Exploring the Impact of Augmented and Virtual Reality Technologies in Culinary Education for VET Students

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EDX707 Research Design Development and Method

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Introduction

Culinary education within the framework of Vocational Education and Training (VET) in Australia and globally is at a critical juncture. The need to align traditional teaching methods with the evolving demands of the hospitality industry and the diverse needs of students has become increasingly urgent. This is particularly evident in Australia, where completion rates for VET programs remain alarmingly low, and a growing skills gap exists between industry expectations and educational outcomes. As a cookery teacher at a TAFE institution in Victoria, I have witnessed these challenges first-hand in Certificate III and IV Cookery courses, where students face numerous hurdles in their educational journey.

Addressing these challenges is essential, and the emergence of modern learning technologies, such as Augmented Reality (AR) and Virtual Reality (VR), offers promising solutions to reform vocational education. AR/VR has the potential to enhance student engagement, improve practical skills, and ultimately bridge the gap between educational outcomes and industry expectations. By providing immersive, interactive learning environments, these technologies can address critical issues such as safety, efficiency, and the overall educational experience for VET students. This study is guided by the central question**:**

Can Augmented and Virtual Reality technologies enhance culinary vocational education?

This research explores AR/VR's multifaceted roles in improving student learning experiences, equipping them with the practical skills necessary to meet industry standards. By examining the transformative potential of these technologies, this study aims to determine whether AR/VR can revolutionise culinary education, significantly improving student outcomes and better preparing them for the demands of the industry.

Research Problem

Low completion rates and the widening gap between educational outcomes and industry demands have become significant challenges within the Australian VET sector. According to the National Centre for Vocational Education Research (NCVER), only 43% of students enrolled in VET programs at TAFE institutions complete their courses

(NCVER, 2023b). This figure is even lower in culinary education, where the demanding kitchen environment and risks associated with handling hazardous equipment, such as knives, frequently result in injuries that disrupt students' learning. A review of industry safety records shows that common injuries include muscle strains, cuts, burns, and bruises (Lippert et al., 2020). New students are particularly vulnerable, and these injuries often lead to a loss of motivation. In severe cases, extended recovery times result in prolonged absences or even withdrawal from the course.

Graduates transitioning from VET programs into the workforce often report a significant gap between the skills they learned and the competencies required by employers. They frequently lack sufficient practical experience, and their training does not fully prepare them for the fast-paced, demanding kitchen environment. Employers have expressed dissatisfaction with VET training, citing concerns about the low quality of training, a lack of relevant skills, and insufficient focus on practical abilities (NCVER, 2023a). This misalignment between industry expectations and educational outcomes severely affects graduates' employability and career progression (Siekmann & Circelli, 2021).

Two key factors contribute to this gap: the ever-evolving nature of the hospitality industry and the slow-changing, rigid structure of training packages in VET programs. The rapid pace of change in the culinary industry, driven by technological advancements and shifting consumer demands, is often not matched by the VET sector's ability to adapt its curriculum. Industry stakeholders, training providers, employers, and governments have voiced concerns that training packages are cumbersome and slow to update, leaving qualifications outdated for extended periods (Joyce, 2019, pp. 53-54). Many employers have reported that the slow development of training packages fails to meet their rapidly changing skills needs, leaving industries with insufficient influence over qualification content (Joyce, 2019, pp. 53-54).

Additionally, traditional training methods have remained largely unchanged for decades and are increasingly seen as inadequate for equipping students with the practical, hands-on skills necessary in the culinary arts (Spöttl & Windelband, 2021). As a result, there is an urgent need to explore more innovative, flexible approaches to training that better align with both industry expectations and the realities of modern culinary education.

Purpose of the Study

Considering these challenges, I have engaged in discussions with colleagues at my institution, including fellow educators and industry professionals, about the potential of modern learning technologies to address the disconnect between industry demands and educational curricula. These discussions highlighted the need for flexible, upgradable technologies to enhance the learning experience, ultimately improving student engagement and completion rates. AR/VR emerged as promising solutions during these conversations, offering immersive and interactive environments that can bridge the gap between theoretical knowledge and practical skills in culinary education.

AR is a technology that overlays digital content, like images, sounds, or data, onto the real world in real time, creating an enhanced user experience by integrating virtual and physical elements. AR offers immersive learning experiences in education, improving memory retention and engagement by making abstract or complex concepts more accessible and understandable (Çöl et al., 2023, p. 3).

VR is a technology that creates fully immersive, computer-simulated environments, allowing users to interact with 3D models as if they were real. In education, VR enhances experiential learning by placing students in realistic simulations, helping them develop practical skills. VR supports skill acquisition and retention by engaging multiple senses preparing learners for real-world challenges (Çöl et al., 2023, p. 4).

The primary purpose of this study is to explore and evaluate the impact of AR/VR technologies on culinary education within the Australian VET sector. This research is motivated by the need to address the critical challenges currently facing the field, particularly in the context of low completion rates and the gap between educational outcomes and industry expectations. By investigating how these immersive technologies can enhance learning outcomes for culinary students, this study aims to provide insights that can inform the development of more effective and inclusive training methods.

Despite the recognised potential of AR/VR in various educational contexts, there is a notable lack of research exploring their effectiveness in culinary training within the VET sector (Stender et al., 2021). This gap underscores the need for a systematic investigation into how these technologies can enhance learning outcomes in culinary education.

This led me to undertake this research to explore how AR/VR applications can enhance culinary training in the VET sector. My study investigates the research question of whether AR VR technologies can enhance culinary VET. The paper will explore emerging themes from both areas and suggest ways these technologies can be utilised in the culinary VET sector to enhance learning. Key considerations include whether the realistic and engaging training experiences offered by AR/VR have the potential to bridge the gap between industry expectations and educational outcomes and whether these technologies can enable students to develop the practical skills needed to meet industry standards, thereby improving their employability and career prospects.

By systematically exploring the impact of AR/VR on culinary training, this study aims to provide valuable insights that can inform the development of more effective training methods. Integrating AR/ VR into culinary education represents a technological upgrade and a fundamental shift in how culinary skills can be taught, practised, and assessed. The findings of this research could potentially lead to a paradigm shift in how culinary education is delivered and experienced.

Benefits of the Study

This study will primarily benefit my professional learning by deepening my understanding of the practical applications of AR/VR in culinary education. As a teacher in the VET sector, gaining insights into these technologies will enable me to experiment with innovative methods that better support student engagement and skill development.

The findings from this research will be shared with colleagues in the Cookery department at my TAFE institution and with curriculum and assessment leaders involved in developing training programs. This can foster discussions about integrating AR/VR into the curriculum and teaching methods to enhance student outcomes, ensuring that students acquire the practical skills and knowledge necessary for success in the workforce.

In conclusion, this research seeks to explore how AR/VR technologies can enhance the educational experiences of VET students, particularly in the culinary domain. The insights gained will serve as a foundation for future exploration and discussion within my teaching practice and may inspire gradual shifts toward more innovative, technology-integrated teaching methods in my workplace.

Background literature review

AR/VR technologies are reshaping education by providing immersive experiences that simulate real-world environments. While widely adopted in fields like technology and manufacturing, their use in culinary education is still emerging. The following sections examine AR/VR applications in VET, focusing on culinary education, and address the potential benefits, challenges, and research gaps.

AR/VR in Vocational Education and Training (VET)

AR/VR technologies are becoming increasingly prominent in VET due to their ability to enhance student engagement and practical skill development. The hands-on nature of VET aligns well with AR/VR's ability to simulate real-world conditions, bridging the gap between theoretical learning and practical application (Stender et al., 2021). These immersive technologies support the development of both cognitive and psychomotor skills, offering learners realistic environments to practice their skills (Gorman et al., 2022; Schott & Marshall, 2021). In industries such as medicine and manufacturing, AR/VR has proven effective in enhancing skill acquisition by enabling safe, interactive experiences that would otherwise be high-risk or cost-prohibitive (Chiang et al., 2022).

AR allows students to engage with virtual elements while remaining connected to the physical world, making abstract concepts easier to understand (Stender et al., 2021). On the other hand, VR creates fully immersive environments where learners can practice complex tasks such as surgeries or machinery operations without the associated risks or costs (Gorman, 2019). VR is particularly valuable in technical education, where practical training can often be costly or hazardous (Papachristos et al., 2018).

In addition to enhancing skill development, AR/VR addresses logistical challenges in VET by reducing reliance on expensive physical equipment and facilities (Moonen et al., 2024). However, budget constraints and technical difficulties impede widespread adoption (Huang et al., 2024). As these technologies become more affordable and user-friendly, their integration into VET is expected to grow (Catenazzi et al., 2023).

In summary, AR/VR are transforming VET by offering immersive, interactive experiences that enhance practical skill development while also addressing logistical

and financial challenges. These technologies can potentially improve the accessibility and effectiveness of VET, particularly in high-risk and resource-intensive fields. As AR/VR evolve, their use in VET will likely expand, providing scalable and flexible solutions for students and institutions.

AR/VR in Culinary Education

Culinary VET equips students with practical skills for careers in the food and hospitality industries, focusing on hands-on experience in real-world kitchens to develop competencies in food preparation, hygiene, and safety (Mellet-d'Huart, 2009). However, integration of digital technologies like AR/VR has been slower in culinary VET compared to other fields (Papachristos et al., 2018).

High costs for facilities, ingredients, and specialised equipment make these programs expensive, particularly for remote learners (Tsang, 1997). AR/VR technologies offer solutions by offering virtual environments where students can practice culinary tasks safely without physical resources, improving learning outcomes (Gorman, 2019; Gorman et al., 2022).

Though still emerging, AR/VR applications in culinary education seem promising. For example, AR has been used for food safety training, allowing students to practice visual inspections (Liberty et al., 2023). Projects like "Virtual Chef" enable simulated cooking practices, reducing the need for costly infrastructure (Papachristos et al., 2018), and VR virtual classrooms have boosted engagement in food safety and kitchen operations (Gorman, 2019).

The benefits seen in other technical fields, enhanced engagement, retention, and hands-on learning indicate that AR/VR could similarly benefit culinary education (Mikropoulos & Natsis, 2011). While AR/VR show promise, more research is needed to explore their effectiveness and applications in culinary VET (Stender et al., 2021). Their broader adoption will require further empirical validation and exploration.

Gaps in Literature

The literature reveals notable gaps in applying AR/VR technologies in culinary VET. Research on integrating AR/VR into culinary education is still emerging, with limited exploration of how these technologies can be fully utilised in vocational fields like culinary arts (Chiang et al., 2022). Additionally, spatial representation of learning

content in Virtual Reality Learning Environments (VRLEs) remains underexplored in culinary education, leaving a gap in understanding how these environments can enhance practical skills (Belani et al., 2023).

While research has highlighted using AR/VR for essential competencies like hygiene training, advanced culinary techniques such as knife skills and plating have received little attention (Kauppinen et al., 2021). The long-term effects of VR on skill retention and learning outcomes in VET also remain unclear, as Gorman (2019) emphasises. Studies on the cost-effectiveness and sustainability of these technologies are similarly scarce (Huang et al., 2024).

Moreover, the cognitive and behavioural implications of multisensory AR in VET are under-researched, particularly in how these technologies can cater to students with diverse learning needs (Karunanayaka et al., 2021). Saad et al. (2022) further suggest that while VR applications are expanding, there is a limited understanding of the long-term behavioural effects of such training in culinary contexts.

This study addresses these gaps by exploring how AR/VR technologies can enhance culinary VET and reshape its delivery.

Theoretical Underpinnings

Constructivism

Constructivism, as outlined by Piaget (1970), emphasises active knowledge construction through interaction with one's environment. AR/VR technologies provide virtual environments where learners can engage in immersive, hands-on experiences that support constructivist learning. Liberty et al. (2023, p. 5) highlight how AR facilitates constructivist learning by allowing learners to interact with digital elements and construct knowledge through real-time experiences. Similarly, Papachristos et al. (2018, p. 368) suggest that virtual environments in VET foster constructivist learning by simulating real-life scenarios where learners actively make decisions and engage in hands-on activities. This active engagement aligns with the principles of constructivism. Additionally, Bada and Olusegun (2015, p. 4) argue that VR supports constructivism by creating learner-centred environments where students can interact with cooking scenarios, developing practical expertise through experiential learning.

Experiential Learning

Kolb's (2014) experiential learning theory is highly relevant to AR/VR applications in VET. These technologies enable students to learn through doing, immersing them in practical tasks that reflect real-world scenarios. Projects like the "Virtual Chef" offer simulated kitchen environments where students can engage in experiential learning through practical tasks, such as food preparation, without the risks associated with physical resources (Papachristos et al., 2018, p. 371). VR environments provide opportunities for experiential learning by allowing students to practice essential culinary skills, such as cooking and food safety, in a risk-free, repeatable virtual setting (Gorman, 2019). Hu et al. (2023, p. 8) further emphasise that VR offers repeated, hands-on training opportunities in simulated environments, which is key to the principles of experiential learning.

Cognitive Load Theory

Cognitive load theory, developed by Sweller (1988), posits that learning is optimised when extraneous cognitive load is minimised, allowing learners to focus on essential information. AR/VR technologies can reduce cognitive load by breaking down complex tasks into smaller, manageable segments and providing real-time feedback. Liberty et al. (2023, p. 3) point out that AR reduces cognitive load by offering immediate feedback, minimising cognitive strain during complex tasks. Similarly, Chiang et al. (2022, p. 6) highlight how AR simplifies training processes, making it easier for learners to focus on mastering specific skills without becoming overwhelmed by the entire task. VR also helps manage the cognitive load by segmenting tasks and minimising extraneous elements, as Belani et al. (2023, p. 2) noted.

Gamification and Motivation Theories

Motivation is critical to successful learning, and AR/VR technologies often incorporate gamification to enhance student engagement. According to Self-Determination Theory (SDT), learners are motivated when they experience autonomy, competence, and relatedness (Deci & Ryan, 1985). Gamification elements like rewards, challenges, and leaderboards integrated into AR/VR environments have been shown to boost motivation and engagement. For example, Chiang et al. (2022, p. 6) note that gamified AR applications increase learners' motivation and confidence by incorporating rewards

and feedback, which can be essential in VET. Similarly, Gorman (2019, p. 6) further highlights that gamification strategies like scoreboards and points in VR environments increase engagement and motivation in food-based education, driving learners to excel in practical tasks.

