

Enhancing Vocational Education Teachers' Ability to Create Augmented Reality Instructional Media Through Participatory Training

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ABSTRACT

The transformation of learning in the digital age requires vocational high school (SMK) teachers to possess the competence to integrate Augmented Reality (AR) technology into their teaching. However, most teachers still face challenges in developing and implementing AR technology. This study aims to determine teachers' initial competence level, assess improvements in SMK teachers' competence following the intervention, and identify the constraints and supporting factors involved. This school-based action research, modeled after Ernest T. Stringer's "look, think, act" framework, uses a mixed-methods approach. The study collected data from 15 SMK teachers through interviews, tests, product assessments, observations, and questionnaires. Data analysis utilized data triangulation, descriptive statistics, t-tests, and NGain Scores. The results showed that most respondents were unfamiliar with AR-based learning media and could not create it. Participatory training improved the cognitive domain, raising the average score from 38.13 to 89.73; increased the affective domain by 100%; and improved the psychomotor domain, with the percentage of participants able to create AR-based learning media rising from 27% to 100%. Challenges included varying levels of teachers' initial abilities, self-confidence issues, and the perceived lack of time for photogrammetry practice and 3D model editing. Facilitator support, project-based learning, discussions, collaboration, and a guidebook helped address these challenges and improved teachers' ability to integrate AR into instruction.

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1. INTRODUCTION

Vocational education aims to prepare skilled, work-ready, and productive human resources in specific fields [1]. This means vocational education is designed to bring "work conditions into the school through learning and practice," so that during the learning

process, students learn “how to work” effectively and efficiently and can adapt to technological advancements. Teachers are a key factor in the success of educational programs. High-performing teachers deliver high-quality instruction [2]. This statement is reinforced by [3], who assert that teachers who improve the quality of education in the digital age have adequate digital skills and can create interactive, technology-based learning environments.

However, the reality on the ground is quite the opposite: many educators have not yet been able to optimize technology to create learning experiences that incorporate technology-based learning media such as computers [4]. Findings from a study by [5] also confirm that a lack of skills in information and communication technology is a major barrier for teachers in integrating digital learning media. AR technology can help bridge this gap; however, most teachers lack the experience or training to create AR [6] based learning media. In agreement with this statement, [7] describes AR as a breakthrough and a solution for improving the quality of education. Therefore, a participatory, flexible training model grounded in teachers’ own experiences is needed. As noted by [8], this implies that for learning activities to succeed in the digital age, teachers must possess AR competencies as one solution to the challenges of teaching in the digital era. [9] suggest that training in AR implementation could begin with prospective teachers while they are still in college.

Numerous studies indicate that a participatory approach to educational technology training is more effective at improving teachers’ skills than conventional methods. As found by [10], participatory training can enhance teachers’ pedagogical competencies. Similarly, [11] states that participatory training can improve the competencies and professionalism of vocational education teachers, particularly in producing academic publications. This statement is reinforced by [12], which asserts that participatory training models contribute positively to improving teachers’ ability to write scientific papers.

However, research on participatory-based training to improve VET skills in developing AR media remains limited. Therefore, further research is needed to develop a participatory training model as an alternative solution to bridge this gap and enhance VET competencies in using AR. This study aims to determine improvements in VETs’ ability to create AR-based learning media and to identify the factors that support and hinder the training’s implementation.

Competency is a set of knowledge, behaviors, and skills that teachers must possess to achieve learning and educational objectives. According to [13], competency is the ability to carry out or perform a job or task based on skills and knowledge and supported by the work attitude required by that job. Meanwhile, according to [14] as cited in [15], competency refers to an individual’s ability or capacity to perform various tasks within a specific job. This implies that teacher competency combines various types of abilities, including knowledge, skills, and behaviors that teachers must possess, understand, and master to carry out their duties [16].

