



## Developing RekonX-AR: An Interactive Augmented Reality Learning Media for Bank Reconciliation in Vocational Accounting Education

**Aulia Zein Nur Arifah\*, Susanti**

Universitas Negeri Surabaya, Indonesia

Email : [aulia.22081@mhs.unesa.ac.id](mailto:aulia.22081@mhs.unesa.ac.id)

DOI: <https://doi.org/10.61987/jemr.v5i4.2619>

### ABSTRACT

#### Keywords:

Interactive Learning Media; Augmented Reality; Smart Apps Creator 3; Bank Reconciliation

\*Corresponding Author

This study aims to develop and evaluate the feasibility of RekonX-AR, an interactive learning media integrating Smart Apps Creator 3 and Assemblr Edu to facilitate students' understanding of bank reconciliation. The development was motivated by the limited use of technology-integrated learning media and the complexity of bank reconciliation concepts, which require more interactive and contextual visualization to enhance conceptual understanding. This study employed a Research and Development (R&D) approach using the ADDIE model, consisting of Analysis, Design, Development, Implementation, and Evaluation. The resulting product is an application-based learning medium integrated with Augmented Reality (AR), featuring learning materials, instructional videos, AR-based simulations, case studies, formative quizzes, and reflection activities. The findings indicate that RekonX-AR achieved a high level of feasibility, with material expert validation reaching 92% and media expert validation 98%, both categorized as Very Feasible. A limited trial involving Grade XI accounting students also demonstrated a positive response of 91%, classified as Very Good, indicating that the product is practical and well accepted by users. These findings imply that RekonX-AR can serve as an innovative technology-enhanced learning medium to support interactive learning, strengthen conceptual understanding, and improve students' learning engagement in accounting education.

#### Article History:

Received: March 2026; Revised: April 2026; Accepted: May 2026

#### Please cite this article in APA style as:

Arifah, A. Z. N., & Susanti. (2026). Developing RekonX-AR: An Interactive Augmented Reality Learning Media for Bank Reconciliation in Vocational Accounting Education. *Journal of Educational Management Research*, 5(4), 4230-4245.

## INTRODUCTION

Education plays a strategic role in improving human resources and strengthening national competitiveness in the global era. Beyond transmitting knowledge, education develops critical thinking, creativity, collaboration, communication, and problem-solving skills needed to address increasingly

complex social and technological challenges (Berkat et al., 2025; Thornhill-Miller et al., 2023). The emergence of Society 5.0 reinforces this responsibility by integrating human intelligence with digital technology to improve quality of life through innovation (Daffa et al., 2023; Lampropoulos, 2025). Consequently, educational institutions must prepare graduates equipped with digital literacy, computational thinking, and adaptive competencies to thrive in a technology-driven society (Zaid et al., 2025; Susanto et al., 2025). Failure to respond to these demands may widen the gap between educational outcomes and labor market expectations, limiting graduates' competitiveness and contributions to sustainable national development. Therefore, educational innovation supported by digital technology has become an urgent necessity rather than merely an optional improvement.

The transformation of education requires learning approaches that integrate technology while promoting meaningful learning through sound pedagogical foundations. Constructivist learning theory emphasizes that knowledge is actively constructed through interaction, exploration, and authentic experiences rather than passively received from teachers (Iswara & Usman, 2025; Fadillah, 2025). This perspective aligns with the Merdeka Curriculum, which emphasizes student-centered learning, competency development, and contextual problem solving supported by technology integration (Kemendikbudristek, 2022; Paramita et al., 2025). Furthermore, the implementation of deep learning within the Indonesian curriculum encourages conceptual understanding, reflection, authentic knowledge application, and digital competence through coding and Artificial Intelligence education (Kemendikdasmen, 2025; Permadhani & Rohayati, 2025). Consequently, teachers are expected to integrate pedagogical, content, and technological knowledge through the TPACK framework to create interactive learning environments that enhance student participation and conceptual understanding (Oktaviana & Yudha, 2022; Silvester et al., 2024). Therefore, technology-supported interactive learning media are essential for achieving curriculum objectives and meaningful learning experiences.

