
Development of a Virtual Reality (VR)-Based Interactive Quiz Using the ASSURE Model for Polytechnic Students

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Abstract: This study aimed to develop and evaluate a Virtual Reality (VR) based interactive quiz using the ASSURE instructional design model to support outcome-based assessment in a polytechnic context. The increasing demand for immersive and student-centred learning approaches in Technical and Vocational Education and Training (TVET) has highlighted the need for innovative assessment methods that align with Outcome Based Education (OBE) principles. A quantitative research approach was employed involving 30 polytechnic students to evaluate the usability, engagement, and learning effectiveness of the developed VR application. Data were collected using a 4-point Likert scale questionnaire and analysed using descriptive statistics, including mean and standard deviation. In addition, supportive qualitative feedback was obtained through open ended responses to provide further insights into students' learning experiences. The findings revealed high levels of student acceptance, with mean scores ranging from 3.47 to 3.70, indicating that the VR interactive quiz is effective in enhancing engagement, improving conceptual understanding, and supporting learning outcomes. Qualitative feedback further indicated increased motivation and improved visualisation of technical concepts. The study concludes that VR based assessment, when guided by the ASSURE model, provides a promising approach for enhancing teaching and learning in TVET. The findings contribute to addressing the gap in VR-based assessment design within an OBE framework.

Key words: Virtual Reality, Interactive Quiz, ASSURE Model, OBE, Polytechnic

1.0 Introduction

The fast growth of digital technologies has changed the way people teach and learn in Technical and Vocational Education and Training (TVET) in a big way, especially when it comes to meeting the growing need for skills needed in the 21st century. In polytechnic education, students must not only acquire theoretical knowledge but also exhibit procedural proficiency, spatial awareness, and practical competencies that conform to industry standards. Nonetheless, traditional pedagogical methods frequently exhibit constraints in promoting active student participation and enabling profound comprehension of intricate technical concepts.

Virtual Reality (VR) has come up as a new way to teach and learn in TVET in response to these challenges. VR establishes immersive and interactive learning environments that let students see abstract ideas, practise real world technical situations, and interact with content in three dimensions. These skills are especially important for TVET programs, where learning by doing and using what you've learned are key to getting the skills you need. As a result, VR has become more and more popular as a teaching tool to boost student interest, motivation, and overall learning effectiveness in polytechnic schools.

At the same time, TVET assessment practices have gradually moved toward the Outcome-Based Education (OBE) framework, which emphasises the need for teaching, learning activities, and assessment to all be in line with clearly defined learning outcomes. In the OBE framework, assessment is meant to see how well students have met certain course learning goals, not just how well they remember the material. Interactive quizzes are commonly employed as assessment instruments; however, traditional screen-based formats may fail to fully represent the intricacies of procedural skills and practical competencies necessary in TVET environments.

The present endeavour aims to develop an interactive VR quiz utilising the ASSURE instructional design framework to address this deficiency. The ASSURE methodology provides a systematic framework that includes the analysis of student characteristics, the design of learning objectives, the

strategic selection of media, the active engagement of learners, and the continuous assessment. This study aims to develop an interactive assessment tool that enhances student engagement and accurately evaluates the achievement of learning outcomes in polytechnic TVET education by integrating virtual reality technology with outcome-based education principles through the ASSURE model.

2.0 Literature Reviews

VR is becoming more popular as a transformative teaching tool in TVET. This is mainly because it can create immersive, interactive, and experiential learning environments. In TVET settings, where it's important to learn practical skills and skills that are useful in the workplace, VR offers unique benefits that go beyond traditional teaching methods. Previous studies (Radianti et al., 2020; Makransky et al., 2021) indicate that VR enables students to visualise complex technical systems, manipulate virtual objects, and practise procedural tasks within a secure and regulated setting, devoid of the risks linked to actual equipment. Additionally, repeated practice and instant feedback are made possible by VR-based simulations, which are essential for developing technical abilities. These characteristics are particularly helpful in fields like engineering, manufacturing, and technical maintenance that call on spatial reasoning and procedural comprehension.

According to an empirical study, VR-based learning environments can considerably improve students' motivation, engagement, and conceptual understanding when compared to traditional teaching methods (Wu et al., 2022). By placing students in realistic problem-solving situations, virtual reality's immersive quality encourages active learning, deeper cognitive processing, and experiential learning. This is in line with the pedagogical focus of "learning by doing" in TVET education, where students are encouraged to combine theoretical knowledge with real-world application. As a result, VR has been extensively used as a training and teaching aid in a variety of technical fields.

