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Enhancing Wood Technology Education: The Role of Digital Technologies and Artificial Intelligence

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Abstract: Integration of digital technologies and artificial intelligence (AI) in vocational education has largely changed the traditional learning methods in the three -technology program. The study examines 3D modelling software, A-driven equipment, digital manufacturing tools and Virtual Reality (VR) about woodworking education. These technologies contribute to more efficient and modern learning experience by increasing students' involvement, improving the accuracy of wood treatment and durable practice.Through detailed analysis of their applications, this research emphasizes how digital progress promotes innovation, skills development and environmental awareness among students. Conclusions suggest that AI-driven equipment and VR-based simulation facilitate experienced learning, which allows students to interact with complex woodworking processes in a controlled digital environment before using practically implementation. . In addition, AI-Manual machines increase accuracy and efficiency, reduce material waste and adapt to production.The study concludes that professional tree technology can be more adaptable courses than the inclusion of AI and digital technologies in education, which causes students to prepare students for the developed requirements for the woodworking industry and the labor market. These findings emphasize the importance of constant technical integration to equip future professionals with necessary advanced competences in a modern industrial environment.

Keywords: Wood Technology Program, 3D. Design programs, Digital manufacturing Techniques, Virtual Reality, Artificial intelligence.

1. Introduction

1.1 Problem of Research

- insufficient integration of digital technologies and AI in wood technology education. This research is trying to understand how to integrate into the course to increase the learning experience of these techniques and ensure that students are required to meet the challenges of industry.

1.2 Research Questions

1- How can digital technologies and AI be integrated into the current course of Wood Technology program?

2- What do Technological Universities have to meet in implementing these technological advances?

3- How do AI and digital equipment affect the students' learning outcomes and their preparedness for the wood industry?

4- In what ways can these technologies bridge the academic education and the demands of the real world?

1.3 Aim of Research

- This study aims to examine the role of digital technologies and artificial intelligence in fostering wood technological program in vocational education. By checking how these advanced technologies can be integrated into teaching practice, research aims to improve the quality of educational education and give students a broad understanding of their ability to better prepare for future industry challenges.

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1.4 Importance of Research

- the research addresses the important need to modernize wooden technology education by incorporating digital technologies and artificial intelligence. Since the timber industry adopts advanced technologies quickly, academic programs must develop to equip students with the necessary skills to meet the requirements of these industries. As well as this research bridges educational training and real-world applications, ensuring that new graduates are well-prepared for the rapidly changing workforce. In addition, this study will provide valuable insight into the benefits of technology-enhanced learning benefits in wood technology.

1.5 Methodology of Research

- The research is based on the analytical descriptive approach as the most appropriate methods that are consistent with the nature of this research.

2. 3D. DESIGN PROGRAM

Virtual reality technologies are internally associated with gradual technological progress in computer software. These different and versatile programs, which determine a wide range of areas and scientific domains, use virtual reality methods to increase different applications. These technologies are not only widespread, but also play an important role in many scientific areas, including medical, engineering and various industrial areas. In addition, they play an important role in sophisticated imaging science, cinematic effects and technically advanced gaming systems.
When considering the purpose of the specific categories of these programs within the domain of internal architecture, wood industry technology and sculpture art, it becomes clear that it becomes clear from the selection of programs used in providing size and modelling of choices is necessary for optimal results. These selected program categories are used in a wide range of engineering, industrial and artistic subjects, such as architecture, internal decoration, wood products and artistic sculpture. The most prominent categories of such programs can be identified and classified in this way:
(Blender – Cinema 4D – Autodesk 3DS max – ZBrush - SketchUp) (F. Melendez, 2019).

2.1 Blender:

Blender is the free and open-source 3D creation suite. It supports the entirety of the 3D pipeline—modelling, rigging, animation, simulation, rendering, compositing and motion tracking, even video editing and game creation. Advanced users employ Blender's API for Python scripting to customize the application and write specialized tools; often these are included in Blender's future releases. Blender is well suited to individuals and small studios (Website: https://www.blender.org/).

