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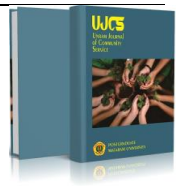

Strengthening Student Competencies in the Digital Era to Support the Sustainable Development Goals (SDGs) through a Guest Lecture on Artificial Intelligence, Augmented Reality, and STEM

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Abstract: The transformation of education in the digital era requires prospective teacher students to possess competencies in utilizing innovative learning technologies that are relevant to the needs of 21st-century education. This academic community service activity aimed to strengthen the competencies of students in the Undergraduate Physics Education Study Program, Faculty of Teacher Training and Education, University of Mataram, through the implementation of a guest lecture themed *Artificial Intelligence* (AI), *Augmented Reality* (AR), and STEM in physics learning. The activity was conducted on April 28, 2026, in a hybrid format involving two guest speakers. The implementation method consisted of three stages: preparation, implementation, and evaluation. The evaluation was conducted through a Google Form-based questionnaire distributed to participants to measure their responses regarding material content, speakers, implementation, benefits, and the impact of the activity on students' level of understanding. A total of 131 participants attended the activity, consisting of students from various semesters and alumni. The results showed that the majority of participants gave positive responses regarding the relevance of the materials, the competence of the speakers, the quality of implementation, and the benefits of the activity in improving learning motivation, academic insight, technological literacy, and readiness as prospective physics teachers in the digital era. In addition, participants perceived that the materials on AI, AR, and STEM integration provided contextual and applicable learning experiences. This activity was proven effective in strengthening the competencies of Physics Education students and contributing to the achievement of the *Sustainable Development Goals* (SDGs), particularly in quality education, while also supporting the implementation of the *Impactful Campus* program in higher education.

Keywords: Artificial Intelligence, Augmented Reality, STEM, SDGs.

Introduction

Digital transformation has brought significant changes across various aspects of life, including education. The advancement of technologies such as *Artificial Intelligence* (AI), *Augmented Reality* (AR), interactive digital media, and the *Science, Technology, Engineering, and Mathematics* (STEM) approach has created new opportunities to develop learning environments that are more adaptive, interactive, and student-centered. These changes require higher education institutions, particularly teacher education programs, to prepare graduates who not only master their academic disciplines but also possess digital literacy, critical thinking, creativity, collaboration, and the ability to integrate technology into the learning

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process (Mansour et al., 2025); (Tunc & Bagceci, 2021). Prospective physics teachers, as part of the future generation of educators, need to be equipped with relevant competencies to address the challenges of 21st-century education (Ouyang & Jiao, 2021); (Putra et al., 2021).

In the context of physics education, learning challenges have become increasingly complex because many physics concepts are abstract and require visualization, simulation, and contextual representation to facilitate student understanding. The utilization of technologies such as AI and AR provides significant opportunities to support the learning process through the development of digital teaching materials, interactive media, virtual simulations, and the visualization of physics concepts that are difficult to observe directly. In addition, the STEM approach has become a relevant strategy in physics learning because it integrates scientific concepts with technology, engineering, and mathematics, making learning more applicable and meaningful (Hwang, 2020); (Özdemir & Özçakır, 2026); (Retnowati et al., 2020).

On the other hand, strengthening the competencies of prospective teacher students is also aligned with the global agenda of the *Sustainable Development Goals* (SDGs), particularly Goal 4, namely *Quality Education*, which emphasizes the importance of inclusive, high-quality, and adaptive education. Higher education institutions have a strategic role in supporting the achievement of this goal through learning innovation, strengthening human resource capacity, and organizing academic activities that directly contribute to improving student quality. Mastery of AI-, AR-, and STEM-based learning technologies represents a tangible contribution to preparing prospective teachers who are capable of delivering high-quality and sustainable learning experiences (Yang, 2022); (Simon et al., 2025); (Astuti et al., 2021).