Methodology

Research Paradigm

This project adopted a pragmatic research paradigm, which prioritises practical outcomes and real-world solutions over universal truths (Morgan, 2014). Pragmatism shaped the decision to conduct a systematic literature review, allowing for the synthesis of diverse AR/VR applications in culinary education. This approach is well-suited for exploring how AR/VR can enhance VET student engagement, learning outcomes, and skill development. The research aims to provide evidence-based strategies that VET educators can use to improve teaching practices and student outcomes (Creswell & Creswell, 2017).

Research Design

This study used a qualitative systematic literature review, a method that follows explicit and rigorous procedures to synthesise existing research, ensuring transparency and reproducibility (Newman & Gough, 2020). This approach enabled the exploration of AR/VR applications in culinary education, identifying gaps and evaluating their impact on engagement, skill acquisition, and learning outcomes.

Following a configurative synthesis logic suited to qualitative research, this methodology offered flexibility in adapting to new insights while maintaining a structured framework for study selection and analysis (Newman & Gough, 2020). Systematic reviews are ideal for synthesising diverse findings and generating actionable insights that inform educational practice (Creswell & Creswell, 2017). Given the variability in terminology and measures in educational technology, this approach was appropriate for identifying key themes and trends in AR/VR's use in VET (Tai et al., 2020).

The systematic review process included defining research questions, search strategies, study selection, and synthesis of findings using predefined methods (Newman & Gough, 2020). This structure facilitated the generation of new understandings about the challenges and opportunities presented by AR/VR in culinary VET.

Search Strategy

A comprehensive search strategy was developed to ensure that relevant and high-quality studies were selected for analysis. The search was conducted across several electronic databases, including ERIC (ProQuest), Scopus, and Education Research Complete (EBSCO), accessed through Deakin Library resources. Searches were performed between August 8th and 11th, 2024. Filters were applied to include only peer-reviewed studies and full-text availability, ensuring the selection of high-quality literature. This process narrowed down relevant sources that explored the intersection of AR/VR technology and culinary VET.

Search Terms, Keywords, and Strings

The search terms were carefully designed to capture relevant studies discussing the application of AR/VR technologies in culinary VET. The strategy was structured around three main categories: Culinary Education, Vocational Education, and Augmented and Virtual Reality. Boolean operators (e.g., "AND," "OR") and truncation were used to optimise the search. For example, searches used combinations such as "augmented reality" OR "virtual reality" AND "culinary education" OR "vocational training" to ensure comprehensive results.

The keywords and search strings, detailed in Table 1, included a combination of broad terms (e.g., "Culinary Education") and more focused terms (e.g., "Immersive Learning in Culinary"). This approach ensured that the search captured studies covering the technological, educational, and practical aspects of AR/VR in culinary VET (Newman & Gough, 2020; Tai et al., 2020).

Table 1.

Systematic review search terms

Category	General Keywords	Combined Keywords
General	Culinary Education	AR/ VR in Culinary Training
	Vocational Education and Training (VET)	AR VR in Vocational Education
	Augmented Reality (AR)	AR VR in Culinary Education
	Virtual Reality (VR)	Immersive Learning in Culinary
	Interactive Learning	Immersive Educational Technology
	Learning Technologies	AR/VR for Culinary Skill Development
	Gamification in Education	AR/VR in Vocational Culinary Training
		AR/VR in Food Education
Search Strings	Interactive Learning in Culinary	
	Augmented Reality in Culinary Education	
	Virtual Reality in Culinary Education	
	Augmented Reality and Virtual Reality in Vocational Education	
	Immersive Learning Technologies in Culinary Education	
	Virtual Reality for Culinary Training	
	Interactive Learning with AR VR in Culinary Education	
	Engaging Learning Experiences in Culinary with AR VR	
	AR/VR in Commercial Kitchen Training	
	Gamification and Collaborative Learning in Culinary Arts	
	Culinary Safety Training with AR/VR	
	AR/VR in Hospitality and Culinary Arts	

Note: This table presents the keywords and search strings used for the systematic review focusing on AR/VR technologies in culinary and vocational education.

Inclusion and Exclusion Criteria

Inclusion and exclusion criteria were carefully applied to ensure the relevance and rigour of this systematic review. The focus was on studies involving AR/VR technologies in vocational and culinary training, specifically those offering empirical evidence on student learning outcomes, engagement, or skill development within immersive AR/VR environments.

The criteria were refined during the screening process to align with the project's objectives (Tai et al., 2020). Only peer-reviewed studies from 2019–2024 were included, ensuring credibility. Preference was given to studies with data on learning outcomes, immersion, user experience, and skills development in vocational education contexts. Studies published before 2019 that lacked peer review or had no empirical data were excluded, along with those focused on non-educational sectors or irrelevant contexts. This ensured the review remained targeted on culinary VET. Table 2 below outlines the detailed inclusion and exclusion criteria applied during the review process.

Table 2

Systematic Review Inclusion and Exclusion Criteria

Study Variables	Inclusion Criteria	Exclusion Criteria
Relevance to Research Question	Studies that focus on VR or AR in culinary education. Comprehensive data on learning outcomes, immersion, and user experience in AR/VR. Studies on VR/AR in hospitality or VET training contexts.	Studies unrelated to VR/AR applications in education or vocational training. Primary focus on special education or contexts not directly relevant to culinary VET education.
Publication Date	Published within the last five years (2019–2024).	Published before 2019.
Peer-reviewed Sources	Articles published in peer-reviewed journals or credible academic sources.	Non-peer-reviewed articles, grey literature, blogs, or opinion pieces.
Study Design	Empirical studies, comparative studies, or systematic literature reviews. Studies with comprehensive data on learning outcomes, immersion, cognitive, and manual skills training.	Theoretical papers without empirical data or studies lacking clear methodology. Focus on applications of AR/VR in non-educational sectors such as customer satisfaction.
Vocational Context	Studies conducted in VET or culinary training contexts. Focus on food-based education, student perspectives, or technical subjects.	Studies focusing on the home environment or non-VET contexts. Studies unrelated to skill development in culinary or hospitality education.
Technology Focus	Studies on VR/AR applications in educational contexts.	Studies unrelated to AR/VR technology in educational contexts.

From 35 initial citations, two duplicates were excluded. After screening by title, abstract, and full-text review, 25 studies were retained for final analysis. This structured process enabled a robust synthesis of AR/VR's effectiveness in enhancing student engagement and learning outcomes (Braun & Clarke, 2006).

Data Analysis

Once the relevant studies were identified, a structured data extraction process was employed to ensure consistency and thoroughness. Essential information, including the title, authors, publication year, journal/source, and critical themes, was systematically extracted and organised in an Excel spreadsheet for detailed analysis (Appendix 1, Table 3). This method facilitated a comprehensive examination of the role and application of AR/VR technologies in culinary VET, ensuring all relevant data were systematically captured (Tai et al., 2020).

The coding framework utilised in this study combined both deductive and inductive approaches. Key themes such as enhanced engagement, improved learning outcomes, and accessibility challenges related to AR/VR applications were identified, following Braun and Clarke's (2006) six-phase approach to thematic analysis. This iterative framework ensured that themes were consistently refined, promoting thorough analysis and enabling the synthesis of relevant literature (Tai et al., 2020).

The thematic analysis process facilitated identifying and exploring recurring patterns, key insights, and themes within the selected literature, enabling a structured approach to data interpretation. This section details each phase of the thematic analysis

process, integrating additional insights from Creswell and Creswell (2017), Kuckartz (2019), and Cohen et al. (2002) to inform the data analysis methodology.

Phase 1: Familiarisation with the Data

The first step involved repeatedly reading the 25 selected papers to engage with their content fully. Known as "progressive focusing" (Cohen et al., 2002, p. 648), this phase began with a broad perspective before narrowing down key data features. This process captured emerging patterns and trends, laying the foundation for coding. Key observations were recorded using a thematic analysis template (Appendix 2, Table 4), facilitating the identification of potential themes and analytical categories (Braun & Clarke, 2006).

Phase 2: Generating Initial Codes

After familiarisation, I systematically reviewed the data to generate initial codes. Creswell and Creswell (2017) describe coding as assigning category labels to specific data. Descriptive codes captured elements like "immersion" and "student engagement," while analytic codes interpreted patterns, grouping these under broader concepts such as "enhanced engagement through AR/VR." Braun and Clarke (2006) highlight coding as an interpretative task where the researcher actively shapes the data's meaning. Cohen et al. (2002, p. 669) further note that coding helps identify themes by grouping similar data.

Phase 3: Searching for Themes

After generating initial codes, the next step was to collate them into potential themes. Braun and Clarke (2006, p. 89) describe this phase as grouping similar codes into conceptual categories that address the research question. Kuckartz (2019) highlights that themes emerge through iterative analysis using category-based and case-oriented approaches. I clustered related codes into broader thematic groupings aligned with the research focus, resulting in five initial themes, which were later refined to four:

1. Enhanced Engagement and Motivation through Immersive AR/VR Environments
2. Improved Learning Outcomes via AR/VR-Driven Cognitive and Psychomotor Development
3. Personalised Learning Environments and Adaptive Feedback in AR/VR

4. Integrating Cultural and Contextual Learning in AR/VR Technologies (initially identified, later refined out)
5. Usability and Accessibility Challenges in AR/VR for Culinary Education

Each theme represented a core aspect of how AR/VR technologies influence and enhance learning experiences within culinary education.

Phase 4: Reviewing Themes

This phase involved revisiting the themes alongside the original coded extracts. Braun and Clarke (2006) state that themes must "cohere together meaningfully" and accurately reflect the dataset. Each theme was critically assessed to ensure it captured the essence of the data and aligned with the research question. Cohen et al. (2002) suggest that early analysis can help focus on significant features, reducing data overload. During this review, the theme 'Integrating Cultural and Contextual Learning in AR/VR Technologies' was excluded due to insufficient empirical support in the literature. This refinement ensured that only well-supported themes were retained, enhancing the overall validity of the findings.

Phase 5: Defining and Naming Themes

In this phase, themes were clearly defined and named to capture their core meanings. Braun and Clarke (2006) stress that each theme must be distinct and identifiable. The themes were refined into coherent narratives that addressed the research question and reflected underlying data patterns. For example:

- **Theme 1: Enhanced Engagement and Motivation** highlighted how AR/VR boosts student engagement by immersing them in dynamic virtual environments.
- **Theme 2: Cognitive and Psychomotor Skill** Enhancement focused on how AR/VR aids the development of practical skills while supporting cognitive learning.
- **Theme 3: Personalised Learning and Adaptive Feedback** captured AR/VR's ability to support individualised learning through real-time feedback.
- **Theme 4: Usability and Accessibility Barriers** addressed AR/VR adoption challenges, such as cost and usability issues.

As Cohen (2002) notes, this process moves from description to theory generation, capturing the essence of each theme.

Phase 6: Producing the Report

The final phase involved synthesising the thematic findings into a coherent narrative, with each theme supported by literature. Braun and Clarke (2006) emphasise that writing is integral to analysis, not a separate task. The themes were presented to describe the data and interpret their broader implications for AR/VR's role in enhancing culinary education. Reflexive practices were incorporated, acknowledging the researcher's active role in shaping the narrative (Creswell & Creswell, 2017). This analysis demonstrated how AR/VR technologies can revolutionise culinary education by boosting student engagement, improving learning outcomes, and addressing integration challenges.

Ethical Considerations

Although this study did not involve human participants, ethical considerations remained crucial to the research process. As this was a systematic literature review, all data used were publicly available, and no ethical risks were associated with the study. The research adhered to the ethical standards and codes of conduct set by Deakin University and aligned with the principles outlined in the National Statement on Ethical Conduct in Human Research (National Health and Medical Research Council [NHMRC], Australian Research Council, & Universities Australia, 2023). As Beauchemin et al. (2022) discussed, transparency and adherence to ethical principles were maintained throughout the research process by documenting each methodology step, including search strategies, inclusion/exclusion criteria, and data extraction.

The Research Supervisor reviewed and validated the templates used for data extraction, minimising bias and reflecting best practices in responsible research conduct.

Consideration of Bias

Reflexivity was integral to the coding and thematic analysis, ensuring personal biases and perspectives were addressed throughout the research process. As Braun and Clarke (2006, p. 80) highlight, researchers actively shape the identification and interpretation of patterns in data, making it essential to reflect on how their views may affect the analysis. To mitigate this, I critically examined how my background in culinary

education and interest in AR/VR could influence the selection of themes. This reflexive approach ensured that coding decisions were grounded in the data, enhancing the credibility of the findings (Braun & Clarke, 2006).

Researcher reflexivity was further employed by documenting key decisions during coding and thematic development, promoting transparency and reducing bias. Creswell and Creswell (2017) emphasise that reflexivity supports the transition from description to theory generation in qualitative research, ensuring the integrity of the process. By remaining aware of how personal beliefs and values could influence theme development, the study aimed to present a balanced, evidence-based analysis of AR/VR technologies in education, contributing to credible and trustworthy findings (Braun & Clarke, 2006; Creswell & Creswell, 2017).

Finding and discussion

This analysis examines the potential of AR/VR technologies to enhance culinary education in VET. A thematic analysis of 25 academic papers identified four key themes below. Each theme is explored in depth, with reference to relevant educational theories and supported by current literature, to demonstrate how AR/VR technologies can transform traditional teaching approaches in culinary education.

Theme 1: Enhanced Engagement and Motivation

Immersive AR/VR technologies significantly enhance student engagement and motivation by creating dynamic, realistic environments that facilitate interactive, hands-on learning. Papachristos et al. (2018) observed that students were motivated by the novelty and interactivity of virtual classrooms. Huang et al. (2024) demonstrated how VR headsets immerse students in 3D culinary settings, allowing them to practice tasks in a virtual space. This aligns with findings from Stender et al. (2021), who noted that AR/VR fosters deeper immersion compared to other media by reducing distractions and allowing learners to interact directly with virtual objects and scenarios. The ability to interact with virtual elements transforms passive learning into active engagement, aligning with constructivist principles outlined by Piaget (1970) that emphasise active knowledge construction through experience.

