

Strengthening Indonesian Language Teachers' Pedagogical Competencies in the Transformation of 3D Pop-Up Book Teaching Materials Integrated with Augmented Reality

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Abstract. The Indonesian Language teacher pedagogical competence strengthening program in Semarang Regency Junior High Schools integrates teaching material innovation in the form of 3D pop-up books with Augmented Reality (AR) technology. The program began with identifying the needs of teachers and students through surveys and interviews, which then served as the basis for developing 3D pop-up books and AR applications in accordance with the national curriculum. Teachers are actively involved through intensive training to master technical and pedagogical aspects, so they are ready to implement them in the classroom. The application of this media enriches learning strategies by providing interactive and contextual experiences. Teachers can guide students in understanding the material through 3D visualization and AR interaction, thereby increasing engagement and learning outcomes. Periodic evaluations show the program's effectiveness in strengthening teachers' competencies in utilizing information technology. Additionally, the program designs advanced training and community forums to enhance collaboration and facilitate the sharing of best practices among educators. With a sustainable approach, this program not only improves the quality of Indonesian language learning but also fosters awareness of the importance of integrating digital technology into education. This innovation has the potential to become a widely adopted model for the education community to address the challenges of the digital age.

Keywords: Pedagogical Competence; Indonesian Language Teacher; 3D Teaching Materials; Augmented Reality

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INTRODUCTION

As technology advances and the need for more innovative education grows, Indonesian language teachers in junior high schools in Semarang Regency are expected to utilize more modern and engaging teaching materials for their students. On the other hand, current technological developments are considered closely related to learning needs within the education system (Hendriyani Y, et al., 2019). Technological advancements can provide engaging learning materials (Hasanudin, C; et al., 2023) and effectively support the learning process (Hasanudin, C; et al., 2022). However, Indonesian language teachers in junior high schools in Semarang Regency tend to find it difficult to find

and develop innovative teaching materials that meet the needs of students and the existing curriculum. Therefore, it is important to strengthen teachers' pedagogical competence in using innovative teaching materials to improve the quality of Indonesian language learning in junior high school. One potential innovative teaching material is 3D teaching material in the form of a pop-up book integrated with augmented reality to improve Indonesian language learning outcomes. With the integration of augmented reality, 3D pop-up books can provide a more interactive and engaging learning experience for students. In addition, 3D pop-up book materials can be used to improve students' visual abilities, imagination, and creativity (WuPF, 2018), making it easier for educators to achieve the expected competencies

(Sahara, 2022).

Therefore, Indonesian language teachers in junior high schools in Semarang Regency need to be strengthened in the use of this teaching material to improve the quality of learning.

Strengthening the pedagogical competence of junior high school teachers in Semarang Regency in using 3D teaching materials in the form of augmented reality-integrated pop-up books is in line with the era of the industrial revolution 4.0, where the use of technology in education is becoming increasingly important. Therefore, activities to strengthen teachers' pedagogical competence in producing innovative teaching materials such as 3D pop-up books integrated with augmented reality can help improve the quality of education in Central Java and prepare students to face future challenges. This is because 3D pop-up books integrated with augmented reality have been proven effective in consistently increasing student motivation (Ulfa MS et al., 2020) and learning achievement (Febri, NR et al., 2021). Strengthening the pedagogical competence of junior high school teachers in Semarang Regency in preparing teaching materials begins with creating a pop-up book design. This pop-up book will be designed to present Indonesian language concepts visually appealingly and interactively, utilizing 3D pop-up elements to enhance the learning experience. This pop-up book can help students better understand and retain information, making the learning process more enjoyable and effective.

To further enhance the learning experience, augmented reality technology will be integrated into the pop-up book. Augmented reality allows virtual objects to be overlaid onto the real world, creating an immersive and interactive learning environment. This integration will enable students to interact with the pop-up book in a completely new way, providing a more engaging and memorable learning experience. The use of augmented reality technology can also help increase students' motivation and interest in learning (Ong SW et al., 2022), thus having great potential to support a more optimal teaching and learning process (Akçayır Met al., 2017).

