

Optimizing the Role of Teachers and Students in the Digital Era in Facing VUCA Challenges

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ABSTRACT

In the rapidly developing digital era, technologies such as Artificial Intelligence (AI), Blockchain, Internet of Things (IoT), Augmented Reality (AR), Virtual Reality (VR), and Artificial Intelligence of Things (IoT) are becoming an integral part of education. The role of teachers and students needs to be adapted to utilize this technology effectively in facing the challenges of VUCA (Volatility, Uncertainty, Complexity, Ambiguity). This community service aims to identify strategies that can be implemented by teachers and students to utilize digital technology, as well as explore its impact and benefits in education. In addition, this community service will also examine how this technology can help reduce uncertainty and complexity in a changing educational environment. The evaluation results showed excellent achievements with high scores for conceptual understanding and overall benefits, confirming that this activity provides a solid foundation for developing education responsive to the demands of the times, especially in the current VUCA era.

Keywords
Digital Technology
Empowerment
Society 5.0
VUCA

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Introduction

Digital technology has changed how we communicate, work, and learn [1], [2]. Education, as one of the main pillars of human resource development, has also undergone significant transformation due to the development of digital technology [3]. Advanced technologies such as Artificial Intelligence (AI), Blockchain, Internet of Things (IoT), Augmented Reality (AR), Virtual Reality (VR), and Artificial Intelligence of Things (AIoT) are starting to be adopted in the learning process to improve the efficiency and effectiveness of education [4], [5], [6].

In the context of education, digital technology is not just a tool, but also a major driver in creating a more dynamic and interactive learning environment [7]. [8]revealed that teachers and students are required to adapt quickly to these changes. Teachers no longer only act as material deliverers, but also as facilitators and guides who help students explore and utilize technology to achieve learning goals. On the other hand, [9]said that currently students are required to be more proactive and independent in accessing information and knowledge through digital technology.

However, amidst the rapid development of technology, the world is also faced with challenges represented by the acronym VUCA, namely Volatility, Uncertainty, Complexity, and Ambiguity [10], [11]. VUCA describes environmental conditions that are full of rapid, uncertain, complex, and ambiguous changes. In the context of education, VUCA affects the way teachers and students interact with technology and how they overcome the challenges that arise [12], [13].

Volatility describes rapid and unpredictable changes in the educational environment. Digital technology continues to develop at an incredible pace, and innovations are constantly emerging. This requires teachers and students to always be ready to adapt to the changes that occur [14]. AI, for example, provides advanced data analysis capabilities and personalized learning but also requires teachers to understand how algorithms work and the ethics of using data [15]. On the other hand, Blockchain offers solutions for data security and transparency in the education system. This technology can be used to store students' academic records safely and transparently [16], [17]. However, the adoption of Blockchain technology requires a deep understanding of how it works and its legal implications. Teachers need to continue to improve their competence in the field of technology to take full advantage of this technology's potential.

Uncertainty is a condition in which the outcome of an event or development cannot be predicted accurately. In education, uncertainty arises from a variety of sources, such as changes in education policy, unexpected technological developments, and socioeconomic dynamics that affect access to education [18]. The Internet of Things (IoT) and AIoT can provide solutions by providing real-time data and analytics that can help in more informed decision-making [19], [20]. However, uncertainty remains, especially in terms of data security and privacy. Teachers and learners need to develop adaptive skills to deal with this uncertainty. Critical thinking skills, problem-solving, and the ability to learn throughout life are becoming increasingly important

[21]. Teachers need to guide learners in developing these skills so that they are prepared for the uncertainty and continuous change in the educational and work environments of the future [22].

Complexity in education arises from various factors that are interrelated and influence each other. Digital technology brings its complexity with various platforms, applications, and tools available for learning. AR and [23]*VR*, for example, offer immersive and interactive learning experiences, but also require technical skills and knowledge of effective learning design [3]. The use of these technologies in learning requires a holistic approach, where teachers need to consider pedagogical, technical, and ethical aspects. Complexity also arises from the need to integrate technology with existing curricula, as well as ensuring that all learners have equal access to technology. In dealing with this complexity, collaboration between teachers, learners, and other stakeholders is key to creating an inclusive and effective learning environment. [24], [25], [26].