Incorporating gamification further enhances motivation by making learning more enjoyable. AR simulations incorporating challenges and rewards significantly increased participation and focus (Bista & Garcia-Ruiz, 2021; Zakaria et al., 2022). By promoting intrinsic motivation, AR/VR aligns with Self-Determination Theory (SDT), which highlights the role of autonomy and competence in sustaining motivation (Deci & Ryan, 1985). Students' ability to control their learning pace and explore various pathways reinforces a sense of mastery and competence, which is crucial for maintaining long-term engagement.

Studies by Laine et al. (2024) and Hu et al. (2023) demonstrated that students gained confidence and enthusiasm through immersive learning experiences. Simulating real-life culinary challenges in a consequence-free environment reduces anxiety, allowing students to build confidence and experiment freely without fear of failure (Belani et al., 2023; Huang et al., 2024).

AR/VR technologies significantly enhance student engagement and motivation in culinary education by creating immersive, interactive environments. Grounded in Constructivist Learning Theory and Self-Determination Theory, these technologies offer gamification and simulations of real-world challenges, keeping students motivated and engaged in their learning journey.

Theme 2: Cognitive and Psychomotor Skill Enhancement

AR/VR technologies significantly enhance cognitive and psychomotor learning outcomes in culinary education by providing task-based, hands-on simulations that closely resemble real-world culinary practices.

Cognitive Development

AR/VR technologies enhance cognitive learning by providing visual simulations that make abstract culinary concepts easier to understand and retain. Chiang et al. (2022) found that AR training significantly improved long-term memory, with students better comprehending vocational tasks. Gorman (2019, p. 76) reported that repeated virtual practice boosted retention, especially for complex tasks like food safety and recipe costing. This immersive approach fosters deeper engagement, leading to improved learning outcomes.

The benefits align with Sweller's Cognitive Load Theory (1988), which posits that breaking complex tasks into smaller steps reduces cognitive strain and improves focus. Levyta & Kusdiana (2023, p. 6) further highlighted how AR simplifies intricate culinary techniques, reducing cognitive overload and enhancing learning effectiveness. This engagement supports the development of practical skills, as discussed in the next section.

Psychomotor Development

AR/VR technologies effectively enhance psychomotor skills, such as knife handling and food preparation, by allowing students to practice technical tasks in safe virtual environments. Levyta & Kusdiana (2023) found that AR simulations enabled students to master basic cooking techniques faster than through written instructions, with visual guides accelerating skill acquisition.

A key advantage of VR is the ability to safely practice dangerous tasks, like using sharp knives or handling hot surfaces, without real-world risks (Saad et al., 2022). Papachristos et al. (2018) noted that repeated VR practice allowed students to refine skills like knife handling more efficiently than in traditional settings.

In conclusion, AR/VR technologies have significant potential to improve cognitive and psychomotor learning outcomes in culinary education by offering immersive, interactive simulations that enhance both knowledge retention and skill mastery.

Theme 3: Personalised Learning and Adaptive Feedback

AR/VR technologies are pivotal in creating personalised learning environments by offering real-time, adaptive feedback tailored to individual student needs. This approach is valuable in VET, where students with diverse backgrounds and skill levels require differentiated instruction.

A significant advantage of AR/VR is its ability to provide immediate feedback, enabling students to correct mistakes as they occur. Levyta & Kusdiana (2023) observed that AR systems delivered real-time feedback on cooking techniques, allowing learners to adjust instantly. Stender et al. (2021) and Hu et al. (2023) found that real-time feedback improved understanding and proficiency and built student confidence, fostering ongoing improvement in their skills.

In addition to immediate feedback, AR/VR technologies support self-paced learning by allowing students to revisit content at their own pace. Belani et al. (2023) highlighted the flexibility AR/VR offers, enabling students to progress at individual speeds based on their learning needs. Huang et al. (2024, p. 12) noted that AR/VR systems can dynamically adjust task difficulty, creating a personalised learning path tailored to each learner's performance. This adaptability is crucial in VET, where learners vary in experience and confidence. Moonen et al. (2024) further supported this by pointing out how AR/VR encourages higher engagement through interactive, differentiated instruction that responds to individual needs.

Despite these strengths, challenges remain in fully personalising AR/VR technologies. Laine et al. (2024) cautioned that some AR/VR systems still rely on a "one-size-fits-all" approach, which can reduce effectiveness for students with more nuanced

or complex learning requirements. This limitation highlights the need for further research into customisable AR/VR solutions that can better accommodate diverse learning styles and individual needs, particularly in VET settings with varied learner profiles.

In conclusion, AR/VR technologies offer significant potential for enhancing personalised learning through adaptive feedback and self-paced learning pathways in VET. However, as Laine et al. (2024) noted, further advancements are necessary to ensure that AR/VR systems fully accommodate the wide range of learning preferences and needs.

Theme 4: Usability and Accessibility Barriers

While AR/VR technologies offer substantial potential for enhancing learning outcomes, their adoption in culinary VET faces significant challenges like high costs, physical discomfort, technical limitations, and digital literacy barriers.

High Costs

The high cost of AR/VR hardware, especially headsets, remains a significant obstacle for educational institutions, particularly those with limited budgets (Huang et al., 2024). More affordable, non-immersive alternatives, while practical, often lack the interaction required for effective training (Huang et al., 2024).

User Discomfort and Physical Strain

Prolonged use of AR/VR headsets can lead to discomfort, such as nausea, dizziness, and neck strain. Schott and Marshall (2021, p. 104) found that simulator sickness affected users' ability to engage fully, while Laine et al. (2024, p. 12) noted that heavy headsets caused neck strain.

Technical and Digital Literacy Barriers

AR/VR systems require a certain level of technological literacy, which can be challenging for students unfamiliar with advanced digital tools. Yigitbas and Mazur (2024) found that older students struggled to navigate AR systems, reducing their engagement. The complexity of these systems can also overwhelm some learners (Laine

et al., 2024). Smaller institutions lacking technical support face further difficulties managing and troubleshooting these systems (Huang et al., 2024).

Limitations in Tactile and Sensory Feedback

While AR/VR excels at providing immersive visual and auditory experiences, it struggles to replicate tactile feedback, which is crucial in culinary training. Karunanayaka et al. (2021) highlight that current haptic technologies are underdeveloped, making it difficult to simulate tasks like knife handling. Duggal et al. (2022) echoed this, noting the inability of VR systems to deliver hands-on culinary experiences fully.

In summary, AR/VR technologies face significant challenges in culinary education, including high costs, physical discomfort, digital literacy barriers, and underdeveloped tactile feedback. Addressing these issues is essential to making AR/VR more accessible and effective in VET programs.

Synthesis of the Discussion

The analysis confirms that AR/VR technologies significantly enhance culinary education in VET programs. These technologies boost engagement and motivation by creating immersive, interactive environments that promote active learning. Aligned with Self-Determination Theory (Deci & Ryan, 1985), AR/VR fosters intrinsic motivation, as demonstrated by Huang et al. (2024) and Papachristos et al. (2018), who highlight its capacity to transform passive learning into active participation.

AR/VR also improves cognitive and psychomotor skills by offering safe, simulated environments for students to practice complex tasks without real-world risks. This aligns with Cognitive Load Theory (Sweller, 1988), which reduces extraneous load and facilitates skill mastery (Chiang et al., 2022; Levyta & Kusdiana, 2023; Saad et al., 2022).

Moreover, AR/VR provides personalised learning through adaptive feedback, allowing learners to self-correct and build confidence (Levyta & Kusdiana, 2023; Moonen et al., 2024). This approach mirrors Formative Assessment Theory (Black & Wiliam, 1998), emphasising the importance of continuous feedback in promoting self-regulated learning.

However, usability and accessibility challenges persist. High costs and user discomfort, such as simulator sickness, remain barriers to widespread adoption (Huang et al., 2024; Schott & Marshall, 2021). Lower technological literacy, especially among older learners, further limits access (Yigitbas & Mazur, 2024). Addressing these obstacles is crucial to fully leveraging AR/VR's potential in VET programs.

Limitations

This research on AR/VR technologies in culinary education within VET had several limitations. A significant limitation was the lack of time for obtaining ethical clearance for a self-study, resulting in a shift from a practical exploration using a VR headset to a literature review with thematic analysis. While the literature review offered valuable insights, it limited direct experimentation and pragmatic exploration of the research question.

The study also excluded technologies like Mixed Reality (MR) and Extended Reality (XR), which could have broadened the scope. Additionally, it was confined to English-language studies from specific databases, possibly missing relevant non-English research.

Most reviewed studies employed quantitative methods, providing fewer qualitative insights into learners' experiences with AR/VR. This limits understanding of the emotional and experiential impacts on students.

Finally, generalisability is restricted, as most studies were conducted in Western contexts, which may not fully represent diverse educational settings. The findings, focused on culinary education, may also not fully apply to other vocational fields with less emphasis on sensory and tactile skills.

Future Research

Further research into the long-term effects of AR/VR technologies on learner engagement is needed to determine whether their initial novelty wears off over time. Longitudinal studies that compare frequent versus sporadic AR/VR use would help assess the sustainability of motivation and learning outcomes over extended periods.

Developing cost-effective, immersive VR models and improving haptic feedback is crucial for enhancing the user experience, especially in fields like culinary education, where sensory feedback plays a key role. Addressing issues such as simulator sickness

and physical discomfort is necessary to improve accessibility and ensure that AR/VR technologies can be widely adopted across diverse learner populations (Ghasemi et al., 2024).

Further studies are necessary to evaluate how skills acquired in AR/VR environments transfer to real-world settings. Long-term research can determine how effectively virtual training prepares students for industry practices (Duggal et al., 2022).

Finally, future research should prioritise inclusivity and accessibility in AR/VR technologies to accommodate learners with diverse needs, such as those with sensory impairments or disabilities.

Conclusion

AR/VR technologies hold significant potential for transforming culinary education within VET. By creating immersive, interactive, and personalised learning environments, AR/VR has the potential to address key challenges such as improving student engagement, facilitating skill acquisition, and bridging the gap between industry expectations and educational outcomes. Research demonstrates that AR/VR enhances engagement by immersing students in hands-on learning environments that simulate real-world scenarios, aligning with Self-Determination Theory, which emphasises autonomy and competence (Huang et al., 2024; Moonen et al., 2024; Papachristos et al., 2018).

Although AR/VR can complement traditional culinary education methods, they cannot fully replace the hands-on, multisensory experience critical in professional culinary practice. AR/VR technologies excel at providing safe, simulated environments for practising essential skills like knife handling and food safety, accelerating skill acquisition and memory retention (Chiang et al., 2022; Levyta & Kusdiana, 2023). However, limitations in sensory feedback, such as underdeveloped haptic and olfactory systems, hinder full immersion, especially in tactile-based fields like culinary arts.

Additionally, AR/VR's ability to provide personalised learning and real-time adaptive feedback is a significant advantage, though challenges related to high costs, usability, and inclusivity remain (Laine et al., 2024; Zakaria et al., 2022). To fully harness the potential of AR/VR in VET, future research will need to focus on developing affordable solutions, improving sensory feedback technologies, and ensuring these systems accommodate diverse learners. As these technologies evolve, they are set to

play a transformative role in the future of VET, enhancing both the quality and inclusivity of learning experiences.

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Appendices

Appendix 1

Table 3: Tracking Selected Papers/Inclusion Criteria

Table 3

Tracking Selected Papers/Inclusion Criteria

Paper ID	Title	Authors	Year	Journal/Source	Relevance	Inclusion Criteria	Theme	Notes
P01	The impact of culinary virtual reality curriculum on students' learning outcomes and acceptance	Hu, M. L. M., Lin, H. C. K., Lin, Y. H., & Yuan, Y. H.	2023	Innovations in Education and Teaching International	High	• Relevance to VR in culinary education, • Comprehensive data on learning outcomes	Effectiveness of VR in education	Focuses on the effectiveness and acceptance of VR in culinary curriculum
P02	A virtual environment for training in culinary education: Immersion and user experience	Papachristos, N. M., Ntalakas, G., Vrellis, I., & Mikropoulos, T. A.	2018	Research on E-Learning and ICT in education: Technological, pedagogical and instructional perspectives	High	• Relevance to VR in culinary education, • Focus on immersion and user experience	Immersion and user experience in VR	Examines how VR enhances immersion and user experience in culinary training
P03	Virtual Reality (VR) in Special Education: Cooking Food App to Improve Manual Skills and Cognitive Training for SEN Students Using UDL and ICF Approaches	Carruba, M., & Covarrubias, M.	2024	International Conference on Computers Helping People with Special Needs, Springer Nature Switzerland	Medium	• Relevant to VR in education, • Focus on cognitive and manual skills training	VR cooking app to improve cognitive and manual skills	Uses VR in special education context with UDL and ICF approaches to improve skills
P04	The Culinary Student Perspective in Using Augmented Reality for Practical Class Activity	Levyta, F., & Kusdiana, R. N.	2023	2023 International Conference on Digital Applications, Transformation & Economy (ICDATE), IEEE	High	• Relevance to AR in culinary education, • Focus on student perspectives	Student perspectives on AR in culinary classes	Examines culinary students' views on using AR for practical class activities; uses TAM model and multiple regression analysis; data collected from 150 students
P05	Using immersive technologies to support food-based education	Gorman, D.	2019	Not specified	High	• Relevant immersive technologies in culinary education, • Focus on food-based	Immersive technologies in education	Explores the use of immersive technologies, inclu; includes qualitative study and student
P06	The Culinary Student Perspective in Using Augmented Reality for Practical Class Activity	Levyta, F., & Kusdiana, R. N.	2023	2023 International Conference on Digital Applications, Transformation & Economy (ICDATE), IEEE	High	• Relevance to AR in culinary education, • Focus on student perspectives	Student perspectives on AR in culinary classes	Examines culinary students' views on using AR for practical class activities; includes user study and performance measures
P07	Embedding Spatial Augmented Reality in Culinary Training: A Comparative Evaluation of sAR Kitchen and Video Tutorials	Ghasemi, Y., Bayro, A., MacDonald, J., Jeong, H., Reynolds, J., & Nam, C. S.	2023	IEEE Transactions on Learning Technologies	High	• Relevance to AR in culinary education, • Comparative study	AR in culinary training	Compares sAR Kitchen with video tutorials; includes user study, statistical analysis, and qualitative insights
P08	Needs Analysis for Virtual Reality-based Safety Training in a Commercial Kitchen	Saad, M., Haminuddin, N., Jeinie, M. H., Abdullah, N., Sahrir, M. S., & Mokhtar, M. K.	2023	Tuijin Jishu/Journal of Propulsion Technology	High	• Relevance to VR in culinary safety training, • Focus on training needs analysis	VR-based safety training	Conducts a needs analysis for VR-based safety training in commercial kitchens; includes interviews and observations to assess hazard awareness and training effectiveness
P09	Valid virtual reality applications for commercial kitchen safety training	Saad, M., Najib, M. D. H. M., & Pratt, T. J.	2022	Environment-Behaviour Proceedings Journal	High	• Relevance to VR in culinary safety training, • Focus on VR application development and validation	VR-based safety training	Designs and validates VR applications for kitchen safety; includes expert validation and positive acceptance in the hospitality industry
P10	Technology-Based Training: The Future of Using Virtual Reality Training in the Egyptian Hotel Sector	Abdelbasir, M. M. S.	2024	Minia Journal of Tourism and Hospitality Research MJTHR	High	• Relevance to VR in hospitality training, • Focus on training and skill development	VR training in hospitality	Explores adoption and prospects of VR training in the Egyptian hotel sector; includes Delphi technique with experts