In addition to supporting the SDGs, innovative academic activities are also aligned with the spirit of the *Impactful Campus* program, which currently serves as a strategic direction for higher education development in Indonesia. The *Impactful Campus* program emphasizes that universities should not only function as centers for knowledge development but also generate tangible impacts for students, society, and the education sector. In the context of teacher education programs, the implementation of the *Impactful Campus* initiative can be realized through collaborative activities such as guest lectures, practitioner teaching, applied research, and academic community service that connect students with experts and practitioners. Through such activities, students gain learning experiences that are more contextual, up-to-date, and aligned with the needs of education in the digital era (Wong et al., 2020); (David & Jesús, 2025); (Altakahyneh & Abumusa, 2020).

As an implementation of academic community service that supports the SDGs and the spirit of the *Impactful Campus* program, the Undergraduate Physics Education Study Program, Faculty of Teacher Training and Education, University of Mataram, organized a guest lecture entitled *Artificial Intelligence (AI) and Augmented Reality Integrated with STEM in Physics Learning*. This activity featured two speakers from Universitas Mulawarman and UIN Mataram, both of whom have expertise in educational technology, digital media, and innovation in physics education. Through this activity, students gained insights into the utilization of AI, the development of AR-based teaching materials, the integration of STEM in learning, and the strengthening of pedagogical competencies in the digital era. Therefore, this activity is important to be analyzed as a form of academic community service that contributes to strengthening the competencies of physics education students in facing future educational challenges (Chiu & Chai, 2020); (Mirza et al., 2025); (Ardianti et al., 2020); (Hikmawati et al., 2020).

Method

This academic community service activity was conducted in the form of a guest lecture aimed at strengthening the competencies of students in the Undergraduate Physics Education Study Program, Faculty of Teacher Training and Education, University of Mataram, in facing learning challenges in the digital era. The activity was held on Tuesday, April 28, 2026, at the 3rd Floor Hall of Building D, Faculty of Teacher Training and Education, University of Mataram, involving lecturers and students of the Undergraduate Physics Education Study Program as participants. The implementation method adopted an interactive seminar approach in a hybrid format, combining offline and online learning. The main participants, consisting of lecturers and students, attended the activity directly at the venue, while other participants joined online via Zoom Meeting.

The implementation of the activity consisted of three stages: preparation, implementation, and evaluation. During the preparation stage, the organizing team conducted internal coordination within the study program, prepared the *Term of Reference* (TOR), selected the guest speakers, arranged the activity schedule, and prepared supporting facilities such as the venue, multimedia equipment, internet access, and the Zoom Meeting platform. In addition, the team also prepared an evaluation instrument in the form of a participant response questionnaire to measure students' perceptions regarding the benefits of the guest lecture.

During the implementation stage, the activity began with participant registration, followed by the official opening by faculty leaders, welcoming remarks from the study program coordinator, and presentations delivered by two guest speakers. The first speaker, Prof. Dr. Zeni Haryanto, M.Pd., delivered his presentation online via Zoom Meeting on the topic of developing *Augmented Reality*-based teaching materials integrated with STEM-SDGs and TPACK in physics learning. The second speaker, Prof. Dr. Bahtiar, M.Pd.Si., delivered his presentation offline at the venue on the topic of integrating *Artificial Intelligence* and digital media in physics learning to support 21st-century skills. Following the presentations, the activity continued with discussion and question-and-answer sessions to provide participants with opportunities to deepen their understanding of the topics presented.

The evaluation stage was conducted after the completion of the activity through the distribution of a Google Form-based questionnaire to student participants. The instrument was used to collect data related to participants' level of understanding, perceptions, satisfaction, and the impact of the activity on strengthening student competencies in educational technology. The collected data were analyzed using descriptive quantitative methods, supported by observational data obtained during the activity. The results of the analysis were then used to evaluate the effectiveness of the community service activity and served as the basis for preparing a scientific article to be published in a community service journal.

