determine the teachers who would participate. During implementation, the Head of the MGMP monitored teachers' participation and activities from the beginning to the end of the program. Monitoring and evaluation were also conducted as teachers independently completed the development of instructional resources at their respective schools, with intensive communication between participating teachers and the community service team whenever difficulties arose. As a follow-up, the community service team and the program coordinator coordinated with the partner schools to ensure the continued utilization of the outputs generated through the training. The activity was conducted on Saturday, May 18, 2024, at SMA Muhammadiyah 1 Gresik, and was attended by 30 Biology teachers affiliated with the local MGMP.

RESULT AND DISCUSSION

The community service activity entitled "Utilization of Artificial Intelligence (AI) in Developing Teaching Materials for the Gresik Regency Biology MGMP" was implemented through a practice-oriented training and mentoring approach. The activity aimed to enhance

Biology teachers' ability to apply Artificial Intelligence (AI) technology in developing teaching materials, learning media, and assessment instruments that are more efficient and responsive to the demands of 21st-century education. The target participants were Biology teachers affiliated with the Biology Subject Teachers' Forum (Musyawarah Guru Mata Pelajaran/MGMP) in Gresik Regency. The implementation of the activity was based on a training model developed in the community service program, consisting of four main stages: understanding, observation and instruction, practice, and reflection. This model provided participants with opportunities to master essential concepts while gaining hands-on experience in utilizing various AI platforms to develop learning materials (Jeon et al., 2024).

The first stage began with an opening session followed by a pretest to assess participants' initial knowledge of AI utilization in the learning process. The pretest served as a reference for the community service team to analyze participants' needs, enabling the training materials to be adjusted to the teachers' initial levels of competence. Participants were then introduced to the fundamental principles of Artificial Intelligence in education and its potential applications in designing Biology instructional instruments. After acquiring the essential knowledge, participants engaged in a practical session on developing AI-assisted Lesson Plans (RPP). During this phase, participants were introduced to various methods of using AI to create structured and relevant instructional content aligned with the learning outcomes of the Merdeka Curriculum.

As an application of AI in Biology education, participants received guidance on using iNaturalist as a tool for biodiversity education. They were trained to use the application to digitally identify various species of flora and fauna, which could subsequently be utilized as learning materials based on the local environment. This initiative demonstrated that AI can be used not only to generate instructional narratives but also to support field-based investigation through the automated identification of biological entities (Cotton & Cotton, 2026).

The subsequent training focused on using Quizizz AI to develop learning assessments. Participants practiced generating tests efficiently, creating engaging quizzes, and interpreting student learning outcomes using the AI features available on the platform. In addition to streamlining the assessment development process, the tool enabled teachers to create assessments encompassing a wider range of cognitive levels.

The training also included guidance on developing Genetics learning content with the assistance of AI. In this session, participants developed drafts of teaching materials in which AI was used to support content generation, concept visualization, and the clarification of abstract concepts. Participants were instructed to conduct scientific validation of all AI-generated outputs before incorporating them into classroom instruction to ensure the accuracy and quality of the content.

In addition to developing teaching materials, participants received training on designing assessment instruments using ChatGPT. They utilized AI to develop multiple-choice questions, essay questions, case studies, and questions targeting Higher Order Thinking Skills (HOTS). Throughout the training, participants were provided with examples of effective prompt formulation to ensure that AI-generated outputs were accurate, relevant, and aligned with the intended learning objectives.

As the final stage of the activity, a reflection and evaluation session was conducted with all participants. The reflection session aimed to identify the benefits of the program, challenges encountered during the practical sessions, and the potential applications of AI in teachers' daily instructional practices. Activity records indicated active participant engagement throughout the training, from the opening to the closing session, as demonstrated by their involvement in discussions and hands-on activities in developing instructional resources. The evaluation results showed that 90% of participants considered the activity highly relevant to the needs of Biology teachers, while the remaining 10% considered it relevant. Furthermore, 28 out of 30 participants successfully completed and submitted AI-assisted instructional resources, whereas two participants did not submit their assignments because they did not attend the activity to completion. These findings demonstrate a high level of participation and the effectiveness of the training in producing tangible outputs in the form of instructional resources that can be directly

implemented in schools. The outputs of the activity included not only improved participant competencies but also an AI-based instructional resource bank, teaching materials, assessment instruments, learning media, mass media publications, a documentation video, and a scientific article as part of the dissemination of the community service outcomes (Luo et al., 2025).