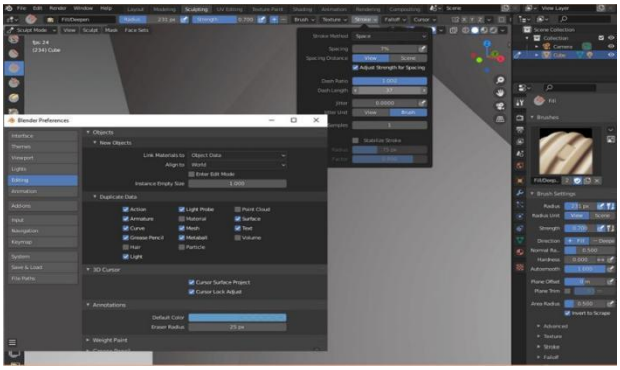

Figure 1. Interface of Blender – 3D modelling software. (Website: https://www.blender.org/)

2.2 Cinema 4D:

A sophisticated software application for three-dimensional graphics modelling, animation, simulation, and rendering. It serves as a robust and versatile tool, enhancing the feasibility and efficiency of three-dimensional workflow across various design disciplines (Koenigsmarck, Arndt Von. 2018).

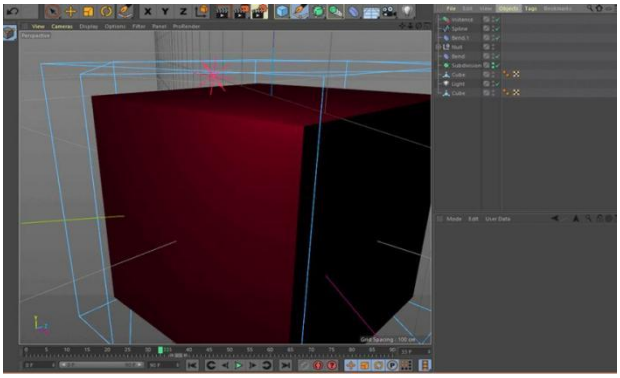

Figure 2. Interface of Blender – 3D modelling software. (Koenigsmarck, Arndt Von. 2018)

2.3 Autodesk 3DS Max:

One of the preeminent technological software applications for employing virtual reality processors and methodologies, as well as for modelling or simulation. It relies upon design, shaping, and animation functionalities, in conjunction with the generation of three-dimensional entities. Developed by Autodesk (Website: https://www.autodesk.com/ca-en).

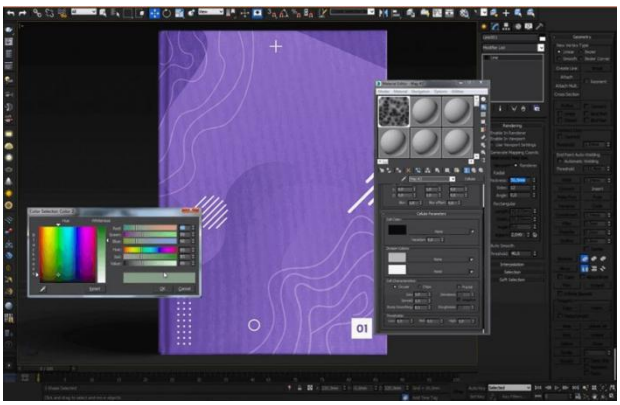

Figure 3. Interface of Autodesk 3Ds Max – 3D modelling software. (https://www.autodesk.com/ca-en)

2.4 ZBrush:

ZBrush is the industry standard digital sculpting software. The latest version features an updated Anchors Brush system which provides an intuitive way to deform meshes by applying anchors onto a mesh while allowing for actions to be performed. The Knife Brushes gain increased design dexterity with a Split to Parts feature set allowing parts to be cut off and retained. Insert Mesh brushes are now compatible with Stroke menu options providing a wild range of visual possibilities. ZBrush provides access to diverse workflows and limitless creative possibilities (Website: https://www.maxon.net/en/zbrush)