Result and Discussion

The guest lecture organized by the Undergraduate Physics Education Study Program, Faculty of Teacher Training and Education, University of Mataram, on Tuesday, April 28, 2026, was attended by 131 participants, consisting of active students from various semesters, alumni, and accompanying lecturers. This activity served as one of the efforts to strengthen students' academic competencies through exposure to materials related to *Artificial Intelligence* (AI), *Augmented Reality* (AR), and the STEM approach in physics learning. The participants' enthusiasm was evident from the registration process through the discussion sessions, both among those who attended directly at the venue and those who participated online via Zoom Meeting. Documentation of the guest lecture implementation is presented in Figure 1 and Figure 2.

Figure 1. Group photo with the guest speakers and lecturers

Figure 2. Group photo with students

Based on participant attendance records, it was found that the participants came from various academic semesters. Figure 3 shows that the participant distribution was dominated by 4th-semester students, with 64 participants (48.9%), followed by 6th-semester students with 29 participants (22.1%), and 2nd-semester students with 27 participants (20.6%). Meanwhile, participants from the 8th semester totaled 7 participants (5.3%), 14th semester students accounted for 2 participants (1.5%), and alumni also accounted for 2 participants (1.5%). This distribution indicates that the guest lecture not only attracted students from early and intermediate semesters but was also attended by final-year students and alumni who remain interested in developing competencies in educational technology.

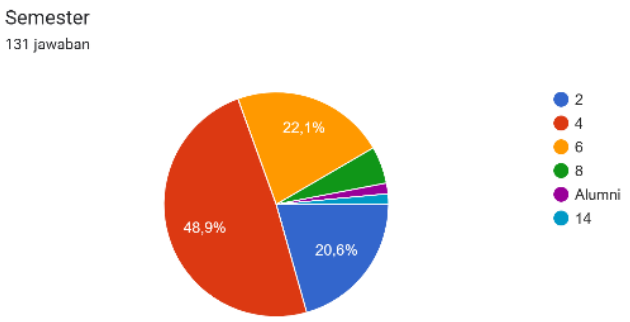

Figure 3. Participants' Semester Distribution

The dominance of participants from the 4th and 6th semesters indicates that students in the intermediate phase of their academic studies have a strong need for strengthening pedagogical competencies and technological literacy, particularly because at this stage they begin to engage more deeply with education-related courses, instructional media development, and teaching preparation. The participation of students from the early semesters also reflects an early awareness of the importance of mastering educational technology, while the involvement of final-year students and alumni indicates the need for continuous professional development in responding to the dynamic changes in education in the digital era. These findings demonstrate that the guest lecture had a broad reach and was relevant to students across different academic levels within the Undergraduate Physics Education Study Program.

