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WELCOME SPEECH FROM THE CHAIRMAN

RISM 17th International Surveying Conference for Undergraduates (ISCU 2025)

بسم الله الرحمن الرحيم السلام

عليكم ورحمة الله وبركاته

Greetings to all,

It is with great pleasure that I welcome you to the 17th RISM International Surveying Conference for Undergraduates (ISCU 2025), themed *"Embracing Construction Revolution 4.0: Transforming Malaysia's Built Environment."* On behalf of the Royal Institution of Surveyors Malaysia (RISM), I also wish to express our sincere appreciation to Universiti Teknologi MARA (UiTM), Perak Campus, for graciously hosting this significant event.

As we navigate the era of the Fourth Industrial Revolution (IR4.0)—or in our context, Construction Revolution 4.0 (CR4.0)—we are witnessing transformative advancements across the global construction sector. Technologies such as Building Information Modelling (BIM), the Internet of Things (IoT), artificial intelligence (AI), robotics, big data analytics, and cloud computing are redefining the way we build, manage, and interact with our built environment. For Malaysia, embracing CR4.0 is a strategic imperative to achieve our socio-economic and environmental goals.

This conference serves as a vital platform to unite surveying undergraduates from various disciplines, fostering critical dialogue on industry challenges, enhancing professional networking, and preparing a new generation of talent for the rapidly evolving construction landscape. It is also an opportunity for employers to engage with and inspire our future professionals.

I would like to extend my heartfelt thanks to all industry speakers, paper presenters, judges, and participants for their time, contributions, and support in making ISCU 2025 a success. I also commend the organising committee for curating a meaningful and dynamic conference experience.

May the knowledge gained, connections formed, and ideas exchanged during this event inspire all participants to lead and innovate in their future endeavours.

Wishing everyone a productive and memorable conference.

Prof. Ts Sr Dr. Adi Irfan Bin Che Ani'
Chairman, Universities' Partnering Committee
RISM Session 2024/2025
May 2025

WELCOME SPEECH FROM CO-CHAIRMAN

RISM 17th International Surveying Conference for Undergraduates (ISCU 2025)

Bismillahirrahmanirrahim.

السلام عليكم ورحمة الله وبركاته and greetings to all.

It is my great pleasure to welcome everyone to the 17th International Surveyor Conference for Undergraduates (ISCU 2025), proudly hosted by Universiti Teknologi MARA (UiTM) Perak Branch in collaboration with the Royal Institution of Surveyors Malaysia (RISM). This event is a meaningful platform for students in the built environment to share ideas, showcase innovations, and build professional networks. We are honoured by your presence and enthusiastic participation, with 135 accepted papers and 78 poster presentations this year.

UiTM Perak, home to the College of Built Environment, has long been a hub for academic excellence in architecture, planning, and surveying. Our commitment remains strong in nurturing competent graduates who meet industry demands and contribute to nation-building.

While you're here, we invite you to experience the heritage and culture of Perak Tengah from the architectural richness of Rumah Kutai to the historical towns of Pasir Salak, Bota, and Kampung Gajah.

To all presenters and winners, congratulations on your achievements. Let your work today be a catalyst for future success and academic growth. We hope this conference will inspire you to explore new ideas, foster collaboration, and make lasting memories.

My deepest thanks to the Royal Institution of Surveyors Malaysia (RISM) and the organising committee for making this event a success.

We hope your experience here will be rewarding and unforgettable.

Thank you. Selamat datang dan selamat berjaya.

Associates Professor Dr. Nur Hisham Ibrahim, *PMP*
Co-Chairman, Universities' Partnering Committee
RISM Session 2024/2025
May 2025

WELCOME SPEECH FROM THE PROJECT DIRECTOR

RISM 17th International Surveying Conference for Undergraduates 2025

Alhamdulillah, all praise to Allah S.W.T. for His guidance and blessings in making the RISM 17th International Surveying Conference for Undergraduates (ISCU) 2025 a reality.