Figure 1. Documentation of the training on teaching materials development for Biology teachers of the Gresik MGMP

The training program on the utilization of Artificial Intelligence (AI) for developing teaching materials for Biology teachers affiliated with the MGMP in Gresik Regency demonstrated its effectiveness in improving teachers' pedagogical, technical, and professional competencies. This finding is consistent with Jagom et al. (2026), who reported that training focused on content enrichment and olympiad problem simulations increased teachers' mean scores from 32.33 to 85.67, with a high N-Gain category. Their findings suggest that hands-on practice-based approaches can be more effective than conventional lecture-only methods. In Biology education, teachers trained to utilize AI were able to develop HOTS-based questions and more systematically structured teaching materials, thereby making the teaching and learning process more meaningful and aligned with curricular demands. This finding is further supported by Palalas et al. (2026), who emphasized that the development of teaching modules incorporating contextual local potential can deepen teachers' understanding of curriculum and relevant instructional planning. Accordingly, the integration of technology into Biology teaching modules enables teachers to connect subject matter with phenomena in students' surrounding environments.

The TPACK framework served as a crucial foundation for this training program. Sulfanjanti et al. (2025) highlighted that TPACK-based learning modules assist prospective and practicing teachers in systematically integrating technology, pedagogy, and subject content. This finding is supported by Pradana et al. (2026), who mapped TPACK research patterns in Southeast Asia and found that technological components, particularly Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK), remain relatively underdeveloped and therefore require reinforcement through practice-based interventions. The program implemented in Gresik addressed this need by training teachers to use Quizizz AI for adaptive assessment, ChatGPT for generating instructional materials, and Canva AI for developing visual learning media. These results are consistent with Kurnia et al. (2026), who found that the TPACK-AI framework was effective in improving teachers' competencies across four major dimensions: conceptual understanding, technical skills, digital content creation, and pedagogical integration.

Beyond instructional aspects, the program also emphasized strengthening teachers' professional development through the production of scientific publications. Alimunddin et al. (2026) reported that training in the use of publication-support software, such as Mendeley and Turnitin, can increase teachers' confidence in preparing scientific articles. This finding is relevant to the Gresik program, which successfully produced a scientific article ready for submission to a community service journal. From an assessment perspective, digital training also contributed to improvements in the quality of learning evaluation. Syahrudin et al. (2026) reported significant improvements in teachers' understanding of assessment validity (from 23% to 91%), item difficulty (from 41% to 95%), and the use of interactive media (from 73% to 86%). Similarly, the Gresik program utilized Quizizz AI and Wordwall to support teachers in developing valid and relevant AI-assisted HOTS questions that were aligned with students' characteristics.

The emphasis on HOTS was further reinforced through support for numeracy assessment. Bhoke and Wea (2025) highlighted that training, simulation, and game-based activities can strengthen elementary school teachers' ability to design HOTS-oriented numeracy assessment instruments. This finding is consistent with the practices implemented in Gresik, where Biology teachers were trained to develop AI-assisted questions emphasizing analytical and synthesis skills, thereby making assessments more challenging and aligned with the standards of the Merdeka Curriculum. The program also influenced the psychosocial aspects of teachers. Sunarsih et al. (2026) demonstrated that technology-supported mentoring can improve teachers' mental well-being and professionalism in remote areas. Similarly, teachers participating in the Gresik program reported increased motivation and confidence in creating AI-assisted learning media, indicating a positive psychosocial impact that may support the sustainability of technology-integrated teaching practices.

Overall, the results of the training demonstrate that participants successfully produced AI-assisted instructional resources, including teaching modules, digital learning media, HOTS-based assessment instruments, and scientific publications. These findings are consistent with Kurnia et al. (2026), who emphasized the effectiveness of the TPACK-AI framework in improving teacher competencies across four key dimensions. Therefore, this community service program not only enhanced teachers' technical skills in utilizing AI but also strengthened their pedagogical capacity, psychosocial confidence, and professional development. The resulting instructional resources, digital assessments, scientific publication, and increased teacher motivation collectively demonstrate the program's success in addressing the practical needs of Biology teachers in Gresik Regency.

CONCLUSION

The training on the utilization of Artificial Intelligence (AI) for developing teaching materials for Biology teachers affiliated with the MGMP of Private Senior High Schools in Gresik Regency demonstrated a significant improvement in participants' pedagogical, technical, and professional competencies. Through the TPACK approach combined with various AI platforms,

such as ChatGPT, Quizizz AI, and iNaturalist, teachers were able not only to develop teaching modules, learning media, and Higher Order Thinking Skills (HOTS)-based assessment instruments more efficiently, but also to demonstrate increased motivation and confidence in integrating technology into their daily teaching practices.

The high level of perceived relevance, with 90% of participants rating the training as very relevant and 10% as relevant, along with the high task completion rate (28 out of 30 participants), indicates that a hands-on practice-based approach was effective in supporting teacher learning. The outputs of the program, including an AI-based instructional resource bank, mass media publications, a documentation video, and a scientific article, demonstrate that the program contributed not only to enhancing individual teacher capacity but also to strengthening the Biology MGMP of Gresik Regency as a sustainable professional learning community.

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