This pedagogical competence can focus on various aspects of teaching, including the use of innovative teaching materials and technology. For example, this type of training can be conducted to train teachers on developing pop-up book teaching materials integrated with augmented reality (AR) technology. Through this training, teachers can expand their knowledge and skills, enabling

them to create engaging and interactive learning experiences for their students.

The implementation and integration of this 3D pop-up book teaching material into the Indonesian language curriculum can also contribute to strengthening teachers' pedagogical competence in Semarang Regency. By incorporating these materials into lesson plans, teachers can provide their students with a more in-depth and interactive learning experience. This approach can help increase student engagement and motivation, leading to improved learning outcomes. Additionally, integrating these materials into the curriculum can help teachers keep pace with changing student needs and the evolving educational landscape.

On the other hand, activities to strengthen educators' pedagogical competence regarding the implementation and integration of 3D pop-up book teaching materials have proven to have a positive impact on both teachers and students. This is evidenced by research (Hasanudin C, et al., 2020), which revealed that activities to strengthen pedagogical competence in creating 3D pop-up book teaching materials were able to increase educators' knowledge and skills in designing creative and innovative teaching materials. Additionally, research (Widyaningrum HK, et al., 2021) indicates that activities to strengthen pedagogical competence regarding 3D pop-up book teaching materials can help educators deliver the desired material with an attractive visual presentation to increase students' interest in learning.

Furthermore, positive results were also obtained in research on mentoring activities for creating 3D pop-up book teaching materials. The research revealed that training activities for creating 3D pop-up book teaching materials can help educators meet the competency demands of using learning materials in the era of the Industrial Revolution 4.0. The research (Astuti AP, et al., 2020) also revealed that 3D pop-up book teaching materials are considered very suitable to assist teachers in teaching because they can attract students' interest in learning activities. However, the research has not been able to be conducted comprehensively or thoroughly, so the researcher suggests that future researchers further develop the 3D pop-up book media more completely and attractively.

Based on the results of previous studies, it is important to conduct more comprehensive training in developing 3D pop-up books in a more

engaging way, such as developing 3D pop-up books integrated with augmented reality.

Therefore, comprehensive training was provided to Indonesian language teachers at Semarang Regency Junior High Schools so that they would have professional development to create 3D pop-up teaching materials integrated with augmented reality. This training equips teachers with the necessary skills and knowledge, prepared to effectively use these innovative teaching materials in their classrooms. Creating a supportive and collaborative environment among teachers is crucial for empowering them in the transformation of teaching materials. Teachers should be encouraged to share their experiences, ideas, and best practices with their colleagues. This can be done through regular meetings, professional learning communities, or online platforms. By sharing knowledge and collaborating with each other, teachers can learn from each other's successes and challenges, leading to continuous improvement in their teaching practices.

To create 3D pop-up book teaching materials integrated with augmented reality, teachers can design interactive activities that allow students to interact with virtual objects or characters in the 3D pop-up book teaching materials using augmented reality. By encouraging creativity and innovation, teachers can create unique and engaging learning experiences.

METHODS

Empowering Indonesian language teachers in Semarang Regency involves a series of planned and technology-based steps. The process begins with identifying teacher needs, followed by designing an interactive 3D pop-up book and developing an AR application to enhance the learning experience. Next, teachers were involved in intensive workshops to improve their understanding of this new technology. After that, the first implementation was carried out in several classes as a trial, while continuously gathering feedback from teachers and students.

