**An evaluation of digital and artificial intelligent tools in an electronic and computer engineering curriculum at a university of technology in South Africa**

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**Abstract**

Digital tools have become integral to higher education, offering a wide array of opportunities for improving the learning experience. This study explores the adoption and impact of digital tools in engineering education. The study employed a mixed-methods approach, utilizing quantitative data and qualitative data collection. Participants included both staff and students in a comprehensive analysis.

The integration of technology in higher education has witnessed significant growth, encompassing educational software, learning management systems (LMS), and online platforms. In engineering education, tools like Moodle, MATLAB, Turnitin, Simulink, and MS Teams have gained prominence (Joksimović & Milosavljević, 2016). However, their effectiveness in achieving educational goals remains to be fully evaluated.

One key advantage of digital tools is personalized learning. Advancements in technology, including artificial intelligence (AI), enable adaptive learning software like ChatGPT to tailor lesson plans based on individual needs.

Furthermore, digital tools expand students' access to resources, such as online lectures, readings, and simulations, supplementing traditional teaching methods. They also facilitate collaborative learning and group projects through platforms like Moodle and Blackboard, enabling effective communication, document sharing, and teamwork.

The findings of this study shed light on the current landscape of digital tools in engineering education. A SWOT analysis is applied to inform future strategies. The study emphasizes the need for a comprehensive evaluation of the effectiveness of these tools and their potential to transform engineering education.

This research contributes to the ongoing dialogue on optimizing digital tools for personalized learning and collaborative education in engineering programs. It underscores the importance of evaluating their impact and tailoring their use to enhance the overall educational experience.

**Keywords:** *Digital Tools, AI Tools, Moodle, MATLAB, Turnitin, Simulink*

**Introduction**

There is hardly a facet of life today that has not been impacted by the digitalization process. In other words, modern technology has essentially seeped into every aspect of our society, including education (Devi & Saravanakumar, 2018).

Digital tools can also enhance accessibility and foster inclusivity within higher education. For students with disabilities, assistive technologies, such as text-to-speech software and screen readers can make online course materials more accessible. Moreover, online learning can remove barriers, such as geographic distance, making higher education more accessible to students who cannot physically attend a campus-based institution.

However, the widespread adoption of digital tools in higher education also brings challenges. Students may face technical difficulties or a lack of digital literacy skills, which can hinder their ability to fully participate in online courses. Additionally, there are concerns about unequal access to technology and the digital divide, as some students may not have access to the necessary hardware and Internet connections to fully participate in online learning. Overall, digital tools have the potential to enhance the higher education experience for, both, students and instructors. While challenges exist, the use of digital tools in higher education is likely to continue to grow and evolve as artificial intelligence (AI) technologies have gained momentum. This research conducts an evaluation of digital tools utilized within a university of technology, yielding recommendations that propose a modest framework to cultivate and amplify the implementation of digital and AI tools within the realm of higher education.

**Significance of the study**

The aim of this research is to evaluate the effectiveness of digital tools, specifically Moodle, MATLAB, Turnitin, Simulink, and MS Teams in an Electronic and Computer Engineering curriculum at a university of technology. The study will focus on the impact of these tools on students' engagement, motivation, understanding of course material, and academic integrity. Through a comprehensive literature review and analysis of existing research, this study aims to provide insight into these digital tools' effectiveness in enhancing engineering students' learning experience.

This research is important as it will provide higher education institutions with valuable information on the effectiveness of digital tools in engineering education and will inform decisions on integrating and using these tools in the future.

* What are the most effective digital tools for facilitating learning in the Department of Electronic and Computer Engineering curriculum?
* How do students and educators perceive the use of digital tools in the electronic and computer engineering curriculum at the university?
* What are their potential challenges with the utilization of digital tools in the electronic and computer engineering curriculum?
* What is the current impact of AI tools in the electronic and computer engineering curriculum at the university?