It is with great honour and gratitude that I welcome all participants, guests, academicians, and industry professionals to this prestigious event, proudly organized under the Royal Institution of Surveyors Malaysia (RISM). This 17th edition of ISCU stands as a proud testament to our collective dedication toward academic excellence, professional collaboration, and youth empowerment in the field of surveying.

I extend my heartfelt appreciation to RISM for its unwavering support, to the hardworking ISCU 2025 Organising Committee, and to all 16 partnering universities across Malaysia for their commitment and contributions. Your efforts have shaped this conference into a dynamic platform for knowledge exchange, innovation, and professional growth.

To the academicians and practitioners present, your insights are invaluable in bridging the gap between academic theory and real-world practice. To our undergraduate participants, your passion, curiosity, and commitment are the very foundation of our future. May this conference not only deepen your academic journey but also ignite a spirit of leadership, integrity, and sustainable thinking.

Let this gathering serve as more than an academic milestone. May it foster lifelong networks, inspire transformative ideas, and chart new directions in our shared professional journey.

Wishing everyone a rewarding and inspiring conference experience.

Sr Dr. Nurul Fadzila Zahari
Project Director
RISM 17th ISCU 2025

ENHANCING SPATIAL VISUALISATION IN QUANTITY SURVEYING EDUCATION WITH AUGMENTED REALITY

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ABSTRACT

In quantity surveying education, measurement skills are fundamental for cost estimation and material quantification. Traditional measurement methods rely on 2D drawings, requiring students to visualise three-dimensional complex structures mentally. However, many students struggle with spatial visualisation, hindering their understanding of building components and measurement accuracy. Augmented Reality (AR) offers a solution by providing interactive 3D visualisations, allowing students to comprehend spatial relationships better and improve their measurement skills. This study investigates the impact of AR-enhanced measurement on students' ability to visualise and acquire knowledge compared to traditional methods. A quasi-experimental research design will involve 80 second-year quantity surveying students, using a quantitative method for data collection. The control group used conventional measurement techniques, while the experimental group utilised AR-based tools. Pre- and post-tests were conducted to assess knowledge acquisition, and statistical analyses were performed to determine significant differences between the two approaches. The findings of this study are expected to demonstrate the effectiveness of AR in improving students' spatial visualisation skills, leading to better comprehension and measurement accuracy. This research contributes to improving quantity surveying education by integrating digital tools that enhance learning outcomes. The significance of this study lies in its potential to reshape teaching methodologies, promote the adoption of AR technology in education, and ultimately produce a more competent quantity of surveying professionals.

Keywords: Quantity Surveying, Augmented Reality, Spatial Visualisation, Educational Technology, Knowledge Acquisition

I. INTRODUCTION

Spatial visualisation skills are fundamental for interpreting architectural plans, understanding structural components, and performing accurate measurements in quantity surveying education (Dursun & Qabshoqa, 2024). These skills enable students to manipulate three-dimensional objects mentally, a critical competency for cost estimation and construction project management tasks. Traditional pedagogical methods, however, often rely on two-dimensional drawings, which may limit students' ability to visualise complex spatial relationships (Dursun & Qabshoqa, 2024) Recent augmented reality (AR) technology advancements present opportunities to address these limitations by providing immersive, interactive learning environments that enhance spatial cognition and academic performance (Gómez-Tone et al., 2022; Medina Herrera et al., 2024).