The use of VR in evaluation is still not widely understood, despite these well-established educational advantages. The majority of current research concentrates on using VR for material delivery, simulation-based training, or skill development; its potential as a tool for assessing learning outcomes has received relatively little attention. In the framework of OBE, which has been extensively used in TVET to guarantee that educational practices are in line with precisely defined learning outcomes and industry competency standards, this constitutes a major gap. According to Biggs and Tang (2022), the OBE framework views assessment as a crucial tool for determining whether students have attained the desired competences in the cognitive, psychomotor, and affective domains.

Traditional techniques, including written exams, practical tests, and screen-based quizzes, are often used in TVET assessment procedures nowadays. Although interactive tests have been demonstrated to enhance formative assessment by offering prompt feedback and encouraging active participation, their traditional formats frequently fall short of accurately evaluating intricate technical abilities. Higher-order skills like spatial visualisation, procedural fluency, and real-time decision making, for example, are difficult for screen-based tests to capture and are typically restricted to assessing cognitive memory or basic conceptual knowledge (Huang et al., 2021). Consequently, there is a discrepancy between the methodologies used to assess TVET programs and the intended learning outcomes.

This restriction emphasises the need for more realistic, immersive, and performance-based evaluation methods that can accurately assess the diverse skills needed for TVET. By making it possible to create assessment activities that mimic real-world situations, demand active student participation, and record behavioural performance data in real time, virtual reality offers a viable answer to this problem. A more thorough evaluation of learning outcomes in line with OBE principles can be obtained by using VR based assessment to evaluate students' abilities to carry out procedures, make decisions, and apply knowledge in context. Nevertheless, despite this promise, rigorous research on the efficient design,

implementation, and validation of VR-based evaluation tools within an OBE framework is still lacking, especially in polytechnic educational contexts.

The incorporation of suitable instructional design frameworks is necessary to fill this research gap and ensure that VR technology is pedagogically sound and in line with assessment goals. For this aim, the learner-centred, structured approach provided by the ASSURE instructional design model is especially appropriate. Six essential steps are highlighted by the model: analysing learner characteristics; defining quantifiable learning objectives; choosing relevant media and materials; making effective use of media; requiring active learner participation; and assessing and modifying the instructional process (Smaldino et al., 2022). These elements closely adhere to the OBE principles, especially when it comes to making sure that instructional activities, assessment techniques, and planned learning objectives are all constructively aligned.

According to recent studies (Aziz & Yusoff, 2023; Rahman et al., 2024), the ASSURE model is highly effective in facilitating the incorporation of emerging technologies, such as virtual reality, into educational settings. The ASSURE methodology ensures that technological innovation is in line with pedagogical objectives by facilitating the meaningful integration of VR into teaching and assessment procedures through a methodical framework for instructional planning. However, the majority of current research has been on using ASSURE to direct instructional delivery rather than assessment design, and there is little empirical data looking at its use in creating VR-based assessment tools in an OBE framework.

This study investigates the use of VR as an assessment tool in TVET using a design and evaluation strategy in response to these issues. In particular, the study creates an interactive VR test based on the ASSURE model and assesses how well it supports outcome-based evaluation in polytechnic education. In contrast to earlier research that focused mainly on system development, this study broadens the scope by using empirical evaluation to evaluate (i) the degree of alignment between VR based assessment tasks and course learning outcomes, (ii) the effect of immersive assessment on student performance, motivation, and engagement, and (iii) the validity and applicability of VR-based quizzes in measuring higher-order competencies, such as procedural and spatial skills.

Three contributions are made by this study. By situating VR as a tool for authentic, outcome-based assessment instead of only for instructional delivery, it first improves the use of VR in TVET. Second, it offers empirical proof of how well VR-based interactive tests capture intricate learning outcomes that are challenging to gauge using traditional techniques. Third, it suggests and validates an integrated framework that supports OBE-aligned assessment methods by fusing VR technology with the ASSURE instructional design approach. By making these contributions, the study not only fills a significant void in the literature but also provides useful advice for educators and organisations looking to improve TVET and polytechnic education's evaluation practices.