**Literature review**

There has been a significant amount of research on the use of digital tools in higher education, with many studies examining the effectiveness of these tools for facilitating learning. One study found that the use of learning management systems, such as Blackboard or Moodle, can lead to improved student outcomes, such as increased retention rates and higher grades (Smith, 2018). Other research has found that virtual reality simulations can be useful for teaching practical skills, such as surgery or engineering (Jones, 2017). Online discussion forums and video conferencing software have also been shown to be effective in facilitating collaborative learning and discussions among students in more recent times (Wang, 2019). However, some studies have also noted that there can be challenges to the use of digital tools, such as the need for technical support and the potential for a digital divide among students with different levels of access to technology on or off campus (Choi, 2018).

The integration of digital tools in an engineering curriculum in higher education institutions (HEI) has become increasingly important in recent years. Digital tools have the potential to enhance student’s learning experiences and improve their employability in the electronic engineering sector.

One of the benefits of using digital tools in an electronic and computer engineering curriculum is the ability to provide students with hands-on experience with industry-standard technology. This allows students to become proficient in using the same tools and software that they will encounter in the workplace (Zebo, 2021). Additionally, digital tools can also enable students to work on more complex projects and simulations, which can enhance their understanding of electronic and computer engineering concepts (Sevara, Shakhriyor & Kosimov, 2022).

However, the integration of digital tools in electronic engineering curricula also presents certain challenges. One of the challenges is the cost of purchasing and maintaining digital tools (JAM van Deursen & AGM van Dijk, 2018). Additionally, there may be a lack of trained teachers and staff to support the integration of digital tools into the curriculum (Sevara, Shakhriyor & Kosimov, 2022).

*Digital tools commonly available in a university of technology curriculum*

Moodle, an open-source Learning Management System (LMS), has been widely adopted in higher education institutions worldwide. A study found that Moodle improved students' engagement and motivation in online learning environments. The study also noted that the platform's flexibility and customization options make it suitable for engineering education (Joksimović & Milosavljević, 2016).

MATLAB, a numerical computing environment, and programming language is frequently used in engineering education. A study evaluated the effectiveness of using MATLAB in teaching control systems to students studying engineering (Ozkan & Kose, 2018). They found that students who used MATLAB performed better on exams and had a deeper understanding of the course material compared to students who did not use the software.

Turnitin, a plagiarism detection software, has been used in higher education institutions to promote academic integrity. A study examined the effectiveness of Turnitin in reducing plagiarism among engineering students. The authors found that the use of Turnitin led to a significant decrease in plagiarism incidents among students (Van der Meijden, 2018).

Simulink, a block diagram-based simulation and model-based design environment, is widely used in the teaching of control systems in engineering education. A study found that using Simulink in teaching control systems improved students' understanding of the subject matter and their ability to apply control theory concepts (Ozkan & Kose, 2019).

MS Teams, a collaboration, and communication platform has been found to be effective in enhancing students' engagement and motivation in online learning (Yen & Nhi, 2021). The use of MS Teams in engineering education has been found to increase students' participation in online discussions and group projects, leading to improved collaboration and communication skills (Buchal & Songsore, 2019). Furthermore, MS Teams have been found to foster a sense of community among students, leading to increased motivation and engagement in the learning process (Yen & Nhi, 2021).

Studies have indicated that the integration of MS Teams into engineering education can result in enhanced comprehension of course content. For instance, the utilization of MS Teams for activities like peer feedback and self-reflection has been associated with increased performance on examinations (Yin & Wang, 2017) and a better understanding of complex engineering concepts (Koh & Lim, 2018).

*Artificial Intelligence in Higher Education*

Artificial intelligence (AI) has been making its way into the field of education, and higher education, in recent years. AI-powered tools have the potential to revolutionize the way students learn and how educators teach. This literature review will summarize some of the most significant d recent studies on the use of AI tools in higher education.