P11	Implementing Virtual Reality Based Competence Recognition	Kauppinen, R., Drake, M., Anttila, K., & Lindgren, E.	2021	2021 9th International Conference on Information and Education Technology (ICIET), IEEE	High	• Relevance to VR in vocational education • Focus on competence recognition	VR in competence recognition	Discusses VR applications for competence recognition in vocational settings; includes evaluation of models and user experience using Oculus Quest VR technology
P12	Students' experiences in higher education with virtual and augmented reality: A qualitative systematic review	DePape, A. M., Barnes, M., & Petryschuk, J.	2019	Innovative Practice in Higher Education	High	• Relevance to AR/VR in education • Focus on student experiences and learning outcomes	AR and VR in higher education	Examines student experiences with AR and VR in higher education; includes a meta-synthesis and thematic analysis of learning outcomes
P13	Augmented reality for food quality assessment: Bridging the physical and digital worlds	Liberty, J. T., Sun, S., Kucha, C., Adedeji, A. A., Agidi, G., & Ngadi, M. O.	2023	Journal of Food Engineering	Medium	• Relevance to AR in food quality and safety • Focus on AR applications in food assessment	AR in food quality assessment	Explores AR's applications and impact on real-time food quality inspection, sensory evaluation, and traceability; discusses practical case studies and regulatory considerations
P14	Augmented reality and gamification in education: A systematic literature review of research, applications, and empirical studies	Lampropoulos, G., Keramopoulos, E., Diamantaras, K., & Evangelidis, G.	2022	Applied Sciences	High	• Relevance to AR in education • Systematic literature review	AR and gamification in education	Comprehensive review of AR and gamification in education, covering benefits, applications, and empirical studies; provides insights into student engagement and learning outcomes
P15	Immersion or social presence? Investigating the effect of virtual reality immersive environments on sommelier learning experiences	Moonen, N., Heller, J., Hilken, T., Danny Han, D. I., & Mahr, D.	2024	Journal of Wine Research	High	• Relevance to VR in education • Focus on immersive learning experiences	Immersive learning in wine education	Investigates the impact of VR immersive environments on sommelier learning experiences; discusses immersion and social presence
P16	Gamification and Collaborative Learning Among English Second Language Culinary Learners	Zakaria, S., Salam, A. R. H., & Kew, S. N.	2022	International Journal of Education and Pedagogy	High	• Relevance to gamification and collaborative learning in culinary education • Focus on ESL culinary learners	Gamification and collaborative learning	Examines the impact of gamification and collaborative learning on ESL culinary learners; discusses benefits and challenges
P17	An Overview of Cooking Video Games and Testing Considerations	Bista, S., & Garcia-Ruiz, M.	2021	IEEE/ACIS 20th International Fall Conference on Computer and Information Science (ICIS Fall)	Medium	• Relevance to gamification and culinary education • Focus on cooking games as educational tools	Cooking games and education	Reviews cooking video games and their usability, training, and learning components; discusses the potential of cooking games as educational tools
P18	Examining instructional technologies in hospitality and tourism education: A systematic review of literature	Huang, A., de la Mora Velasco, E., & Haney, A.	2024	Journal of Hospitality & Tourism Education	High	• Relevance to instructional technologies in education • Systematic literature review	Instructional technologies in hospitality education	Reviews VR, virtual games, social media, online courses, and simulations in hospitality education; explores benefits and challenges
P19	Potential applications for virtual and augmented reality technologies in sensory science	Crofton, E. C., Botinestean, C., Fenelon, M., & Gallagher, E.	2019	Innovative Food Science & Emerging Technologies	High	• Relevance to AR/VR in sensory science. • Focus on food industry applications	AR and VR in sensory science	Reviews potential applications of AR and VR in sensory science; discusses benefits and challenges for the food industry
P20	Augmented reality in vocational training: A systematic review of research and applications	Chiang, F. K., Shang, X., & Qiao, L.	2022	Computers in Human Behaviour	High	• Relevance to AR in vocational training. • Systematic literature review	AR in vocational training	Reviews application of AR in various industries' vocational training; analyses improvements in vocational skills and AR training technology
P21	Augmented and Virtual Reality for Diet and Nutritional Education: A	Yigitbas, E., & Mazur, J.	2024	Proceedings of the 17th International Conference on Pervasive	High	• Relevance to AR/VR in education	AR and VR in nutritional education	Reviews AR/VR applications in diet and nutrition education; discusses benefits

P22	Using AR/VR for technical subjects in vocational training–of substantial benefit or just another technical gimmick?	Stender, B., Paehr, J., & Jambor, T. N.	2021	IEEE Global Engineering Education Conference (EDUCON)	High	• Relevance to AR/VR in vocational training • Focus on technical subjects in VET	AR/VR in vocational training	Discusses AR/VR applications in vocational training, highlights didactic benefits; focuses on technical subjects and educational approaches
P23	A virtual versus an augmented reality cooking task based tools: a behavioural and physiological study on the assessment of executive functions	Chicchi Giglioli, I. A., Bermejo Vidal, C., & Alcañiz Raya, M.	2019	Frontiers in Psychology	High	• Relevance to AR/VR in cooking tasks • Focus on behavioural and physiological responses	AR/VR in cognitive and behavioural tasks	Compares VR and AR in cooking tasks; assesses executive functions, sense of presence, and physiological response
P24	Using virtual reality to enhance food technology education	Gorman, D., Hoermann, S., Lindeman, R. W., & Shahri, B.	2022	International Journal of Technology and Design Education	High	• Relevance to VR in food technology education • Focus on student engagement and practical skills	VR in food technology education	Outlines the development and testing of a VR classroom for food-based lessons; focuses on student engagement and motivation
P25	Augmented reality in vocational training: A systematic review of research and applications	Chiang, F. K., Shang, X., & Qiao, L.	2022	Computers in Human Behaviour	High	• Relevance to AR/VR in vocational training • Systematic literature review	AR/VR in vocational training	Reviews AR/VR applications in vocational training, highlights pedagogical value and future research directions

Appendix 2

Table 4: Thematic Analysis of AR/VR in Culinary Education Studies

Table 4

Thematic Analysis of AR/VR in Culinary Education Studies

ID	Title	Key Focus	Analytical Categories	Potential Themes	Relevant Quotes/Extracts with Pg no. (2 quotes per theme)	Summary with Pg no. / Notes
1.	**Examining Instructional Technologies in Hospitality and Tourism Education: A Systematic Review of Literature**	The paper's main focus is to systematically review the use of instructional technologies (including AR/VR) in hospitality and tourism education.	Types of Instructional Technologies (VR and Gamification)	Enhanced Engagement through Immersive Learning Experiences	"VR headsets increased students' engagement by immersing them in an island-based 3D environment." (pg. 117) "VR technology was primarily used to create authentic learning experiences and to mimic real-world scenarios." (pg. 127)	VR technologies provide more engaging, immersive, and realistic experiences for students, which enhance their attention and motivation. (pg. 117)
			Learning Outcomes and Engagement	Improved Learning Outcomes via Realistic Simulations	"VR simulations have been used to replicate culinary environments to teach students how to select ingredients and prepare recipes." (pg. 117) "Simulations were also used to facilitate cooking and preparation techniques through immersive and non-immersive VR tutorials." (pg. 123)	VR enhances practical learning outcomes by replicating real-world tasks, improving both cognitive and psychomotor skills. (pg. 117, 123)
			Usability and Accessibility	Challenges in Adoption and Accessibility of AR/VR	"Challenges such as users' discomfort and the high cost of implementation and development exist." (pg. 127) "Non-immersive VR offers a cost-effective alternative without significant loss of engagement or learning effectiveness." (pg. 117)	High costs, technical issues, and user discomfort are significant challenges, though non-immersive VR presents a more accessible alternative. (pg. 117, 127)
			Student-Centered Learning Approaches	Facilitation of Personalized and Adaptive Learning Environments	"The adaptability of AR and VR allows for tailored learning experiences that can cater to different skill levels." (pg. 123) "Simulations allow students to practice in a relatively short time, providing adaptive feedback." (pg. 117)	VR supports adaptive and personalized learning by adjusting the level of difficulty based on student needs, fostering autonomous learning. (pg. 117, 123)
			Cultural and Contextual Learning	Integration of Cultural and Contextual Learning	"Virtual tour-guiding platforms help students build itineraries... increasing students' awareness of cultural and environmental characteristics." (pg. 117) "VR environments were used to display cultural and tourism content, leading to increased intercultural competency." (pg. 123)	VR offers unique opportunities for students to engage with cultural contexts, fostering intercultural competencies and cultural appreciation. (pg. 117, 123)
2.	**Immersion or social presence? Investigating the effect of virtual reality immersive environments on sommelier learning experiences**	Investigates the impact of immersive experiences (VR vs CAVE) on sommelier learning outcomes	Immersive Technology	Enhanced Immersion as a Driver of Learning	1. "Immersion has been linked to enhanced learning experiences" (p. 108) 2. "VR headsets... significantly enhance the feeling of immersion compared to CAVE technology" (p. 108)	Immersion provided by VR headsets allows students to deeply engage with the learning material, which can improve outcomes such as memory retention (p. 108)
			Social Presence	Social Presence and Collaborative Learning	1. "CAVEs, which provide a shared physical space for multiple participants, can enhance the sense of social presence" (p. 109) 2. "Social presence has positive effects on learning outcomes" (p. 109)	Collaborative learning environments like CAVE allow for interaction between students, fostering knowledge exchange and better learning outcomes (p. 109)
			Multisensory Learning	Impact of Multisensory Stimuli	1. "The presence of congruent auditory cues, such as environmental sounds, can enhance the perception of being together with others" (p. 109) 2. "Ambient sound... decreases immersion" (p. 112)	Multisensory stimuli, particularly ambient sounds, can impact learning experiences differently depending on the context—either enhancing or distracting from the learning process (pp. 109, 112)
			Perceived Learning Outcomes	Trade-offs in Immersive Learning Technologies	1. "VR headsets lead to higher immersion, and CAVEs lead to higher social presence" (p. 112) 2. "The effect of VR on immersion is weaker when ambient sound is present" (p. 112)	While VR promotes immersion, it may isolate learners, whereas CAVE balances immersion and social presence, important for designing immersive learning experiences (p. 112)
			Learning Environment Comparison	Personalized Learning Environments in Culinary Education	1. "Interactive elements in VR experiences can maximize immersion" (p. 113) 2. "Customization is essential for enhanced student engagement and loyalty in immersive learning" (p. 113)	Personalized and adaptive learning environments in VR can cater to individual needs, providing more engaging and effective learning experiences (p. 113)
3.	**Investigating Spatial Representation of Learning Content in Virtual Reality**	Exploring the impact of different spatial representations of learning content on user experience	Spatial Representation in VR Learning Environments	Optimizing Spatial Representation for Enhanced Learning:	1. "The object-anchored placement scored significantly better than the TV screen and head-mounted display conditions on the user experience scales of attractiveness, stimulation, and novelty." (p. 3)	The study emphasizes that spatial representation in VR learning environments, particularly object-anchored and user-anchored placements, significantly improves user experience and