21st-century teachers must be highly adaptable to changing times, as conventional teaching methods are no longer sufficient to meet the demands of modern education. Teachers must foster critical and creative thinking skills and guide students in digital literacy, including an understanding of digital ethics, information analysis, and technology-

based communication skills. Teachers must continuously improve their competencies through training, professional development, and active engagement in digital learning communities to provide relevant, innovative, and high-quality education. This aligns with the view that, although mastering these technologies is not an instant process, teachers must develop and practice these skills continuously to apply them optimally in the learning process [17].

Augmented reality integrates digital information into the user's real-world environment [18]. This technology lets users view the real world with added virtual elements such as images, sounds, or other data, displayed through devices such as smartphones, tablets, or special glasses. According to research by [19], implementing AR as an interactive learning medium can enhance students' reasoning skills and imagination. Similarly, [20] notes that AR can capture users' interest by transforming two-dimensional (2D) images into three-dimensional (3D) ones. Thus, AR plays a crucial role in bridging the real and virtual worlds, creating a more informative experience for users and potentially serving as an innovative solution to improve the quality of vocational education in the digital age.

According to [21], training serves as a tool for human resource development, particularly in enhancing individuals' intellectual capacity and character. This view is reinforced by [22], who adds that training is a strategic investment organizations make to enhance individual competitiveness, which positively impacts the organization's overall competitiveness. Training, as part of education, describes a process related to developing both organizations and groups [23]. In line with this, [24] explains that training is a method aimed at improving organizational efficiency and productivity by guiding professionals to assist employees over a specific period and enhancing participants' job skills in specific areas of responsibility. In line with this conclusion, [25] also emphasizes that training management must be conducted systematically and based on the organization's needs to ensure its sustainability and effectiveness.

A model is a guideline that reflects a sequence of behaviors that must be followed. Meanwhile, an education and training model is a guideline that describes in detail the sequence of the learning process in both formal education and training that practitioners must carry out [26]. According to [26], training models from the perspectives of process and content include: (1) Skills for the Job; (2) The Otto and Glaser Model (1970); (3) The [27]; (4) The [28]; (5) The Center for International Education (CIE) Model; (6) The Participatory Training Model. This study will use the participatory training model. This model was chosen because participants are selected through mutual participation. Participants also determine the objectives, content, and training implementation through mutual agreement. Furthermore, since the training participants are adults, generally teachers who already have teaching experience, they are capable of independently developing instructional materials. They are highly motivated to participate in training when the material is relevant to their daily duties as teachers.

Thus, participatory learning not only increases participant engagement but also fosters a sense of ownership and responsibility for the learning process, which ultimately contributes to more optimal learning outcomes.

Participatory training is a form of training in which educators actively involve participants throughout the learning process, from planning and implementation to evaluation. This aligns with the perspective in [29], as cited in [30], which states that participant involvement in these three stages—program planning, program implementation, and assessment—is central to participatory learning. In line with this view, [26] the participatory training model emphasizes collaboration between educators and participants to create a dynamic learning environment responsive to everyone’s needs. The participatory training model allows teachers to learn through direct experience, cooperation, and shared reflection, making the knowledge gained more practical and relevant. This training model consists of nine steps, including: 1) recruitment of training participants; 2) needs assessment; 3) formulation of general and specific objectives; 4) development of the training program; 5) active engagement in the training process; 6) initial evaluation of participants; 7) implementation of the training; 8) final evaluation of participants; 9) evaluation of the training program. In addition, this model emphasizes collaboration between educators and participants to create a dynamic learning environment responsive to all parties’ needs.

2. METHOD

This school-based action research employed a mixed-methods embedded design approach, using [31] “Look, Think, and Act” action model, followed by reflection to refine subsequent actions. This view is supported by [32], who state that action research is a structured form of inquiry designed to help individuals find effective solutions to the problems they face in their lives.

