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Transformation of Vocational Learning Through Augmented Reality: An Innovative Concept for Strengthening Visual Skills in Culinary Vocational Schools

Fitriyana*, Didik Nurhadi
Universitas Negeri Malang, Indonesia
Email: fitriyana.2505518@students.um.ac.id*, didik.nurhadi.ft@um.ac.id

ABSTRACT

The development of digital technology in the era of the Industrial Revolution 4.0 requires vocational education to adapt to more interactive, contextual, and competency-based learning approaches. This study addresses critical challenges in Culinary Vocational High Schools (SMK), where students demonstrate low visual-spatial skills in understanding complex culinary techniques such as precision cutting, artistic plating, and creative decorating. This article proposes the concept of Augmented Reality (AR)-based learning as a vocational education transformation strategy that integrates digital learning experiences with real-world practices. The study employs a comprehensive conceptual analysis methodology, synthesizing theoretical frameworks from the Cognitive Theory of Multimedia Learning and Experiential Learning Theory with contemporary research on AR applications in vocational education published between 2020 and 2025. The proposed conceptual model, AR-based Experiential Culinary Learning (ARECL), combines the principles of the Cognitive Theory of Multimedia Learning and Experiential Learning Theory to create an immersive, collaborative, and hands-on experience-based learning process. Through this integrated theoretical approach, the ARECL model is expected to significantly enhance students' visual-spatial competencies, increase intrinsic learning motivation through interactive engagement, strengthen procedural skill development, and establish an adaptive vocational learning ecosystem that effectively prepares students for the dynamic challenges of the modern culinary industry. The implications of this conceptual framework extend to curriculum development, teacher professional development programs, and strategic industry-education partnerships that can collectively transform vocational education delivery in the digital age.

KEYWORDS Augmented Reality, Vocational Learning, Visual Skills, Innovation, Culinary Vocational School

INTRODUCTION

Vocational learning faces complex issues and challenges in the digital age: the rapid digitalization process is often not balanced by an increase in adequate practice facilities; many vocational school students exhibit low visual skills and weak concept representation, especially in programs such as *Culinary Arts*; and the limitations of practical media make the "hands-on" experience less realistic and repetitive, thus hindering the transfer of skills to the world of work (Wiley Handbook of VET, 2020; Pranita, 2025). These challenges are compounded by pressure to close the gap between dynamic industry standards and schools' capacity to provide safe, cost-effective, and repeatable practices without sacrificing the quality of learning (Wiley Handbook of VET, 2020).

In this context, technology-based learning is a strategic need for vocational schools. Technology integration not only provides digital content but also offers new ways to conduct more flexible and measurable practice, simulation, and competency assessments (Han, 2021; Merdeka Centre of Excellence guidelines, 2022). The *Merdeka Curriculum* emphasizes project-based learning, collaboration with the world of work, and the improvement of practical experience—an approach that will gain significant added value when paired with digital tools able to replicate real working conditions (Ministry of Education and Culture Centre of Excellence, 2022).

Augmented Reality (AR) is emerging as a highly relevant technology to overcome the limitations of visualization and practice media in vocational education (Saini, 2022). AR allows for the overlay of 2D/3D objects and interactive instructions onto the real environment, so that students can "see" food structures, cutting techniques, tool placement, or production steps in real time without the risk of material waste or safety hazards (Majil, 2022). Recent research and reviews show that AR can improve conceptual comprehension, procedural skills, task efficiency, and practical confidence—especially in subjects that require fine visual and motor skills such as *Culinary Arts*. Therefore, AR is not just a digital accessory but a pedagogical tool that strengthens the bridge between theory and practice.

The relevance of strengthening AR-based learning aligns with the national and global agenda: the *Independent Curriculum*, which emphasizes learning outcomes, link-and-match with the world of work, and project-based learning; and SDG 4 (Quality Education) goals that demand quality, inclusive, and innovative education for all by 2030 (UNESCO; SDG Secretariat). The integration of AR in *Culinary Vocational Schools* can be considered a concrete step toward realizing quality education that is responsive to workforce needs while supporting broader development goals such as reducing skills gaps and increasing graduates' employability.