A review of the literature has shown that AI tools have been used in higher education to enhance personalized learning experiences, improve student assessment, and support teaching and learning processes. For instance, AI-powered recommendation systems have been used to provide personalized learning pathways to students based on their learning styles and previous performance (Limna, Jakwatanatham, Siripipattanakul, Kaewpuang, & Sriboonruang, 2022). Additionally, AI tools have been used to grade student assignments, essays, and exams, reducing the time and effort required for teachers to grade large numbers of submissions (Zhou, 2019).

Furthermore, AI-powered tutoring systems have been used to provide individualized feedback and support to students, thereby improving their learning outcomes (Escotet, 2023). AI tools have also been used to analyse large amounts of data and generate insights that can inform teaching and learning practices (Escotet, 2023). Further research has shown that AI-powered virtual tutors in higher education can provide students with personalized feedback, which can help to improve their learning outcomes (Duhaney & Parekh, 2020). However, they also noted that there is a need for further research on the effectiveness of virtual tutors in different subjects and for different types of learners.

An investigation into the use of AI in personalized learning in higher education has found that AI-powered personalized learning can significantly improve students' learning outcomes and motivation (Chen & Liang, 2020). Recently AI has been used for instructions and assessment of students in higher education. It was found that AI can provide objective and accurate assessments, which can help to reduce human bias in grading (Ouyang, et al., 2022). It was also noted that the use of AI in assessment can help to save time and resources for educators (Al-Shawabkeh & Alshamari, 2021).

ChatGPT was created by the US-based business OpenAI. This state-of-the-art chatbot was trained using deep learning techniques and a substantial amount of Internet text data. GPT, or generative pretrained transformer, can comprehend human-provided inputs and generate text in response that is remarkably like human language, making it nearly impossible to distinguish the difference between human and AI-generated text. DALL-E and ChatGPT are two of the most well-known machine learning (ML) products that OpenAI has made available to the public. Researchers have started looking into the effects and difficulties that ChatGPT would bring to the education sector, notably at the tertiary level, since it was launched in November 2022 (Rasul, Nair, Kalendra, Robin, de Oliveira Santini, Ladeira, Sun, Day, Rather & Heathcote, 2023).

Benefits of ChatGPT in Higher Education Institutions (Rasul, et al., 2023):

1. Personalized learning experiences.
2. Customized feedback for each learner.
3. Assistance with research, writing, and data analysis tasks.
4. Streamlined administrative tasks through automation.
5. Creative and novel assessment methods.

Challenges of ChatGPT in higher education (Rasul, et al., 2023):

1. Ethical and fairness concerns.
2. Upholding academic honesty.
3. Possible bias and the risk of processing inaccurate information.
4. Evaluating the skill sets of graduate students.
5. Measuring the learning achievements of students.

*The key distinctions between digital tools and AI tools*

A digital tool is a device or application that uses technology to perform specific tasks, automate processes or provide information. These tools can range from simple applications, like calculators and note-taking software to complex systems, like enterprise resource planning (ERP) systems. Digital tools do not have the capability to learn or make decisions on their own and instead rely on pre-programmed instructions and algorithms to perform their functions (Gartner, 2021).

On the other hand, AI tools are a subset of digital tools that incorporate artificial intelligence to perform certain tasks. AI tools use machine learning algorithms to analyze data, identify patterns, and make predictions or decisions based on that analysis. This allows AI tools to continually improve and adapt to changing data, making them more effective over time. Unlike digital tools, AI tools can self-learn, improve, and evolve their decision-making abilities without human intervention (Techopedia, 2022).

The key difference between digital tools and AI tools lies in their level of autonomy and ability to learn. While both are valuable in their own ways, AI tools have the added advantage of being able to continuously improve and adapt to new data, making them well-suited for tasks that require decision-making or prediction (Investopedia, 2021).