Empirical evidence indicates that AR-based training significantly improves spatial visualisation abilities, particularly in STEM disciplines. For instance, a study involving first-year engineering students demonstrated that short AR interventions led to statistically significant gains in spatial skills, correlating with higher academic achievement in subjects requiring spatial reasoning (Gómez-Tone et al., 2022). Similarly, AR applications in geometry education improved preschool children's spatial test scores, underscoring the adaptability of this technology across educational levels. In higher education, immersive AR systems like BeeAR and PARSAT have enhanced spatial navigation and problem-solving skills by allowing users to interact with virtual landmarks and 3D models, fostering deeper environmental engagement (Medina Herrera et al., 2024).
Integrating AR in quantity surveying education aligns with broader trends in construction-related disciplines. A 2024 study evaluating virtual reality (VR) in quantity surveying courses revealed that students using VR exhibited improved motivation, comprehension of structural elements, and proficiency in spatial navigation compared to traditional 2D methods (Dursun & Qabshoqa, 2024). Participants highlighted VR's utility in measurement modules, where immersive 3D models facilitated accurate visualisation of construction components. These findings suggest

that AR, as a complementary tool, could similarly enhance practical skill development by bridging the gap between theoretical concepts and real-world applications (Dursun & Qabshoqa, 2024; Medina Herrera et al., 2024).

Emerging research underscores the synergistic relationship between spatial visualisation tools and academic outcomes. For example, the Revised Purdue Spatial Visualization Test (Revised PSVT: R) revealed a 25% improvement in spatial abilities among students exposed to 3D modelling tools, compared to a 5% increase in control groups (Medina Herrera et al., 2024). Such tools refine spatial reasoning and foster problem-solving skills, integral to quantity surveying tasks like material quantification and cost analysis (Gómez-Tone et al., 2022). By leveraging AR to simulate real-world construction environments, educators can provide students with hands-on experiences that reinforce spatial comprehension while minimising the risks associated with physical site visits (Dursun & Qabshoqa, 2024).

I. PROBLEM STATEMENT

Conventional instructional approaches in Quantity Surveying (QS), including lectures and studio-based sessions, continue to face significant limitations in facilitating students' comprehension of spatial and theoretical concepts. Lectures typically offer passive learning environments, lacking adequate interactive and visual components. As a result, students often encounter difficulties in internalising abstract construction theories and applying them effectively to real-world practices. The limitation of engagement within such delivery methods contributes to reduced motivation and low knowledge retention. On the other hand, studio-based learning provides valuable hands-on exposure. Nevertheless, its implementation demands considerable institutional resources regarding time allocation, physical space, skilled facilitators, and technical equipment. These constraints limit scalability and consistent deployment across academic settings (Wahid, 2020).

Integrating Augmented Reality (AR) into education has become a compelling response to such challenges. AR offers dynamic and interactive 3D visualisations that enhance spatial understanding by overlaying virtual elements onto real-world contexts. According to (Kaur et al., 2021), AR enables learners to interact with complex technical diagrams in ways that foster a deeper understanding of otherwise intangible content. Similarly, (Montalbo, 2021) demonstrated the impact of AR through a mobile learning platform in chemistry education, which yielded substantial gains in students' spatial visualisation capabilities. (Wong et al., 2021) further noted that AR facilitates the inspection and manipulation of virtual molecular models, supporting meaningful comprehension of spatial relationships. The immersive and intuitive characteristics of AR suggest considerable potential for adoption in QS education, particularly in overcoming the limitations posed by static visuals in traditional teaching.

Applications of AR across disciplines consistently indicate enhancements in knowledge retention, learner engagement, and conceptual understanding. (Stromberga et al., 2021) used AR to visualise disease models in health sciences, resulting in improved student interaction and learning outcomes. (Hensen et al., 2021) reported similar benefits in anatomical education, where learners explored 3D organ models synchronised with lectures. (Tan et al., 2023) advanced this practice by developing a physical sandbox for visualising complex UAV pathways, significantly improving spatial awareness. When adapted to the QS context, such methods could enhance students' capacity to visualise architectural plans, volumetric computations, and building elements with greater clarity.