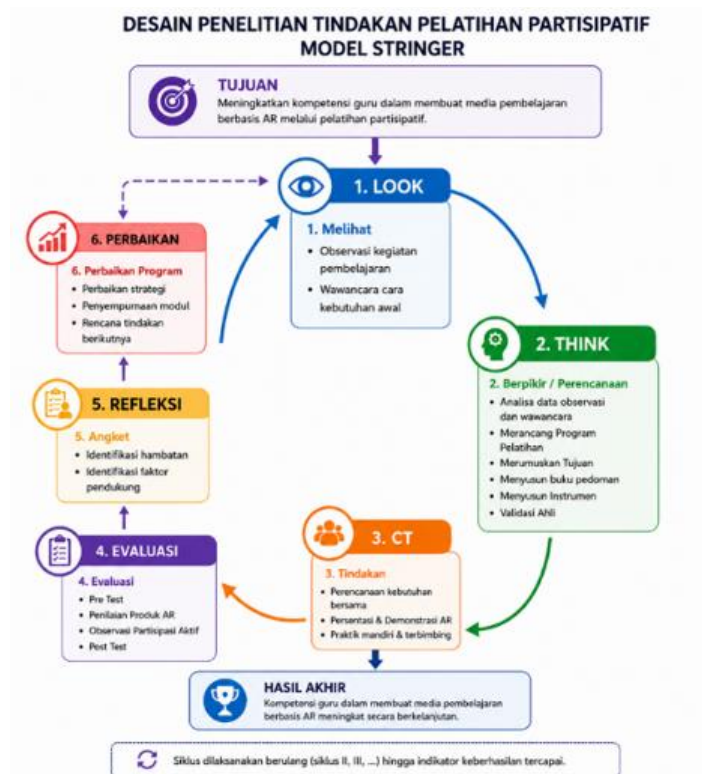


Figure 1. Ernest Stinger’s Action Research Design

The participants in this study were VET KK TSM teachers in Salatiga City and Semarang Regency. Quantitative data were used to measure improvements in teachers' ability to create AR-based learning media by comparing pre-test and post-test results, while qualitative data were used to explore the supporting factors and barriers that influenced the success of the action. Qualitative data analysis followed the interactive model proposed by Matthew B. Miles, A. Michael Huberman, and Johnny Saldaña in [33], comprising three main stages: Data Reduction (DR), Data Display (DD), and Conclusion Drawing and Verification. Quantitative data analysis included descriptive statistics, paired t-tests, and N-Gain.

3. RESULTS AND DISCUSSION

3.1 Results

The implementation of this participatory research project involved several stages, including: 1) recruitment of training participants; 2) needs assessment; 3) formulation of general and specific objectives; 4) development of the training program; 5) active participation in the training process; 6) initial participant evaluation; 7) delivery of the training; 8) final participant evaluation; 9) evaluation of the training program, as outlined in the Participatory Training Guide for AR Media Development. The training activities are based on the three stages of action development: Look, Think, and Act and conclude with reflection.

Results of the Look Stage

Activities in the Look stage began by identifying or observing the needs and initial experiences of training participants in developing AR-based learning media. Based on the results of interviews with training participants, the following data were obtained:

Table 1. Summary of Interview Results

Interview Indicators	Interview Findings
An Introduction to AR	Most teachers do not yet have a deep understanding of the concept of AR
Experience with Digital Media	Teachers are already accustomed to using simple digital media such as PowerPoint, Canva, videos, and the internet
Challenges in AR Media Development	The main challenges include technical skills, user adoption, devices, and internet connectivity
Training Material Requirements	Basic AR material, curriculum integration, 3D object creation, and troubleshooting are considered essential
Desired training model	Teachers need more hands-on practice, coaching, mentoring, and peer learning
School-wide support	Schools are expected to provide internet access, devices, policies, schedules, and funding
Teachers' Motivation for Participating in Training	Teachers' motivation is high because AR is considered relevant to the digital age and TSM learning
Expectations for the Training Outcomes	Teachers hope that AR will improve students' understanding, the visualization of the material, and the quality of learning

The summary above is supported by the results of the initial training needs interviews with the three respondents interviewed by the researcher:

I often use materials or PowerPoint presentations from my spouse's industry because our school is one of the schools they mentor. As for AR, I've never heard of it, but I'm interested in trying it in my teaching. However, if I were asked to learn it on my own, I think it would be difficult and take a long time. (Interview with NWA, March 16, 2026).