Evaluation is conducted to measure the effectiveness of learning, focusing on teacher performance and student learning outcomes. The evaluation results are used to improve teaching content and methods, creating a cycle of continuous improvement. It is also important to

disseminate these learning outcomes to surrounding areas through seminars and workshops, contributing to the improvement of the quality of Indonesian language education in Semarang Regency. Thus, the implementation of this science and technology is expected to empower teachers, improve learning, and stimulate educational innovation at the local level. The following steps for implementing the community service activity can be seen in the following

- 1) Identify teacher needs, data collection on the level of technological skills and the development needs of Indonesian language teachers.
- 2) Accompaniment, implementation of intensive workshops and training for Indonesian language teachers to understand and create 3D pop-up books integrated with augmented reality.
- 3) In-class simulation, implementing the first phase in several classes as a trial. Gathering feedback from teachers and students for further improvements.
- 4) Evaluation and improvement, evaluating the effectiveness of learning using teacher performance indicators and student learning outcomes. Improving content and methods based on evaluation results.
- 5) Dissemination of results, organizing seminars and workshops for Indonesian language teachers in the Semarang district to share experiences and learning outcomes.

RESULTS AND DISCUSSION

Identifying Teacher Needs

The team collected data on the level of technology skills and the development needs of Indonesian language teachers. The activity will be held in person from June 1st to 31st, 2025, by the MGMP team. The identification results show that most teachers have a high interest in utilizing innovative learning media, but their technical skills in integrating augmented reality-based technology are still limited.

Based on the results of initial observations and data collection during the Teacher Needs Identification stage, several facts were found that underscore the need to implement the activity of Strengthening the Pedagogical Competencies of Indonesian Language Teachers at Semarang

Regency Middle Schools in the Transformation of 3D Pop-up Book Teaching Materials Integrated with Augmented Reality:

Curriculum Demands and Technological Developments

The Merdeka Curriculum and national education policies encourage teachers to create interactive, contextual learning that utilizes digital technology. However, most Indonesian language teachers in the Semarang Regency area still use conventional media such as textbooks and blackboards, so learning interaction is not yet optimal.

Limitations in Teachers' Technological Competence

Initial survey results indicate that although 80% of teachers own laptops or smartphones, only about 25% have ever utilized Augmented Reality (AR)-based technology in their teaching. This low level of technical skills makes it difficult to fully implement learning innovations.

The Need for Innovative Learning Media

Teachers expressed the need for media that could both capture students' interest and facilitate understanding of Indonesian language material, which is often considered abstract, such as text analysis, linguistic elements, and literary appreciation. The AR-integrated 3D pop-up book is considered potentially suitable for bridging this need.

Characteristics of Generation Z Students

Current junior high school students are very familiar with digital and interactive visual technology. This requires teachers to adapt to students' learning styles, which are more responsive to visual content, animations, and direct interaction through digital devices.

Lack of Continuous Training and Mentoring

Some teachers have attended training on creating learning media, but the training was general and did not focus on integrating the latest technologies. The lack of ongoing support makes it difficult for teachers to implement new skills in the classroom.

Based on these findings, expanding this service activity to a national scale is a highly relevant strategic step because it can address the challenges of improving teachers' pedagogical competence in various regions while also broadening the positive impact of technology-based learning innovations.

This activity provides knowledge transfer and technical skills related to the development of Augmented Reality (AR)-based 3D Pop-up Books, which teachers had not previously mastered. In addition, this program is also able to meet teachers' need for creative learning media that aligns with the characteristics of digital generation students, supports the implementation of the Merdeka Curriculum through project-based and technology-based learning, and increases teachers' confidence in utilizing technology as part of their ongoing pedagogical competence.

Mentoring

The mentoring activity was conducted through intensive workshops and training aimed at equipping teachers with an understanding of the concepts, techniques, and procedures for creating 3D pop-up books integrated with augmented reality (AR). The activity was conducted online via the Zoom platform, in line with the expansion of the target audience to a national scale. This activity features two speakers, namely Dr. Cahyo Hasanudin, M.Pd. (IKIP PGRI Bojonegoro), and Prof. Dr. Ida Zulaeha, M.Hum. (State University of Semarang), as stated in the activity leaflet.