Moreover, AR-supported environments enable interactive and personalised learning experiences were students transition from passive observers to active participants. According to (Hammady et al., 2020), AR-based storytelling in museum environments significantly enhanced user engagement and technology acceptance. This suggests that contextual interactivity plays a critical role in educational effectiveness. Dalager and (Dalager & Majgaard, 2022) observed similar outcomes in vocational mathematics, where AR-based 3D models allowed learners to grasp volumetric concepts intuitively. (Tiwari & Bhagat, 2024) added that marker-based AR can lower cognitive load while simultaneously boosting spatial reasoning, an essential skill in QS measurements. These outcomes validate the need to explore AR's applicability in QS education, particularly for visualising and interpreting complex structural information that students often struggle to grasp through conventional methods.

Despite the promising outlook, a limited body of research remains to examine AR's direct application in Quantity Surveying, particularly in spatial visualisation and measurement tasks. While various studies confirm AR's effectiveness in other technical disciplines, few have empirically compared knowledge acquisition outcomes between AR-assisted and traditional QS measurement methods. This presents a distinct research gap requiring systematic investigation. Specifically, the degree to which AR enhances students' comprehension of spatial elements in building design and measurement workflows must be assessed. Hence, this study seeks to address this gap by comparing traditional instructional techniques with AR-supported methods in QS education.

II. RESEARCH OBJECTIVES

The objectives of this study are as follows:

1. To identify the level of knowledge acquisition between traditional measurement methods and Augmented Reality (AR)-assisted measurement methods.
2. To determine whether there is a significant difference in students' knowledge acquisition between traditional and AR-assisted measurements.

II. LITERATURE REVIEW

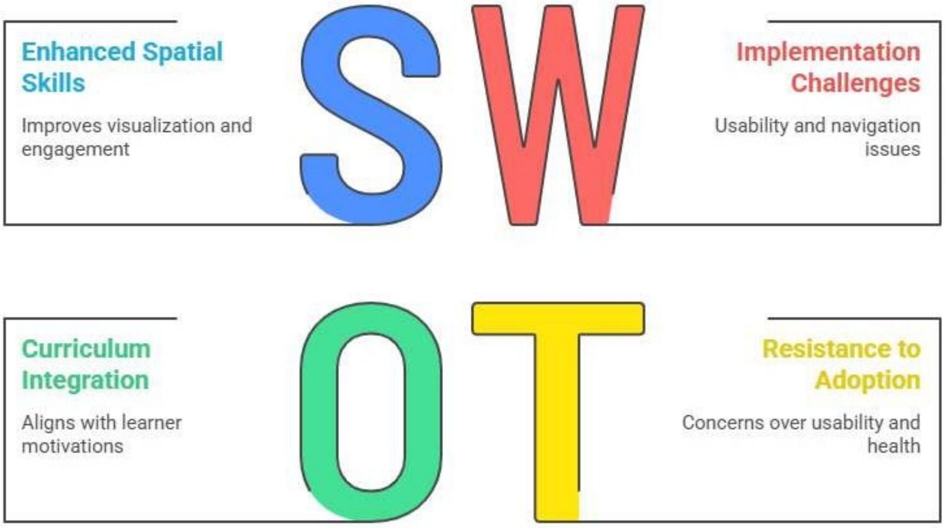
The increasing complexity of built environment education, particularly Quantity Surveying (QS), necessitates innovative instructional strategies to bridge the gap between abstract theoretical knowledge and practical spatial understanding. Augmented Reality (AR) has emerged as a prominent solution for enhancing spatial visualisation, especially in disciplines requiring the manipulation of three-dimensional (3D) objects. (Kaur et al., 2021) highlighted that engineering students often struggle with visualising abstract concepts through conventional diagrams. The integration of AR, as presented through their tangible user interface framework, facilitates intuitive learning by overlaying virtual elements onto physical environments. Similarly, (Montalbo, 2021) demonstrated how the eS2MART teaching material, embedded with AR features, significantly improved learners' spatial skills in chemistry, achieving normalised gain scores of 0.50 and 0.76 in two spatial assessments. (Wong et al., 2021) further affirmed AR's value in promoting compound visualisation from multiple angles in chemistry education, thus emphasising the cross-disciplinary potential of AR in improving spatial cognition.