3.0 Methodology

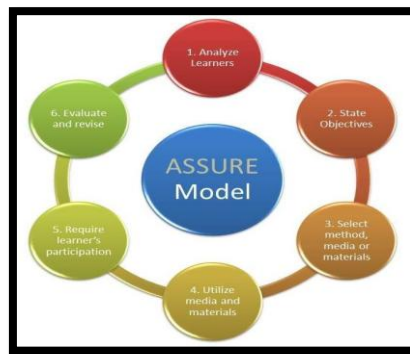


Figure 1: ASSURE MODEL (Heinich, Molenda, Russell and Smaldino, 1999)

The ASSURE instructional design structure (Heinich et al., 1999) was implemented in this study to guide the creation and assessment of an interactive VR quiz for the Measurement Devices course in a polytechnic context. This study used a mixed-method approach, combining quantitative and qualitative data to provide a more thorough assessment of the efficacy and usability of the VR-based assessment tool, in order to overcome limitations sometimes associated with design-based studies.

3.1 Research Design and Participants

The study employed a design and evaluation research design, with two primary stages: (i) creating the VR interactive test using the ASSURE paradigm, and (ii) conducting an empirical assessment of how well it supported Outcome-Based Education (OBE). The study included thirty diploma-level polytechnic students ($n = 30$) engaged in the Measurement Devices course. Convenience sampling was used to choose participants because they were directly involved in the course's execution.

3.2 Data Collection Instruments

Several data gathering tools were used to improve methodological transparency:

- I. Structured Questionnaire: Four constructs, usability, engagement, learning efficacy, and suitability for TVET learning were measured using a 4-point Likert scale (1 = Strongly Disagree to 4 = Strongly Agree). The 16 items in the test were modified from earlier research on virtual reality and educational technology.
- II. Open-ended questions: These are used to gather detailed information about students' opinions, difficulties, and recommendations for development.
- III. Observation Checklist: Used to document student engagement levels, interaction patterns, and technical problems that arise when using virtual reality.

3.3 Implementation Based on the ASSURE Model

Analyse Learners (A):

The demographics, past knowledge, and digital preparedness of the pupils were investigated through an initial needs analysis. The results showed that while most students knew how to use simple digital tools, more than 70% said they had little to no familiarity with virtual reality technologies. This influenced the VR application's design, especially with regard to its user-friendly interface, guided navigation, and cognitive load reduction.

State Objectives (S):

Learning objectives were formulated based on Course Learning Outcomes (CLOs) using the ABCD model. The objectives required students to:

- I. Identify key components of measurement devices,
- II. Apply procedural knowledge in simulated scenarios, and
- III. Interpret measurement readings accurately.

These objectives ensured constructive alignment with OBE principles, particularly in assessing both cognitive and psychomotor domains.

Select Methods, Media, and Materials (S):

A combination of experiential learning and constructivism was used. The MAKAR platform was used to create the VR interactive test, which included scenario-based tasks, 3D models, and instantaneous feedback. By replicating real-world technical situations pertinent to TVET, the design placed an emphasis on authentic assessment.

Utilise Media and Materials (U):

The VR program was put into use during a planned class period. To guarantee familiarity with system controls, students received a systematic orientation before the activity. Systematic observations made during the session showed that there was a lot of student participation, there were a few small usability problems with the first navigation.

Require Learner Participation (R):

Students actively engaged with the VR environment by navigating virtual spaces, interacting with measurement device components, and completing scenario-based quiz tasks. Data were collected immediately after the session using the questionnaire and open-ended responses, ensuring that feedback reflected an authentic user experience.

3.4 Data Analysis

Quantitative Analysis:

Quantitative data were analysed using descriptive statistics, including mean (M) and standard deviation (SD). The results indicate a consistently high level of student acceptance across all measured constructs:

- I. Suitability for TVET learning: M = 3.70, SD = 0.47
- II. Engagement: M = 3.67, SD = 0.48
- III. Learning effectiveness: M = 3.60, SD = 0.49
- IV. Usability: M = 3.47, SD = 0.50

These findings suggest that the VR-based quiz is effective in supporting immersive, outcome-based learning and aligns well with TVET requirements.

Qualitative Analysis:

To strengthen empirical depth, qualitative data were analysed using thematic analysis following Braun and Clarke (2006). The analysis involved data familiarisation, coding, theme development, and refinement. Three major themes emerged:

- I. Enhanced Engagement through Immersion
Students consistently highlighted the immersive nature of VR as a key factor in increasing their interest and focus.