Ambiguity refers to a situation where the available information is insufficient to make a clear decision. In education, ambiguity arises when multiple methods or tools can be used to achieve the same goal, but none of them is considered the most correct or effective [27]. AI and AIoT technologies can provide data-driven recommendations, but the final decision still requires human judgment [28]. Teachers need to develop the ability to work in ambiguous conditions, relying on intuition, experience, and collaboration with colleagues. Project-based learning and classroom action research can be effective approaches to addressing ambiguity, where teachers and learners work together to explore solutions and make informed decisions.

The purpose of this service is to empower teachers and students in utilizing digital technology, including Artificial Intelligence (AI), Blockchain, Internet of Things (IoT), Augmented Reality (AR), Virtual Reality (VR), and Artificial Intelligence of Things (AIoT), as an effective learning tool in the digital era. This service aims to improve teacher competence in integrating these technologies into the curriculum and teaching methods, as well as to develop student skills so that they can face VUCA (Volatility, Uncertainty, Complexity, Ambiguity) challenges more adaptively and proactively. Thus, it is hoped that a more dynamic, inclusive, and innovative educational environment can be created, which can prepare students for a future full of change and uncertainty.

Material and Methods

This service follows a flow consisting of three main stages, namely the preparation stage, the implementation stage, and the evaluation stage, all of which are designed to optimize the role of teachers and students in the digital era by utilizing technologies such as AI, Blockchain, IoT, AR, VR, and AIoT, as well as overcoming the challenges represented by the VUCA concept. The complete presentation is in Fig. 1.

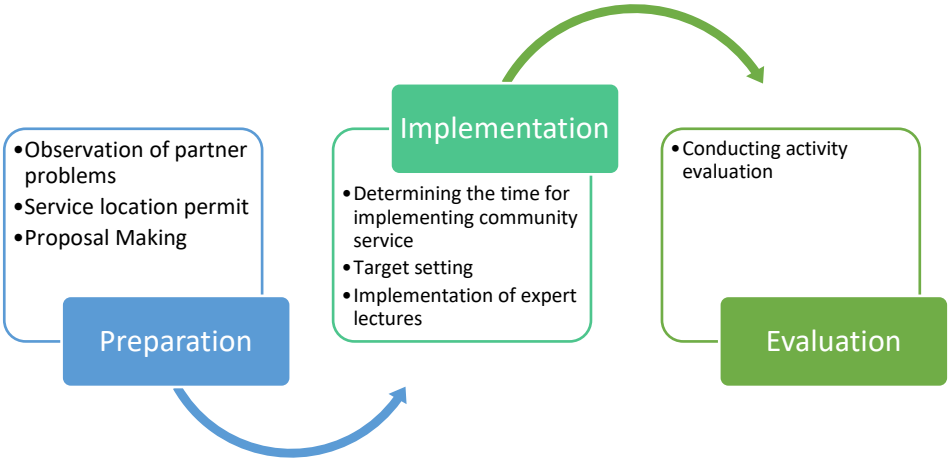


Fig. 1. Stages of implementing community service activities

The Preparation Stage begins with the observation of partner problems, where the service team conducts an in-depth study of the problems faced by teachers and students in integrating digital technology into the learning process. This observation process involves collecting data through interviews, surveys and needs analysis to gain a comprehensive understanding of the challenges. Once the problems are identified, the next step is to prepare a service proposal. This proposal must include an activity plan, methodology, objectives, and strategies designed to optimize the use of digital technology in education and face VUCA challenges. The last part of the preparation stage is the location permit for the service. The service team needs to obtain permission from related parties, such as schools or educational institutions, to ensure that the implementation of activities can run smoothly. The data collected in this program includes documentation of activities and questionnaires of training participant responses. The indicators and statements in the questionnaire are shown in Table 1.