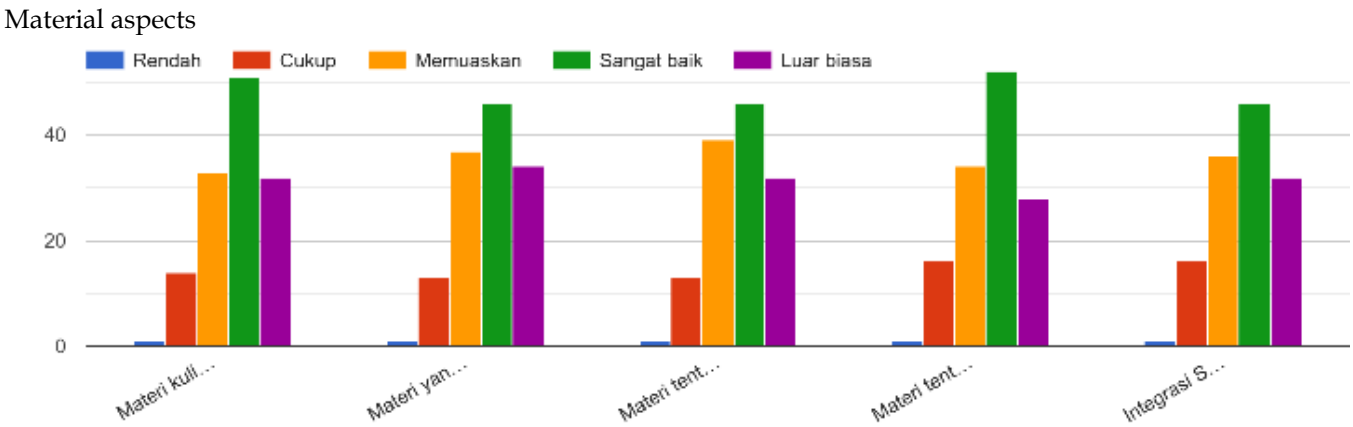

Figure 4. Material Aspect Evaluation

The evaluation results of the guest lecture activity indicate that this community service program had a positive impact on strengthening the competencies of students in the Undergraduate Physics Education Study Program in the digital era. Based on participants' responses to the material aspect (Figure 4), the majority of students stated that the materials presented were relevant to the needs of prospective physics teachers, particularly in addressing the challenges of 21st-century learning, which requires mastery of technology, pedagogy, and innovative instructional media development. The materials related to *Artificial Intelligence* (AI), *Augmented Reality* (AR), and STEM integration were perceived as enriching students' academic insights and providing new knowledge that had not been widely obtained through regular classroom learning (Alhebaishi & Stone, 2024); (Moser et al., 2026). These findings indicate that the guest lecture successfully provided contextual and up-to-date learning experiences aligned with the demands of modern education. This is consistent with the competencies required in the 21st century, where prospective teachers are expected to possess digital literacy, critical thinking skills, creativity, and adaptability to the advancement of educational technology (Zhai et al., 2021); (Balalle, 2025); (Permanasari et al., 2021).

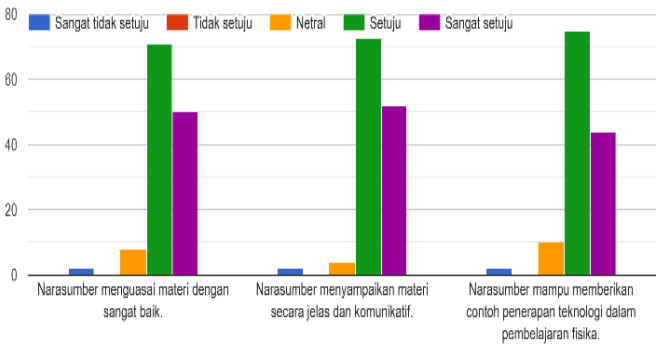

Figure 5. Speaker Aspect Evaluation

In the speaker aspect (Figure 5), participants gave positive evaluations regarding the speakers' mastery of the subject matter, their ability to communicate concepts clearly, and their capability to provide examples of technology implementation in physics learning. Prof. Dr. Zeni Haryanto, M.Pd. emphasized the development of *Augmented Reality*-based teaching materials integrated with STEM-SDGs and TPACK, enabling students to gain practical insights into how technology can be utilized to visualize abstract physics concepts. Meanwhile, Prof. Dr. Bahtiar, M.Pd.Si. provided practical perspectives on the integration of *Artificial Intelligence* and digital media in learning, helping students understand that AI technology can be applied in the development of teaching materials, assessment, and instructional

planning. The speakers' ability to connect theoretical concepts with real educational practices created more meaningful learning experiences and supported the development of students' pedagogical competencies.