In line with the results of the interview with NWA, AK told the researcher the following:

When I was teaching about carburetors, I brought carburetor components into the classroom so that students could see what a carburetor looks like; however, because the number of carburetors was limited, the students had to take turns or wait in line to see the actual carburetor. I've heard there's an app that can display components in 3D, so I'd be interested in learning how to use it if a colleague could serve as a tutor. (Interview with AK, February 24, 2026).

This was reinforced by an interview with AR, a vocational high school teacher in Salatiga, who stated:

Before every lab session, I always provide students with some introductory theory on the lab material. For example, if we're doing a lab on pistons, I'll cover the basic components of a piston. But I have trouble visualizing the components because they're located inside the engine, and I only have 2D photos, so students have difficulty imagining what the piston components look like. If only there were an app that could display a 3D model of a piston, I would be happy and eager to learn how to use it. (Interview with AW, March 4, 2026)

Table 2. Pre-test Results

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PreTest	15	12.00	68.00	38.1333	16.89407
Valid N (listwise)	15				

Based on these three data sources, the researchers concluded that VET institutions are not yet familiar with AR applications and therefore cannot create AR-based learning materials; consequently, participants urgently need training in developing AR learning materials. This need includes improving technical skills, guidance on implementation, participatory training models, and ongoing support from schools so that AR can be effectively integrated into the learning process.

Results of the Think Phase

Based on the needs analysis and validation of the research instruments, the researcher designed an action scenario to be carried out over two research cycles. The training was designed using a participatory model with the following details: (1) Action strategies and methods; (2) Time Allocation & Materials; (3) Evaluation Instruments; (4) Development of a participatory training guidebook for the creation of AR-based learning media; (5)

Success indicators, defined as 85% of participants achieving a test score of $\geq 75,00$ and being able to create AR learning media.

Results of the Intervention Phase

The results of the intervention showed an increase in knowledge, as follows:

Table 3. Results of the descriptive analysis of the increase in knowledge

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Pre_Test	15	12.00	68.00	38.1333	16.89407
Post_Test	15	40.00	76.00	56.5333	11.59967
Valid N (listwise)	15				

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Pre_Test	15	40.00	76.00	56.5333	11.59967
Post_Test	15	76.00	100.00	89.7333	7.04543
Valid N (listwise)	15				

Based on the data in the table above, the average knowledge score increased significantly from 38,13 before the intervention to 56,53 after Cycle 1. At the end of Cycle 2, the score increased to 89,73. The results of the parametric test using a Paired Sample T-Test are as follows:

Table 4. Results of the Paired Sample T-Test

Paired Samples Test							
		Paired Differences			t	df	Sig. (2-tailed)
		Std. Deviation	95% Confidence Interval of the Difference				
			Lower	Upper			
Pair 1	Post_Test - Pre_Test	7.24273	29.18911	37.21089	17.753	14	0.000

The t-test results showed a significance value of $0.000 < 0,05$. This indicates a significant difference and improvement in teachers' abilities before and after participating in the participatory training. In other words, this training significantly improved teachers' competence in creating AR learning media. The N-Gain test results are presented in the table below:

Table 5. N-Gain Results

Statistical Data	Pre-test	Post-test	Gain	Notes
Min	40	76	-	-
Max	76	100	-	-
SD	11,21	6,81	-	-
Mean	56,53	89,73	33,20	-
N-Gain			0,78	Effective

Based on the N-Gain calculations, the average pre-test score was 56,53, and the average post-test score was 89,73, with an average gain of 33,20. The analysis results showed an average N-Gain value of 0,78, which falls into the high category.

Competence improved not only in knowledge but also in skills related to product development. The data on skill improvement are as follows:

Table 6. Results of skill improvement in creating AR learning media.