Based on these problems and opportunities, this conceptual article aims to propose a concept of *Augmented Reality*-based vocational learning transformation specifically designed to strengthen the visual skills of Vocational School of Culinary Sciences students. The specific objectives proposed include: (1) formulating an AR pedagogical framework for the learning of visual skills and culinary practices; (2) identifying an implementation model aligned with the principles of the *Independent Curriculum*; and (3) proposing policy implications and practice recommendations for the development of teaching materials, teacher training, and industry collaboration as a basis for further research and pilot projects. This concept is expected to help bridge the gap between the needs of the culinary industry and the capacity of practice in vocational schools.

METHOD

This article employed conceptual approaches and theoretical analysis focused on developing ideas. The writing process involved a literature review and in-depth theoretical analysis to formulate a conceptual model of vocational learning transformation through Augmented Reality (AR). It integrated relevant theories and studies published between 2020 and 2025 related to the application of AR in vocational education, visual-spatial learning, and experiential learning approaches.

The development of this conceptual article proceeded through three main stages. First, a comprehensive literature review identified issues, opportunities, and gaps in the use of AR in Culinary Arts learning. Second, theoretical analysis examined the relationship between the Cognitive Theory of Multimedia Learning (Mayer, 2021) and Experiential Learning Theory (Kolb, 1984) as the conceptual basis of experiential learning. Third, conceptual synthesis combined theoretical insights and practical implications into an AR-based Experiential Culinary Learning (ARECL) model aimed at strengthening students' visual and procedural skills in vocational education.

This article did not involve empirical data collection or hypothesis testing. Its focus was on literature-based conceptual argumentation and the development of integrative frameworks to guide future research or implementation trials in vocational high school settings. Selection of recent, reputable, and indexed sources ensured the validity and relevance of the theories included.

RESULTS AND DISCUSSION

Vocational Education in the Era of the Industrial Revolution 4.0

Vocational education in the era of the Industrial Revolution 4.0 has undergone a significant paradigm shift, from conventional instructional-based learning to a learning model based on technology, competencies, and real experiences. According to the ILO (2021), vocational education must adapt to the characteristics of the digital era that demands flexibility, creativity, and technological literacy as the main competencies of the modern workforce. Meanwhile, vocational education in Indonesia, including in Vocational High Schools (SMK), still faces the challenge of the gap between the world of education and industrial needs, both in terms of facilities, digital skills, and the adaptive abilities of teachers and students (Wahyudi, 2022).

The new paradigm of vocational learning emphasizes the integration between digital skills and practical competencies, with a primary orientation on work-based learning and blended learning (Han & Reeves, 2021). Vocational learning not only functions to transfer knowledge, but also creates a collaborative, adaptive, and simulation-based learning ecosystem so that students can experience work situations that resemble the industrial world (OECD, 2020). Technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), Virtual Reality (VR), and Augmented Reality (AR) open up new opportunities to strengthen the learning process of practices that were previously limited by space, time, and resources (Mahmud & Sani, 2023).

In the context of vocational education in the field of Culinary Arts, this digital transformation presents an opportunity to overcome the limitations of physical laboratories and practical materials. Through technologies such as AR, teachers can create immersive learning experiences that allow students to understand cooking techniques, plating, or the use of kitchen utensils with realistic visual representations without the risk or waste of materials (Ministry of Education and Culture, 2022). Thus, the transformation of vocational education in the era of the Industrial Revolution 4.0 is not only about digitizing tools, but also a paradigm shift towards experiential-based learning, collaboration, and sustainable innovation.

Augmented Reality in the Context of Education

Augmented Reality (AR) is a technology that combines two- or three-dimensional virtual objects into the real environment in real-time, so that users can interact with digital information that seems to be present in the physical world (Azuma, 2021). The main characteristics of AR include the integration of the real and virtual worlds, live interactivity, and the ability to display dynamic spatial visualizations (Cai et al., 2022). In the context of education, AR has great potential to increase learning *engagement*, conceptual understanding, and knowledge retention because it provides a more contextual and multisensory learning experience (Mayer, 2021).