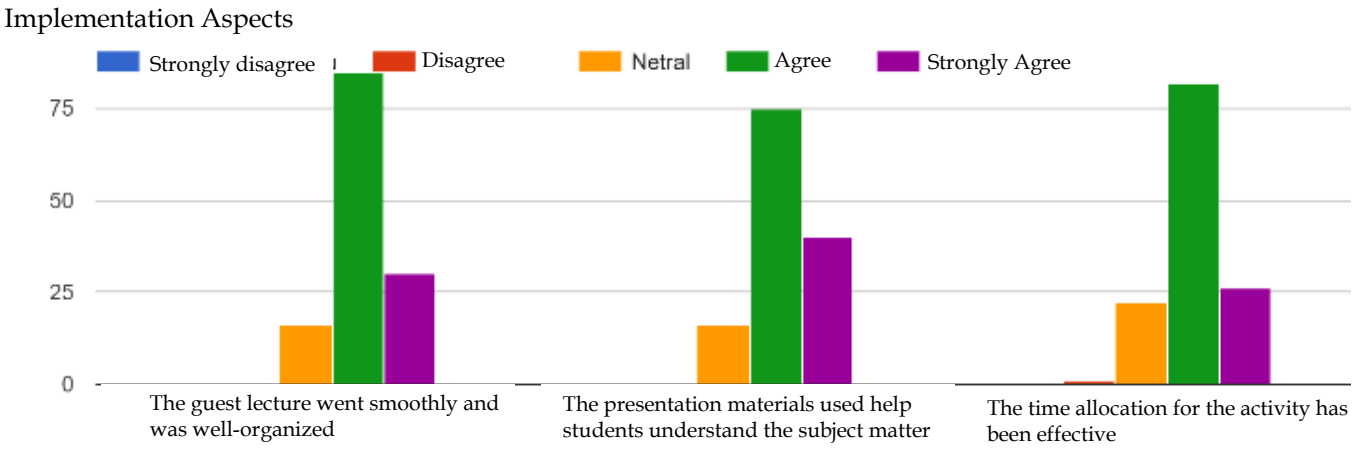

Figure 6. Implementation Aspect Evaluation

From the implementation aspect (Figure 6), the hybrid format of the activity demonstrated that the integration of offline and online learning could be carried out effectively with the support of appropriate presentation media. The presence of one speaker online via Zoom Meeting and another speaker onsite at the venue provided a more flexible academic experience and expanded participation access for attendees. However, based on participants' feedback, aspects related to time management and the duration of discussion sessions still need improvement to optimize interaction between participants and speakers. These findings indicate that the quality of academic activities is determined not only by the relevance of the materials and the expertise of the speakers, but also by the effectiveness of technical management, participant engagement, and the utilization of supporting learning media.