Despite these educational expectations, classroom practices in vocational high schools remain inconsistent with current curriculum demands. Preliminary observations and interviews with accounting teachers from several vocational high schools in Surabaya revealed that classroom instruction still relies primarily on textbooks, PowerPoint presentations, and instructional videos, indicating that digital technology has not been optimally utilized. These conventional approaches create difficulties in teaching bank reconciliation, particularly when students analyze differences between company records and bank statements. Supporting these findings, preliminary data from 66 Grade XI Accounting

students showed that 67.71% experienced difficulties understanding bank reconciliation, while 80.26% preferred interactive visual media and 73.59% reported greater motivation when learning used innovative instructional media. These findings demonstrate a considerable gap between technology-integrated learning promoted by educational policy and classroom realities. Consequently, students remain passive recipients of information, and opportunities to strengthen conceptual understanding through interactive digital learning experiences remain limited.

The challenges identified in vocational accounting education indicate the need to develop learning media that bridge conceptual understanding with meaningful learning experiences. Although various digital learning media have been introduced, many remain limited to presenting text, videos, and two-dimensional illustrations without enabling active exploration or visualization of abstract accounting concepts (Ali et al., 2025; Ryanto et al., 2025). In bank reconciliation learning, students must compare financial records, identify transaction discrepancies, and apply analytical reasoning, requiring conceptual understanding rather than memorization. Interactive multimedia integrated with visualization technologies can simplify these complex processes by combining text, graphics, animation, audio, simulations, and immediate feedback within one learning environment (Siregar et al., 2022; Fatimah, 2025). Moreover, Smart Apps Creator enables teachers to develop cross-platform interactive applications without programming expertise, while Assemblr Edu integrates Augmented Reality to visualize learning objects in three-dimensional environments (Abi & Sujatmiko, 2022; Nugrohadi & Anwar, 2022). Therefore, integrating these technologies can provide more engaging, contextual, and student-centered learning experiences aligned with the objectives of the Merdeka Curriculum.

Previous studies have consistently demonstrated that technology-based learning media improve students' motivation, conceptual understanding, and learning outcomes across various educational contexts. Studies utilizing Smart Apps Creator have reported high product validity and positive student responses because the platform provides interactive multimedia features that enhance learner engagement (Haliza & Pratiwi, 2024; Ramadhoni & Muchtar, 2024). Likewise, research on Augmented Reality has shown that three-dimensional visualization facilitates comprehension of abstract concepts while creating immersive learning experiences that strengthen motivation and conceptual retention (Joseph et al., 2024; Nengsih et al., 2023). Other investigations integrating Augmented Reality into educational media have also confirmed excellent feasibility and effectiveness in improving learning performance (Febriansyah et al., 2025; Diharjo et al., 2025). Nevertheless, previous studies have

mainly focused on science subjects or general educational contexts, whereas research integrating Smart Apps Creator 3, Assemblr Edu, and Augmented Reality into vocational accounting, particularly bank reconciliation learning, remains limited. Existing studies also evaluate media feasibility or learning outcomes separately, indicating a research gap requiring further investigation.

Unlike previous studies, this research introduces RekonX-AR, an integrated interactive learning medium specifically designed for bank reconciliation learning in vocational accounting education. The product combines application-based interactive learning, multimedia content, formative assessments, and Augmented Reality visualization within a single platform accessible through smartphones and computers. RekonX-AR presents accounting concepts through text, graphics, videos, quizzes, and three-dimensional AR objects representing accounting documents and reconciliation processes, creating a contextual, immersive, and meaningful learning experience. This integration enables students to actively construct conceptual understanding while increasing learning engagement through direct interaction with digital learning objects. Accordingly, this study addresses how to develop an interactive learning medium that effectively supports students' understanding of bank reconciliation while meeting current demands for technology-enhanced learning. It is hypothesized that integrating Smart Apps Creator 3 with Augmented Reality will produce a valid and practical instructional medium. Therefore, this study aims to develop RekonX-AR, validate its content and media quality, and evaluate its practicality through limited implementation involving Grade XI Accounting students in vocational high schools.

## RESEARCH METHODS

This study employed a Research and Development (R&D) approach to develop and evaluate an interactive learning media called RekonX-AR, which integrates accounting learning with Augmented Reality (AR) technology. R&D was selected because it is specifically designed to produce educational products while systematically evaluating their feasibility before implementation (Slamet, 2022). The development process adopted the ADDIE model, consisting of Analysis, Design, Development, Implementation, and Evaluation, because the model provides a structured, systematic, and iterative framework that enables continuous revision throughout the product development process (Safitri & Aziz, 2022; Rusmayana, 2021). As illustrated in Figure 1, the ADDIE model guided every stage of the research, while the detailed development procedure of the RekonX-AR media is presented in Figure 2. During the analysis stage, learning

problems, curriculum requirements, and students' difficulties in understanding bank reconciliation were identified through classroom observations and interviews. The design stage focused on preparing learning objectives, instructional content, storyboards, user interfaces, and Augmented Reality learning scenarios. Subsequently, the product was developed using digital media integrated with AR technology, validated by experts, implemented through limited classroom trials, and continuously refined based on evaluation results to ensure that the final product met pedagogical, technological, and learner needs.