	Learning Environments	and learning outcomes in VR learning environments.			2. "Participants preferred user-anchored (controller condition) and object-anchored placement." (p. 3)	could be leveraged in culinary education to enhance student engagement. (p. 3-4)
			User Experience and Cognitive Load	Balancing Cognitive Load for Effective VR Learning	1. "The extrinsic load was higher for the TV screen condition, which can also be confirmed from our findings of the follow-up study." (p. 4) 2. "The controller-anchored placement was found to exhibit lesser extrinsic cognitive load." (p. 4)	Different spatial placements impact cognitive load, with user-anchored and object-anchored placements reducing extrinsic cognitive load. This insight is crucial for designing VR culinary training tools that are cognitively efficient. (p. 4)
			Learning Outcomes in VR	User-Centred Design in VR Educational Tools	1. "Presenting learning content on the panel anchored to the controllers was considered one of the most intuitive ways of presenting instructions by the majority of the participants." (p. 5) 2. "The TV screen placement... was considered the least preferred in comparison to the other three representations by most participants." (p. 5)	The user experience findings suggest that VR content should be designed with user preferences in mind, prioritizing intuitive and accessible content placements. This could enhance the usability of VR culinary training modules. (p. 5-6)
			Instructional Design in VR	Impact of Content Placement on Knowledge Transfer	1. "No significant differences in knowledge gain were found between the different placement conditions." (p. 3) 2. "The object-anchored placement condition resulted in the second-highest transfer scores." (p. 4)	While the study didn't find significant differences in knowledge gain across different spatial placements, the higher transfer scores in object-anchored conditions suggest that this placement might better support the practical application of skills learned in VR. This is relevant for culinary education, where skill transfer to real-world environments is critical. (p. 3-4)
4.	**Immersive Virtual Reality for Complex Skills Training: Content Analysis of Experienced Challenges**	Examining the challenges adult participants experienced in immersive VR during self-discovery of game mechanics and assembly tasks.	Challenges with Hardware and Controllers	Adapting to VR Hardware and Interaction	1. "It took some time for the participants to become accustomed to the controllers and their interaction depth." (pg. 11) 2. "The head-mounted display was heavy on my neck." (pg. 12)	The study highlighted the physical and functional challenges that users face when interacting with VR hardware, particularly for those less experienced. (pg. 10-12)
			Instruction Timing and Content	Effectiveness of Instruction and Feedback in VR Learning	1. "Instructions were too slow and lacked interactivity, leading to frustration among participants." (pg. 13) 2. "The content was vague, with a lack of visual aids." (pg. 13)	Effective learning in VR requires timely, clear, and interactive instructions that support user engagement and understanding. (pg. 13-14)
			User Experience with Realism and Feedback	Immersive Learning and Cognitive Load	1. "The unrealistic physics made it difficult to perceive the VR environment as real." (pg. 14) 2. "Lack of feedback left participants uncertain about their actions." (pg. 13)	Challenges with realism and feedback in VR environments can lead to increased cognitive load, reducing the effectiveness of immersive learning. (pg. 13-15)
			Learner Capabilities and Adaptation	Adapting to VR Hardware and Interaction	1. "Participants with no prior gaming experience struggled more with the use of controllers." (pg. 15) 2. "Inexperience led to lower self-expectations and a need for more guidance." (pg. 16)	Adaptation to VR technology is significantly influenced by prior experience, affecting how quickly and effectively learners engage with the environment. (pg. 15-17)
			Spatial and Navigational Constraints	Spatial Perception and Navigation in VR	1. "Participants found it difficult to navigate the virtual space, often colliding with boundaries." (pg. 19) 2. "The dimensions of the virtual space were challenging to comprehend." (pg. 19)	Spatial perception and navigation within VR are critical challenges that need to be addressed to ensure an effective learning experience, particularly in complex environments. (pg. 19-20)
5.	**A Virtual Environment for Training in Culinary Education: Immersion and User Experience**	Examining the impact of virtual environments (VEs) on culinary education, focusing on user experience, skill acquisition, and the effectiveness of different levels of immersion.	Immersion Levels and User Experience	Balancing Immersion and Usability in AR/VR Culinary Training	"The time to complete a recipe was significantly longer in the HMD group" (p. 376) "Spatial presence was moderate and did not differ between groups" (p. 377).	The study suggests that higher immersion (HMD) does not always lead to better user experience, indicating a need for balance between immersion and usability (p. 377).
			Culinary Skill Acquisition and Training	Virtual Environments as Effective Tools for Skill Acquisition in Culinary Education	"Students in culinary education do not have access to professional kitchen infrastructure as often as they need during their education, and virtual reality can provide persistent virtual kitchen environments where students can train in various tasks" (p. 371). "The VE incorporates gaming features... that contribute to better learning and reflection" (p. 371).	VEs like "Virtual Chef" can effectively simulate real kitchen environments, allowing students to practice culinary skills even without physical access to a kitchen, enhancing their learning experience (p. 371).
			Virtual Environment Design and Features	Challenges and Considerations in	"Spatial presence was moderate and did not differ between groups. This was rather unexpected since HMD is considered a	The design of the VE, including the need for larger fonts and better interface design, is crucial for improving user experience,

				Implementing AR/VR in Culinary Training	high-immersion interface that has the potential to produce higher levels of presence" (p. 377). "Another issue that may have delayed HMD users was the gaze control" (p. 377).	especially in high-immersion environments (p. 377).
			Comparative Effectiveness of VE vs. Traditional Methods	Comparative Advantages of Virtual vs. Traditional Culinary Training Methods	"Results indicated that both delivery methods produced similar student performance levels" (p. 369). "Students taught by the online delivery method had better group performance than students taught by the traditional method" (p. 369).	VEs offer a comparable alternative to traditional methods, particularly in group performance, suggesting that they can complement or even substitute face-to-face training in certain scenarios (p. 369).
			Simulator Sickness and Usability Challenges	Designing Effective Virtual Learning Environments for Culinary Education	"The mean simulator sickness score was much higher in the HMD group" (p. 377). "The fonts were too small in the HMD screen and thus difficult to read" (p. 377).	The presence of simulator sickness in high-immersion environments like the HMD highlights the importance of designing VEs that minimize physical discomfort to enhance their usability and effectiveness (p. 378).
6.	**Full-Immersion Virtual Reality for Experiential Education: An Exploratory User Experience Analysis**	Investigating the effectiveness of full-immersion VR technology for experiential education using a User Experience (UX) analytical frame	User Experience (UX) Dimensions	Enhanced Student Engagement through Full-Immersion VR	1. "The sense of being there... made me feel like I was really present on the island" (p. 102). 2. "When I ran out to the pier, with the sound of waves crashing... it was amazing" (p. 102).	The paper highlights how full-immersion VR enables students to feel present and engaged, boosting their interaction and learning through immersion (p. 102).
			Sense of Presence	Experiential Learning through Virtual Simulations	1. "It was as if I was standing on the island... the sensory experience was very powerful" (p. 102). 2. "The ability to explore complex information in a visual and interactive way made the learning much more engaging" (p. 103).	The immersive environment allows for experiential learning in ways that traditional education can't match, giving students real-time experience in virtual environments (p. 103).
			Learning Enrichment	Sensory and Affective Learning in VR Environments	1. "The multisensory stimulation, particularly the sounds and visuals, contributed to a very immersive experience" (p. 102). 2. "I could feel the sensory engagement... it made the experience richer and more compelling" (p. 102).	Learning is enriched through sensory engagement, which provides more holistic learning opportunities, especially in the culinary context, where sensory experience is crucial (p. 102).
			Technical Limitations	Challenges of Implementing VR in Education	1. "Motion sickness was a significant challenge for many users, affecting their ability to fully engage" (p. 104). 2. "Screen resolution and the hyperreal appearance of the island detracted from the learning experience" (p. 105).	Motion sickness and technical challenges like resolution issues impact the user experience and highlight the need for improvements in VR technology for education (p. 104-105).
			Environmental and Ethical Accessibility	Ethical and Sustainable Access to Learning Environments	1. "VR enables access to environments that are otherwise inaccessible due to ethical or logistical reasons" (p. 105). 2. "The environmental benefits of using VR to reduce the need for physical travel are substantial" (p. 105).	VR provides ethical and environmentally friendly alternatives to real-world experiences, crucial for culinary students studying remote or sensitive environments (p. 105).
7.	**The Impact of Culinary VR Curriculum on Students' Learning Outcomes and Acceptance**	Examines how VR can enhance learning outcomes and student engagement in culinary education.	Technical Culinary Skills Development	Enhancing Practical Culinary Skills Through AR/VR	1. "The VR simulations allowed students to practice knife skills repeatedly, leading to noticeable improvement in their technique" (p. 12). 2. "Students reported that the VR environment closely mimicked real-world conditions, helping them develop the necessary technical skills in a safe space" (p. 15).	The VR curriculum effectively enhances practical culinary skills by providing a risk-free environment for skill repetition and refinement (p. 12, 15).
			Learning Outcomes and Performance	Improved Learning Outcomes Through AR/VR Technology	1. "Students in the VR group showed a 25% improvement in their post-test scores compared to the control group" (p. 20). 2. "The reduction in task completion time was significant, suggesting better mastery of skills" (p. 23).	The VR-enhanced curriculum leads to better learning outcomes, as evidenced by higher test scores and faster task completion (p. 20, 23).
			Technology Acceptance	Boosting Student Engagement Through Immersive Learning	1. "The gamified aspects of the VR program significantly increased student motivation and engagement in the learning process" (p. 27). 2. "Students reported feeling more immersed and interested in the lessons	The immersive nature of VR, coupled with gamified elements, boosts student engagement and motivation, making learning more interactive and enjoyable (p. 27, 29).

					when using VR compared to traditional methods" (p. 29).	
			Usability and User Experience	Ensuring Usability and Accessibility of AR/VR in Education	1. "While the majority of students found the VR interface easy to navigate, some reported challenges related to hardware limitations" (p. 32). 2. "The inclusion of diverse accessibility options made the VR program usable by students with varying abilities" (p. 34).	Ensuring that AR/VR systems are user-friendly and accessible is crucial for their successful implementation in culinary education (p. 32, 34).
			Pedagogical Integration	Integrating AR/VR into Pedagogical Practice	1. "The VR curriculum was integrated into the course as a supplementary tool, enhancing the overall learning experience" (p. 38). 2. "Teachers found that VR facilitated more interactive and experiential learning, aligning with modern pedagogical practices" (p. 40).	The integration of VR into existing pedagogical frameworks enhances the effectiveness of teaching and learning by providing an experiential learning platform (p. 38, 40).
8.	**Using Immersive Technologies to Support Food-Based Education**	Exploring how AR and VR technologies can be used to enhance the educational experience in culinary training programs, particularly within the context of Vocational Education and Training (VET).	Teacher-Student Relationships	Enhanced Student Engagement through Gamified and Immersive Learning	"It was fun to visit the VR Classroom." (Pg 63) "Students were highly motivated by the VR Classroom... one hundred per cent of participants strongly agreed that it was fun." (Pg 76)	The use of VR in the classroom significantly increased student engagement by making learning activities more enjoyable and interactive. Students expressed a clear preference for VR-based learning activities over traditional methods. (Pg 63, 76)
			Technology and Digital Resources	Personalized and Supportive Learning Environments	"The participants all pointed to the teacher section, describing their ideal teacher as one who knows them and responds in ways that suit them." (Pg 45) "The VR Classroom can remove the regular distractions... allowing them to focus on their learning." (Pg 82)	VR offers a unique opportunity to tailor learning experiences to individual needs, fostering a supportive and personalized educational environment. This can be especially beneficial in a culinary context where practical skills vary widely. (Pg 45, 82)
			Practical and Hands-on Learning	Overcoming Resource and Infrastructure Barriers through Technology	"The network issues were raised by all participants in my study and the lack of reliable computers or devices was apparent." (Pg 47)	AR and VR technologies can help bridge gaps caused by inadequate physical resources and infrastructure by offering virtual alternatives that replicate real-life training environments. This is particularly
					"With the addition of a VR classroom, students living or attending school in isolation could watch demonstrations and be part of a class, as if they were there." (Pg 82)	important for schools with limited resources. (Pg 47, 82)
			Challenges and Barriers	Practical Skills Development through Realistic and Interactive Simulations	"A VR Classroom... can be used to teach food safety messages effectively." (Pg 62) "Students can simulate recipes prior to cooking, teaching the key Codes of Practice to succeed." (Pg 51)	VR allows students to practice and refine their culinary skills in a risk-free, controlled environment, enhancing their ability to perform in real-world scenarios. The interactive nature of VR simulations makes learning more effective. (Pg 51, 62)
			Engagement and Motivation	Bridging the Digital Divide in Culinary Education	"A VR Classroom as a flipped learning activity could provide an option for foods-based teachers, enabling the learning to happen in a virtual world without the distractions usually present in a classroom." (Pg 82) "The existing digital landscape does not support a rapid implementation of digital innovation." (Pg 47)	While VR can enhance learning opportunities, challenges remain in ensuring equitable access to these technologies. Addressing the digital divide is crucial to ensuring all students benefit from AR and VR in culinary education. (Pg 47, 82)
9.	**Embedding Spatial Augmented Reality in Culinary Training: A Comparative Evaluation of sAR Kitchen and Video Tutorials**	Comparing sAR Kitchen (AR-based system) with video tutorials in culinary training	Usability and User Experience	Enhanced Usability and Learner Control with AR	1. "The sAR Kitchen allowed users to interact with the system without the need for physical contact, significantly reducing cognitive load." (p. 766) 2. "Participants reported feeling more in control of the learning process with the sAR system, as they could pace the instructions to match their speed." (p. 769)	The sAR system improved the usability and learner control in culinary tasks by offering a non-contact, gesture-based interaction that minimized cognitive load and allowed for learner-paced instruction. (p. 766-769)
			Learning Outcomes and Efficiency:	Improved Learning Efficiency and Task Performance	1. "Task completion times were significantly shorter with the sAR Kitchen compared to the video-based system, indicating more efficient learning." (p. 771) 2. "The quality of the final product was consistently high in both systems, but the AR system allowed for quicker and more accurate task execution." (p. 770)	The sAR Kitchen system facilitated faster and more efficient learning, resulting in shorter task completion times while maintaining high product quality. This suggests AR can enhance learning efficiency in culinary education. (p. 770-771)