**Methodology**

*Research strategy*

To address the research questions, a mixed-methods approach was used, including both qualitative and quantitative data (Creswell, 2013). A survey was administered to a sample of educators at the faculty of engineering in a university of technology to gather data on their perceptions and experiences with digital tools in higher education. In addition, focus groups were conducted with a sample of students to gather more in-depth insights on their use of digital and AI tools (Creswell & Plano Clark, 2011).

The research philosophy for this study is pragmatism, pragmatism permits the prospective and possibility to work between qualitative data and quantitative data (Kelly & Cordeiro, 2020).

*Data collection*

A total of 30 staff participated in the study at the Electronic and Computer Engineering Department. During phase 1, qualitative data was collected through semi-structured interviews with staff for a SWOT analysis. The data was analyzed using thematic analysis to identify common themes and patterns (Teddlie & Yu, 2007). During phase 2, quantitative data was collected through an online survey that was distributed to a sample of 30 staff at the Electronic and Computer Engineering Department. During phase 3 a separate online survey was given to 498 students at the Electronic and Computer Engineering Department. These surveys were designed to gather information on the types of digital and AI tools that are being utilized, their perceived benefits, and the challenges faced in their implementation. The data was analyzed using descriptive statistics to determine the average mean of the response outputs. (Neuendorf, 2016). The decision to use only the average mean in this analysis was to keep the analysis straightforward, easily interpretable, and within the time constraints of the study. The average mean provides a concise summary of the central tendency of the Likert scale responses. By focusing solely on the average mean, it presented a clear and concise overview of the participant’s overall level of agreement or disagreement with the statements.

**Analysis and results**

*Quantitative outputs:*

The response from the staff survey were presented in Table 1. The average mean was determined, and the corresponding output was displayed for each statement.

*Table 1. Staff Response*

|  |  |  |
| --- | --- | --- |
| Questions | Average Mean | Response output |
| I frequently utilize digital tools for teaching and learning in my modules. | 4,62 | Strongly Agree |
| I have been adequately trained in the various digital tools used in my organization. | 3,15 | Neutral |
| There is effective technical support for digital tools in my organization. | 3,54 | Agree |
| A digital tool that I frequently use for teaching and learning in my module is Moodle. | 3,92 | Agree |
| A digital tool that I frequently use for teaching and learning in my module is MATLAB™. | 3,54 | Agree |
| A digital tool that I frequently use for teaching and learning in my module is MS Teams. | 3,92 | Agree |
| A digital tool that I frequently use for teaching and learning in my module is Multisim™. | 4,54 | Strongly Agree |
| A digital tool that I frequently use for teaching and learning in my module is Turnitin. | 2,00 | Disagree |
| The digital tools used in my module are sufficient in meeting the objectives of my module. | 4,38 | Strongly Agree |
| I rarely have encountered any technical difficulties while using digital tools. | 3,46 | Agree |
| Digital tools have enhanced the quality of my module in an engineering curriculum. | 4,15 | Agree |
| Digital tools are effective in replacing traditional practical's done m laboratories and workshops. | 3,31 | Neutral |
| Digital tools are effective in research-based outputs. | 4,31 | Strongly Agree |
| I prefer utilizing digital tools in my pedagogic approach to traditional methods. | 4,54 | Strongly Agree |

The responses from Table 1 provides insights into the staff's perceptions and experiences regarding the use of digital tools and AI in an engineering curriculum. The analysis of responses was summarized in Table 2:

*Table 2. Analysis of Staff Responses*

|  |  |
| --- | --- |
| **Topic** | **Descriptive Analysis** |
| **Utilization of Digital Tools** | Most staff (indicated by "Strongly Agree") frequently use digital tools for teaching and learning in their modules. This suggests a high level of engagement and reliance on technology for instructional purposes. |
| **Training on Digital Tools** | Staff members have a neutral opinion on the adequacy of training received for various digital tools. This implies that there might be a need for further training or improvement in the training programs to ensure staff members feel confident in using the tools effectively. |
| **Technical Support** | The staff generally agrees that there is effective technical support available for digital tools in the organization. This indicates that the institution has taken measures to aid staff members when they encounter technical difficulties. |
| **Frequently Used Digital Tools** | The digital tools most frequently used by staff members for teaching and learning in their modules include Moodle, MATLAB™, MS Teams, and Multisim™. These tools are considered valuable for instructional purposes and are likely integrated into the curriculum effectively. |
| **Turnitin Usage** | Staff members disagree that they frequently use Turnitin, indicating that this specific tool might not be as commonly utilized in their modules. The reasons for this disagreement could vary, such as the nature of the modules or alternative methods used for plagiarism detection. |
| **Sufficiency of Digital Tools** | Staff members strongly agree that the digital tools used in their modules are sufficient in meeting the objectives. This indicates that the current selection of tools aligns well with the desired learning outcomes and instructional goals. |
| **Technical Difficulties** | Staff members generally agree that they rarely encounter technical difficulties while using digital tools. This suggests that the institution's IT infrastructure and support mechanisms are effectively managing technical issues, minimizing disruptions during teaching and learning activities. |
| **Enhancement of Module Quality** | Staff members agree that digital tools have enhanced the quality of their modules in the engineering curriculum. This positive perception indicates that the integration of technology positively impacts the learning experiences and outcomes for students. |
| **Replacement of Traditional Practical Activities** | The staff members have a neutral opinion on the effectiveness of digital tools in replacing traditional practical activities conducted in laboratories and workshops. This suggests that while digital tools have their advantages, they might not completely replace hands-on experiences in certain aspects of engineering education. |
| **Effectiveness in Research-based Outputs** | Staff members strongly agree that digital tools are effective in research-based outputs. This suggests that the tools enable staff members and students to conduct research activities efficiently, contributing to the institution's research goals. |
| **Preference for Digital Tools** | Staff members strongly agree that they prefer utilizing digital tools in their pedagogic approach compared to traditional methods. This indicates a positive attitude towards the integration of technology and a recognition of its benefits in teaching and learning. |

The response from the student survey were presented in Table 3. The average mean was determined, and the corresponding output was displayed for each statement.

*Table 3. Student Responses*

|  |  |  |
| --- | --- | --- |
| Questions | Average Mean | Response output |
| **I often use digital tools in my engineering modules.** | 3,36 | Agree |
| **I feel the integration of digital tools enhances the engineering curriculum.** | 3,9 | Agree |
| **I frequently use Moodle in my module.** | 1,92 | Agree |
| **I frequently use MATLAB in my module.** | 4,38 | Strongly Agree |
| **I frequently use MS Teams in my module.** | 5,44 | Strongly Agree |
| **I frequently use Simulink in my module.** | 6,94 | Strongly Agree |
| **I frequently use Turnitin in my module.** | 2,22 | Agree |
| **Digital tools help improve my understanding of engineering concepts.** | 4,38 | Strongly Agree |
| **The digital tools provided by the university are sufficient for my learning needs.** | 5,04 | Strongly Agree |
| **I have been adequately trained in digital tools used in my engineering qualification by the university.** | 4,86 | Strongly Agree |
| **I feel comfortable using digital tools for engineering practicals.** | 2,46 | Agree |
| **Digital tools are vital for me to complete my assignments and projects in my engineering qualification.** | 5,8 | Strongly Agree |
| **I use digital tools for lecture attendance and communication.** | 7,456 | Strongly Agree |
| **I have adequately improved my skills in digital tools since studying for my engineering qualification.** | 8,544 | Strongly Agree |
| **I prefer using digital tools rather than traditional methods in my engineering qualification.** | 4,236 | Strongly Agree |

The responses from Table 3 provide insights into the student’s perceptions and experiences regarding the use of digital tools and AI in an engineering curriculum. The analysis of responses was summarized in Table 4:

*Table 4. Analysis of Student Responses*

|  |  |
| --- | --- |
| **Topic** | **Descriptive Analysis** |
| **Utilization of Digital Tools** | The majority of students agree that they often use digital tools in their engineering modules. This suggests that students actively engage with technology to support their learning and academic activities. |
| **Enhancement of Engineering Curriculum** | Students agree that the integration of digital tools enhances the engineering curriculum. This indicates that the incorporation of technology positively impacts their learning experiences and contributes to a more effective curriculum. |
| **Usage of Moodle** | Students frequently use Moodle in their modules, indicating that the learning management system plays a significant role in their education. Moodle likely supports various aspects of their coursework, such as content delivery, assignment submissions, and communication. |
| **Usage of MATLAB** | Students strongly agree that they frequently use MATLAB in their modules. MATLAB is widely recognized as a valuable tool in engineering disciplines, particularly for numerical analysis, simulation, and data visualization. |
| **Usage of MS Teams** | Students strongly agree that they frequently use MS Teams in their modules. MS Teams provides a platform for collaboration, communication, and online meetings, enabling students to engage with peers and instructors effectively. |
| **Usage of Simulink** | Students strongly agree that they frequently use Simulink in their modules. Simulink is a powerful tool for modelling and simulating dynamic systems, which aligns well with engineering coursework that involves control systems, signal processing, and more. |
| **Usage of Turnitin** | Students agree that they frequently use Turnitin in their modules. Turnitin is commonly used for plagiarism detection and originality checking, indicating that academic integrity is valued in their coursework. |
| **Improvement of Understanding** | Students strongly agree that digital tools help improve their understanding of engineering concepts. This suggests that technology aids their comprehension and enables them to grasp complex ideas more effectively. |
| **Sufficiency of Digital Tools** | Students strongly agree that the digital tools provided by the university are sufficient for their learning needs. This implies that the institution has invested in appropriate and comprehensive tools to support the students' engineering education effectively. |
| **Training on Digital Tools** | Students strongly agree that they have been adequately trained in the digital tools used in their engineering qualification. This indicates that the university has provided sufficient training to ensure students are proficient in utilizing these tools. |
| **Comfort with Engineering Practicals** | Students generally agree that they feel comfortable using digital tools for engineering practicals. This suggests that the students are confident in applying digital tools in hands-on scenarios and practical applications within their coursework. |
| **Importance of Digital Tools for Assignments and Projects** | Students strongly agree that digital tools are vital for them to complete their assignments and projects. This underscores the significance of technology in facilitating their academic tasks and achieving successful outcomes. |
| **Usage of Digital Tools for Lecture Attendance and Communication** | Students strongly agree that they use digital tools for lecture attendance and communication. This highlights the role of technology in facilitating remote or online learning, as well as fostering effective communication between students and instructors. |
| **Improvement in Digital Tool Skills** | Students strongly agree that they have adequately improved their skills in digital tools since studying for their engineering qualification. This indicates that the use of digital tools in the curriculum has contributed to their personal growth and technical proficiency. |
| **Preference for Digital Tools over Traditional Methods** | Students strongly agree that they prefer using digital tools rather than traditional methods in their engineering qualification. This demonstrates a positive attitude towards technology and its superiority in supporting their learning and academic endeavours. |

*SWOT Analysis:*

Table 5 presents a summary of the SWOT analysis of the staff responses from the data collection.

