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VARKonstruct: INNOVATING SUSTAINABLE EDUCATION IN CONSTRUCTION TECHNOLOGY THROUGH ADAPTIVE E-LEARNING

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ABSTRACT

The construction sector is quickly evolving through technological integration in education; yet, conventional methods frequently overlook diverse learning preferences, resulting in inconsistent educational outcomes. 'VARKonstruct: Innovating Sustainable Education in Construction Technology through Adaptive E-Learning' tackles this issue by incorporating the VARK learning styles model (Visual, Auditory, Reading/Writing, Kinesthetic) with customized e-learning tools to promote a more inclusive and engaging educational atmosphere. The approach utilizes immersive simulations, interactive laboratories, and multimedia resources to deliver a tailored educational experience that corresponds with each student's primary learning preference. This adaptive method fits personal learning preferences and mitigates educational inequities by democratizing access to varied learning resources. Preliminary results suggest that VARKonstruct significantly improves understanding and retention by enabling learners to interact with intricate construction concepts via their preferred learning modality, therefore cultivating more proficient and motivated workers prepared to address industry requirements. Moreover, the project emphasizes the significance of sustainable education through the use of digital platforms that reduce resource consumption while enhancing learning effectiveness. It is advisable to implement data-driven learning analytics to enhance personalized learning pathways and evaluate student progress, while also broadening VARKonstruct's application to additional STEM fields to foster sustainable educational practices that empower both educators and learners.

Keywords: *Learning Styles, Adaptive E-learning, Digital Pedagogy, Construction Technology, Sustainable Education*

INTRODUCTION

The swift evolution of the construction sector, propelled by the Fourth Industrial Revolution and the advent of Education 4.0, demands a reassessment of conventional educational frameworks (Mubarak & Selimin, 2023). Although technology has infiltrated construction activities, the educational delivery in construction programs frequently remains unchanged, adhering to traditional, uniform methodologies. These methods neglect the varied cognitive and sensory learning preferences of students, thereby restricting their ability to comprehend intricate construction concepts successfully (Bondie et al., 2019; Gupta, 2018).

In reaction to this educational deficiency, the VARKonstruct Model was created to enhance construction education via personalized technological learning. Based on the VARK learning styles theory—Visual, Auditory, Reading/Writing, and Kinesthetic—the model offers a framework for the integration of adaptive e-learning aids with classroom technologies. The objective is to cultivate an inclusive, dynamic, and efficient learning environment that accommodates individual preferences while addressing the construction industry's need for qualified and adaptable personnel.

The innovation of VARKonstruct is in its integration of immersive digital technologies, including virtual simulations and multimedia content, with a tailored instructional design. VARKonstruct enhances student engagement, improves idea retention, and fosters deeper comprehension by customizing learning experiences. Furthermore, it tackles overarching sustainability objectives by diminishing the necessity for physical resources and facilitating fair access to high-quality education. This study delineates the conceptual underpinnings, methodological framework, implementation tactics, and preliminary findings related to the VARKonstruct Model, as well as a discourse on its ramifications, commercialization possibilities, and societal advantages.

METHODS

Conceptual Framework

The VARKonstruct Model is based on the VARK learning theory (Visual, Auditory, Reading/Writing, Kinesthetic), which emphasizes that individuals assimilate and process information in distinct ways. Acknowledging this variability is essential in construction education, where intricate spatial, material, and procedural information must be communicated in ways that align with diverse cognitive preferences.

Empirical Design and Data Collection

This study utilized a quantitative research approach with stratified random sampling to guarantee representative feedback from construction technology students. A total of 43 students were surveyed across two diploma-level construction classrooms; following data validation and cleaning, 37 valid replies were preserved for analysis. A structured VARK-based questionnaire was utilized to ascertain each student's predominant learning choice. The measure addressed aspects of learning preferences

across many modalities (visual, aural, read/write, and kinesthetic), encompassing the preferred method of content delivery (synchronous or asynchronous). The survey findings were examined by descriptive statistics in SPSS to ascertain the distribution of learning styles and preferred delivery methods. These findings directly influenced the organization of VARKonstruct's modular learning concept.

RESULTS AND DISCUSSION

Demographic Profiles

The respondents were 68% female and 32% male students, aged 20 to 22, all in their final year of diploma studies. The gender and age distribution illustrates the standard demographic within Malaysia's built environment diploma programs.