The benefits of AR in vocational learning include improving the ability to visualize abstract concepts, simulating complex procedures without risk, and strengthening practical skills through exploration-based learning experiences (Majil et al., 2022). In engineering and vocational learning, AR allows students to understand machine mechanisms, material structures, or operational steps with high accuracy through digital overlays. Recent research by Al-Ansi (2023) found that the use of AR in engineering education improves students' procedural skills by 35% compared to conventional methods. A similar thing is also found in the culinary field: AR helps students understand the anatomy of foodstuffs, cutting techniques, and food decoration with better efficiency (Nurhayati & Saputra, 2024).

In addition, AR also supports self-paced learning and experiential learning approaches, where students can learn based on their own rhythm and learning style. In the context of Culinary Vocational Schools, AR can be used to visualize recipes, cooking instructions, and food presentations in an interactive three-dimensional format. This technology significantly helps students with visual-spatial intelligence to develop fine motor skills and technical precision that are key in the culinary profession (Widyawati & Hanum, 2023). Thus, AR plays a role not just as a digital tool, but as a bridge that enriches the learning experience, strengthens connections between theory and practice, and fosters 21st-century skills such as creativity, collaboration, and problem-solving.

Visual Skills in Culinary Learning

Visual skills are a fundamental aspect of culinary learning because they are directly related to students' ability to identify, construct, and represent culinary concepts into real practice forms. In the context of vocational education, visual skills include the ability to understand proportions, shapes, colors, textures, and layouts in food serving (plating), as well as the precision of techniques such as pieces of materials and decorations (Suryani & Wibowo, 2022). This skill requires spatial sensitivity and high mental imagery skills so that students can imagine the result before the execution of the practice is carried out (Anderson & Bork, 2021).

Unfortunately, many students at Culinary Schools still have difficulty in connecting visual representations with real practice, especially due to limited learning media and practice time (Nurhayati & Saputra, 2024). This has an impact on the low precision of practice results, lack of creativity, and limitations in the exploration of new techniques. Research conducted by Rahma and Utami (2023) showed that 68% of Culinary Vocational School students had difficulty identifying the sequence of visualization of the plating process independently without interactive visual guidance.

In this case, the use of technologies such as Augmented Reality (AR) has the potential to strengthen visual skills through interactive visualization and 3D object-based simulations that resemble real conditions. AR allows students to learn food structure, ingredient composition, and decoration techniques in virtual mode before practice in the kitchen, thereby reducing the risk of errors and improving the efficiency of the learning process (Widyawati & Hanum, 2023). In addition, AR also encourages exploration-based learning, where students can rotate, zoom in, or change the angle of view of food objects to understand their spatial dimensions more deeply (Al-Ansi, 2023). Thus, strengthening visual skills through AR is not only a matter of aesthetics, but also a pedagogical strategy to improve visual literacy, technical precision, and creativity of students in the professional culinary world.

Theoretical frameworks

The use of Augmented Reality (AR) in vocational learning, particularly in the field of Culinary Arts, can be explained through two main theoretical frameworks: Cognitive Theory of Multimedia Learning (CTML) by Richard E. Mayer and Experiential Learning Theory (ELT) by David A. Kolb. These two theories provide a conceptual basis for how learners gain understanding and skills through visual experience and direct interaction with technology-based learning environments.

According to the Cognitive Theory of Multimedia Learning, effective learning occurs when students are able to integrate verbal and visual information simultaneously through dual-channel processing (Mayer, 2021). In this context, AR provides a multimodal learning environment that combines text, images, animations, and three-dimensional objects into real-life situations. This facilitates the process of active processing, where students not only passively receive information but also organize and associate it with the cognitive schema they already have (Moreno & Mayer, 2022). Thus, the use of AR can strengthen long-term memory, improve learning transfer, and enrich the conceptual understanding of Culinary Vocational School students to complex practical skills.

Meanwhile, Experiential Learning Theory (Kolb, 1984) emphasizes that knowledge is built through a cycle of direct experience consisting of four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. In AR-based learning, students experience all four stages simultaneously: they interact with virtual objects (concrete experiences), reflect on their actions through simulation (reflective observation), understand engineering concepts or procedures (abstract conceptualization), and finally apply them in real practice in school kitchens (active experiments) (Huang et al., 2022). Thus, AR becomes a medium that is very aligned with the principle of learning by doing, which is the foundation of vocational learning.