Figure 4. Interface of ZBrush – 3D modelling software. (https://www.maxon.net/en/zbrush)

2.5 SketchUp:

One of the foremost specialized computer programs, also adept in virtual reality processing and modelling or simulation techniques. It relies upon the capabilities of design, sculpting, and animation, as well as the production of three-dimensional entities, through a wide array of toolsets and diverse applications. These are utilized across various fields and disciplines, including architectural drawing, interior and exterior design, furniture design, civil, and mechanical engineering (Website: **https://www.sketchup.com/en**).

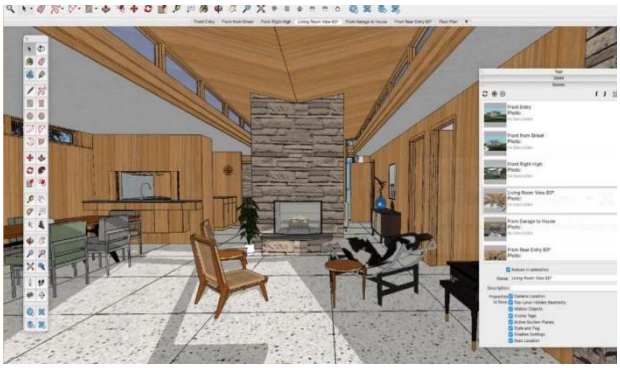

Figure 5. Interface of SketchUp – 3D modelling software. (https://www.sketchup.com/en)

Figure 6. One of researcher's work utilizing SketchUp, one of these 3D. Design Programs

Figure 7. One of researcher's work utilizing SketchUp, one of these 3D. Design Programs.

3. DIGITAL MANUFACTURING TECHNIQUES

3.1 Computer Numerical Control (CNC)

The CNC router is a type of computer-controlled machine used for milling, drilling, cutting and engraving materials. There are many different types of CNC machines commonly used, depending on the intended purpose. Technology has helped to reduce the time required for production by reducing costs and enabling the production of complex products (Koenigsmarck, Arndt Von., 2018).

Figure 8. One of researcher's work demonstrating the process to students then their implementation through CNC. (Koenigsmarck, Arndt Von., 2018)

3.2 3D PRINTING (ADDITIVE MANUFACTURING)

3D printers are a scientific and technological revolution, not only in modern technology field, but also in various areas of life. There is no field that the printer had not an effect there. It is technology to medicine, engineering, education, science, dentistry, down to wood industries. 3D printing is efficient in energy consumption, It also less waste, that making it environmentally friendly. The products manufactured from it - especially with continuous progressive development in speed and precision and search for better materials - are lighter and longer lasting and have a complex and sustainable design (M. H. Imam, D. Abdel Rahman, N. Shehab, 2024).

Figure 9. 3D printed smart wood and stool (Sh. Abd El Sataar, 2019).

4. VIRTUAL REALITY (VR)

Virtual Reality (VR) is innovative technology to create three dimensional environments and is an interactive technology. Virtual Reality gives possibility for someone to do a simulation the real object with the use of computer that fan generate three-dimensional situation and gives a user an almost real situation and the user physically involves in that experience. This system can be used by architect, wood worker, even the layman to involves in near real situations. This technology

visualizes abstract concept intuitively to enhance the understanding in describing objects. VR stimulates students to develop communication skills and motivates students to develop skill (M. Aydin, 2015).

Figure 10. The operationalization of VR Tour in Measured Drawing course (A.I. Widiaty, C. Yulia, A.G. Abdullah, 2022).

5. ARTIFICIAL INTELLIGENCE (AI) IN WOODWORKING

AI can be used in various ways in the wood processing industry to increase productivity, quality and efficiency. Here are some selected promising applications of AI technologies in the wood industry:

- Generative design and customization.
- Optimization of the supply chain.
- Quality control and inspection.
- Predictive maintenance.
- Virtual shopping and augmented reality (AR).