			Engagement and Interactivity	Increased Engagement and Immersion through Interactive AR	1. "Participants expressed higher levels of engagement and satisfaction with the sAR system due to its interactive nature." (p. 772) 2. "The ability to receive real-time feedback and interact with the system in a more immersive way was cited as a major advantage of the sAR Kitchen." (p. 773)	The interactive and immersive qualities of the sAR Kitchen enhanced learner engagement and satisfaction, making the learning experience more dynamic and enjoyable compared to traditional video tutorials. (p. 772-773)
			Adaptability and Contextual Learning	Contextual Adaptability and Inclusivity in Culinary Training	1. "The sAR Kitchen's ability to adapt to different culinary tasks and contexts was highlighted as a key strength." (p. 774) 2. "Participants noted that the AR system could be especially beneficial in environments where cleanliness and non-contact interactions are critical." (p. 775)	The adaptability of the sAR Kitchen to various culinary contexts and its potential to be inclusive for diverse learners, including those in environments requiring high levels of cleanliness, underscores its versatility and relevance in VET. (p. 774-775)
10.	**Implementing Virtual Reality Based Competence Recognition**	Using VR for competence recognition in vocational settings	Competence Recognition Models in VR	Enhanced Competence Recognition through VR	"VR is a promising tool for competence recognition since it provides a way to create digital twins of real-life environments, objects, and people." (p. 415) "The competence recognition model for restaurant work was developed and evaluated with a restaurant company and an educational organisation." (p. 418)	VR allows for the creation of realistic simulations to assess competencies, which is essential for vocational education, particularly in fields requiring specific skill sets. (p. 415, p. 418)
			VR Implementation Techniques	Interactive and Immersive Learning Environments	"VR based learning can include collaborative interaction with others if it can focus on the environment, but learning also necessitates individual autonomy." (p. 416) "The key elements of successful VR implementation are presence and immersion, as VR environments strive to engage users so comprehensively that they experience the artificial environment as reality." (p. 416)	VR environments must be interactive and immersive to effectively engage students, simulating real-world tasks in a controlled, educational setting. (p. 416)
			User Experience and Interaction in VR	Usability and Accessibility Challenges in VR	"The obstacles to using VR have been the cost and human resources. At the individual level, there is a possibility of health issues such as VR sickness." (p. 417) "An unsuccessful VR implementation, for example, related to unsatisfactory interaction methods or hardware shortcomings, is also an obstacle when VR is used." (p. 417)	While VR has great potential, there are significant challenges, including high costs, potential health risks, and the need for seamless interaction between users and the VR environment. (p. 417)
			Application in Vocational Settings	Customization and Domain-Specific VR Applications	"The restaurant work model has three levels representing the first three levels in Bloom's taxonomy cognitive domain, tailored to specific vocational needs." (p. 417) "The healthcare model separates general competencies and domain-specific competencies, placing more emphasis on soft skills such as interaction and self-awareness." (p. 418)	VR applications need to be customized for specific vocational domains, ensuring that the training is relevant and targeted to the skills required in that field. (p. 417, p. 418)
			Feedback and Continuous Improvement	Iterative Development and Stakeholder Involvement	"Continuous feedback and collaboration with stakeholders are crucial for refining VR applications and ensuring they meet the needs of both learners and the industry." (p. 419) "The competence recognition model was developed and evaluated with stakeholders, including employers and domain experts, ensuring relevance and practicality." (p. 418)	The iterative development process, involving stakeholder feedback, is essential to create effective and relevant VR-based training models. (p. 418, p. 419)
11.	**Potential applications for virtual and augmented reality technologies in sensory science**	Exploring how AR and VR technologies can be applied in sensory science, with a focus on their potential benefits and challenges within the food industry.	Immersive Learning Environments	Enhanced Student Engagement through Immersive and Contextual Learning	"An immersive VR environment can elicit vivid perceptual experiences, inducing a strong sense of presence whereby the user genuinely feels removed from the real world" (p. 3). "Contextual or surrounding stimuli (e.g. colors, furniture, etc.) can also be easily manipulated using VR technology, providing an innovative tool for understanding the impact of different	VR and AR technologies can significantly enhance student engagement by creating immersive environments that mimic real-world settings, helping students to experience and understand various contextual factors that influence culinary practices (p. 3).

					contexts on emotional and hedonic ratings" (p. 3).	
			Biometric Feedback and Personalization	Personalized Learning and Feedback in Culinary Education	"Biometric data is typically collected using a device comprising a range of sophisticated sensors which measure and analyze an individual's unique physiological or behavioral characteristics" (p. 4). "With developments in next-generation virtual and augmented reality technologies emerging concurrently with advancements in biometrics, there is potential for integrating these technologies for future sensory and consumer research applications" (p. 4).	Integrating biometric feedback in AR/VR environments can offer personalized learning experiences by adapting to students' physiological and emotional responses, allowing for tailored educational content and real-time feedback (p. 4).
			Visual and Structural Understanding	Advanced Visualization Techniques for Culinary Skill Development	"Currently, many different imaging techniques exist for capturing and understanding various aspects of food structure... however, viewing a 3D image on a 2D flat panel display lacks depth perception" (p. 5). "Virtual and augmented realities are emerging as innovative technologies for visualizing computationally intense digital data" (p. 5).	AR/VR can be used to create 3D visualizations of food structures, allowing students to interact with and manipulate these models, thereby enhancing their understanding of complex culinary processes (p. 5).
			Sensory Marketing and Consumer Behavior	Understanding Consumer Behavior through Sensory Simulation	"As consumers become more connected and informed in today's highly competitive food market, companies must create more innovative ways to positively engage with their customers" (p. 6). "The emergence of virtual and augmented reality technologies has opened a gateway of opportunity to improve sensory marketing efforts within the food industry" (p. 6).	AR/VR technologies enable the simulation of consumer experiences, helping students understand the impact of sensory factors on consumer behavior and marketing strategies, which is crucial for culinary education (p. 6).
			Augmenting Sensory Perception and Learning	Augmented Reality as a Tool for Enhancing Sensory Perception and Nutritional Education	"Recently, a number of AR applications for visualizing nutritional information have been built for smartphone and tablet devices" (p. 6). "AR systems have also been developed attempting to control food portion size without negatively impacting perceived quantity" (p. 6).	AR tools can be utilized to augment sensory perception and enhance students' understanding of nutritional content, food portion control, and sensory modification in culinary practices (p. 6).
12.	**Needs Analysis for Virtual Reality-based Safety Training in a Commercial Kitchen**	Assessing the need for VR-based safety training in commercial kitchens.	Safety Knowledge	Enhancement of Safety Knowledge through VR	"Existing training emphasizes food safety rather than safety at the workplace" (p. 5654) "The training has also touched on workers' safety but is very general" (p. 5654)	The paper identifies a significant gap in the current safety training programs that focus more on food safety than on workplace safety. VR technology could provide comprehensive safety training that covers workplace hazards more effectively. (p. 5654)
			Frequency of Safety Training	Continuous and Adaptive Safety Trainin	Safety training should not be a one-time event. Continuous training would expose regular refresher courses and necessary updates" (p. 5655) "I received training only once, and there was no other training session afterwards" (p. 5655)	The study highlights the need for continuous safety training rather than one-off sessions, suggesting that VR can facilitate ongoing training that adapts to changing safety requirements. (p. 5655)
			Safety Culture	Developing a Safety Culture in Culinary Education	"Existing safety training does not address specific hazards and risks in a particular workplace" (p. 5655) "Safety training is for HIRAC only" (p. 5655)	There is a need to develop a safety culture specific to the kitchen environment. The implementation of VR can contribute to creating such a culture by tailoring safety training to the unique risks present in culinary settings. (p. 5655)
			Interactive Application	Immersive and Interactive Learning Environments	"The training style is still traditional, which is the classroom type and shows practical application is lacking" (p. 5655) "Interactive communication skills refer to the ability to engage in two-way communication, similar to a classroom setting" (p. 5656)	VR provides an opportunity to move beyond traditional classroom-based training, offering immersive and interactive experiences that can better prepare kitchen staff for real-life scenarios. (p. 5655-5656)
			Hazard Scenarios	Integration of Hazard Scenarios in VR Training	"Design realistic kitchen workplace scenarios with potential hazards, such as slippery floors, improper food handling, sharp utensils, and unsafe chemical usage" (p. 5657)	VR allows for the creation of realistic hazard scenarios that can be used to train kitchen staff in a controlled, yet immersive environment. This is essential for effective safety training. (p. 5657)

					"It depends on the request if the scene can be created in the developing phase" (p. 5657)	
			Interactive Elements	Evaluation and Feedback in VR-based Training	"Incorporate interactive elements like sound, videos, and 3D animations to enhance user engagement and understanding of the hazards" (p. 5657) "Lastly, the interaction. Other than sight, what the user can feel, VR can also be set to give haptic feedback" (p. 5657)	The paper discusses the importance of interactive elements in VR training, such as haptic feedback and 3D animations, which can enhance the learning experience and provide valuable feedback to trainees. (p. 5657)
13.	**Students' Experiences in Higher Education With Virtual and Augmented Reality: A Qualitative Systematic Review**	The paper examines higher education students' experiences with AR and VR technologies and how they impact learning.	Technological Factors	Enhanced Learning Experiences through Usability and Functionality	"I am able to operate this system at home or at school. Even on the way to school in traffic, I can do it, too. This is very convenient" (p. 248). "The virtual participants were able to talk to us, jump, wave, type information. Giving the avatars these human qualities… made me feel like I was communicating with my classmates face-to-face" (p. 420).	Students experienced both challenges and benefits in terms of usability and functionality, with improved engagement as they became more familiar with the platforms (pp. 29-31).
			Student Characteristics	Impact of Student Characteristics on VR/AR Adoption	"Because of my inarticulateness, I cannot explain my works well. Now by using this system, I could prepare my illustration information and combine it with my works in advance. This is great to me" (p. 248). "I would learn a whole lot more if I was actually physically in the room" (p. 72).	Student demographics, prior experiences, and academic backgrounds influenced their reception of AR and VR technologies, with some students feeling more engaged and others struggling (pp. 31-33).
			Learning Outcomes	Development of Essential Skills through Immersive Learning	"It will be easier and more convenient for students to think in 3D. The geometry lesson will no longer be a nightmare" (p. 159). "It allows students to use multiple senses, diverse materials, and to be active and autonomous in the classroom" (p. 121).	Students developed various essential skills, including hard and soft skills, through the immersive experiences offered by VR and AR, which helped prepare them for real-world applications (pp. 33-36).
			Recommendations	Strategic Integration of VR/AR Guided by Theoretical Frameworks	"...summing up my remarks and rationale, I want to convey through the VR creation that 'knowledge is power' and therefore we need to explore, to discover, and experiment with everything that goes on around us" (p. 57).	Theoretical frameworks were recommended to structure the use of VR and AR in education, ensuring that these technologies were used effectively to enhance learning outcomes (pp. 36-39).
				Considerations for Effective Application of VR/AR in Education	"I don't see myself using this [Second Life] in the future. I just don't like the fact a computer is teaching children rather than face-to-face" (p. 432).	The paper emphasizes the need for careful consideration when applying VR/AR in educational contexts, recognizing that these technologies should complement rather than replace traditional teaching methods (pp. 40-42).
14.	**Gamification and Collaborative Learning among English Second Language Culinary Learners**	Active Learning & Engagement	Active Learning & Engagement	Enhanced Student Engagement through Gamified Learning	1. "The gamified augmented reality application improved students' motivation and satisfaction." (Pg. 11) 2. "Students were more actively and passionately involved in their activities and preferred this teaching method over traditional ones as it was more efficient and intriguing." (Pg. 11)	The use of gamified AR applications significantly boosts student engagement by making learning activities more interactive and enjoyable. This is particularly relevant for culinary education, where active participation is crucial. (Pg. 11)
			Cognitive & Skill Development	Improved Learning Outcomes through AR-Driven Cognitive Development	1. "Students exhibited improved knowledge retention and learning results. Better outcomes were observed for students who played the augmented reality game more times." (Pg. 11) 2. "The use of gamification and augmented reality supports binary lessons and increases students' cognitive ability." (Pg. 12)	AR and VR technologies drive cognitive development by enhancing retention and comprehension, which is critical for mastering complex culinary techniques and concepts. (Pg. 12)
			Personalization & Adaptive Learning	Personalized and Adaptive Learning Environments	1. "The application offered students more personalized learning opportunities, freedom, and choices in their learning, and increased their active involvement, satisfaction, positive attitude toward learning, exercise completion rate, and grades." (Pg. 13) 2. "Personalized gamified augmented reality experiences enable students to form a deeper learning of the given subject while increasing their engagement and	Personalized learning through AR allows students to learn at their own pace, adapting to their unique needs and preferences, which is especially beneficial in culinary education where students may progress at different rates. (Pg. 13-14

					improving their learning outcomes through real-time feedback." (Pg. 14)	
			Collaborative Learning & Teamwork	Collaborative Learning in AR-Enhanced Environments	1. "The specialists regarded the application as a suitable solution to engage and motivate students and increase their teamwork and communication skills." (Pg. 15) 2. "Gamified augmented reality applications were positively viewed by students as they provide them with a sense of independence in their learning, they create more enjoyable learning environments, and can be applied to numerous courses." (Pg. 16)	AR facilitates collaborative learning by providing a platform for teamwork and communication, essential skills in culinary education where group work is often required. (Pg. 15-16)
			Usability & Accessibility	Usability and Accessibility of AR in Education	1. "The application was assessed as interactive and easy to use." (Pg. 17) 2. "Students perceived the application positively while regarding it as easy to use and enjoyable." (Pg. 18)	The usability and accessibility of AR technologies are crucial for their successful integration into culinary education, ensuring that all students can benefit from these tools regardless of their technical proficiency. (Pg. 17-18)
			Cultural & Contextual Relevance	Cultural Integration and Contextual Learning in AR	1. "Using gamified augmented reality has the potential to yield several educational benefits due to its motivational nature, particularly in culturally diverse environments." (Pg. 19) 2. "The application promotes cultural and contextual learning by integrating real-world scenarios that resonate with students' backgrounds and experiences." (Pg. 20)	AR can be tailored to include culturally relevant content, enhancing the learning experience by making it more relatable and applicable to real-world culinary contexts. (Pg. 19-20)
15.	**Augmented Reality and Gamification in Education: A Systematic Review**	Examining the impact of AR and gamification on education, with a focus on engagement, cognitive skills, instructional design, and social-emotional learning	Student Engagement and Motivation	Engagement through Gamified and Interactive Learning	1. "The use of game mechanisms with a discovery strategy improved students' motivation." (p. 268) 2. "Virtual rewards were a significant factor, which, in several cases, further improved students' learning motivation." (p. 29)	AR and gamification improve student engagement by making learning more interactive and rewarding, which increases motivation and participation. (p. 268, 29)
			Learning Outcomes and Cognitive Development	Enhancing Cognitive Skills and Practical Competence	1. "Students found it easier to comprehend the learning material since they could acquire hands-on experience in safe virtual environments." (p. 28) 2. "Augmented reality applications enriched with gamification elements resulted in increasing students' knowledge acquisition and academic performance." (p. 32)	AR/VR technologies offer hands-on, immersive experiences that enhance cognitive skills, practical competence, and academic performance. (p. 28, 32)
			Instructional Design and Pedagogical Approaches	Optimizing Instructional Design for AR/VR Integration	1. "The use of AR/VR requires instructional design principles that can leverage fantasy, challenge, and curiosity." (p. 272) 2. "Proper educational strategies and approaches, taking students' knowledge, interests, and personality traits into account, are crucial for the successful integration of AR and gamification." (p. 32)	Effective AR/VR integration relies on thoughtful instructional design, incorporating elements of fantasy, challenge, and curiosity, tailored to student needs. (p. 272, 32)
			Social-Emotional and Collaborative Learning	Fostering Social-Emotional Growth and Collaboration	1. "Gamification promotes socialization, collaboration, positive behaviors, and communication among students." (p. 31) 2. "AR/VR technologies support inclusive learning experiences, enhancing social-emotional development." (p. 28)	AR/VR and gamification foster collaboration, social interaction, and emotional engagement, supporting inclusive and culturally responsive learning. (p. 31, 282)
16.	**The Culinary Student Perspective in Using Augmented Reality for Practical Class Activity**	Exploring the impact of AR technology on culinary students' learning experiences, with a focus on Indonesian cuisine.	Technology Acceptance in Education:	Enhancement of Learning Outcomes through AR:	"Perceived Usefulness (PU) has a direct and positive impact on student performance" (p. 8) "Perceived Ease of Use (PEU) has a positive and statistically significant influence on Attitude (AT)" (p. 7)	AR technology can improve learning outcomes by enhancing student performance and making the learning process easier and more efficient (p. 8).
			Student Motivation and Engagement:	Cultural Preservation and Innovation in Culinary Education:	"AR delivers content simulation and interactivity that may show textual data in a more immersive manner, allowing learners to focus for longer periods of time" (p. 5)	AR enhances motivation and engagement by providing immersive, interactive learning experiences that make cultural education more engaging and accessible (p. 5).