The integration of CTML and ELT in the use of AR for Culinary learning shows that technology is not just a visual aid, but part of a comprehensive cognitive and experiential learning system. AR can stimulate visual processing, strengthen students' emotional engagement, and create a more meaningful learning experience because it combines cognitive and affective dimensions simultaneously (Chang & Tsai, 2023). Thus, this theoretical foundation strengthens the argument that the transformation of vocational learning through AR has a strong scientific basis and has great potential to improve the quality of vocational education in the digital era.

The Concept of AR-Based Vocational Learning Transformation

1. Analysis of Learning Needs at Culinary Schools

Learning in Vocational High School (SMK) Culinary Arts has unique characteristics because it demands a balance between conceptual abilities and practical skills that are fine motor and aesthetic. However, the learning process still faces a number of fundamental obstacles that hinder the effectiveness of competency mastery. Based on various studies (Nurhayati & Saputra, 2024; Rahma & Utami, 2023), the main obstacles in learning culinary practices at vocational schools include: (1) limitations of visual and interactive learning media; (2) limitations of practice materials and kitchen equipment; and (3) the low ability of students to visualize the results of the cooking and decoration process.

The practical media used today are mostly still in the form of print modules, static images, and video tutorials. Although helpful, the media is one-way and is not able to provide an immersive learning experience that resembles a real work situation (Suryani & Wibowo, 2022). As a result, students have difficulty understanding the spatial dimension of certain techniques, such as differences in the shape of pieces of materials (*julienne*, *brunoise*, *dice*), or how to arrange plating with a balanced composition of colors and textures. This deficiency has an impact on the low ability to transfer knowledge from theory to practice (Anderson & Bork, 2021).

Another obstacle is the limited practice time and cost of procuring materials. In the context of vocational schools that have a large number of students and limited facilities, culinary practices are often carried out in groups with a short time. This condition reduces the opportunity for students to practice repeatedly until they achieve the expected technique accuracy (Wahyudi, 2022). As a result, learning tends to be demonstrative and teacher-centered, rather than student-centered. Therefore, an innovative learning model is needed that allows students to learn independently, repeatedly, and visually, with minimal risk and cost — one of which is through the integration of Augmented Reality (AR) technology into the learning process of culinary practices.

2. The Concept of Vocational Learning Transformation through Augmented Reality Integration

The transformation of learning at Culinary Vocational Schools must be oriented towards improving the quality of students' learning experience by utilizing the potential of digital technology, especially AR, as a bridge between theory and practice. The integration of AR in culinary practice learning allows students to *see*, *interact*, and *understand* cooking procedures and food serving techniques in a realistic and contextual three-dimensional visual format (Majil et al., 2022). For example, through an AR app, students can scan images of recipes or cookware and display 3D models that show how they are used in sequence. This makes the learning process more active, intuitive, and repetitive without having to use real materials every time.

In this transformation, the role of teachers changes significantly from instructors to technological *facilitators*. Teachers are no longer the only source of knowledge, but rather companions who help students navigate, evaluate, and reflect on AR-based learning experiences. Teachers play a role in designing digital learning scenarios, directing students' exploration of AR objects, and assessing the visual and procedural skills students develop

during the interactive process (Han & Reeves, 2021). Thus, teachers' pedagogic competencies must be developed to be able to integrate technology into instructional design creatively and relevant to the context of the culinary industry.

In addition to technology integration, it is important to maintain synergy between conventional media and AR. The blended pedagogy approach combines traditional media such as practice modules, flashcards, and live demonstrations with interactive AR applications (Widyawati & Hanum, 2023). Flashcards, for example, can feature QR codes that display 3D animations of cutting or plating techniques when scanned with a mobile device. Print modules are still used to provide theoretical guidance and reflection, while AR serves to reinforce visualization and procedural exercises. This combination provides a multimodal learning experience that simultaneously strengthens students' visual, cognitive, and psychomotor skills.

With this transformation concept, vocational learning has not only become more interesting and efficient, but also more relevant to the needs of the 21st century that demand mastery of digital literacy, visual thinking, and problem-solving skills. The integration of AR opens opportunities for Culinary Vocational Schools to create a collaborative, experience-based, and sustainable learning environment, in line with the principles of the Independent Curriculum and the Sustainable Development Goal 4 goals of quality and innovative education (UNESCO, 2023).