AR has also been applied to address cognitive demands involving spatial orientation in health and anatomical sciences. (Stromberga et al., 2021) observed positive outcomes using mixed reality to visualise complex disease models in medical education, suggesting that students benefit from increased interactivity and engagement. Similarly, (Hensen et al., 2021) developed ImPres, an immersive AR-based presentation tool that combined traditional slides with 3D augmentations, allowing students to explore anatomical structures using mobile devices. These tools mirror the requirements of QS students who must interpret architectural and structural plans. (Tan et al., 2023) further reinforce this by proposing an AR visualisation framework for UAV-based virtual infrastructure, which enhances user spatial perception, a skill directly correlating to tasks such as site planning and volume quantification in QS practice.

Various studies have identified that AR improves visualisation and reduces cognitive overload. (Tiwari & Bhagat, 2024) compared different AR approaches and found marker-based AR to be most effective in minimising cognitive load while enhancing spatial skills. This aligns with (Supli & Yan, 2024) quasi-experimental study, which showed that primary school students significantly improved spatial ability after AR-based intervention. These outcomes are consistent with (Dalager & Majgaard, 2022), who observed better spatial comprehension in vocational education students using AR to visualise 3D mathematical shapes. These findings underline the relevance of AR to QS, where students need to mentally rotate and manipulate 3D representations of structures and quantities, which often result in cognitive fatigue when approached through traditional 2D resources.

Despite the optimism surrounding AR's educational potential, challenges remain in its implementation. (Wild et al., 2021) noted that although AR installations like UNBODY are effective in promoting spatial interaction, usability and navigation issues persist, especially among novice users. Similarly, (Walecki et al., 2024) documented adverse health effects such as eye strain and sensory overload during immersive AR sessions, suggesting a need for careful design and moderated exposure. (Altmeyer et al., 2024) added that learners with lower verbal working memory capacities might not benefit equally from AR, indicating that individual learner profiles must be considered. While these limitations may not entirely disqualify AR from QS education, they highlight the necessity for tailored instructional design that considers learner variability and ergonomic delivery.

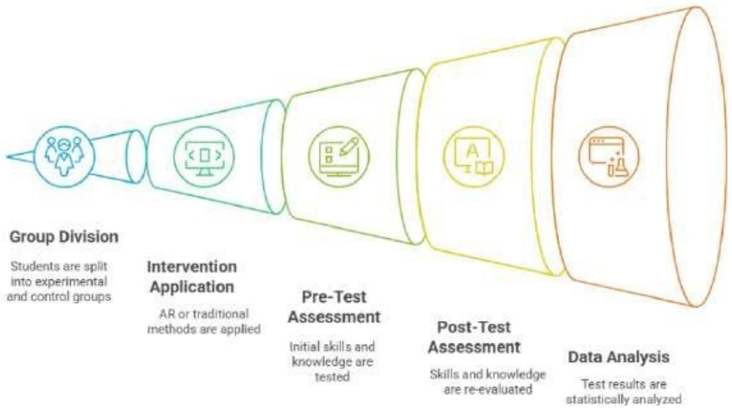
When reviewing AR tools' user experience and technology acceptance aspects, (Hammady et al., 2020) found that ease of use and enjoyment were key factors influencing the continued use of their Mixed Reality prototype in museum storytelling. The Technology Acceptance Model constructs revealed that willingness for future use was predominantly driven by perceived usefulness. Similar insights were echoed by (Piri et al., 2024), who found that interactional affordances in Mixed Reality environments reduced cognitive load and improved spatial reasoning. These findings suggest that integrating AR into QS curricula should consider not just the technological novelty but also its alignment with learners' motivations and task relevance.