The leaflet is titled "Penguatan Pedagogik Guru Bahasa Indonesia: Bahan Ajar 3D Terintegrasi AR" and features the UNNES logo. It lists three speakers: Dr. Cahyo Hasanudin, M.Pd. (Dosen Pendidikan Bahasa dan Sastra Indonesia IKIP PGRI Bojonegoro), Prof. Dr. Ida Zulaeha, M.Hum. (Guru Besar Pendidikan Bahasa dan Sastra Indonesia Universitas Negeri Semarang), and Zullyani, S.Pd., M.Pd. (Dosen Pendidikan Bahasa dan Sastra Indonesia Universitas Negeri Semarang). The event details are: Pendaftaran: mpg@ibt.yuliana@unnes.ac.id; Pelaksanaan: SELASA 8 Juli 2025, 09.00 WIB via zoom; Benefit: Sertifikat 4.3P and Ilmu Yang Bermartabat; Kontak: +62 821-3180-4531. A fourth speaker, Henaldi Satrio, M.Pd., is also mentioned at the bottom.

Figure 1. Activity Leaflet

Participants showed high enthusiasm, as evidenced by the number of attendees on the attendance list, which totaled 552 registrants, as shown on the attendance list in the appendix. The activity will be held on Tuesday, July 8, 2025, online via the Zoom platform starting at 09:00 WIB. This training will be attended by Indonesian language teachers from various regions in Indonesia, ranging from junior high to high school levels, with a large number of participants filling the virtual meeting room. The activity is divided into two main sessions. The first session focuses on strengthening teachers' pedagogical skills and is presented by Prof. Dr. Ida Zulaeha, M.Hum., an expert in Indonesian language and literature education from Semarang State University. In this session, participants are invited to understand pedagogical concepts and strategies relevant to the demands of 21st-century learning, including how to effectively integrate technology into the learning process. The second session discussed the technical and practical aspects of creating 3D pop-up books integrated with augmented reality (AR), led by Dr. Cahyo Hasanudin, M.Pd., from IKIP PGRI Bojonegoro. Participants received step-by-step explanations, from design planning and pop-up component creation to the integration of AR elements.

From the opening session to the end, participant interaction was very active. They utilized the chat feature to ask questions, provide feedback, and share ideas. During the discussion session, participants enthusiastically asked direct questions related to the challenges they faced in the classroom, shared experiences, and discussed the potential for developing creative learning media. The training atmosphere became dynamic, warm, and collaborative, making the knowledge transfer process effective despite being conducted online. Here is the activity documentation.