Figure 1. The ADDIE Model Framework

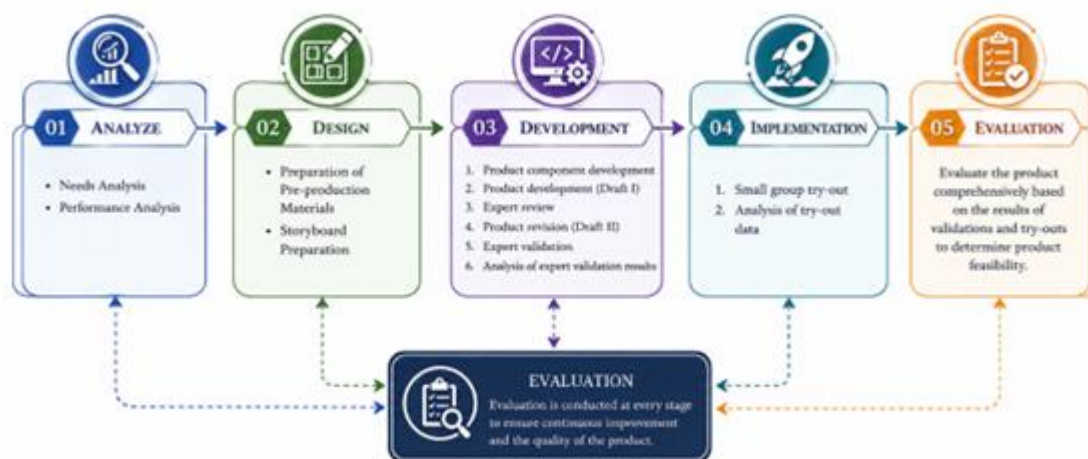


Figure 2. Procedure for Developing RekonX-AR Interactive Learning Media

The study was conducted in several vocational high schools in Surabaya, Indonesia, involving accounting lecturers, vocational accounting teachers, and Grade XI Accounting students. Subject matter experts evaluated the relevance, accuracy, completeness, and presentation of the instructional content, whereas media experts assessed interface design, navigation, visual appearance, multimedia integration, and system functionality. The product was then implemented through a limited trial involving 20 Grade XI Accounting students

selected using purposive sampling, considering that participants had previously studied bank reconciliation material and possessed sufficient digital literacy skills to operate the developed application. The sample size followed recommendations for small-group evaluation in educational product development, which suggest involving approximately 10–20 participants to obtain representative feedback while maintaining manageable evaluation procedures (Rochmah & Susanti, 2024; Cahyani & Susanti, 2025). Data were collected through observations, interviews, and questionnaires. Observation and interviews were conducted during the needs analysis stage, whereas questionnaires were administered during expert validation and student trials. Expert validation instruments measured both content and media quality, while student response questionnaires assessed the practicality and usability of RekonX-AR following product implementation.

**Table 1. Likert Scale for Expert Validation**

Criteria	Score
Strongly Agree	5
Agree	4
Neutral	3
Disagree	2
Strongly Disagree	1

The collected data were analyzed using both qualitative and quantitative approaches to determine the validity, practicality, and feasibility of the developed product. Qualitative data obtained from observations and interviews were analyzed using the interactive model of data reduction, data display, and conclusion drawing (Qomaruddin & Sa'diyah, 2024). Quantitative data from expert validation were analyzed descriptively using a five-point Likert scale, as presented in Table 1, whereas student response data were analyzed using the Guttman scale (Yes = 1; No = 0) and converted into percentages to determine product practicality (Cahyani & Susanti, 2025). Product validity was determined from expert judgments regarding instructional content and media quality, while product practicality was measured based on students' responses after using RekonX-AR during the limited trial. The feasibility of the developed media was interpreted using percentage criteria, where a minimum score of 61% indicated that the product was feasible for classroom implementation. The interpretation of feasibility categories used in this study is presented in Table 2, which served as the basis for determining whether further revision or implementation of the product was required (Ali et al., 2025; Ryanto et al., 2025).