In conclusion, a review of current literature indicates that AR is a viable pedagogical tool for enhancing spatial visualisation in Quantity Surveying education. Numerous studies across disciplines from engineering and medicine to mathematics and museum education demonstrate AR's capacity to improve spatial skills, reduce cognitive burden, and elevate user engagement. However, despite its promise, challenges related to usability, learner variability, and technological ergonomics persist. As a result, there remains a significant gap in applying AR, specifically within QS education. While AR has proven effective in spatially intensive domains, limited empirical research has been conducted to validate its effectiveness in QS-specific competencies, such as interpreting building information models, quantity take-offs, and spatial cost mapping. Therefore, future research must develop and assess QS-specific AR applications that test spatial skill improvements and examine long-term academic and professional impacts. In doing so, AR can be effectively aligned with QS pedagogical goals, ultimately transforming traditional QS education into a more interactive, spatially aware, and future-ready discipline.

III. METHODOLOGY

This study adopts a quasi-experimental research design to examine the effectiveness of Augmented Reality (AR) in enhancing spatial visualisation and knowledge acquisition among Quantity Surveying (QS) students. Eighty Second-year QS students were selected from the Department of Quantity Surveying, UTM, and divided equally into experimental and control groups. The experimental group engages with an AR-based measurement application centred on a staircase 3D model, while the control group applies conventional paper-based and manual measurement methods. This design enables comparative analysis between traditional and AR-assisted pedagogical strategies while maintaining the internal validity of the intervention. Quasi-experimental methods are widely employed in education to measure the impact of technology-driven interventions, mainly when randomisation is not feasible. Previous research by (Tiwari & Bhagat, 2024) confirmed the value of such an approach in assessing the cognitive effects of AR, where marker-based AR interventions yielded higher spatial visualisation scores and lower cognitive load among engineering students. Similarly, (Supli & Yan, 2024) employed a quasi-experimental design in a study with primary school learners, revealing that those using smartphone-based AR tools achieved significantly higher spatial test scores. (Montalbo, 2021), in a single-group pre-post design, validated the effectiveness of AR-based teaching tools in improving spatial comprehension through the eS2MART TLM system.



Population and Sampling

Samplings are selected using purposive sampling from a cohort of 80 second-year Quantity Surveying students. The selection criteria include students with no prior exposure to AR applications and those currently enrolled in a measurement course. The students will be tested twice. These groups have been exposed and taught using conventional instructional methods, including lectures, diagrams, and printed plans. Then, they will be exposed to AR-based tools via mobile devices, allowing interactive manipulation of a virtual 3D staircase model. This sample size aligns with other AR education studies involving comparable numbers of students to validate instructional interventions. For instance, the study by Singh, (Singh et al., 2023) involved 127 undergraduate students to compare conventional and AR-based teaching in trigonometry, and (Schlummer et al., 2023) used 73 participants to assess learning outcomes in an MR-supported lab setting. The selected sample size in this QS-focused study is adequate to ensure statistical robustness while facilitating effective classroom implementation.

Instruments and Data Collection

Data collection uses structured pre-and post-test questionnaires to assess students' knowledge acquisition and spatial visualisation skills. Both groups complete identical tests before and after the instructional intervention. The test items include measurements, visualisation questions, and content aligned with the QS curriculum, particularly involving staircase design and interpretation elements. The experimental AR tool features an interactive staircase model, allowing students to zoom, rotate, and dissect the structure virtually, enabling a deeper understanding of volume, height, rise, and run. To evaluate students' perceptions and usability experiences, a post-intervention questionnaire is administered. The questionnaire is designed based on a similar construct: perceived usefulness, perceived ease of use, personal innovativeness, enjoyment, and willingness for future use. The questionnaire in this study provides insights into learner motivation and the perceived educational value of AR tools.

AR Tool Development and Implementation

The AR application was developed for this study using platforms Unity and Vuforia, featuring a staircase 3D model relevant to quantity surveying measurement tasks. The model incorporates accurate scale, geometry, and sectional views to mimic real-life architectural structures. Students in the experimental group access the model through mobile devices during the measurement exercise, allowing real-time engagement with the virtual object in a physical learning environment. The AR tool enables manipulation functions such as zooming, rotation, and part-isolation, reflecting the affordances identified by (Piri et al., 2024) in Mixed Reality training programs designed to enhance mental rotation and spatial cognition.