One participant stated: “The VR quiz feels like a real situation, not just answering questions. It makes me more interested to learn.”

II. Improved Conceptual and Spatial Understanding

Participants reported that 3D visualisation helped them better understand complex components and procedures “I can see the measurement device clearly in 3D, which helps me understand how it works better than pictures.”

III. Usability and Navigation Challenges

“At first, I was confused about how to move and select objects, but after some time it became easier.”

These qualitative findings complement the quantitative results by providing deeper insights into student learning experiences, particularly highlighting both the strengths and limitations of the VR application.

3.5 Validity and Iterative Refinement

Data triangulation was used to combine questionnaire results, observational data, and qualitative comments in order to increase the findings' trustworthiness. Iterative enhancements to the VR program, such as improved navigation directions, simplified interfaces, and more user guiding, were created based on the review. This iterative improvement is in line with the ASSURE model's Evaluate and Revise (E) phase, guaranteeing ongoing development of the assessment instrument and instructional design.



Figure 2: Virtual Reality (VR) interactive quiz link developed using the MAKAR platform for the Measurement Devices subject

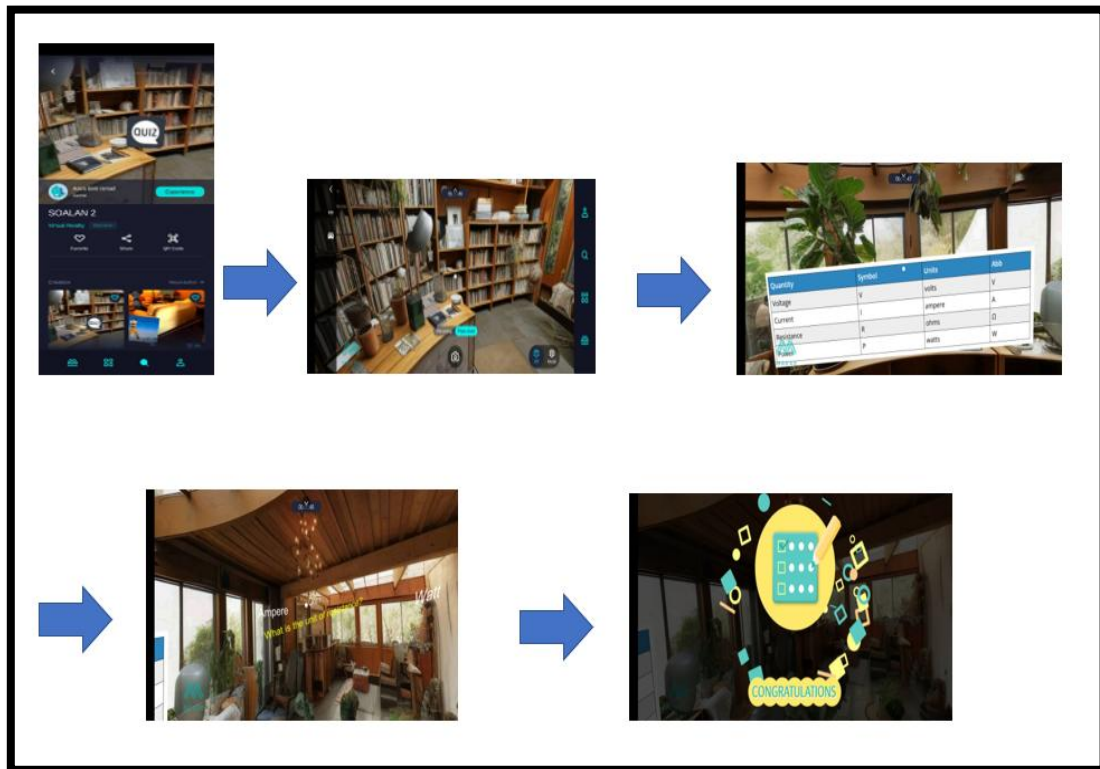


Figure 3: Flow experience during the VR-based interactive quiz

Figure 2 presents the access interface of the Virtual Reality (VR)–based interactive quiz developed using the MAKAR platform for the Measurement Devices subject. The QR code enables students to easily access the VR application using their mobile devices, supporting flexible and technology-enhanced learning in a polytechnic environment. Figure 3 illustrates the flow of user experience during the VR-based interactive quiz. The process begins with the main interface where students enter the quiz environment, followed by navigation within an immersive 3D setting. Students then interact with virtual objects and respond to scenario-based questions. The process concludes with immediate feedback and result display, reinforcing learning outcomes and enhancing engagement. Overall, the figures demonstrate how the VR application provides a structured, interactive, and immersive assessment experience aligned with the ASSURE instructional design model.