3. Proposed Conceptual Model

The conceptual model proposed in this article is designed to integrate Augmented Reality (AR) technology into culinary practice learning in Culinary Schools through a blended experiential learning approach. This model focuses on dynamic interaction between three main components, namely students (learners), teachers (facilitators), and AR-based learning media (digital-physical media). The main goal of this model is to create a visual, contextual, and interactive learning experience so that students can develop procedural and visual-spatial skills simultaneously.

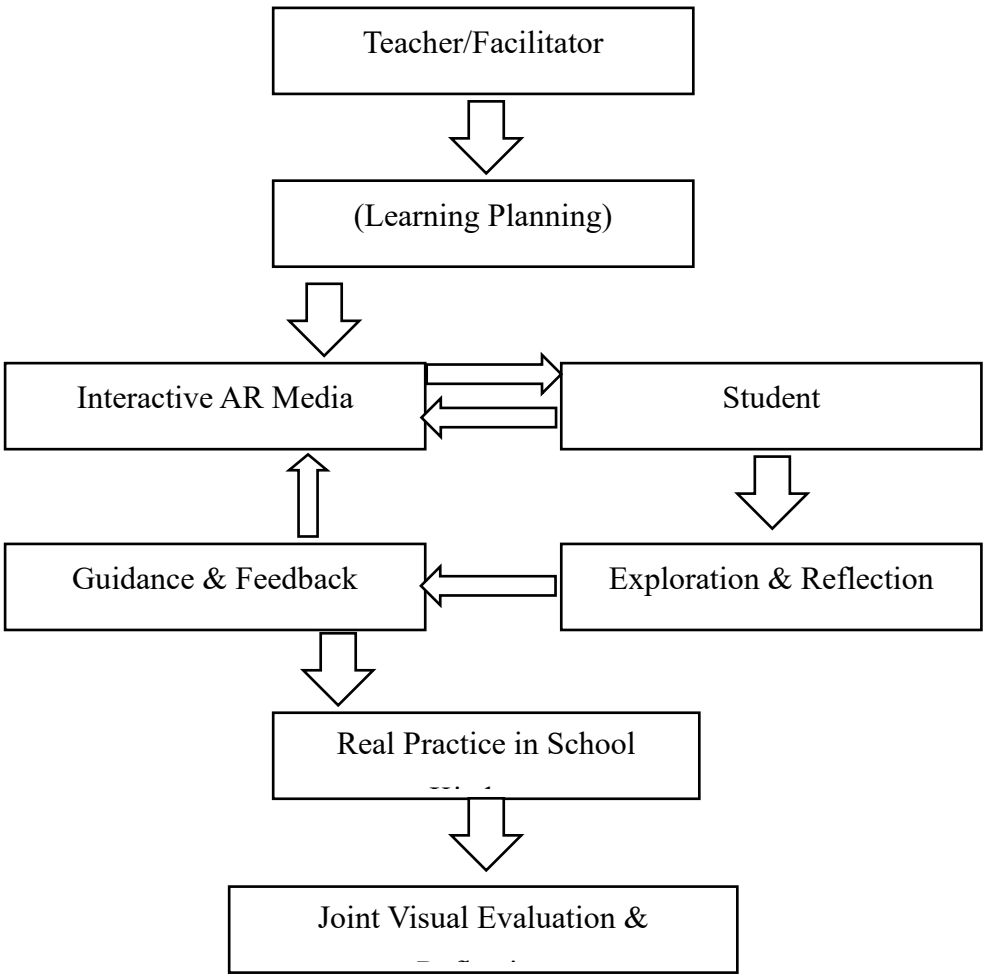
Conceptually, this model consists of four main interconnected stages, describing an experiential learning cycle (Kolb, 1984) modified with the principles of Cognitive Theory of Multimedia Learning (Mayer, 2021):