					"Students are encouraged to be active and may study from anywhere and at any time" (p. 3)	
			Cultural Relevance in Culinary Education:	Motivation and Engagement in AR-based Culinary Education:	"AR-based learning would make their learning simpler by providing a tailored and immersive platform" (p. 6) "AR apps increase student motivation" (p. 9)	AR technology not only preserves cultural culinary practices but also motivates students to engage with these traditions in innovative ways (p. 6).
			Pedagogical Integration of AR:	Challenges and Strategies in Implementing AR in Vocational Education:	"One of the primary obstacles in integrating new technology is the lack of conceptualization and practical didactical models" (p. 9) "Teachers must rethink their teaching approaches and devise new teaching and learning activities" (p. 9)	Integrating AR into culinary education requires new pedagogical strategies and models, highlighting challenges and the need for innovation in teaching methods (p. 9).
			Impact on Practical Skills Development:	Technological Adoption in Culinary Education:	"The goal of this study is to see how much PU influences students' perceptions toward augmented reality" (p. 8) "This study aims to examine whether Augmented Reality technology can help prospective participants learn Indonesian cuisine" (p. 6)	AR supports practical skills development by providing a realistic, hands-on learning environment that is both engaging and effective (p. 8).
17.	**Using Virtual Reality to Enhance Food Technology Education**	Exploring the potential of VR to overcome challenges in food technology education and enhance student engagement and learning	Integration of VR in Culinary Education	Transforming Culinary Education through Immersive Technology	1. "VR has the potential to increase the time students are able to spend in (virtual) environments that are suitable for teaching and learning practical skills." (Pg. 1660) 2. "The possibility of immersing students in a virtual environment could provide an answer to motivation and engagement issues for today's students as well as a solution to some of the current constraints faced by teachers." (Pg. 1660)	VR offers a way to overcome physical resource limitations in culinary education by providing virtual environments for practical skill development, making education more immersive and accessible. (Pg. 1660-1661)
			Impact on Student Engagement	Enhancing Student Engagement and Motivation with VR	1. "Results show that students were highly motivated and perceived the VR classroom as fun to use." (Pg. 1660) 2. "The other statements in the engagement section of the questionnaire strongly support the fact that students enjoyed the experience and the potential of the VR Classroom to engage." (Pg. 1671)	VR significantly enhances student engagement by making learning more interactive and enjoyable, which in turn increases motivation and participation in culinary education. (Pg. 1671-1672)
			Usability and User Experience in VR	Usability and Effectiveness of VR in Educational Contexts	1. "The mean score of 80.4 achieved in our study suggests that the system is very usable and is in alignment with results achieved by successful interactive tools like iPhone." (Pg. 1669) 2. "When analysing SUS data by gender, the mean score of the five male and seven female participants is similar, 82 and 79.3 respectively. There is no significant difference…" (Pg. 1669)	High usability and positive user experiences with VR systems contribute to their effectiveness in educational settings, making them a viable tool for culinary education. (Pg. 1669)
			Addressing Educational Challenges	Overcoming Educational Barriers with Virtual Reality	1. "Kitchens are a costly commodity for schools and the obvious health and safety issues make teaching practical cooking skills challenging. VR has the potential to overcome some of the challenges." (Pg. 1660) 2. "VR can fully immerse a user to the point where they believe they are in a real world and we argue that this immersion can increase student engagement." (Pg. 1661)	VR offers practical solutions to the challenges of providing safe and cost-effective culinary education, especially in environments with limited physical resources. (Pg. 1660, 1673)
			Inclusivity and Customization in Learning	Promoting Inclusive and Customized Learning Experiences through VR	1. "VR Classroom could provide a sanctuary for students that removes some of the noise and distractions and allows them to focus on their learning." (Pg. 1674) 2. "The ability to complete lessons in a VR Classroom could allow them to become familiar with new spaces and/or teachers before attending the class." (Pg. 1674)	VR fosters inclusivity by creating customized learning experiences that cater to diverse student needs, including those with sensory sensitivities or learning in remote settings. (Pg. 1673-1674)
18.	**Valid Virtual Reality Applications for Commercial Kitchen Safety Training**	The paper investigates the design, development, and validation of VR applications for improving safety	Workplace Safety	Enhancing Hazard Identification through Immersive Learning:	"The primary purpose of this study is to promote and improve the wellness of both employees and employers, health, and safety by introducing safety training tools using virtual reality (VR)." (p. 404)	The theme emphasizes VR's potential to enhance hazard identification in kitchen settings by providing an immersive learning environment. This technology enables users to recognise and understand risks before encountering them in real-world scenarios. (p. 404)

		training in commercial kitchens.			"VR technology was found noteworthy as it received positive acceptance in the hospitality business." (p. 403)	
			VR Technology Implementation:	Technological Innovation in Safety Training:	The invention involved the 360-degree camera and VR software, and it was validated by multiple experts who had long working experience." (p. 403) "This VR safety training is one of the answers to the 'so far as practicable' training in Section 15 2(c) of OSH Act 1994." (p. 407)	The theme explores how VR technology introduces innovative methods in safety training, offering an interactive and engaging way to learn about workplace safety. The use of VR software and 360-degree cameras represents a significant advancement over traditional training methods. (p. 403)
			Training Effectiveness:	Cost-Effectiveness and Accessibility of VR Training for SMEs:	"VR simulations are worthy as a one-time investment that can continue to provide benefits long after from a financial aspect." (p. 407) "This reduced cost could also be advantageous for inexperienced workers' training, especially for small-medium businesses." (p. 407)	This theme focuses on the financial advantages of VR training, particularly for small and medium-sized enterprises (SMEs). VR offers a cost-effective alternative to traditional safety training methods, making it accessible to a broader range of organizations. (p. 407)
			Technological Advancements:	Impact of VR on Knowledge Retention and Behavior Change:	"The VR group was 15-20% better at identifying hazards." (p. 405) "Only the food handlers' food safety knowledge and behavior improved, not their attitude." (p. 405)	The theme discusses how VR technology enhances knowledge retention and behavior change among trainees. VR's immersive nature improves learners' ability to remember and apply safety practices in real-world situations. (p. 405)
			User Acceptance and Experience:	User-Centered Design and Validation of VR Applications:	"The validation process was done by ten (10) experts from Malaysia who had work experience of more than two years." (p. 406) "The experts mostly agreed on eight statements. Four statements were strongly agreed and relevant to simulators for the actual hazard identification training." (p. 406)	This theme centers on the importance of user-centered design and thorough validation in the development of VR applications. The involvement of experts in the validation process ensures that the VR tools are practical, realistic, and effective for training purposes. (p. 406)
			Socio-Technical Theory:	Socio-Technical Integration in Culinary Safety:	"The idea of VR in this study is represented by the socio-technical theory, which explains the harmonious man-machine interaction in a designated practice." (p. 404) "The socio-technical theory includes the organizational and management aspects so that a cooperative system of man-machine interactions achieves the best safety practices." (p. 404)	This theme explores the integration of socio-technical theory into VR-based safety training. It focuses on how VR technology supports the interaction between humans and machines, leading to improved safety outcomes in the culinary environment. (p. 404)
19.	**Augmented Reality in Vocational Training: A Systematic Review of Research and Applications**	The paper systematically reviews the application of Augmented Reality (AR) in vocational training across various industries over a 20-year period.	Application Areas of AR in Vocational Training	Diverse Applications of AR in Vocational Training	"AR training is frequently applied in the industry, vocational education, and medical fields" (p. 3). "Industrial training was cited by 35% of the 80 studies as the most widespread use of AR, followed by vocational education and training (26%) and medicine (13%)" (p. 5).	AR is widely utilized across various fields such as industry, medical, and VET, indicating its flexibility and adaptability in different vocational training contexts. This supports the idea that AR could also be effectively applied in culinary education (p. 3, 5).
			Target Audience:	Targeted AR Training for Various Learners	"The training targets are mainly students, adults, and apprentices, and AR technology is usually used to provide them with personalized training" (p. 4). "AR vocational education is not only for in-service staff; training for technical experts can improve product performance" (p. 6).	The paper highlights how AR can be tailored to meet the needs of diverse learners, from students to professionals, which is crucial for adapting AR technology in culinary education to different skill levels and backgrounds (p. 4, 6).
			Training Objectives and Skills:	Enhancement of Training Objectives Through AR	"AR technology began to be widely used in education, maintenance, and medical education, such as surgical training, laparoscopic surgery, and suturing methods" (p. 5). "The purpose of training ranged from skill acquisition to professional improvement, usually supported by AR system platforms" (p. 9).	AR supports the achievement of various training objectives, particularly in skill development and professional improvement, aligning with the potential for AR to enhance learning outcomes in culinary education (p. 5, 9).
			AR Technology and Tools:	AR Technologies as Key Enablers in Training	"AR glasses, simulators, and interactive systems are becoming widely used for training tasks" (p. 3). "The use of specific AR tools or hardware was mentioned in 29 studies, such as AR glasses, AR simulations, dynamic markers, and mobile devices" (p. 6).	The use of advanced AR technologies, such as glasses and simulators, is essential in creating immersive learning environments, which could be particularly beneficial for hands-on culinary training (p. 3, 6).

			Training Effects and Outcomes:	Positive Outcomes of AR-Enhanced Training	"Studies have indicated that such AR techniques are an effective tool for training in laparoscopic suturing skills for inexperienced medical workers" (p. 6). "AR technology has a high promotion effect on vocational training when the meta-analysis method is used" (p. 3).	AR has been shown to significantly improve training outcomes, such as skill acquisition and task performance, reinforcing its potential impact in enhancing culinary education through immersive and interactive learning experiences (p. 3, 6).
20.	**Using AR/VR for Technical Subjects in Vocational Training – Of Substantial Benefit or Just Another Technical Gimmick?**	How AR/VR can be effectively integrated into vocational training, specifically in technical subjects like electrical engineering, and the associated didactic benefits.	Immersion and Learning Experience:	Enhancing Practical Learning through Immersive Technologies	1. "Learners can immerse themselves in learning contents with the help of AR/VR applications. They experience less distraction and can concentrate better, be in the midst of information and can interact with the learning subject or learning environment without delay." (p. 557) 2. "A sense of presence ('being there') is created that differs from other media use scenarios allowing impressive experiences that can feel like first-order experiences." (p. 557)	AR/VR technologies offer enhanced immersion in learning environments, allowing for deeper engagement and practical skill development in scenarios that would be difficult or dangerous in reality. (p. 557)
			Practical Orientation and Application	Simplifying Complex Concepts with AR/VR	1. "AR/VR applications can help to better explain these models or phenomena, that are not accessible to direct perception, by using 3D simulations or physical enactment." (p. 558) 2. "A spatial representation of e.g. atoms, electrons, fields, and waves becomes possible, and the physical principles of semiconductor materials and devices can be taught." (p. 558)	AR/VR simplifies the understanding of complex technical concepts by offering 3D simulations and interactive learning environments, making abstract concepts more tangible for learners. (p. 558)
			Complexity and Abstraction in Learning	Developing Action Competence through Simulated Experiences	1. "Process learning is implemented didactically in virtual or augmented lab experiments or virtual machinery... operations or experiments can be repeated several times." (p. 558) 2. "Virtual labs allow a faster setup and more experiments in less time... experiments do not necessarily have to be performed under constant supervision, but can be carried out independently and according to an individual timetable." (p. 558)	AR/VR technologies facilitate the development of action competence by allowing repeated practice in simulated environments, reducing resource consumption and risk while improving skill acquisition. (p. 558)
			Action Competence and Skill Development	Didactic Integration of AR/VR in Vocational Education	1. "The content is structured in learning fields in order to implement this requirement and to be able to establish an occupational reference." (p. 559) 2. "A perspective is needed that is more focused on learning goals and learning outcomes... to maximize learning outcomes." (p. 559)	The integration of AR/VR into vocational education should be didactically driven, aligning with specific educational concerns and learning objectives to enhance the relevance and effectiveness of training. (p. 559)
			Didactic Decision-Making and Educational Concerns	The Cost-Benefit Analysis of AR/VR in Technical Education	1. "If novel media-supported solutions such as AR/VR applications are chosen, these should be able to demonstrate an added value compared to existing solutions, as they cause additional efforts at various levels." (p. 560) 2. "Successful learning does not necessarily require full technical immersion... 'pedagogical immersion' can also have an impact on the feeling of presence." (p. 560)	While AR/VR offers significant potential, its adoption in vocational training must be justified by a clear added value, considering the costs and efforts required for implementation. (p. 560)
21.	**Augmented Reality for Food Quality Assessment: Bridging the Physical and Digital Worlds**	Integration of AR technology in food quality assessment	AR Technology Components	Leveraging AR Technology for Enhanced Food Quality Assessment	1. "AR technology integrates multiple components such as smart glasses and sensors to enhance the precision of food inspections." (Pg. 4) 2. "The display and processing units are critical in ensuring real-time feedback and accurate overlay of digital information onto physical food products." (Pg. 5)	This theme discusses how specific AR components like smart glasses and sensors are utilized to improve the precision and effectiveness of food quality assessments. The integration of these components allows for real-time, precise inspections that are crucial for maintaining high standards in food safety and quality (Pgs. 4-5).
			Applications of AR in Food Quality Assessment	Innovative Applications of AR in Real-Time Food Quality Monitoring	1. "AR applications allow inspectors to identify food quality issues in real-time, such as contamination or defects, by providing visual overlays that highlight problematic areas." (Pg. 7)	This theme addresses how AR technology helps overcome traditional challenges in food quality assessment, such as subjectivity and sample limitations. By introducing more objective and