Indicators	pre	Cycle 1	Cycle 2
Identifying Learning Objectives	Participants are not yet able to create AR-based learning materials	15 Participants (100%)	15 Participants (100%)
Photogrammetry		15 Participants (100%)	15 Participants (100%)
Generating 3D models		7 Participants (100%)	15 Participants (100%)
3D model editing		4 Participants (100%)	15 Participants (100%)
Integration of markers with 3D objects		4 Participants (100%)	15 Participants (100%)
Displaying AR objects on a smartphone		4 Participants (100%)	15 Participants (100%)
AR products can be used as learning tools		4 Participants (100%)	15 Participants (100%)

Participatory attitudes also increased during the training. The following data show the increase in participatory attitudes:

Table 7. Results showing the increase in participants' participatory attitudes.

Indicators of Participatory Attitudes	Cycle 1	Cycle 2
Verbal participation in discussions	13 Participants (87%)	15 Participants (100%)
Engagement in AR practices	6 Participants (40%)	15 Participants (100%)
Collaboration within groups	8 Participants (53%)	15 Participants (100%)
Providing feedback (peer feedback)	10 Participants (67%)	15 Participants (100%)
Responses to facilitator instructions	9 Participants (60%)	15 Participants (100%)
Initiative to explore	10 Participants (67%)	15 Participants (100%)
Task completion	8 Participants (53%)	15 Participants (100%)

The participants' level of engagement appeared to increase after attending the training, as shown in the table above. This data is supported by feedback from one participant, who stated:

Using PowerPoint presentations and materials provided by the manufacturer was more than enough. However, after Cycle 2 of the training, I feel much more confident using AR technology and plan to explore creative ideas from Gen Z students. (Feedback from AAM during Cycle 2).

The principal also expressed appreciation for the tangible impact of this training.

When I walked around, the participants' confusion about what to do and their fear of exploring features independently or in groups during Cycle 1 had disappeared. Now the participants seem to have a newfound enthusiasm; creative ideas are emerging, and they are actively interacting with one another. The training served as a very good

and positive catalyst; hopefully, it can continue so that participants can share what they've learned with their colleagues at their respective institutions. (Interview with the School Principal)

Action Evaluation Results

By comparing the implementation of Cycle 1 and Cycle 2, the researcher evaluated what was achieved and what still needs improvement.

Table 8. Results of the Action Evaluation

Evaluation Aspects	Cycle 1 Findings	Cycle 2 Findings	Final Status
Photogrammetry Competencies	VET students are not yet familiar with AR technology; during the photogrammetry lab, they still struggle to determine lighting, frame rate, and the 3D upload process. The allotted time feels too short, so there is not enough time to explore the features or editing menus.	Provide mentoring in small groups, encourage two-way communication, and engage in hands-on practice creating AR learning media	Students achieved the required post-test scores and were able to perform photogrammetry practices with cleaner 3D image results
Editing Asemlr	Teachers did not yet understand Asemlr's editing features. During practice sessions, teachers were hesitant to explore editing features and lacked confidence in developing ideas.	By providing small-group mentoring during the editing process and sparking teachers' creative ideas for creating AR learning media, they became more confident in exploring Asemlr's features	The resulting AR learning media products were more engaging and creative.
Number of Learning Media	The number of teachers able to complete AR learning media products was limited to only 4	All 15 participants (100%) successfully created AR learning media products	There was an increase

The evaluation phase showed that participants' skills improved after corrective actions were implemented in the second cycle. In photogrammetry, the first cycle showed that participants still struggled to adjust lighting, shutter speed, and the 3D upload process. The second-cycle evaluation used small-group guidance, two-way communication, and hands-on practice, enabling participants to create neater 3D images and achieve results consistent with photogrammetry best practices. Regarding editing in Asemlr, participants in the first cycle still lacked a thorough understanding of and familiarity with the editing features. With guidance and encouragement to be creative in the second cycle, participants became more confident exploring Asemlr's features. This was evident in the improved quality of AR media product designs, which became increasingly engaging and creative. Product development skills in Cycle 1 were still limited; only four participants completed

their products. After implementing corrective actions in Cycle 2, all 15 participants (100%) successfully created AR-based educational media products. Thus, the evaluation results indicate that the actions taken in Cycle 2 improved technical skills, confidence in exploration, and the quality of AR-based educational media products.