The AR application, which features a 3D model of a staircase, is developed in alignment with the Construction Measurement Augmented Reality (CMAR) conceptual framework proposed by (Fauzi et al., 2022). CMAR serves as a framework specifically designed for creating mobile AR learning modules aimed at construction measurement. It emphasizes the use of interactive 3D visualizations to support spatial cognition and improve educational outcomes in this field. The framework underscores the role of immersive AR tools in helping students interpret architectural elements more effectively and in bridging the gap between traditional 2D drawings and interactive digital models. By incorporating a staircase model that allows for dynamic interaction and analysis of virtual construction elements, our application exemplifies the core principles of CMAR, thereby enhancing students' understanding of complex building structures.

Implementation is carried out over two instructional sessions. Instructors follow a standardised lesson plan to control instructional variation. During the sessions, the first phase control group will answer a questionnaire based on previous experience using printed technical drawings and measurement tools. After that, an AR session will be conducted, and they will be exposed directly to the AR environment. These methods will differ due to the prior knowledge and experience in conventional methods.

Data Analysis

The pre-and post-test results are analysed using paired and independent sample t-tests to evaluate within-group improvement and between-group differences in knowledge acquisition and spatial comprehension. Questionnaire responses, based on the Technology Acceptance Model (TAM), are analysed using descriptive statistics to assess central tendencies and dispersion across constructs such as perceived usefulness and ease of use. Statistical significance is set at $p < 0.05$. The hypothesis is constructed as follows:

H_0 : *There is a significant difference in students' knowledge acquisition between traditional and AR-assisted measurements.*

The analysis procedure follows the approach used by (Medina Herrera et al., 2024), where spatial skill gains were compared between control and experimental groups using statistical testing, yielding a 25% gain in spatial ability in the AR-integrated learning group. Similarly, (Saidin et al., 2024) employed data mining techniques to link visualisation test results with critical thinking development among chemistry students using AR. These methods support a multidimensional understanding of AR's educational impact, combining knowledge performance with effective and perceptual outcomes.

IV. EXPECTED OUTCOMES

The expected outcomes of this study include a significant improvement in students' spatial visualisation skills and knowledge acquisition in Quantity Surveying through the integration of Augmented Reality (AR) tools, particularly in measuring staircase elements. The experimental group, exposed to interactive AR-based models, is anticipated to demonstrate better comprehension of complex spatial relationships and achieve higher post-test scores than the control group using conventional methods. Additionally, students interacting with the AR staircase model are expected to display greater measurement accuracy and a more intuitive understanding of dimensional concepts. Furthermore, positive feedback regarding usability, engagement, and perceived usefulness will likely emerge from the post-intervention questionnaire, indicating strong learner acceptance of AR tools. Ultimately, this study is expected to validate the educational benefits of AR in Quantity Surveying and provide evidence for its integration into construction-related curriculum.

V. CONCLUSIONS AND RECOMMENDATIONS

This study concludes that integrating Augmented Reality (AR) into Quantity Surveying education significantly enhances students' spatial visualisation skills, leading to better comprehension of building components and improved measurement accuracy. The findings indicate that AR-based tools offer a more interactive and intuitive learning experience than traditional 2D methods, particularly benefiting the students who often struggle with visualising complex structures. As such, it is recommended that AR technology be incorporated into measurement-related modules within the Quantity Surveying curriculum, with appropriate training provided to educators for effective implementation. Developing AR content that aligns with specific learning outcomes—such as staircase measurement—can further support its practical application. Future research should examine the long-term educational benefits of AR and explore its broader use across other construction and built environment disciplines to ensure a more digitally proficient and competent generation of Quantity Surveying professionals.

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