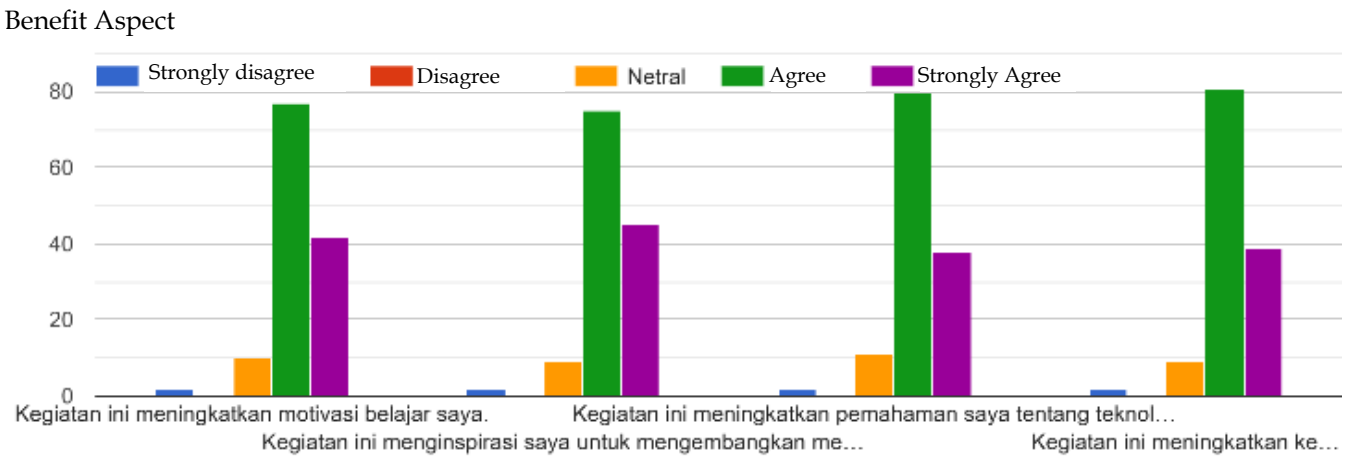

Figure 7. Benefit Aspect Evaluation

In the benefit aspect (Figure 7), the majority of participants stated that the guest lecture activity successfully increased their learning motivation, inspired them to develop physics learning media, and enhanced their understanding of 21st-century educational technology. In addition, the activity was also perceived to improve students' readiness as prospective physics teachers in the digital era. Participants' responses indicated that after attending the activity, their level of understanding of the discussed topics had improved, particularly regarding the application of *Artificial Intelligence* (AI), *Augmented Reality* (AR), and the STEM approach in the context of physics learning (Tedre et al., 2021). These findings demonstrate that the guest lecture not only facilitated knowledge transfer but also had a significant impact on

students' professional readiness. More broadly, this activity also supports the implementation of the *Sustainable Development Goals* (SDGs), particularly Goal 4: Quality Education, through strengthening the digital competencies of prospective educators, and is aligned with the spirit of the *Impactful Campus* program, which encourages higher education institutions to organize academic activities that generate tangible benefits for human resource development in education (Gligorea et al., 2023); (Yasir et al., 2025); (Aguilera & Ortiz-Revilla, 2021).

Based on the results of the participant response questionnaire after attending the guest lecture, the majority of participants gave positive feedback regarding the implementation of the activity (Figure 8). In general, participants perceived that this guest lecture provided substantial benefits, particularly in broadening their insights, knowledge, and new experiences that are not always obtained through regular classroom learning. Participants reported that the materials presented helped them better understand the application of *Artificial Intelligence* (AI), *Augmented Reality* (AR), and the STEM approach in physics learning in a more practical and contextual manner (Luan et al., 2020); (S. Zhang & Yao, 2025); (Oktavia & Ridlo, 2020).