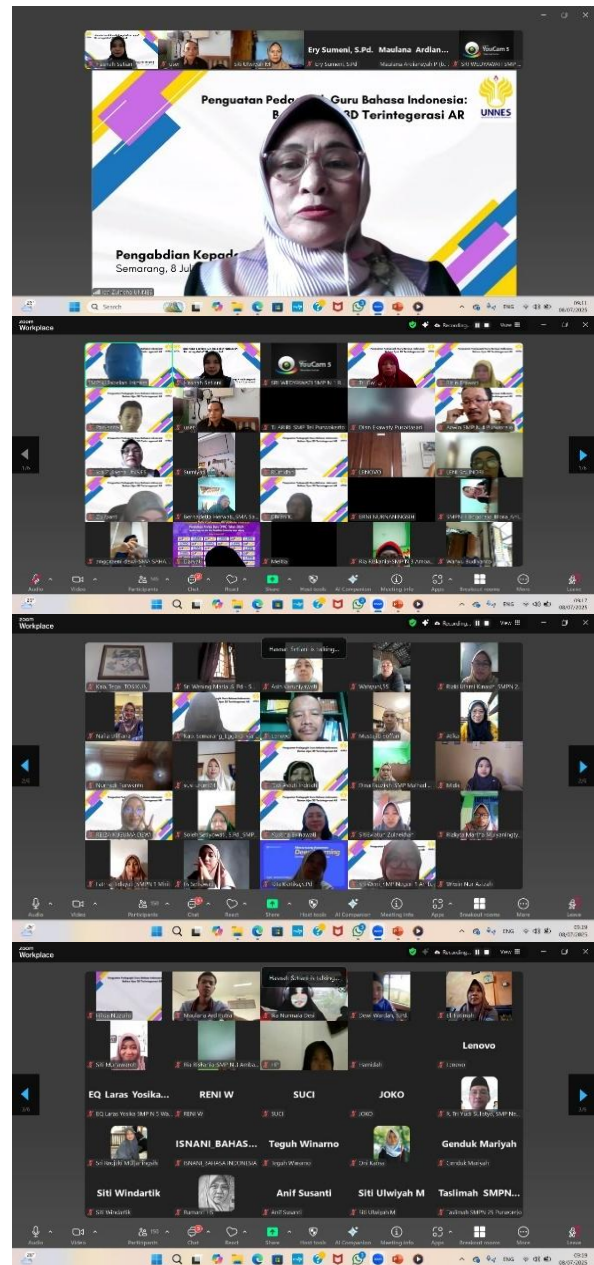


Figure 2. Activities

Classroom Simulation

Initial implementation was carried out in several pilot classes at partner junior high schools that had been determined during the planning phase. Teachers who previously participated in intensive training were given the opportunity to directly practice using the Augmented Reality (AR) integrated 3D pop-up book media in Indonesian language learning. The selected material is adapted to the current curriculum, including descriptive texts, folklore texts, and the analysis of linguistic elements.

The simulation process will be carried out from July 21st to August 1st, 2025, by teachers at each school. The simulation activity began with the teacher preparing the necessary equipment, such as a 3D pop-up book equipped with AR codes, devices or tablets for scanning, and installed AR support applications. The teacher then started the lesson with a brief explanation of the objectives and activity flow, followed by a demonstration of how to use the media. Students are allowed to scan the Pop-up Book pages to view 3D animations, interactive objects, or supporting videos that appear through the AR application. During the simulation, student engagement was very high. They seemed enthusiastic about exploring every page of the pop-up book, asking questions, and discussing the information they found with their classmates. This media encourages students to be more focused and motivated in understanding the material, as learning becomes more contextual and visual. Additionally, the two-way interaction between teachers and students increased, as evidenced by the large number of students actively answering questions and providing opinions.

Feedback collected through questionnaires and brief interviews indicates that the majority of students find learning with AR-based 3D pop-up books more engaging than conventional methods. Students said they found it easier to understand the material because it was presented visually and interactively. Some students even proposed that this media be used regularly in Indonesian language learning as well as other subjects. This result serves as an important basis for improving media design and teaching methods before wider implementation.

Evaluation and Improvement

The evaluation activity was conducted offline on August 5, 2025. Below is documentation of the evaluation activity.



Figure 3. Evaluation activities

The activity evaluation is conducted comprehensively using two main indicators: (1) teacher performance indicators and (2) student learning outcomes.

Teacher Performance Evaluation

Teacher performance evaluation is conducted thru observation during the learning process, teaching skills assessment sheets, and post-implementation interviews. The aspects evaluated include the teacher's ability to:

- 1) Design a 3D Pop-up Book-based learning scenario integrated with Augmented Reality (AR)
- 2) Operate AR devices and applications smoothly
 - o Manage the class interactively during media use
- 3) Integrate media with varied teaching methods (discussion, question and answer, student presentations)

The evaluation results show an improvement in teachers' skills in utilizing learning technology. Before the training, only a small percentage of teachers were able to operate AR-based media independently, but after mentoring, over 85% of teachers were able to implement it without significant technical obstacles.