**Table 2. Product Feasibility Criteria**

Percentage	Interpretation
81–100%	Very Feasible
61–80%	Feasible
41–60%	Fairly Feasible
21–40%	Less Feasible
0–20%	Not Feasible

## RESULTS AND DISCUSSION

### Results

#### Development Process of RekonX-AR Interactive Learning Media

The development of the RekonX-AR interactive learning media based on Smart Apps Creator 3 and Assemblr Edu was conducted using the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation:

#### *Analysis Stage*

The analysis stage aimed to identify learning problems and user needs. Data were collected through observation, interviews, and questionnaires involving teachers and students from four vocational schools. Findings indicated that bank reconciliation is a difficult topic for students, particularly in transaction analysis and identifying differences between company and bank records. Teachers reported limited learning media, predominantly consisting of textbooks, worksheets, PowerPoint, whiteboards, and videos. A preliminary survey involving 65 students showed that 67.71% experienced difficulties in understanding bank reconciliation concepts, while 80.26% preferred interactive visual media and 73.59% were more motivated by innovative learning approaches. These findings indicate the need for interactive digital learning media to improve conceptual understanding and engagement.

#### *Design Stage*

The design stage involved preparing the system architecture, learning flow, and content structure of the media through pre-production planning, storyboard development, and interface design. Pre-production included determining learning content, preparing supporting devices (laptop and smartphone), and utilizing software such as Smart Apps Creator 3, Assemblr Edu, Canva, and CapCut. A storyboard was developed to define the navigation flow and interface structure. Content preparation involved collecting and

organizing learning materials aligned with curriculum objectives, including instructional modules for Phase F financial accounting, self-developed learning videos, and contextual case studies based on real-world accounting practices.

### Development Stage

The development stage focused on producing the RekonX-AR learning media based on the design specifications. This process included production, expert validation, and revision based on feedback from subject matter and media experts to ensure product feasibility. The validated media was then tested in a limited trial to obtain student responses for further improvement. The following presents the product and feasibility results from the expert validation.



Figure 1. The product "RekonX-AR"

### *Implementation Stage*

The implementation stage involved product testing of the RekonX-AR learning media. The validated media was implemented in a limited trial to obtain student responses. The trial involved 20 Grade XI Accounting students from SMK Negeri 1, SMK Negeri 4, SMK Negeri 6, and SMK Negeri 10 Surabaya. The selection of these schools was based on their strong accounting learning environment, allowing for diverse and representative student responses toward the use of the media.

### *Evaluation Stage*

The evaluation stage was conducted to assess the development process based on the ADDIE model. This stage focused on determining the feasibility of the developed media through expert validation results and limited trial feedback. The final output of this process is the RekonX-AR interactive learning media for bank reconciliation material.

### **Feasibility of the RekonX-AR Interactive Learning Media**

The feasibility of the RekonX-AR interactive learning media was evaluated through validation by subject matter and media experts using a Likert-scale instrument, and the data were analyzed using percentage descriptive analysis. The following are the results of expert validation:

**Table 1. The Results of Expert Validation:**

<b>Validator</b>	<b>Percentage</b>	<b>Qualification</b>
Subject Matter Expert	92%	Very Feasible
Media Expert	98%	Very Feasible

### **Student Responses to the RekonX-AR Interactive Learning Media**

Following expert validation, the RekonX-AR interactive learning media was tested through a limited trial involving 20 Grade XI Accounting students from SMKN 1, SMKN 4, SMKN 6, and SMKN 10 Surabaya. This stage aimed to evaluate students' responses to the media as a learning support tool. The following presents the results of student responses:

**Table 2. The Results of Student Responses**

Assessed Aspect	Percentage	Category
Content	93%	Very Good
Presentation	88%	Very Good
Language	93%	Very Good
Total	<b>91%</b>	<b>Very Good</b>

## Discussion

The development of the RekonX-AR interactive learning media was conducted using the ADDIE model, which is widely applicable for developing instructional products, including learning media and teaching materials (Rusmayana, 2021). The preliminary findings revealed a strong need for technology-based learning media that are more interactive, visual, and contextual. This need aligns with student-centered learning approaches, where teachers act as facilitators and learning emphasizes active engagement and learner autonomy. Furthermore, 21st-century learning requires the integration of technology, pedagogy, and content (Mulyana et al., 2023).