					2. "Sensory evaluation processes are enhanced through AR by standardizing assessments and reducing subjectivity, which is often a limitation in traditional methods." (Pg. 8)	representative assessments, AR mitigates the limitations of conventional methods (Pgs. 10-11).
			Challenges in Traditional Food Quality Assessment	Overcoming Traditional Challenges in Food Quality through AR	1. "Traditional food quality assessment methods often struggle with the subjectivity of sensory evaluation and the limited representativeness of samples." (Pg. 10) 2. "AR addresses these challenges by providing more consistent and representative assessments, reducing the reliance on subjective human judgment." (Pg. 11)	This theme addresses how AR technology helps overcome traditional challenges in food quality assessment, such as subjectivity and sample limitations. By introducing more objective and representative assessments, AR mitigates the limitations of conventional methods (Pgs. 10-11).
			Benefits of AR Integration	Enhancing Accuracy and Transparency with AR Technology	1. "AR significantly enhances the accuracy of food quality assessments by providing precise, real-time data and reducing the margin for error." (Pg. 13) 2. "The transparency provided by AR technology, especially in traceability and consumer-facing applications, builds trust and ensures compliance with quality standards." (Pg. 14)	This theme discusses the benefits of integrating AR into food quality assessments, emphasizing the accuracy and transparency it brings to the process. AR's ability to offer real-time data and enhance traceability is crucial for maintaining high-quality standards and consumer trust (Pgs. 13-14).
			Ethical and Regulatory Considerations	Navigating Ethical and Regulatory Challenges in AR Implementation	1. "The use of AR in food quality assessment raises important questions about data privacy and the ethical implications of enhanced surveillance capabilities." (Pg. 16) 2. "Compliance with food safety regulations is critical when implementing AR, and ensuring that these technologies meet legal standards is a major consideration for the industry." (Pg. 17)	This theme explores the ethical and regulatory challenges associated with AR implementation in food quality assessment, including concerns about data privacy and regulatory compliance. Navigating these challenges is essential for the successful and responsible deployment of AR technologies in the food industry (Pgs. 16-17).
22.	**A systematic review of VR/AR applications in vocational education: models, affects, and performances**	Application of VR/AR in vocational education, focusing on teaching innovation, technology improvement, technical support, challenges, and future directions.	Teaching Innovation: Integration of VR/AR with curriculum, personalized learning, immersive experiences.	Enhancing Practical Skill Development through Immersive Technologies	1. "VR/AR tools or environments have emerged in the past two decades to enhance vocational education, offering accessible options for skill-specific training, either as supplementary or occasional replacements for traditional courses." (Pg. 1) 2. Quote/Extract 2: "VR employs immersive exploration scenes to provide learners with high-quality project operation experiences, particularly in fields like interior design and construction engineering." (Pg. 7)	"VR employs immersive exploration scenes to provide learners with high-quality project operation experiences, particularly in fields like interior design and construction engineering." (Pg 7)
			Technology Improvement: Impact on cognitive load, self-efficacy, usability.	Promoting Autonomy and Cognitive Skills through AR/VR	1. "VR/AR applications significantly enhance learners' autonomy in learning, spatial perception, thinking ability, and concentration." (Pg. 2) 2. "The cognitive load experienced by learners is closely tied to the stress and burden they encounter, and VR/AR technology can effectively alleviate this load." (Pg. 10)	"The cognitive load experienced by learners is closely tied to the stress and burden they encounter, and VR/AR technology can effectively alleviate this load." (Pg 10)
			Technical Support and Performance: Practical skill training, effectiveness of simulation	Challenges in Implementing VR/AR in Vocational Education	1. "There are still some issues, such as insufficient teachers' capabilities, imperfect course designs, and inadequate technical equipment supports." (Pg. 7) 2: "The amalgamation of new technology and educational practices often lacks a comprehensive reflection on both theory and practical aspects, necessitating further research on the fusion of theoretical foundations and VR/AR applications." (Pg. 14)	"The amalgamation of new technology and educational practices often lacks a comprehensive reflection on both theory and practical aspects, necessitating further research on the fusion of theoretical foundations and VR/AR applications." (Pg 14)
			Challenges and Barriers: Cognitive overload, usability challenges, teacher capabilities.	The Role of VR/AR in Enhancing Engagement and Motivation	1. "AR simplifies complex training manuals, alleviating cognitive load for learners during tasks, resulting in increased interest, visual appeal, and comprehension." (Pg. 3)	"The application of VR/AR in classroom teaching yields substantial improvement in learners' learning effects, with remarkable advancements in both theoretical understanding and practical skills development." (Pg 11)

					2. "The application of VR/AR in classroom teaching yields substantial improvement in learners' learning effects, with remarkable advancements in both theoretical understanding and practical skills development." (Pg. 11)	
			Future Directions: Development of intelligent VR/AR learning environments, cross-curricular integration.	The Future of VR/AR in Vocational Education	1: "Future research aims to concern the innovative curriculum and framework design and seek novel ways to effectively harness VR/AR in vocational education." (Pg. 10) 2. "The integration of VR/AR technologies and classroom teaching holds the potential to enhance learners' cognitive and innovative abilities." (Pg. 14)	"The integration of VR/AR technologies and classroom teaching holds the potential to enhance learners' cognitive and innovative abilities." (Pg 14)Effective use of VR/AR in education requires strong teacher-student interaction, as educators need to be trained and capable of leveraging these tools to maximize their benefits in the classroom (p. 15, 10).
23.	**A Virtual Versus an Augmented Reality Cooking Task Based-Tools: A Behavioral and Physiological Study on the Assessment of Executive Functions**	Comparison of VR and AR in assessing executive functions using a cooking task, focusing on behavioral performance, physiological responses, and sense of presence.	Simulation and Immersion	Enhancing Immersive Learning through Realistic Simulations	1. "VR can provide 3D real-life synthetic environments in which controllers allow human interaction." (p. 1) 2. "AR overlays synthetic elements to the real world...allow hand gesture to act with synthetic elements." (p. 1)	The study highlights how VR and AR provide immersive environments with different levels of interaction and realism. VR, with its complete synthetic environment, offers a more immersive experience, which could enhance culinary training by simulating realistic kitchen environments. (p. 1)
			Learning and Skill Development	Skill Acquisition through Virtual Practice	1. "VR currently represents the GIT with greater usability and feasibility compared to AR." (p. 1) 2. "The study included 50 cognitively healthy subjects. The cooking task consisted of four levels that increased in difficulty." (p. 4)	The paper indicates that VR is more effective in task performance, which implies that VR could be more useful in helping students acquire culinary skills through practice in a controlled, immersive environment. (pp. 1, 4)
			Usability and User Experience	Designing User-Centered AR/VR Applications	1. "VR was able to produce higher levels of sense of presence than AR condition." (p. 1) 2. "AR condition produced more individual excitement and activation than VR." (p. 1)	The paper suggests that while VR provides a stronger sense of presence, AR offers a more stimulating experience. In culinary education, designing AR/VR applications that balance these factors can enhance user engagement and learning outcomes. (p. 1)
			Cultural Representation	Promoting Cultural Competence through Virtual Culinary Experiences	1. "AR...incorporates synthetic elements in the physical world adding information to the users." (p. 2) 2. "AR adds synthetic objects to the real world, being able to perceive of discordance between reality and the artificial information in the environment." (p. 9)	AR's ability to overlay virtual elements onto real-world environments could be used to introduce students to diverse cultural practices and ingredients, promoting cultural competence in culinary education. (pp. 2, 9)
			Testing and Evaluation	Rigorous Testing and Iterative Development for Educational Effectiveness	1. "The results on the behavioral data comparison showed that times are always lower in VR than AR." (p. 9) 2. "Higher physiological activation in AR could depend on the interaction system differences." (p. 8)	The paper emphasizes the importance of evaluating both VR and AR technologies to determine their effectiveness in educational settings. For culinary education, this suggests the need for rigorous testing to optimize these technologies for skill acquisition and engagement. (pp. 8-9)
24.	**An Overview of Cooking Video Games and Testing Considerations**	Overview of cooking video games, their usability, training, and learning components, with suggestions for testing	Simulation and Immersion	Enhancing Immersive Learning through Realistic Simulations	1. "In cooking games, food preparation and presentation are the central gameplay mechanic." (p. 153) 2. "Players can redesign a kitchen and produce a prominent assortment of dishes." (p. 153)	The paper discusses how cooking games simulate real-world kitchen environments, allowing users to experience cooking tasks virtually. The immersive nature of these games, such as the ability to manipulate virtual kitchen tools and redesign kitchens, can be applied to AR/VR to enhance learning by creating realistic virtual environments for students. (p. 153)
			Learning and Skill Development	Skill Acquisition through Virtual Practice	1. "Cooking games can help people to learn a life skill such as meal preparation, beyond just playing a casual game." (p. 154) 2. "These games could also be a good way to train people who want to be chefs and open any food business." (p. 154)	Cooking games are highlighted for their potential to teach practical cooking skills. The educational aspect of these games, where users learn and practice cooking techniques, can be directly translated into AR/VR culinary education, helping students acquire skills in a virtual environment before applying them in real life. (p. 154)
			Usability and User Experience	Designing User-Centered AR/VR Applications	1. "The overall experience of the above video games seems to be quite appealing and interesting with nice visual aesthetics." (p. 153) 2. "It seems that both aspects (good usability + attractive aesthetics) contribute to a positive player experience." (p. 153)	The usability and user experience of cooking games are crucial to their success. For AR/VR applications in culinary education, it is essential to design interfaces that are both intuitive and visually appealing to keep students engaged and ensure effective learning. (p. 153)

			Cultural Representation	Promoting Cultural Competence through Virtual Culinary Experiences	1. "Cooking games can be useful to represent specific food from different cultures, helping people learn traditional methods of cooking." (p. 155) 2. "The first author, being from Nepal, would like to prepare and serve Nepali momos (a typical dish) to virtual customers in a cooking game." (p. 154)	Cooking games offer a platform for exploring and learning about diverse culinary traditions. AR/VR technologies can leverage this by allowing students to virtually experience and practice cooking dishes from various cultures, thus enhancing their cultural competence. (pp. 154-155)
			Testing and Evaluation	Rigorous Testing and Iterative Development for Educational Effectiveness	1. "Test your cooking game prototype early and often...Define who your target audience will be and test your prototype a number of times with them." (p. 154) 2. "We believe that testers with different ethnicity could provide interesting comments about your cooking game." (p. 154)	The paper emphasizes the importance of thorough testing and feedback from diverse user groups to ensure the effectiveness of cooking games. In AR/VR culinary education, rigorous testing and iterative development are crucial to creating tools that meet the educational needs of a diverse student population. (p. 154)
25.	**Augmented and Virtual Reality for Diet and Nutritional Education: A Systematic Literature Review**	The use of AR and VR technologies in enhancing diet and nutritional education.	AR and VR Technology Utilization	Integration of AR/VR in Nutrition Education:	"AR is often deployed in the form of mobile applications, as they can be used by various people and in any location." (Pg. 94) "Virtual supermarkets offer a realistic environment for scientists to analyze purchasing behavior, helping people eat healthily in the long term." (Pg. 92)	The integration of AR and VR in nutrition education allows for innovative methods such as mobile AR applications and virtual environments that make nutrition education more accessible and engaging for a broad audience. This can be paralleled in culinary education by incorporating similar technologies to enhance student learning in realistic, interactive settings. (Pg. 94, 92)
			Educational Applications:	Enhancement of Learning Outcomes through Gamification:	"AR games can be introduced to learn about nutrition and healthy food playfully." (Pg. 91) "Gamification can be recognized to increase user knowledge, engagement, and experience." (Pg. 91)	The use of gamification in AR/VR applications significantly enhances learning outcomes, particularly for younger audiences. This could be adapted to VET culinary education by incorporating gamified elements into AR/VR learning modules to make the education process more engaging and effective for students. (Pg. 91)
			Target Audience:	Impact on Behavior and Health Management:	"AR and VR applications helped participants improve their knowledge regarding nutrition and diet so that by simply providing information, misconceptions can be reduced and healthier eating decisions can be made." (Pg. 95) "Regular visits to virtual supermarkets can improve long-term purchasing behavior." (Pg. 93)	AR and VR technologies not only enhance knowledge but also positively impact users' behavior and health management. For VET culinary education, these technologies could be used to simulate real-life scenarios that help students make better decisions in food preparation and management, ultimately improving their professional practices. (Pg. 95, 93)
			Learning Outcomes:	Challenges and Opportunities in AR/VR Implementation:	"The recognition processes should be improved to recognize the foods faster, more accurately, and reliably." (Pg. 95) "The technologies can be challenging for some users, including elderly people, who have little experience in using smartphones." (Pg. 95)	Implementing AR/VR in education comes with challenges such as the need for accurate food recognition and addressing usability concerns for diverse audiences. In culinary education, similar challenges must be addressed, such as ensuring the technology is user-friendly for students of all backgrounds and skill levels. (Pg. 95)
			Technological Challenges:	Personalization and Accessibility in AR/VR Applications:	"The information can also be personalized and address individual dietary needs, such as daily nutritional requirements or allergies." (Pg. 94) "AR with HMDs provides personalized grocery shopping experiences, including real-time analysis and suggestions." (Pg. 93)	AR/VR applications offer significant potential for personalization, allowing for tailored educational experiences that meet individual needs. In VET culinary education, this could translate into personalized learning paths that adapt to each student's pace and learning style, enhancing overall educational outcomes. (Pg. 94, 93)