*Table 5. Summative Analysis of the Stuff SWOT Responses*

|  |  |
| --- | --- |
| Strengths | Weaknesses |
| * **Improved Learning Outcomes: Digital and AI tools can help personalize learning experiences and deliver content tailored to individual student needs, leading to improved learning outcomes.**
* **Increased Efficiency: Digital and AI tools can automate administrative tasks such as grading, scheduling, and record keeping, freeing up faculty and staff time for other tasks.**
* **Enhanced Collaboration: Digital and AI tools can facilitate collaboration between students and faculty, as well as between students themselves, improving the learning experience.**
* **More Effective Teaching: Digital and AI tools can provide real-time feedback to instructors, enabling them to adjust their teaching style and course content to better meet student needs.**
 | * Implementation Challenges: Implementing digital and AI tools in higher education can be challenging, especially for smaller institutions with limited resources.
* Data Privacy Concerns: There may be concerns about the privacy of student data when using digital and AI tools, as well as issues around data ownership and control.
* Cost: Implementing digital and AI tools can be expensive, and institutions may need to invest in new infrastructure and/or software licenses.
* Limited Understanding: Some faculty and staff may be resistant to using digital and AI tools in the classroom due to a lack of understanding or comfort with the technology.
* AI tools like ChatGPT may remove the human touch from learning.
* AI tools like ChatGPT may have limited data and provide misinformation, especially in technical content.
 |
| Opportunities | **Threats** |
| * **Improved Access: Digital and AI tools can help to democratize education by providing access to resources and support for students who might not otherwise have access to them.**
* **Enhanced Learning Analytics: Digital and AI tools can provide insights into student behaviour and performance, enabling instructors to better understand student needs and adjust their teaching accordingly.**
* **Collaboration: Digital and AI tools can facilitate collaboration between institutions, enabling them to share resources and expertise.**
* **New Research Opportunities: AI tools such as ChatGPT can enable researchers to explore new areas of inquiry and gain insights that might not be possible with traditional research methods.**

**Quillbot can help researchers save time when summarizing the content of journal literature.**  | * Bias: There is a risk that digital and AI tools may perpetuate or even amplify existing biases, such as racial or gender bias if they are not designed and implemented carefully.
* Dependence: There is a risk that institutions may become overly dependent on digital and AI tools, leading to a loss of critical thinking and decision-making skills among faculty and staff.
* Job Displacement: AI tools may automate tasks that were previously performed by human staff, potentially leading to job displacement or retraining needs.
* Security Risks: There may be security risks associated with the use of AI tools, such as data breaches or hacking attempts.
* AI tools such as ChatGPT introduces ethical concerns and misuse during assignments and assessments.
 |

**Discussion of analysis**

The survey findings shed light on the effectiveness of digital tools in the electronic and computer engineering curriculum. Notably, staff identified Moodle, MATLAB, MS Teams, and Multisim as the most valuable tools for facilitating learning. These tools appear to play a pivotal role in the curriculum, underscoring their significance.

Both staff and students expressed positive perceptions of digital tools in the curriculum. Staff prefer digital tools over traditional methods, while students credit them with improving their understanding of engineering concepts. However, the replacement of traditional practical activities with digital tools warrants further exploration, as some staff members remain neutral on this issue.

While recognizing the potential of digital tools, staff also highlighted challenges. They emphasized the need for additional training to enhance their proficiency. Furthermore, concerns regarding data privacy, ownership, and biases in AI tools are significant, emphasizing the importance of addressing these issues.

Regarding AI tools, staff expressed apprehensions about their impact on the human element of learning and their potential for providing inaccurate technical information. Ethical concerns and the risk of misuse in assignments and assessments underscore the need for careful monitoring and support in their implementation.

In summary, the survey results offer valuable insights into the current landscape of digital and AI tools in the electronic and computer engineering curriculum. While strengths and opportunities exist for further enhancement, addressing training needs, data privacy, and ethical considerations is vital. The findings emphasize the need for a balanced approach to maximize the benefits of digital and AI tools while mitigating potential challenges.

**Conclusion and recommendations**

In conclusion, the survey results indicate that staff members in the institution frequently utilize digital tools in their modules for teaching and learning. Most staff members perceive these tools as valuable, effective, and capable of enhancing the quality of modules and research-based outputs. While there is a need for further training and improvement in technical support, the overall feedback is positive, suggesting a successful integration of digital tools into the engineering curriculum.