Learning Mode Preferences

Among the participants, 95% indicated a preference for synchronous learning, appreciating real-time engagement with instructors and peers. Merely 5% favored asynchronous modes solely. Although asynchronous methods allow flexibility, students reported that synchronous modes provided instant clarification and social interaction, both essential in technical education. These observations underscore the necessity for VARKonstruct to incorporate hybrid content delivery, guaranteeing that real-time engagement coexists with adaptable, on-demand modules tailored to individual learning schedules.

Distribution of Learning Styles

The findings on dominant learning styles among the 37 students were as follows (Figure 1):

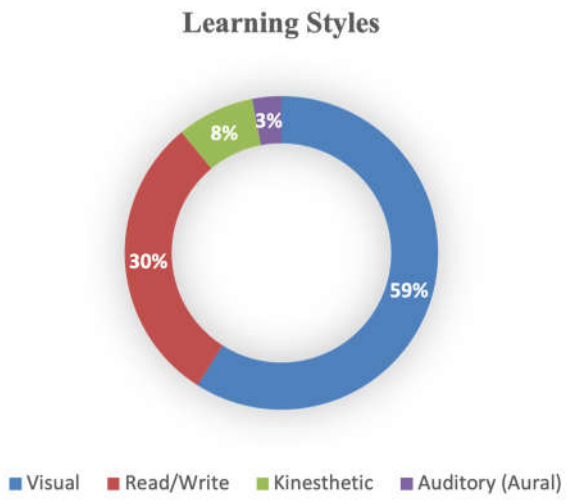

Figure 1.: Learning styles distribution among the students

The results indicate that visual learners predominate within the construction technology cohort, consistent with the visually demanding characteristics of construction drawings, site planning, and modeling tasks. Read/write learners constituted a substantial segment, presumably owing to their need for documentation, notes, and written directives in academic tasks. Despite kinesthetic (8%) and auditory (3%) learners being in the minority, their incorporation in VARKonstruct is essential to guarantee that no student is overlooked. Kinesthetic learners gain from immersive simulation tools and virtual laboratories, but auditory learners thrive on podcast-style content, audio tutorials, and collaborative voice discussions.

Instructional Design Based on Data

The VARKonstruct platform was refined to reflect these findings:

- **Visual learners** were accommodated through three-dimensional walkthroughs, construction process animations, and annotated diagrams.
- **Read/Write learners** utilized organized texts, printed resources, and interactive note-taking instruments.
- **Kinesthetic learners** were included through interactive virtual activities, drag-and-drop construction simulations, and field-oriented project assignments.
- **Auditory learners** employed audio explanations, recorded lectures, and peer-group podcast discussions.

This approach ensured an inclusive digital learning ecosystem grounded in evidence-based personalization.

Impact on Learning Outcomes

While long-term effect studies are still under progress, initial feedback from the pilot deployment indicates that it has improved engagement across all learning styles, especially among visual learners, who constituted the majority of respondents. Enhanced understanding and academic achievement in practical evaluations. Favorable student evaluations indicate that learners have enhanced clarity and confidence in the application of construction ideas. A significant decrease in learning anxiety and passive engagement was observed among kinesthetic and auditory learners when their preferences were directly addressed. These results correspond with the research of Belt & Lowenthal (2022) and Fleming (2001), substantiating that instructional alignment with learning styles might enhance motivation, retention, and pleasure.

CONCLUSION

The incorporation of real learner data into the VARKonstruct Model reinforces its capacity to transform

construction education. The results from 37 diploma students indicated a predominant inclination towards visual (59%) and read/write (30%) learning styles, alongside smaller but significant groups of kinesthetic and auditory learners. By aligning instructional content and technological delivery with these preferences, facilitated by real-time and adaptable learning modalities, VARKonstruct exemplifies inclusivity and creativity. It tackles the fundamental problems of disengagement and underachievement that afflict conventional, standardized teaching approaches in technical education.

The model's capacity to generate customized, captivating, and sustainable learning environments renders it more pertinent as the sector transitions towards digital and eco-friendly futures. The focus on flexible pedagogy, technological integration, and individualized learning pathways equips learners for the progressively interdisciplinary and dynamic construction industry. Subsequent versions of VARKonstruct ought to integrate learning analytics, AI-driven customization, and go beyond construction into additional STEM fields. This will guarantee the ongoing significance and scalability of the approach as a leader in sustainable digital education.

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