Table 1. Expert Lecture Activity Responsiveness Questionnaire

Indicators	Statement
Understanding the Education Revolution in Era 5.0	1. My understanding of the educational revolution in Society 5.0 increased after attending this expert's lecture. 2. I feel more aware of developments in the world of education after attending this expert lecture. 3. This expert lecture helped me understand the factors that influence shifts in education. 4. The material presented in this expert lecture provides a clear explanation of optimizing the role of teachers and students in the digital era through AI, Blockchain, IoT, AR, VR, and AIoT in facing VUCA challenges. 5. After attending this expert lecture, I am more confident in explaining the VUCA concept in learning.
Awareness of Optimizing the Role of Teachers and Students in the Digital Era	6. This expert lecture provides important information on how teachers should improve their professionalism in learning.

Indicators	Statement
	7. The material presented in this expert lecture helped me understand the importance of improving professionalism in learning. 8. After attending this expert's lecture, I feel more prepared and know how to start improving myself. 9. This expert lecture provides adequate explanations about optimizing the roles of teachers and students in the digital era.
Benefits	10. This expert lecture increased my interest in better understanding developments in education, especially learning. 11. I am motivated to find more information about AI, Blockchain, IoT, AR, VR, and AIoT integrated into learning. 12. After attending this expert's lecture, I gained new knowledge that is useful in everyday life.

The score for each questionnaire was obtained using the Likert scale formula according to Equation 1 [29].

$$p_i = \frac{n_i}{N} \times 100\% \quad (1)$$

Where p_i is the percentage, n_i is the score obtained, and N is the total score. The scores are then converted into interval categories as shown in Table 2.

Table 2. Likert Scale Index Category

Percentage	Category
80-100	Very good
60-79	Good
40-59	Enough
20-39	Bad
0-19	Very bad

The Implementation Phase involves several important steps. First, the team determines the implementation time of the service according to the availability of partners and the needs of the activity. Proper scheduling is essential to ensure optimal participation from teachers and students. The next step is determining the target of the service. The target is set based on the results of observations and needs analysis that have been carried out previously. The main focus is on teachers and students who will be trained and assisted in the use of digital technology. The implementation of expert lectures is the core of this stage, where the service team holds seminars delivered by experts in the field of digital technology. These lectures aim to provide practical knowledge and skills on the use of AI, Blockchain, IoT, AR, VR, and AIoT in learning. In addition, expert lectures also discuss strategies for dealing with VUCA challenges, so that teachers and students can be more adaptive and proactive in managing rapid change, uncertainty, complexity, and ambiguity in the educational environment.

The Evaluation Stage is the final process that is very crucial to assess the success and impact of community service activities. The community service team conducts a comprehensive

evaluation of the entire series of activities that have been implemented. This evaluation includes measuring the improvement of teacher and student competencies in utilizing digital technology, as well as the effectiveness of strategies implemented in facing VUCA challenges. The evaluation results are collected through various methods, such as questionnaires, interviews, and direct observations, to obtain accurate and holistic data. This evaluation data is then analyzed to identify the strengths and weaknesses of the community service activities. Based on this analysis, the community service team can provide constructive recommendations for improvements for future community service. In addition, the evaluation results can also be used to compile transparent and accountable community service reports, which can be used as references for similar community service programs in the future.

Results and Discussion

A. Preparation

As part of the preparation for the activity, the first step taken was to conduct in-depth observations of the problems faced by partners, namely the teachers of PPG Mathematics Pre-Service Unismuh Makassar (a professional teacher program). This observation was carried out to clearly understand the challenges and needs they face in integrating digital technology into the learning process. The community service team identified several key issues, including a lack of understanding of advanced technology, limited access to digital devices and resources, and the need to develop more interactive and adaptive learning methods. These observations were conducted through interviews, questionnaires, and discussions with teachers, which provided valuable insights into field conditions and their expectations of this community service activity. The location of the community service chosen was online via the Zoom platform, considering the situation and conditions that require high flexibility and accessibility.