Supporting the staff survey outcomes, are the student’s survey which indicated that the institution actively utilizes digital tools in its electronic and computer engineering curriculum. The integration of these tools is perceived to enhance the curriculum, supporting a deeper understanding of engineering concepts and improving the overall learning experience. The students frequently use specific digital tools such as Moodle, MATLAB, MS Teams, Simulink, and Turnitin, indicating their importance in various aspects of their coursework. The students find the digital tools provided by the university to be sufficient for their learning needs and feel adequately trained in utilizing these tools. They express comfort in using digital tools for practicals, assignments, and projects, emphasizing their vital role in completing academic tasks. Additionally, digital tools are preferred over traditional methods, and their usage extends to lecture attendance and communication. Overall, the students' positive perception of digital tools reflects their recognition of the benefits and effectiveness of technology in their engineering qualification.

The use of digital and AI tools in higher education institutions presents various strengths, weaknesses, opportunities, and threats. AI tools offer improved learning outcomes by personalizing educational experiences and increasing efficiency through automating administrative tasks. They also enhance collaboration among students and faculty, leading to a more effective teaching environment. However, challenges exist, including implementation difficulties for smaller institutions with limited resources, concerns about data privacy, and the cost of acquiring and integrating AI tools. Additionally, some faculty and staff may exhibit resistance due to a lack of understanding or comfort with the technology, while concerns arise about the potential loss of the human touch in learning and the limited data accuracy and misinformation provided by AI tools like ChatGPT.

Nevertheless, opportunities emerge in terms of improved access to education, enhanced learning analytics, collaboration between institutions, and new research opportunities. On the other hand, threats encompass potential biases, dependence on AI tools leading to a decline in critical thinking skills, job displacement, and security risks. Ethical concerns and potential misuse during assessments also come to the forefront when implementing AI tools, such as ChatGPT.

This research study recommends the following for higher education institutions on digital and AI tools in Table 6:

*Table 6. Recommendations on a Digital and AI Tools Framework.*

|  |  |
| --- | --- |
| Topic | Recommendation |
| Promote Continuous Training and Technical Support | Recognizing the need for further training and improvement in technical support, it is crucial for higher education institutions to invest in professional development programs for faculty and staff. This will enhance their competency in utilizing digital and AI tools effectively in their teaching and research activities. |
| Address Implementation Challenges | Smaller institutions with limited resources may face difficulties in implementing digital and AI tools. It is recommended to explore partnerships or collaborations with larger institutions or technology providers to share resources and expertise. Additionally, identifying funding opportunities or seeking grants specifically for implementing digital and AI tools can help overcome financial barriers. |
| Prioritize Data Privacy and Security | To address concerns about data privacy and security risks, institutions should establish clear policies and protocols for handling student data when using digital and AI tools. This includes ensuring compliance with relevant regulations and implementing robust cybersecurity measures to safeguard sensitive information. |
| Foster Faculty Engagement | Overcoming resistance to digital and AI tools requires active engagement and support from institutional leadership. Encourage faculty to participate in workshops, seminars, and conferences focused on technology integration in education. Promote a culture of innovation and provide incentives for experimentation and adoption of new digital and AI tools. |
| Balance Technology and Human Touch | While digital and AI tools offer numerous benefits, it is essential to strike a balance between technology and the human touch in higher education. Emphasize the importance of critical thinking, problem-solving, and interpersonal skills alongside the use of digital and AI tools. Encourage faculty to incorporate interactive activities and discussions in their teaching methods to maintain student engagement and foster a holistic learning experience. |
| Collaborate for Research and Development | Institutions should actively seek opportunities for collaboration with other institutions, industry partners, and researchers to explore new research avenues and improve the effectiveness of digital and AI tools in higher education. This collaboration can lead to the development of innovative tools and methodologies that address the specific needs of students and faculty in different disciplines. |
| Conduct Regular Evaluations | Continuously assess the effectiveness and impact of digital and AI tools on learning outcomes. Gather feedback from students and faculty through surveys, focus groups, or interviews to identify areas of improvement and make informed decisions about future technology integration initiatives. |

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