1. Visual Immersion: in this stage, students are introduced to culinary concepts and procedures through AR media that displays 3D objects such as kitchen utensils, groceries, or plating results. Through a mobile phone or tablet, students can scan the images on the module or flashcard to see a simulation of cooking techniques, the shape of the cuts, or the color combinations of the presentation. This process stimulates dual-channel brain processing (verbal and visual), so that students get a more concrete and in-depth picture of the concepts to be practiced (Mayer, 2021).
2. Guided Interaction: The teacher acts as a facilitator who directs students' exploration of AR media. At this stage, students engage in active interactions such as rotating objects, comparing models, or following step-by-step visual instructions. The teacher provides conceptual guidance, explains the meaning of each technique, and assesses the extent to which students understand the visual procedures and work sequences. This stage strengthens cognitive scaffolding and helps students build connections between theoretical knowledge and practical skills (Han & Reeves, 2021).

3. Applied Simulation: After understanding concepts through AR, students conduct real practice in the school kitchen with reference to digital guides. This stage represents active experimentation in the experiential learning cycle (Kolb, 1984). AR is still used as a visual aid that allows students to independently recheck procedures during practice. This multisensory experience develops psychomotor skills and engineering precision, especially in decoration, ingredient cutting, and food presentation.
4. Reflective Evaluation: The final stage is reflection and feedback. Teachers and students jointly evaluate the results of the practice by comparing the final product with the AR model. Through visual reflection, students analyze the suitability of shapes, colors, textures, and techniques with the expected standards. Teachers use the results of observations to assess the development of students' visual and procedural skills in a more objective and evidence-based manner (Chang & Tsai, 2023).

Conceptual Model Interaction Flow

This model can be described in the form of the following conceptual flow:



Information:

- Two-way interaction (⇄) indicates a collaborative relationship between students and AR media, where students become not only passive users but also decision-makers in visual exploration.

- The role of teachers is described as a facilitator who designs learning scenarios, provides reflective feedback, and assesses digital experience-based learning processes.
- Real practice becomes the point of integration between the digital world (AR) and the physical world (culinary laboratory), ensuring a balance between simulation and hands-on application.

Mechanism of Strengthening Visual Skills and Procedural Comprehension

AR strengthens visual skills through the presentation of rich spatial representations, allowing students to understand the shapes, proportions, and relationships between objects in a culinary context. In culinary learning, this ability is important to achieve aesthetic and functional results that are in accordance with industry standards (Suryani & Wibowo, 2022). AR also supports *visual scaffolding*, where students learn from a gradual representation from the basic shape to the final stage of food presentation.

Meanwhile, an improvement in procedural understanding was obtained through simulation of interactive work steps. When students observe the sequence of movements in AR, they build a procedural schema that can be applied in real practice (Moreno & Mayer, 2022). Research by Widyawati and Hanum (2023) shows that the use of AR in vocational learning can increase the accuracy of students' movements by 30% and accelerate the time to achieve practical competencies by up to 25%. Thus, this conceptual model not only increases the effectiveness of learning, but also the efficiency of the skill mastery process.

Overall, this AR-based Experiential Culinary Learning (ARECL) conceptual model combines the power of cognitive theory and experience to deliver more visual, reflective, and adaptive vocational learning. This model is in line with the direction of Indonesia's vocational education policy and the vision of SDG 4 on innovative education that promotes sustainable employment skills in the 21st century.

Implications and Development Direction

1. Implied theorem

Theoretically, the concept of Augmented Reality (AR)-based vocational learning transformation makes an important contribution to the development of vocational learning theory and digital learning in the era of the Industrial Revolution 4.0. The proposed AR-based Experiential Culinary Learning (ARECL) conceptual model expands the application of the Cognitive Theory of Multimedia Learning (Mayer, 2021) by adding dimensions of visual-spatial interaction and multisensory experiences in the context of vocational education. In this model, 3D visualization and contextual interaction are the main mediums in strengthening dual-channel processing and meaningful learning, where students not only understand information cognitively, but also internalize skills procedurally (Moreno & Mayer, 2022).

In addition, the ARECL model also strengthens the relevance of Experiential Learning theory (Kolb, 1984) in the realm of modern vocational learning. By utilizing AR, the learning experience cycle—concrete experience, reflective observation, abstract conceptualization, and active experimentation—can be presented simultaneously and iteratively without space or time limitations (Huang et al., 2022). Thus, this concept not only enriches the theory of experiential vocational learning, but also presents a new framework for digital experiential learning, namely

the integration of concrete experiences with immersive digital media to build sustainable practical skills.