B. Implementation

The community service activities carried out online via Zoom and attended by participants from the Unismuh Makassar Pre-Service Mathematics PPG, produced various significant positive impacts (Fig 2). As an initial step before the start of the expert lecture, the participants were given an initial apperception that described their contribution to the Education revolution (Fig. 3).

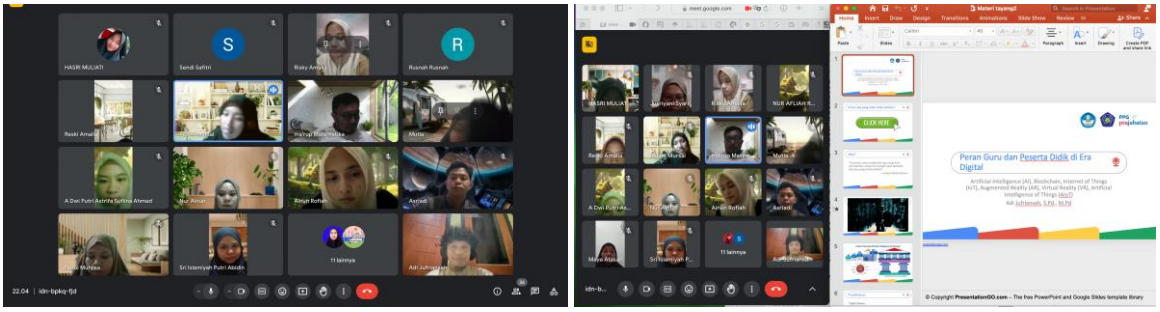


Fig. 2. Activity Participants

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Fig. 3 shows various responses from participants regarding their efforts in utilizing technology to support learning. Responses such as "not being a technologically illiterate teacher," "supporting the use of technology in learning," and "using technology in the learning process" show their awareness and commitment to continue developing in the field of technology. This initial apperception provides a strong foundation for deeper community service activities, where participants are invited to explore advanced technologies such as AI, Blockchain, IoT, AR, VR, and AIoT.



Translation of some responses of “What have you done in the education revolution?”

- Not becoming a "technologically illiterate" teacher.
- Supporting the use of technology in learning
- Trying to democratize education by using technologies such as PowerPoint, Google Meet, and others.
- Using technology wisely and responsibly.
- Using technology in the learning process
- Utilizing broader and more flexible technologies, such as online learning platforms

Fig. 3. Initial apperception before the activity

The results of this activity are very impressive. Teachers showed significant improvements in their digital literacy and technological competence. They are now better able to utilize technology to create more innovative and engaging learning methods. For example, the use of AI to personalize learning, Blockchain to create a transparent assessment system, IoT to develop interactive learning environments, and AR and VR to provide immersive learning experiences.

In addition to improving technical skills, the activity also succeeded in building a deeper awareness of the importance of facing VUCA challenges. Teachers are now better prepared to adapt to rapid change and uncertainty, and better understand how technology can be used as a tool to overcome these challenges.

The presentation sessions and practical workshops provided both theoretical understanding and practical skills that could be applied immediately. Teachers actively participated in discussions and exercises, showing great enthusiasm for learning new technologies. This opened up opportunities for collaboration and networking among teachers, where they could share their knowledge and experiences in using educational technology.

Overall, this activity not only improves the technical skills of teachers but also inspires them to continue to innovate in learning methods. With these new skills and knowledge, teachers are expected to be able to create a more adaptive, responsive, and effective learning environment in facing the challenges of the digital era, to improve the quality of education in Indonesia. The initial

apperception infographic used as a trigger for discussion shows that our teachers are ready and committed to continue learning and adapting for a better future of education.

C. Evaluation

The evaluation of the results of this community service activity illustrates the participants' preferences regarding the type of teacher they want in the digital era (Fig. 4).