Evaluating Student Learning Outcomes

Student learning outcomes are measured thru formative tests, observation of learning behavior, and student satisfaction questionnaires. The indicators used include:

- 1) Level of understanding of Indonesian language material (measured by formative test scores)
- 2) Active participation during learning (frequency of asking questions, answering, and giving opinions)

- 3) Enthusiasm and motivation to learn (measured by responses on questionnaires)

The data show an increase in students' average formative test scores of 15–20% compared to conventional learning. Additionally, active student participation significantly increased; classes that were initially passive became more interactive with many students engaging in discussions and media exploration.

Media Design Adjustments

Based on feedback from teachers and students, several adjustments were made to the design of the 3D Pop-up Book media, including:

- 1) Simplification of text and illustrations for material intended for students with low literacy skills
- 2) Addition of AR codes to sections that previously only displayed static images
- 3) Adjustment of colors and font sizes to be more user-friendly for students with mild visual impairments

This evaluation proves that the service activity not only improves teachers' pedagogical competence but also has a real impact on students' motivation and learning achievement. The positive changes in learning interactivity are a strong indicator of the program's success.

Dissemination of Results

The results dissemination activity was carried out as the final stage of the service program with the aim of disseminating the knowledge, skills, and best practices that were acquired during the training and implementation of the Augmented Reality (AR) integrated 3D Pop-up Book media. Dissemination was carried out through seminars and workshops attended by Indonesian language teachers from various schools in the Semarang Regency area, from both junior high and high school levels.

The activity was conducted in person on August 12, 2025. The event began with a presentation of activity results by the implementing team, which included a summary of the training process, classroom implementation, teacher performance evaluation results, and student learning achievements. Subsequently, several participating teachers were asked to share their classroom practice experiences, including learning management strategies, student responses, and technical obstacles encountered. Various challenges that arose, such as device limitations or adapting materials for students with

diverse abilities, were also openly discussed. Here is the documentation of the dissemination activity. This sharing session became a platform for active discussion, where other participants provided input and ideas for further development. Some teachers even showcased 3D pop-up book creations that they modified to suit the characteristics of students in their respective schools. From that discussion, the initiative was born to form a community of teachers developing technology-based learning media, committed to sustainable collaboration and resource sharing.

Through this dissemination activity, the program's impact is not only felt by partner schools but also extends to other schools in Semarang Regency. This opens up opportunities for the development of innovative learning media on a wider scale, while also strengthening the professional network of Indonesian language teachers in facing the challenges of 21st-century learning.



Figure 4. Dissemination activities

This program also successfully fostered a collaborative ecosystem among teachers. Through the dissemination stage, a community of media development teachers was born in Semarang Regency, actively sharing experiences, modifying

content, and designing implementation strategies. The presence of this community creates a multiplier effect that spreads to other schools, thus broadening the program's impact. Although challenges are encountered in practice, such as limitations in device availability and preparation time, creative solutions can be found through rotating device loans and collaboration among teaching teams. proves that limited resources are not the main obstacle if there is a collective commitment to supporting learning innovation. Overall, this program successfully shifted the paradigm of Indonesian language learning from a conventional to a digital approach, while also strengthening teachers' pedagogical competencies to meet the challenges of the Industrial Revolution 4.0 era.

CONCLUSION

Based on the results of the community service program "Strengthening the Pedagogical Competencies of Indonesian Language Teachers in Semarang Regency in the Transformation of 3D Pop-up Book Teaching Materials Integrated with Augmented Reality," it can be concluded that this program has a significant impact on improving teacher competence. Intensive training and mentoring have proven successful in improving teachers' skills in developing innovative teaching materials. As many as 85% of participants were able to independently design, modify, and implement 3D pop-up books based on Augmented Reality (AR) in the classroom. This shows that the hands-on training approach is effective in addressing the technology competency gap among teachers. Additionally, the integration of technology in learning also improves the quality of the teaching and learning process. The application of 3D+AR pop-up books can create Indonesian language learning that is more interactive, contextual, and motivating for students. The evaluation results show an increase in student participation to 90% and a 15-20% increase in formative test scores. This learning media has proven effective in transforming abstract material, such as literary text analysis, into a deeper visual learning experience.

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