

Challenges of Pedagogy in an ODeL Setting: [Making Magic out of Mayhem]

Ngaka Mosia

University of South Africa, Johannesburg, South Africa

mosian@unisa.ac.za

Abstract: The teaching and learning environment has undergone substantial changes as a result of technological advancements. Educators at all levels constantly face the challenge of increasing students' interest. In response to students' exposure to technology and social trends, practices are changing. This presentation provides a case study of how technology can be used to improve the learning environment for engineering-based courses in higher education. The method includes integrating web application technologies to improve the learners' experience and delivering interactive materials via a virtual learning environment. There are phases in the pedagogy execution that demonstrate the development from the first event through the implementation of the materials, after which the module is evaluated and is improved even more in light of the qualitative assessment. Electronic surveys are used in the evaluation process to gather input on the distance learning module. Furthermore, there is oversight of how the students are using the resources. The first findings from a recent online course are presented as the presentation comes to a close. A qualitative research approach is adopted to explore and explain the challenges of pedagogy in an ODL setting.

Keywords: DE, Pedagogy, Technology, VLE, Student, ODL

1. Introduction

Due to its convenience, the Internet has become a necessary tool for managing the day-to-day aspects of our lives. Because of this, there is a need for more inventive, applications that are innovative and practical and that can help and uplift the digital generation. It is well known that teachers can make use of these cutting-edge resources to help bridge the gap between the classroom and learners (Benson, 2014), particularly for students who are enrolled off-campus or at distant locations.

Technology-enhanced learning (TEL) or e-learning are terms commonly used to describe the integration of technologies into educational settings (Hidayatno et al., 2019). This paper will outline a method for improving and delivering engineering-based courses to remote learners through the use of technology. The approach used in the creation of online educational resources, which is explained in Section 2 is a gradual and frequently time-consuming process. In Section 3, a selection of the produced and delivered materials is presented; in Section 4, conclusions are drawn.

It was decided early on in the development and implementation program that a protocol for fostering an e-learning culture among the University of South Africa's staff members in the School of Engineering, (SOE). As a result, the strategy that was going to be put into practice needed to be both practical and easily understood. The Plan-Do-Check-Act (PDCA) cycle was judged to be an appropriate method to use in light of these requirements. (Shewhart, 1986) created the PDCA cycle, which Deming popularized (Deming, 2018) when it was implemented as a quality control technique in Japan following World War II. The PDCA cycle, sometimes referred to as the Deming cycle or the Shewhart cycle, is depicted in Figure 1.

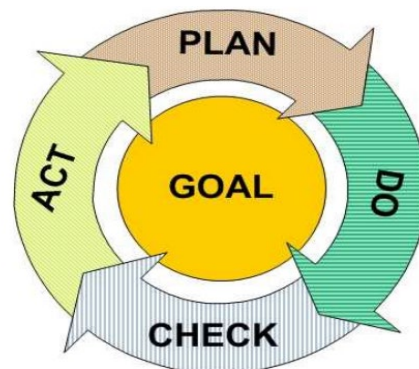
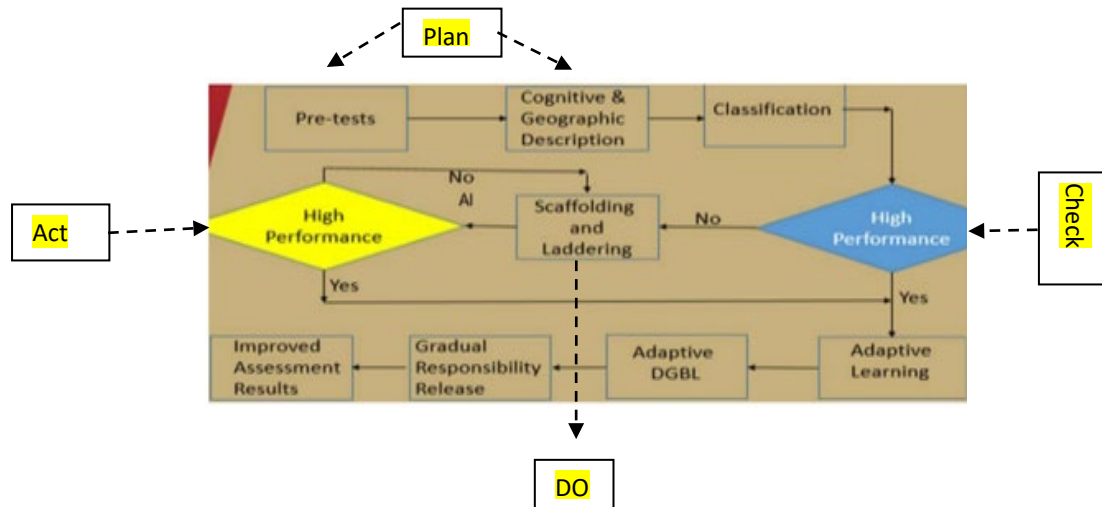


Figure 1: Plan-Do-Check-Act (PDCA) Cycle

The strategy was changed and modified for the e-learning development because of the way the school operates. The modified strategy, referred to as the teaching and learning mechanic, was kept mostly

unchanged from the PDCA cycle and is displayed in Figure 1. As can be seen, there are five primary stages to the Bradford methodology, which will be further discussed in Section 2.2.