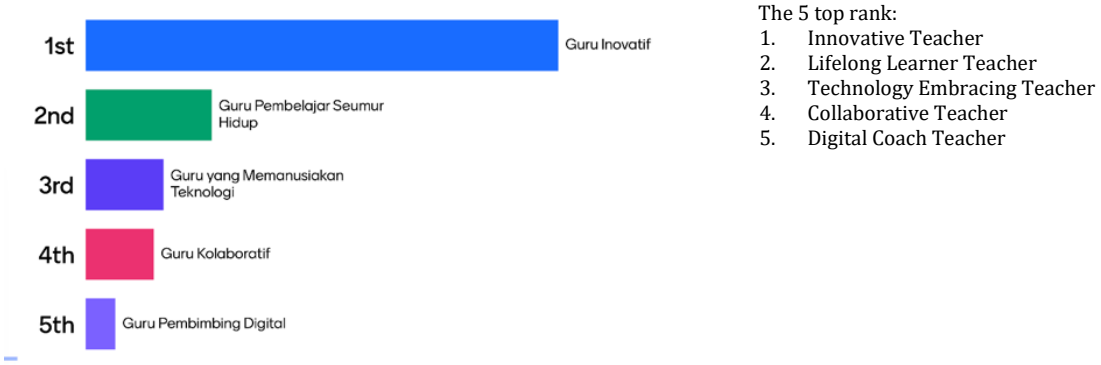


Fig. 4. Evaluation Results on Teacher Type Choice

From these results, it can be seen that the majority of participants want the "Innovative Teacher" type as their first choice. This shows how important innovation is in teaching methods, where teachers are expected to be able to bring fresh and creative ideas into the classroom to motivate and inspire students.

The second choice went to the “Lifelong Learner Teacher,” which reflects the awareness of the importance of teachers who are always eager to learn and grow. This emphasizes that education does not only happen in the classroom but also through the experiences and continuous learning of the educator. Furthermore, the “Technology Embracing Teacher” ranked third, affirming that the integration of technology in learning is highly valued and necessary to meet the demands of the digital age.

The “Collaborative Teacher” is in fourth place, indicating a desire for collaboration between teachers, students, and the educational community to create a richer and more diverse learning environment. Finally, the “Digital Coach Teacher” type, although in fifth place, still shows the importance of the teacher’s role as a guide in utilizing digital technology for learning.

The results of this evaluation reflect the strong desire of the participants to see a transformation in the role of teachers who are not only educators but also innovators, lifelong learners, technology users, collaborators, and mentors in the digital world. This community service activity has succeeded in providing valuable insights and inspiration for teachers to continue to develop themselves according to the hopes and needs of the digital era.

The evaluation results of community service activities on the choice of skills prioritized by teachers in supporting technology-based learning show some interesting insights (see Fig. 5).



New teacher skills:

1. Adapting to new technologies
2. Technology-based instructional design
3. Creativity and innovation in learning
4. Digital literacy
5. Virtual classroom management
6. Digital collaboration and communication
7. Data analysis
8. Understanding digital ethics and security

Fig. 5. Evaluation Results of a Teacher's New Skills

First, the skill of adapting to new technologies is at the top. This shows that educators realize how important the ability to continue learning and adapt to evolving technology is. In today's digital era, this ability is vital so that teachers can provide relevant and up-to-date learning experiences for students.

Technology-based instructional design ranked second, confirming that in addition to adapting, teachers are also very concerned with how technology can be effectively integrated into their lesson plans. They are looking for ways to use technology not just as a tool, but as a key element in the educational process that can increase student engagement and understanding.

In third place, creativity and innovation in learning underlines that teachers strive to remain innovative and creative in their approach. They want to use technology to create new, more engaging, and effective teaching methods so that students can learn more interactively and enjoyably. Digital literacy, which is in fourth place, shows that a basic understanding of technology and the ability to use digital tools effectively are still important priorities. This is the foundation that all educators must have to operate various devices and applications used in technology-based learning. Virtual classroom management in fifth place indicates that teachers also recognize the importance of being able to manage a fully online learning environment. This ability is especially relevant in situations where distance learning is a necessity, such as during the COVID-19 pandemic.