These findings are consistent with the Cognitive Theory of Multimedia Learning (CTML), which explains that learning becomes more effective when information is delivered through a combination of verbal and visual elements (Siregar et al., 2022). The integration of text, images, video, and Augmented Reality (AR) in RekonX-AR supports students in understanding complex accounting concepts more effectively. In addition, this development aligns with constructivist theory, which emphasizes that knowledge is actively constructed through experience and interaction (Iswara & Usman 2025), reflecting a shift from teacher-centered to student-centered learning (Fadillah, 2025). The development process resulted in a comprehensive learning media integrating features such as AR visualization, instructional videos, and case-based exercises. The use of Smart Apps Creator 3 and Assemblr Edu was based on their usability and ability to enhance interactivity and engagement (Harahap et al., 2024; Nugrohadi & Anwar, 2022), supporting previous findings that interactive digital media can improve student motivation and participation (Diharjo et al., 2025).

The validation results indicate that the media achieved a “very feasible” category, with 92% from subject matter experts and 98% from media experts. These results confirm that the media meets the criteria of content quality, presentation, and technical aspects (Ramadhoni & Muchtar, 2024). From a theoretical perspective, this finding is consistent with BSNP (2014) in Haliza

(2024), which emphasizes that effective learning media must ensure content accuracy, relevance, and systematic presentation. Additionally, the findings align with Haryono (2015) in Haliza (2024), highlighting the importance of integrating visual design, interactivity, and technical quality. Similar findings were reported by Haliza & Pratiwi (2024), who found that Smart Apps Creator 3-based media achieved validation scores of 91.8% (material) and 94% (media). Likewise, Ramadhoni & Muchtar (2024) reported a feasibility level of 89.6%, while Abi & Sujatmiko (2022) found media feasibility at 85.33% and material feasibility at 91.11%. In terms of AR integration, Nengsih et al. (2023) reported high validity (85.18% material; 90% media), and Febriansyah et al. (2025) reported 86% and 89% for material and media validation, respectively. These findings collectively strengthen the evidence that interactive and technology based learning media are very feasible and beneficial in educational settings.

Furthermore, the implementation results show that students responded positively, with a response rate of 91% (very good), indicating improved engagement, motivation, and understanding. This finding supports the effectiveness of interactive and technology-based learning environments in facilitating meaningful learning experiences. It also reinforces BSNP (2014) in Haliza (2024), which states that effective media should be communicative, engaging, and relevant to learner characteristics. This finding is consistent with Diharjo et al. (2025), who reported an 89% positive response, as well as Dewi et al. (2024) with 87.2%, and Ramadhoni & Muchtar (2024) with 82.2%. Similarly, Syafitra et al. (2025) reported a response rate of 84.95%, highlighting that AR-based media enhances understanding, visualization, and active participation. Joseph et al. (2024) also emphasized that Augmented Reality can significantly increase students' interest and engagement in learning. The use of AR features in RekonX-AR enables concrete visualization of abstract accounting concepts, thereby facilitating deeper conceptual understanding.

Compared to conventional learning media, such as textbooks and PowerPoint, RekonX-AR provides a more interactive and student-centered learning environment. This aligns with the current curriculum orientation that emphasizes active learning and the integration of digital technology. The combination of AR visualization, multimedia content, and case-based learning also supports the development of higher-order thinking skills and practical competencies. However, several limitations were identified based on student feedback, including the need for improved system performance and additional interactive features. These findings indicate that continuous development and refinement are necessary to optimize the effectiveness and scalability of the media. Overall, the results confirm that RekonX-AR not only addresses the learning problems identified in the preliminary study but also aligns with

contemporary learning theories and technological demands. Therefore, the developed media can be considered both feasible and effective as an innovative learning tool in vocational accounting education, particularly for complex topics such as bank reconciliation.

## CONCLUSION

This study demonstrates that the development of RekonX-AR, an interactive learning media integrating Smart Apps Creator 3 and Assemblr Edu, successfully produced a valid and practical learning medium that supports students' understanding of bank reconciliation through interactive multimedia and Augmented Reality (AR). The findings highlight that combining digital applications with AR visualization can create more meaningful, engaging, and student-centered learning experiences, suggesting that technology integration should emphasize not only digitalization but also conceptual understanding and active learning. From an academic perspective, this study contributes to the growing body of knowledge on technology-enhanced learning by presenting an integrated learning media that combines interactive multimedia and AR within vocational accounting education, thereby extending the application of these technologies beyond science-related disciplines. Nevertheless, this study was limited to product development and small-group implementation without examining learning effectiveness through experimental comparison. Therefore, future research should investigate the effectiveness of RekonX-AR using larger samples and experimental designs, expand its implementation to other accounting topics or educational contexts, and further enhance its interactive features to support more adaptive and personalized learning experiences.

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