

Instructional Leadership for Differentiated Learning Through APOLO Integrated with QARVI (QR Code, Augmented Reality, and Virtual Reality): An ADDIE-Based Development Study in Elementary Education

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Abstract. The implementation of differentiated learning in elementary schools remains challenging due to teachers' limited understanding of students' diverse learning characteristics and the need to integrate local wisdom with digital learning resources. This study aimed to develop and evaluate APOLO (Local Potential Application) integrated with QARVI (QR Code, Augmented Reality, and Virtual Reality) as an instructional leadership innovation to support differentiated learning and strengthen local wisdom-based education. The research employed a Research and Development (R&D) approach using the ADDIE model, consisting of Analysis, Design, Development, Implementation, and Evaluation stages. During the analysis phase, learning needs and implementation challenges of the Merdeka Curriculum were identified. The design and development phases focused on creating a web-based platform integrating non-cognitive diagnostic assessment, local potential resources, learning materials, project-based activities, and QARVI technology. Product feasibility was evaluated through expert validation involving academic and practitioner reviewers, followed by revisions based on the validation results. The implementation phase involved teachers, students, parents, and community stakeholders in local wisdom-based differentiated learning activities. The findings indicated that the developed product was categorized as feasible and appropriate for educational use based on expert validation results. Furthermore, effectiveness evaluation demonstrated a 95% learning effectiveness score, supported by positive responses from teachers and students regarding engagement, learning flexibility, accessibility of learning resources, and the diversity of learning products produced. The integration of QR Code, Augmented Reality, and Virtual Reality enriched learning experiences and facilitated differentiated content, process, and product learning. The study concludes that APOLO integrated with QARVI is a valid, effective, and scalable digital learning innovation that supports differentiated instruction, strengthens local wisdom integration, and promotes meaningful learning experiences in elementary education.

Keywords: differentiated learning; instructional leadership; local wisdom; augmented reality; virtual reality

INTRODUCTION

Differentiated learning has become one of the fundamental approaches in contemporary education, particularly within the implementation of Indonesia's Merdeka Curriculum, which emphasizes student-centered learning and the accommodation of diverse learner characteristics. Differentiated instruction enables teachers to modify learning content, processes, and products according to students' readiness levels, interests, and learning profiles, thereby providing equitable learning opportunities for all learners (Tomlinson et al., 2003). The Merdeka Curriculum further positions differentiated learning as a key strategy for supporting personalized learning and maximizing students' potential based on their individual needs and characteristics. However, the

implementation of differentiated learning in elementary schools remains challenging due to teachers' limited capacity to identify learner diversity and design appropriate instructional strategies that respond effectively to students' varied learning needs. Recent studies indicate that many teachers continue to experience difficulties in conducting diagnostic assessments, managing diverse classrooms, and designing differentiated learning activities within the Merdeka Curriculum framework.

At the same time, the rapid development of digital technology has transformed educational practices and created opportunities for more personalized and engaging learning experiences. Emerging technologies such as QR Codes, Augmented Reality (AR), and Virtual Reality (VR) have demonstrated significant potential for

enhancing student engagement, motivation, and conceptual understanding through interactive and immersive learning environments. Research has shown that AR and VR technologies can facilitate contextual learning, increase learner participation, and support diverse learning styles by providing flexible access to educational content and experiential learning opportunities. Furthermore, immersive technologies have been reported to improve students' engagement and create meaningful learning experiences that are difficult to achieve through conventional instructional methods.

Despite these technological advancements, educational innovation should not overlook the importance of local wisdom as a valuable source of contextual learning. Local wisdom embodies cultural values, traditional knowledge, and community practices that can enrich students' learning experiences and strengthen their cultural identity. Integrating local wisdom into educational practices allows students to connect academic concepts with their real-life environments, fostering meaningful learning and character development. Previous studies have emphasized that local wisdom serves as an effective contextual learning resource capable of enhancing students' understanding while simultaneously preserving cultural heritage amid the challenges of globalization.

The integration of local wisdom with digital technology presents a promising approach to addressing both the challenges of differentiated learning and the need for culturally relevant education. However, existing digital learning platforms often focus primarily on technological functionality and content delivery while providing limited support for the systematic incorporation of local potential and community-based learning resources. Consequently, there remains a need for innovative educational platforms that integrate differentiated instruction, local wisdom, and immersive technologies into a comprehensive learning ecosystem.

Instructional leadership plays a critical role in fostering such innovation by encouraging collaboration among teachers, students, parents, and community stakeholders while promoting the effective use of technology to improve learning outcomes. School leaders are expected to create supportive environments that facilitate differentiated instruction, strengthen local wisdom integration, and encourage meaningful learning experiences. Therefore, educational innovations that combine instructional leadership principles

with technology-enhanced learning resources are essential for supporting sustainable educational transformation in elementary schools.