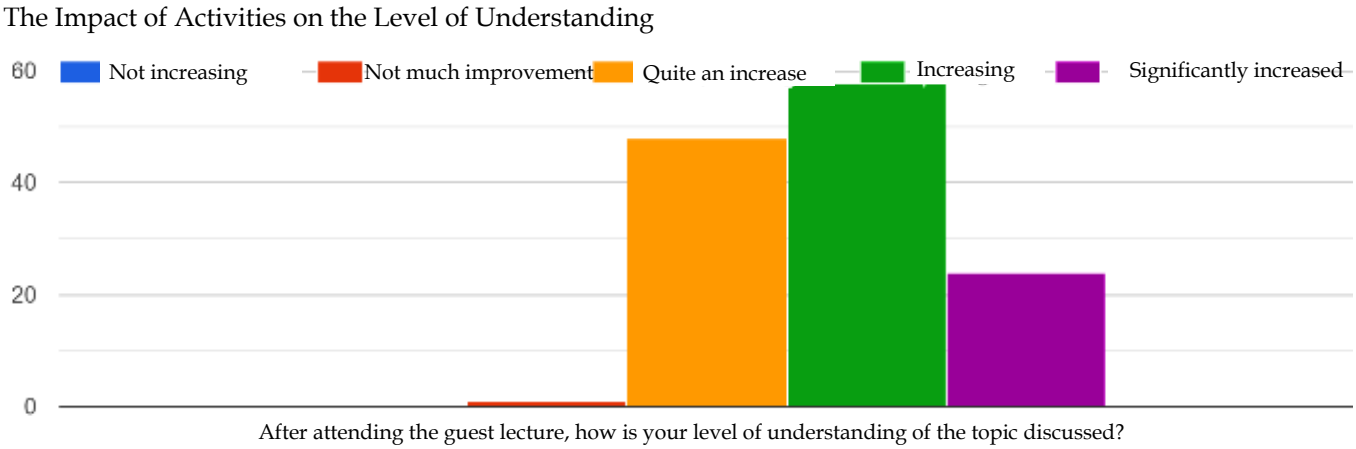

Figure 8. Impact of the Activity

In addition, participants considered the topics presented to be highly relevant to the needs of prospective teachers in the digital era and aligned with current developments in educational technology. The quality of material delivery by the speakers was also highly appreciated, as participants viewed the speakers as highly competent, communicative, interactive, and capable of explaining the materials clearly and understandably. Some participants also mentioned that the AR materials helped visualize abstract physics concepts into more concrete representations, while the AI materials provided new perspectives on the use of technology in developing teaching materials, learning media, assessment, and instructional planning. Beyond improving academic understanding, this activity was also perceived to enhance learning motivation, broaden perspectives, and strengthen students' readiness as prospective physics teachers who are adaptive to digital transformation in education. Overall, participants' responses indicate that the guest lecture made a positive contribution to strengthening the competencies of Physics Education students while supporting the implementation of quality education in line with the *Sustainable Development Goals* (SDGs) (Fahimirad, 2018); (Tian & Ironsi, 2025); (Wahono et al., 2020).

Based on the questionnaire results regarding suggestions for the improvement of future guest lectures, the majority of participants expected future activities to be designed to be more interactive, practical, and participatory. Many participants suggested adding hands-on practice sessions, technology demonstrations, short workshops, case studies, and technical tutorials related to the use of *Artificial Intelligence* (AI), *Augmented Reality* (AR), and digital media in physics learning, so that students would not only understand theoretical concepts but also be able to implement them directly. In addition, participants suggested extending the duration of discussion and question-and-answer sessions to optimize interaction between participants and speakers (Balcha & B, 2025); (Ateş & Polat, 2025); (Seage & Türegün, 2020).

From the technical implementation perspective, several participants provided feedback regarding punctuality, time efficiency, schedule adjustments to avoid conflicts with other lectures, and improvements in supporting facilities such as audio quality, internet connectivity, and the provision of learning materials or recorded sessions after the event. Some participants also expressed the expectation that future activities would involve more diverse speakers, including industry

practitioners, academics from other universities, and even international experts, in order to broaden students' perspectives on the development of educational technology. Overall, participant feedback indicates that the guest lecture provided a positive learning experience, and future development should place greater emphasis on practice-based learning, collaboration, and the strengthening of technology implementation in physics education (Chen & Chen, 2020); (R. Zhang et al., 2025); (Kong & Matore, 2022).

Conclusion

The academic community service activity conducted through the guest lecture organized by the Undergraduate Physics Education Study Program, Faculty of Teacher Training and Education, University of Mataram, made a positive contribution to strengthening student competencies in the digital era. This activity, which featured two guest speakers, successfully provided students with new insights regarding the utilization of *Artificial Intelligence* (AI), *Augmented Reality* (AR), and STEM integration in physics learning. Based on the evaluation results of 131 participants, students gave highly positive responses regarding the material content, speakers, implementation, and overall benefits of the activity. The materials presented were considered relevant to the needs of prospective physics teachers, enriched students' academic insights, enhanced their understanding of 21st-century learning technologies, and inspired them to develop more innovative learning media.

In addition to improving technological literacy, this activity also had a positive impact on increasing students' learning motivation and their readiness as prospective physics teachers who are adaptive to the advancement of digital education. The hybrid implementation of the activity expanded participation access and provided a more flexible learning experience for participants. Overall, this guest lecture proved to be effective as a form of academic community service in supporting the strengthening of Physics Education students' competencies, while also contributing to the achievement of the *Sustainable Development Goals* (SDGs), particularly in the area of quality education, and supporting the implementation of the *Impactful Campus* program within higher education institutions.

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