These technologies offer numerous opportunities to increase efficiency, personalise products and improve the customer experience (R. Velusamy, Kh. Deris, N. Yusof, 2023).

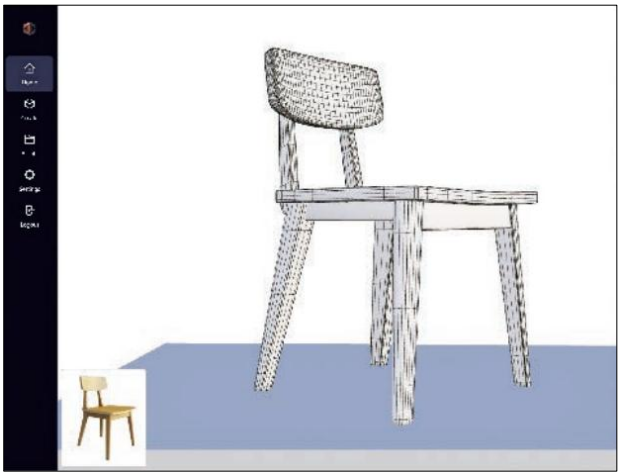

Figure 11. 3D model from image generator - Kaedim3d (https://www.app.kaedim3d.com/dashboard)

6. FINDINGS

- Integration of digital tools has significantly improved the teaching and learning process in Wood Industries Program.
- Digital technologies provide immersive, hands-on experience that enhance skill development and bridge the gab between theory and practice.
- Artificial intelligence tools optimize wood product design and manufacturing, leading to efficiency and reduced material waste.
- Virtual reality applications enable students to interact with 3D models, simulate real-world workshop environments, and visualize complex woodworking processes before actual implementation.
- Computer numerical control (CNC) In woodworking has transformed traditional woodworking by allowing precision cutting, engraving, and automated manufacturing reducing errors and improving efficiency.
- CNC in technological universities ensures that students acquire technical skills in the industry.
- Utilizing technological machines such as CNC and 3D printing enhance the quality of products.

- Using AI Tools can broaden the perspective of students during stages of design and implementation.

7. RECOMMENDATION

- Technological Universities (Polytechnic Universities) should modernize their programs such as wood industries technology program by utilizing digital applications and artificial intelligence.
- Research institutions should work on Digital and virtual reality solutions tailored to this type of universities, fostering their outcomes of educational operations.
- Its crucial to provide students with practical skills before actual implementation by VR tools to protects them from dangers.
- Leveraging the 3D design program is necessary to enhance the steps of actual execution.
- Its necessary to provide workshops with technological machines such as CNC and 3D Printing to improve the quality of products.
- Raising awareness among students about artificial tools during steps of designing and manufacturing.

8. CONCLUSION

- Integration of digital technologies including virtual reality (VR), Artificial Intelligence (AI) and CNC machining have changed significantly, vocational education and wooden industry technology. This progress has increased learning experiences, improved production and have promoted stability in production processes. The use of VR and AI operated simulation allows students to develop technical skills in a realistic and interactive environment, which reduces the difference between theoretical knowledge and practical application. In addition, CNC technology has revolutionized woodworking by automating complex design processes and ensuring accuracy in construction.
- Despite these benefits, challenges such as high implementation costs, inadequate instructor training and limited access to development fields reduce a lot. In order to remove these obstacles, educational institutions, industry leaders and decision makers must work together to invest in digital infrastructure, develop a cost -effective training program and integrate sustainability-focused digital manufacturing techniques.
- By embracing technological innovation in vocational education, institutions can better prepare students with future clear skills that correspond to industry requirements. Continuous progress and strategic application of digital units in the wood industry, internal architecture and design will not only increase educational results, but will also contribute to permanent and efficient production practices, to ensure long -term progress in the region.

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