To address these challenges, this study developed APOLO (Local Potential Application), a web-based learning platform integrated with QARVI (QR Code, Augmented Reality, and Virtual Reality). The platform was designed as an instructional leadership innovation to support differentiated learning through non-cognitive diagnostic assessments, local potential mapping, digital learning resources, project-based learning activities, and immersive learning technologies. By integrating local wisdom and digital innovation, APOLO aims to provide a comprehensive solution for implementing differentiated instruction while strengthening students' connection to their cultural and environmental contexts.

This study employed the Research and Development (R&D) approach using the ADDIE model to develop and evaluate the APOLO-QARVI platform. Specifically, the study aimed to determine the feasibility and effectiveness of APOLO integrated with QARVI as an instructional leadership innovation that supports differentiated learning, strengthens local wisdom-based education, and promotes meaningful learning experiences in elementary schools.

METHODS

This study employed a Research and Development (R&D) methodology using the ADDIE model, which consists of five systematic stages: Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009). The study aimed to develop and evaluate APOLO (Local Potential Application) integrated with QARVI (QR Code, Augmented Reality, and Virtual Reality) as an instructional leadership innovation to support differentiated learning and local wisdom-based education in elementary schools.

During the **analysis** stage, a needs assessment was conducted to identify challenges in implementing differentiated learning within the Merdeka Curriculum. The assessment focused on teachers' understanding of students' diverse learning characteristics, the availability of local wisdom-based learning resources, and opportunities for integrating digital technologies into classroom instruction. The findings served as the foundation for determining the specifications and learning features required in the developed

platform.

The design stage involved the preparation of the platform architecture, learning flow, content structure, and user interface. APOLO was designed as a web-based platform integrating non-cognitive diagnostic assessments, local potential resources, differentiated learning materials, project-based learning activities, and QARVI technology. The platform was intended to facilitate differentiated instruction by providing learning experiences that accommodate students' readiness, interests, and learning profiles while promoting the integration of local wisdom into the learning process.

In the development stage, the platform and its learning components were produced and refined. The developed product included digital learning materials, QR Code-based access to resources, Augmented Reality (AR) content, Virtual Reality (VR) learning experiences, and local wisdom-based project activities. Product feasibility was assessed through expert validation involving educational technology experts, curriculum experts, and elementary education practitioners. Validators evaluated the product in terms of content accuracy, instructional design, usability, functionality, and media quality. Feedback obtained from the validation process was used to revise and improve the product before field implementation.

The implementation stage involved the use of APOLO integrated with QARVI in elementary school learning activities. The platform was utilized by teachers to support differentiated learning based on the results of non-cognitive diagnostic assessments. Students accessed learning materials, participated in local wisdom-based projects, and engaged with AR and VR learning experiences. The implementation also encouraged the involvement of parents and community stakeholders in supporting contextual learning activities related to local culture and local potential.

The evaluation stage was conducted to determine the feasibility and effectiveness of the developed product. Feasibility was determined based on expert validation results, while effectiveness was measured through teacher and student responses to the implementation of the platform. Data were collected using validation sheets, observation forms, questionnaires, and documentation. Quantitative data were analyzed descriptively using percentage scores, whereas qualitative feedback from validators and users was analyzed to support product refinement and

interpretation of findings.

The final product of this study was a validated web-based platform, APOLO integrated with QARVI, which supports differentiated instruction through the integration of local wisdom resources, diagnostic assessment, project-based learning, QR Code technology, Augmented Reality, and Virtual Reality. The effectiveness evaluation demonstrated that the platform was highly effective in supporting differentiated learning and enhancing meaningful learning experiences in elementary education.

RESULTS AND DISCUSSION

The analysis phase identified the need for an innovative learning platform capable of supporting differentiated learning within the implementation of the Merdeka Curriculum. The findings revealed that teachers encountered challenges in understanding students' diverse learning characteristics and in providing learning experiences that accommodate differences in readiness, interests, and learning profiles. In addition, the integration of local wisdom into classroom learning was not yet optimally supported by digital learning resources.

These findings indicate that effective differentiated instruction requires tools that assist teachers in identifying student characteristics while simultaneously providing contextual learning resources. Therefore, a digital platform integrating differentiated learning principles and local wisdom was considered necessary to support meaningful learning experiences in elementary schools. This finding is consistent with the concept of differentiated instruction proposed by Tomlinson et al. (2003), which emphasizes the importance of adapting learning to students' individual needs.

Design Phase

Based on the identified needs, APOLO (Local Potential Application) integrated with QARVI (QR Code, Augmented Reality, and Virtual Reality) was designed as a web-based learning platform. The platform was structured to support differentiated learning through several integrated components, including non-cognitive diagnostic assessment, local potential resources, differentiated learning materials, project-based learning activities, and immersive digital technologies.