Reflection Phase Results

The training participants' reflections are as follows:

Table 9. Training Participants' Reflections

Aspects Explored	Open-Ended Questions
Learning Experience	Participants became more active and gained a better understanding of the training stages; hands on practice and group discussions
Challenges	Participants have mastered the Polycam and Assemblr features
Supporting Factors	Participants noted that the facilitator's guidance, hands on practice, the modules, and collaboration among participants were very helpful
Strategies for Overcoming Challenges	Participants were able to find solutions to the challenges they faced and engaged in more frequent discussions

The reflection results show that participants made good progress during the training. In terms of the learning experience, participants were more engaged and gained a better understanding of the training steps through hands-on practice and group discussions. Regarding challenges, participants successfully mastered the Polycam and Assemblr applications and features, enabling them to begin resolving technical issues. Key supporting elements included facilitator guidance, hands on experience, instructional materials, and collaboration among participants. Furthermore, regarding strategies for addressing challenges, participants demonstrated the ability to find solutions independently and became increasingly active in discussions. These findings indicate that participatory training enhances active engagement, independent learning, and participants' problem-solving skills.

Results of the Improvement Phase

The improvement phase was implemented based on the Cycle 1 evaluation results, which indicated ongoing limitations in technical proficiency, exploration of application features, and completion of AR educational media products. Improvements focused on strengthening small-group guidance, hands-on experience, complementary communication, collaboration among participants, and use of the handbook. For photogrammetry, guidance focused on hands-on practice in capturing and processing objects, helping participants address technical issues and produce cleaner 3D images. Facilitators guided the editing process and helped participants explore creative ideas, boosting their confidence in using the app's features.

Results from open-ended questions indicate that these improvements fostered a more active learning experience through hands-on activities and group discussions. Participants also identified the facilitators' support, the modules used, hands on practice, and collaboration among participants as key factors contributing to their success. Meanwhile, participants overcame technical challenges by finding solutions independently and

discussing them with others. These improvements increased the number of participants who successfully produced a final product from 4 participants in the first cycle to 15 participants (100%) in the second cycle who successfully created AR-based learning media. Thus, the improvement phase showed that enhanced guidance and collaborative learning overcame previous obstacles and increased participants' participation and ability to create AR-based learning media.

3.2 Discussion

The research results show that participatory training significantly improves VET teachers' competence in developing AR-based learning media. This improvement is evidenced by an increase in the average score from 56.53 to 89.73, a statistically significant result from the paired-sample t-test ($p < 0.001$), and an N Gain of 0.78, which falls into the high category. In addition to increased knowledge, all participants produced AR-based learning media by the end of the second cycle.

These findings contribute to teacher competency enhancement programs for developing AR-based learning media and reinforce previous studies showing that AR technology has great potential to improve the quality of vocational education. As teaching staff competencies improve, higher-quality learning will be more easily achieved. This statement reinforces the findings of a study [3], which emphasizes that teacher competence is a key factor in successfully integrating AR in educational settings. Previous research by [15] also explains that implementing AR in vocational education can enhance visualization of practical and technical skills, as well as students' learning experiences. In line with [3] and [7], AR is one of the key innovations transforming vocational education in the digital age because it enables more interactive and contextual learning. The vocational education curriculum must fully leverage AR's potential and integration, supported by infrastructure and enhanced training. A similar point is made by [1], who state that technology-based professional development for teachers requires continuous, contextual, and hands-on training. Teachers must receive appropriate training to apply AR in practice: "Teachers should receive the appropriate training in order to put AR into practice utilizing the appropriate pedagogical methods" [6].