Digital collaboration and communication skills, ranked sixth, reflect the importance of being able to work together and communicate effectively through digital platforms. In an increasingly digitally connected world, these skills are not only important for the learning process but also the professional development of teachers themselves. Data analysis came in seventh, indicating that understanding how to interpret and use data to improve the learning process was also considered important. With this ability, teachers can make better, evidence-based decisions in planning and evaluating learning.

Finally, understanding digital ethics and security in eighth place underlines that while technology offers many benefits, there are also ethical and security aspects that need to be considered. Teachers must be able to protect the privacy and security of students' data and educate them about the responsible use of technology.

Overall, the results of this evaluation indicate that educators have a high awareness and commitment to the development of diverse technological skills. They understand that to be effective in the digital age, not just one or two skills are needed, but a combination of complementary abilities. The results of the evaluation of a teacher's new skills are fully presented in Fig. 5.

The results of the evaluation of this activity are presented in Table 3.

Table 3. Activity Evaluation

Indicator	Mark
Understanding the Education Revolution in Society 5.0	95
Awareness of Optimizing the Role of Teachers and Students in the Digital Era	87
Benefits	90

Based on the evaluation results in Table 2, this activity showed very good achievements in several key indicators. Understanding of the Education Revolution in Society 5.0 reached a score of 95, indicating a very good level of understanding of the participants towards important concepts in the current education revolution. Furthermore, awareness of optimizing the role of teachers and students in the digital era reached a score of 87, reflecting a strong understanding of the importance of roles and adaptation in an increasingly digitalized educational environment. Overall, this activity was considered very useful with an overall score of 90, indicating that participants felt significant benefits from the material and interactions in the activity. Thus, this evaluation confirms that the activity has succeeded in providing insight and deep understanding to participants in the context of rapidly changing modern-era education. The complete evaluation results are presented in Fig. 6.

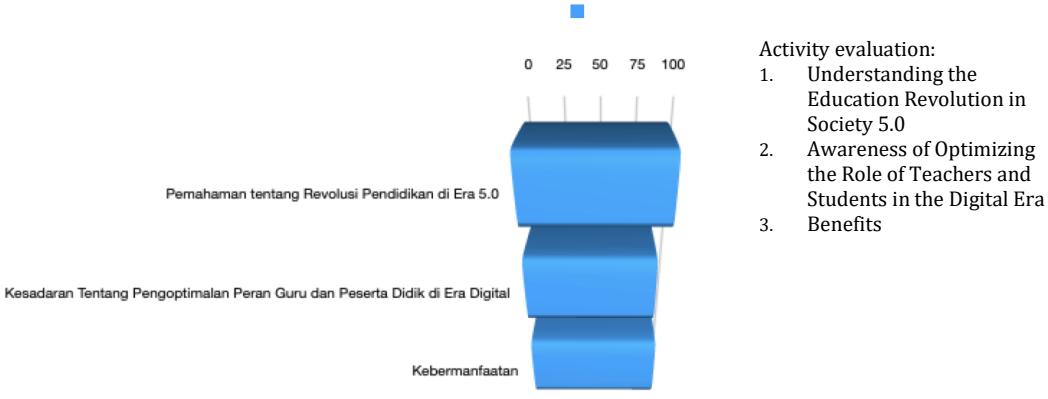


Fig. 6. Activity Evaluation Results

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Conclusion

Overall, this community service activity has succeeded in producing a significant positive impact on the teachers of PPG Mathematics Pre-Service Unismuh Makassar. With a focus on the integration of digital technology in learning, this activity not only increases the understanding and awareness of the participants about the educational revolution of Society 5.0 and the crucial role of technology in digital education but also improves their ability to use technology to create more innovative and effective learning. The evaluation showed excellent achievements with high scores for conceptual understanding and overall benefits, confirming that this activity provides a solid foundation for the development of education that is responsive to the demands of the times.

Conflict of Interest

The authors declare that there is no conflict of interest.

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