4.0 Data Analysis and Findings

The data collection and analysis results offer a methodical assessment of the interactive virtual reality VR test created for the Measurement Devices course in a polytechnic setting. This review critically assesses how well the VR application satisfies instructional objectives, supports OBE principles, and improves student learning experiences rather than just summarising system performance. The analysis specifically focuses on emphasising the main advantages, drawbacks, and practical difficulties related to using VR as a TVET assessment tool.

Product testing was carried out using predetermined assessment criteria that included instructional alignment, functional performance, and usability in order to guarantee methodological rigour. A thorough examination of both educational efficacy and technical dependability was made possible by the operationalisation of both criteria through structured evaluation tools. A methodical approach for

assessing whether the VR-based interactive test met its desired learning objectives was made possible by the application of design testing criteria, especially with regard to procedural comprehension, spatial visualisation, and student engagement.

Crucially, by looking at how the VR environment promotes meaningful interaction, encourages active learning, and allows the measurement of higher-order competencies that are frequently challenging to capture through traditional approaches, the assessment goes beyond surface-level usability. The results show that including immersive aspects improves conceptual understanding and learner engagement, but they also highlight certain usability and navigation issues that could have an impact on the first user experience.

Overall, the findings show that VR-based assessment has the potential to be a practical strategy for assisting real, outcome-based TVET evaluation. Simultaneously, the limits that have been found offer important information for future research and iterative design development. Table 1 presents an overview of the results obtained from the design testing criteria.

Table 1: Application Testing Criteria for VR-based interactive quiz

No	Design Testing Criteria	Evaluation Scale				
		1	2	3	4	5
1	Safety				√	
2	Clarity of Understanding				√	
3	VR Interactive Quiz System				√	
4	Functionality				√	
5	Type of Software				√	
6	Type of Testing: The type of testing is parameter testing. A description field of each criterion for testing the Measurement Devices Application.				√	

Criterion	Description
User	<ul style="list-style-type: none"> The VR-based interactive quiz is developed for polytechnic students who are enrolled in the Measurement Devices subject. The application is also intended to support lecturers in delivering interactive teaching and formative assessment related to measurement concepts and instruments.
Function	<ul style="list-style-type: none"> The primary function of this application is to assess students' understanding of measurement devices through interactive quiz questions embedded in a virtual reality environment. Students are required to interact with virtual measurement instruments and simulated scenarios to answer quiz items accurately.
Aesthetics	<ul style="list-style-type: none"> The VR-based interactive quiz is designed with immersive three-dimensional visual elements to attract students' attention and enhance engagement. The use of realistic virtual instruments and visual cues facilitates students' understanding and retention of concepts related to measurement devices.
Materials/ Software	<ul style="list-style-type: none"> Using the MAKAR Using the Canva Website.

Source: (Mohd *et al.*, 2017)

Table 2: Application Testing Criteria for VR-based interactive quiz

No	Item	Mean	SD	Interpretation
1	The VR quiz is easy to use	3.51	0.51	High
2	The VR quiz is engaging	3.67	0.48	Very High
3	The VR quiz improves understanding	3.60	0.49	Very High
4	The VR quiz provides useful feedback	3.47	0.52	High
5	The VR quiz supports learning outcomes	3.57	0.50	Very High
6	The VR quiz is suitable for TVET learning	3.70	0.47	Very High

Scale: 1 = Strongly Disagree, 4 = Strongly Agree

The quantitative results show that students' acceptance of the VR-based interactive test is consistently high, with mean values above 3.40 for all measured constructs. Notably, the TVET learning context had the highest mean score for appropriateness ($M = 3.70$, $SD = 0.47$), indicating that students thought the VR application was in line with the program's practical and competency-based nature. This is a crucial discovery because it shows how VR can facilitate real-world assessment settings that adhere to the principles of OBE.