Furthermore, conceptually this model confirms that the transformation of vocational education cannot be separated from the dimensions of visualization and spatial cognition. This means that visual skills are not just additional skills, but the core of technology-based vocational learning that connects visual perception with real actions (perceptual-motor linkage). This can broaden perspectives in the study of vocational learning theory, especially in the fields of culinary, engineering, and design, where visual mastery is the main prerequisite for successful learning and work (Anderson & Bork, 2021).

2. Practical Implications

In practical terms, the AR-based learning model provides significant benefits for various stakeholders in the vocational education environment, especially teachers, students, and educational media developers.

For teachers, this concept expands their role from just instructors to technological pedagogue. Teachers can use AR as a supporting medium for demonstrations of cooking techniques or food decoration, as well as as a visual assessment tool to evaluate students' precision and creativity (Han & Reeves, 2021). In addition, AR helps teachers create safer and more efficient learning environments, as many risky procedures (e.g. cutting techniques or the use of hot equipment) can be simulated digitally in advance.

For students, AR provides a self-paced, interactive, and contextual learning experience. Students can learn at their own pace, repeat as many stages of the procedure as necessary, and develop visual-spatial skills without having to wait for a live demonstration from the teacher. This process fosters self-directed learning and increases intrinsic motivation as students feel more engaged in the learning process (Chang & Tsai, 2023).

Meanwhile, for media developers and instructional designers, the ARECL concept opens up opportunities to create a collaborative digital learning ecosystem between the world of education and the technology industry. Developers can design interactive modules, local recipe-based AR simulations, or adaptive learning systems that adjust the difficulty level to the student's ability. Thus, this innovation can strengthen collaboration between vocational education institutions, the culinary industry, and the creative technology sector in the development of educational products that are relevant to employment needs (Mahmud & Sani, 2023).

3. Development Direction and Plan

This conceptual idea has great potential to be further developed into research and development (R&D) and digital vocational education innovation projects. The initial stage of development can be focused on prototyping an interactive AR module for one specific Culinary subject, for example "Basic Cooking Techniques" or "Cake Decorating and Plating." This prototype can be tested on a limited basis in vocational schools with a design-based research approach to evaluate its effectiveness in improving students' visual skills and practice performance (Nurhayati & Saputra, 2024).

In the next stage, advanced research can develop adaptive learning models that utilize user data analysis to tailor AR displays to students' learning speeds and styles. In addition,

innovation projects can be expanded into industry-educational collaborations, where app developers, professional chefs, and Culinary gurus jointly design content on recipe visualizations, cooking techniques, and AR-based industrial kitchen simulations. This collaboration is in line with the direction of Indonesia's vocational education link and match policy launched by the Ministry of Education and Culture (2022), and supports the achievement of Sustainable Development Goal 4 on quality, relevant, and innovation-based education.

Thus, the direction of the development of this idea is not only to create new technological products, but to build a new paradigm of vocational learning that is adaptive, inclusive, and future-oriented where technology does not replace practice, but enriches and strengthens students' learning experiences as creative and competent professional workforce candidates in the digital age.

CONCLUSION

The transformation of vocational learning in the Industrial Revolution 4.0 era demands a shift from traditional methods to interactive, technology-based approaches, with Augmented Reality (AR) serving as a strategic innovation to bridge theory and practice in Vocational High Schools. AR offers immersive, simulation-based experiences that help students grasp complex work procedures and abstract concepts, aligning with the *Merdeka Belajar* vision and SDG 4 goals for quality, innovative education. In Culinary Arts, AR enhances visual skills crucial for mastering practical techniques by enabling precise, repeated practice unconstrained by physical resources. This integration enriches experiential learning, fostering students' creativity, confidence, and professional readiness. However, further empirical research is needed to evaluate the effectiveness of AR in this context. Future studies should focus on developing an AR prototype for Culinary Vocational Schools and assessing its impact on learning outcomes, visual skills, and motivation, employing research and development or design-based research methods to evaluate feasibility, usability, and acceptance among teachers and students.

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