These findings indicate that improvements in teacher competence stem not only from content delivery but also from participant engagement during the training process. Teachers can identify their learning needs, practice using the application directly, discuss challenges, receive feedback from facilitators and peers, and reflect on their learning at the end of each cycle. This finding supports the theory of participatory learning proposed by [10] in [11], which states that training effectiveness increases when participants are actively involved in planning, implementation, and evaluation. This finding aligns with the research results of [19], which emphasize that improving teachers' digital competencies is more successful when training focuses not only on software proficiency but also on the skills needed to integrate technology meaningfully into the learning process. Researcher [26] also explains that participatory training models create a collaborative learning environment, thereby fostering more sustainable mastery of competencies. Reinforcing previous research, [28] argues that participatory training effectively enhances the

professional competencies of vocational education teachers. The findings [13] seem to corroborate the results of [8], which state that 21st-century teachers must master and develop creative, innovative, technology-based learning. Another study [9] also found that professional development for teachers yields more sustainable outcomes when it is collaboratively designed, participant-centered, grounded in real-world practice, and supplemented with ongoing feedback.

This study also shows that institutional support from schools plays a crucial role in the sustainability of AR implementation. Support in the form of device provision, internet access, school policies, and professional development opportunities is a strategic factors that ensure training outcomes can be sustainably applied in the classroom. Another key supporting factor, no less important, is teachers' self-motivation to develop their professional competencies in line with technological advancements continuously. As noted by [16], teachers who are motivated to learn digital technology tend to find it easier to develop innovative teaching methods. Furthermore, collaborative support among participants and a participatory learning environment enable participants to learn from their peers' experiences, exchange solutions, and receive immediate feedback on the challenges they face. These factors are reinforced by findings from a study [26], which explains that the primary characteristic of participatory training is active collaboration between facilitators and participants, creating a learning environment responsive to participants' needs.

At the beginning of the program, the main obstacles teachers faced included low technical skills, limited practice time, a lack of self-confidence, and difficulty integrating learning materials with three-dimensional objects. However, after intensive mentoring, small-group discussions, re-demonstrations, and joint reflection, these obstacles gradually diminished. These results show that training success depends not only on the quality of the material but also on social support during the learning process. Facilitators, collaboration among participants, coaching, mentoring, and peer learning helped boost teachers' confidence to try various application features they had previously considered difficult. These findings align with [26], which explains that the primary characteristic of participatory training is active collaboration between facilitators and participants, thereby creating a learning environment responsive to participants' needs. The results of this study also expand upon the findings of [26], which state that low ICT competency is the main barrier to technology integration in learning. This study shows that these barriers can be mitigated through participatory, practice-based training designs.

These findings have strategic implications for reforms in vocational education in Salatiga City and Semarang Regency; strengthening teachers' digital competencies will improve learning quality. This aligns with the findings [14] that Augmented Reality in vocational education can provide a more realistic, interactive, and relevant learning experience. This is further supported by [18], which explains that using AR in vocational teacher training positively affects digital literacy, critical thinking skills, and learning outcomes.

A broader impact can be achieved through continuous training, intensive discussions and mentoring, and collaboration among teachers facilitated by MGMPs and government

institutions. This collaboration can help AR technology evolve from a creative classroom idea into an integral part of the digital transformation system for regional vocational education in the city of Salatiga and Semarang Regency, capable of addressing workforce competency needs in the digital age.

4. CONCLUSION

This action research demonstrates that participatory training successfully improved VET instructors' skills in creating AR-based learning materials. The increase in knowledge was evident from the pre-test and post test results, with the average score rising from 56.53 to 89.73. Skill improvement in creating AR learning media was evident: initially, 27% of participants completed the learning media, while by the end of the action, 100% had completed it, and 100% of participants actively participated in the training. Several supporting factors influenced the training's success, including facilitator guidance, hands-on experience (learning by doing), group discussions, the training manual, collective reflection, and peer support. Conversely, major challenges such as a lack of technical skills, limited practice time, difficulties in integrating materials with three-dimensional objects, and low self-confidence can be mitigated through peer support, repeated demonstrations, coaching, mentoring, and collaborative learning. A participatory approach combined with experience-based practice effectively enhances teachers' digital competencies in creating AR-based learning media. This training model can be applied to teacher professional development programs in other vocational fields to accelerate the transformation of digital learning.

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