Furthermore, the high engagement mean score ($M = 3.67$, $SD = 0.48$) suggests that the VR environment's immersive elements were successful in maintaining students' focus and encouraging active participation. This supports the claim that immersive technology can increase student engagement above and beyond what is usually possible with traditional screen-based evaluation tools. According to the perceived learning effectiveness ($M = 3.60$, $SD = 0.49$), students' conceptual knowledge was positively impacted by the VR-based test, especially when it came to visualising and interacting with technical elements.

From a perspective of analysis, the findings' reliability is strengthened by the very small standard deviation values ($SD < 0.50$) across all constructs, which show a high degree of consistency in student replies. The convergence of high mean scores for learning effectiveness, engagement, and applicability further indicates that the VR application not only satisfies usability requirements but also significantly advances educational goals.

Collectively, these results provide empirical support for the integration of VR as an assessment tool in TVET, particularly in addressing the limitations of traditional assessment methods in evaluating higher-order competencies. However, while the findings demonstrate strong initial acceptance, they also highlight the need for further investigation into long-term learning impact and comparative performance outcomes.

5.0 Discussion and Conclusions

The results of this study offer empirical evidence for the educational benefits of incorporating an interactive test based on VR in a TVET setting. A high degree of student acceptance in terms of usability, engagement, and instructional efficiency is indicated by the consistently high mean scores ($M = 3.47-3.70$) across all evaluated constructs. Specifically, the highest mean score for suitability in TVET learning ($M = 3.70$, $SD = 0.47$) indicates that the VR-based evaluation is in line with the practice-oriented and competency-based character of polytechnic education. This alignment is important because it shows how VR can offer authentic assessment environments that mirror real-world technical applications, which is a crucial OBE requirement.

From a perspective of analysis, the high engagement score ($M = 3.67$, $SD = 0.48$) suggests that immersive elements are essential for maintaining student focus and encouraging active engagement. This result lends credence to the claim that VR-based environments, as opposed to traditional

assessment formats, can promote deeper cognitive engagement, especially in technical domains requiring procedural and spatial comprehension. Similarly, the learning effectiveness score ($M = 3.60$, $SD = 0.49$) indicates that using interactive features and three-dimensional visualisation improves students' conceptual grasp. These findings support the idea that VR is a useful tool for evaluating higher-order skills, such as spatial reasoning and procedural fluency, which are sometimes challenging to measure using conventional techniques.

However, a more thorough analysis of the results identifies areas that need greater development. Although the VR application was generally effective, its feedback systems could not have been sufficiently adaptable or informative to completely support student learning, as indicated by the considerably lower mean score for feedback usefulness ($M = 3.47$). This implies that to improve the formative evaluation function of VR-based tools, more complex feedback systems are required, such as real-time guidance, adaptive hints, or performance-based analytics.

By highlighting the advantages and difficulties that students perceive, qualitative findings enhance the interpretation of the results. The quantitative evidence of greater engagement and learning effectiveness is supported by the participants' consistent reports of improved knowledge and increased motivation as a result of immersive 3D visualisation. However, several students first encountered usability issues, especially when navigating the virtual environment and interacting with things. Even though these problems are small, they show that interface design and user onboarding are still important aspects affecting how well VR is implemented.

Crucially, this study also recognises several restrictions related to the use of VR in educational contexts. First, scalability and widespread adoption in institutions with limited resources may be hampered by VR's technical and infrastructure needs, which include hardware availability, device compatibility, and system performance. Second, difficulties with usability and accessibility, especially for new users, might create cognitive load that may momentarily impair learning efficacy. Third, VR's promise as a fully responsive assessment tool is diminished by the existing implementation's lack of sophisticated adaptive feedback systems. On top of that, the study's small sample size ($n = 30$) and lack of a control group limit how broadly the results can be applied and how learning effects may be causally interpreted.

Notwithstanding these drawbacks, this study contributes significantly by showing that incorporating VR into the ASSURE instructional design framework offers an organised and pedagogically sound method for creating interactive assessment tools in line with OBE principles. By reorienting VR from a primarily instructional tool to a mechanism for authentic, outcome-based assessment in TVET, the study expands on previous studies.

In order to improve assessment accuracy and personalisation, future study should concentrate on performing experimental or quasi-experimental studies to compare VR based assessment with conventional techniques, using larger and more diverse samples, and combining adaptive feedback and learning analytics. The success of VR as a scalable and trustworthy evaluation tool in TVET and polytechnic education would need to be further validated.

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