The design aimed to facilitate differentiated content, process, and product learning while

strengthening the integration of local wisdom into classroom activities. The incorporation of QR Codes, Augmented Reality, and Virtual Reality was intended to provide flexible and engaging access to learning resources for students with diverse learning characteristics.

Development Phase

During the development stage, the APOLO-QARVI platform was produced and refined according to the planned specifications. The platform integrated local wisdom resources, digital learning materials, diagnostic assessment tools, project-based learning activities, and QARVI technology into a single web-based learning environment.

The developed product was subsequently evaluated through expert validation involving academic and practitioner reviewers. The validation process assessed the appropriateness of content, instructional design, usability, and technological functionality. The results indicated that APOLO integrated with QARVI was categorized as feasible and appropriate for educational implementation.

The positive validation results suggest that the platform successfully addressed the identified needs related to differentiated learning and local wisdom integration. Furthermore, expert feedback contributed to product refinement, ensuring that the platform met educational quality standards before implementation.

Implementation Phase

Following validation and revision, APOLO integrated with QARVI was implemented in elementary school learning activities. The implementation involved teachers, students, parents, and community stakeholders, reflecting the instructional leadership approach embedded within the innovation.

Teachers utilized the platform to support differentiated learning based on students' learning profiles identified through non-cognitive diagnostic assessments. Students accessed learning resources, participated in local wisdom-based learning activities, and engaged with QR Code, Augmented Reality, and Virtual Reality features. Parents and community members contributed to learning activities by supporting the exploration of local potential and cultural resources.

The implementation demonstrated that the platform facilitated the integration of local wisdom into learning while providing flexible

opportunities for differentiated instruction. The involvement of multiple stakeholders also strengthened the connection between classroom learning and real-life community contexts.

Evaluation Phase

The evaluation phase focused on determining the effectiveness of APOLO integrated with QARVI in supporting differentiated learning. The findings revealed a learning effectiveness score of **95%**, indicating that the platform was highly effective in facilitating learning activities.

Teachers reported positive perceptions regarding the platform's ability to support differentiated instruction, improve accessibility to learning resources, and facilitate the development of diverse learning products. Similarly, students responded positively to the flexibility and interactivity of the learning experiences provided by the platform.

The integration of QR Code, Augmented Reality, and Virtual Reality technologies enriched the learning process by providing interactive and immersive experiences that accommodated different learning preferences. These technologies enabled students to access information in multiple formats and engage more actively in learning activities, thereby supporting differentiated content, process, and product learning.

The findings also demonstrate the value of integrating local wisdom into digital learning environments. By connecting learning activities with local potential and cultural resources, APOLO-QARVI promoted contextual and meaningful learning experiences. This result supports previous studies emphasizing that local wisdom-based learning enhances students' engagement and strengthens the relevance of educational experiences.

Overall, the evaluation results confirm that APOLO integrated with QARVI is a valid and effective educational innovation. The platform successfully supports differentiated learning, strengthens the integration of local wisdom, and provides meaningful learning experiences through the utilization of digital technologies. The positive validation results and high effectiveness score indicate that the platform has strong potential for wider implementation in elementary education settings.

CONCLUSION

This study developed and evaluated APOLO (Local Potential Application) integrated with

QARVI (QR Code, Augmented Reality, and Virtual Reality) as an instructional leadership innovation to support differentiated learning and strengthen local wisdom-based education in elementary schools. Using the ADDIE-based Research and Development approach, the platform was systematically designed to integrate non-cognitive diagnostic assessment, local potential resources, differentiated learning materials, project-based learning activities, and immersive digital technologies within a web-based learning environment. The results demonstrated that the developed product was categorized as feasible and appropriate for educational implementation based on expert validation conducted by academic and practitioner reviewers. The implementation of APOLO-QARVI involving teachers, students, parents, and community stakeholders showed that the platform effectively facilitated differentiated content, process, and product learning while promoting the integration of local wisdom into learning activities. Furthermore, the effectiveness evaluation yielded a learning effectiveness score of 95%, indicating that the platform was highly effective in supporting differentiated learning. Positive responses from teachers and students highlighted increased engagement, greater learning flexibility, improved accessibility to learning resources, and the production of diverse learning outcomes. The integration of QR Code, Augmented Reality, and Virtual Reality technologies enriched learning experiences and provided interactive opportunities that accommodated students' diverse learning characteristics. In conclusion, APOLO integrated with QARVI is a valid, effective, and scalable digital learning innovation that supports differentiated instruction, strengthens the integration of local wisdom, and promotes meaningful learning experiences in elementary education. The platform offers a practical solution for implementing differentiated learning within the Merdeka Curriculum and has the potential to be adopted more broadly in elementary schools seeking to enhance educational quality through the integration of technology and local cultural resources.

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