The PDCA integrated Teaching Mechanic (Source: Author)

2. Literature Review

Engineering Education in the Context of Industry 4.0 is as Mogoş (2018) argues that the concept of Education 4.0 is based on symbiosis achieved among different role players in an educational eco-system, i.e., learners, teaching staff, administrative and managerial staff should strive to improve the practice in the education sector. A generic framework of Industry 4.0 engineering education was suggested as having main components related to curriculum, laboratory, and student club, with interdependences among these components by Navarro et al. (2023). Mian et al. (2020) developed a framework that evolved on the various factors that affect the planning and application of Industry 4.0 planning and applications for sustainable education in universities. The factors were, among others, employee willingness, learner understanding, infrastructural configuration, experts' availability, program of training, access to the internet, and partnership with industry.

Neaga (2019) argues that Education 4.0 is an expansion based on Industry 4.0 applied concepts and digitalization of higher education institutions and teaching and learning practices. Advancement of digital and/or online education supported by an Education 4.0 framework will facilitate the development of skills and develop graduates' competencies for modern-day industry based on Industry 4.0 principles. Education 4.0 is a transformation of education institutions and teaching and learning (T&L) methods depend on Industry 4.0 principles and digitalization. Developing skills and creating graduates' competencies for the current industry based on Industry 4.0 will be facilitated by the evolution of digital and virtual education accompanied by an Education 4.0 framework (Marzuki et al. 2022).

Mokhtar and Noordin (2019) propose a process of adaption to Industry 4.0 technology and digitisation in the educational process and argue that it is critical to emphasise teachers' competencies, as depicted in Figure 1. The conceptual model suggests that Industry 4.0 technologies greatly influence the teaching and learning environment. The Industry 4.0 teaching and learning environment is influenced by University administrators, lecturers and professors, and students. The teaching and learning environment are further influenced by industry expectations to prepare future-ready graduates that can meet industry requirements. Accreditation bodies influence teaching and learning environments by setting teaching and learning standards to which universities must adhere in the form of graduate attributes.

Hydayatno et al. (2019) developed a conceptual model based on the input–process–output where the input is interdependent variables, the process is the components and their interlinks in the system referred to as the Causal Loop Diagram (CLD), and the output is considered as output. These authors investigated the impact of Industry 4.0 on sustainable transition energy in developing countries. Rajab et al. [8] developed a causal loop of the Internet of Things and showed the relationships between the following factors individual, instructional, and structural factors. The use of big data and cloud computing was key to the implementation of IoT. From

the literature, it is apparent that CLDs have not been explored adequately in the context of technology and engineering education.

The proliferation of Open Distance and e-Learning (ODEL) has transformed the educational landscape, offering flexible learning opportunities and broader access to education (Andrade & Alden-Rivers, 2019). Despite these benefits, the implementation of ODeL presents unique pedagogical challenges. This literature review examines the challenges of pedagogy in an ODeL setting and explores how technology influences these problems and their potential solutions.

Isolation and Lack of Community: One significant challenge is the sense of isolation that students may experience, which can lead to disengagement and higher dropout rates (Simpson, 2018). Unlike traditional classrooms, ODeL environments often lack the immediate social interaction that fosters a sense of community. Success in ODeL requires a high degree of self-regulation and intrinsic motivation (Kizilcec, Pérez-Sanagustín, & Maldonado, 2017). Students must manage their time effectively and stay motivated without the structure of regular class meetings.

Timeliness and Effectiveness: Providing timely and effective feedback in an ODeL setting is challenging. Instructors may struggle to give personalized feedback promptly, which is crucial for student learning and improvement (Gikandi et al., 2011). Ensuring the authenticity and integrity of assessments in an online environment can be problematic. Issues such as plagiarism and cheating are more difficult to monitor and control (Nguyen, 2015).

2.1 Technical Skills and Access

Both students and instructors may lack the necessary digital literacy skills to effectively navigate ODeL platforms. This can hinder the learning process and the delivery of content (Lei & Gupta, 2010). Inequitable access to technology and the internet can exacerbate educational inequalities, as some students may not have reliable access to the necessary tools for ODeL (Mulienburg & Berge, 2005).

The use of interactive and adaptive learning technologies can enhance student engagement by providing personalized learning experiences (Johnson et al., 2016). Tools such as virtual labs, simulations, and gamified learning environments can make learning more engaging and interactive. **Social Media and Collaborative Tools:** Incorporating social media and collaborative tools can help build a sense of community among students. Platforms like discussion forums, group chats, and collaborative projects encourage interaction and peer support (Hrastinski, 2009).

Automated Assessment Tools: Technology can assist in providing timely feedback through automated assessment tools such as quizzes and tests that give instant feedback. Additionally, learning analytics can help instructors identify students who may need extra support (Ifenthaler, 2017). **Plagiarism Detection Software:** Tools like Turnitin can help ensure the authenticity of student work and reduce instances of plagiarism (Sutherland-Smith, 2010).

Digital Literacy Programs: Offering digital literacy programs for both students and instructors can bridge the skills gap and ensure that all participants can effectively use ODeL platforms (Fraillon et al., 2014). Efforts to provide equitable access to technology, such as lending programs for devices or subsidized internet access, can mitigate disparities and ensure all students can participate in ODeL (Van Deursen & Van Dijk, 2014).

The challenges of pedagogy in an ODeL setting are multifaceted (Tanyanyiwa & Madobi, 2021), encompassing issues of engagement, assessment, and access. Technology offers numerous solutions to these challenges, enhancing student engagement, improving assessment and feedback processes, and supporting the development of digital literacy. However, these solutions also require thoughtful implementation and ongoing evaluation to ensure they effectively address the underlying problems. Continued research and innovation in the use of technology in ODeL will be crucial for overcoming these pedagogical challenges and maximizing the potential of distance and e-learning environments.

3. Research Method

Qualitative case study methodology affords researchers opportunities to explore and explain a phenomenon within its context using a variety of data sources (Baxter & Jack, 2008). This approach ensures that the phenomenon under study is explored through a variety of lenses, which allows an in-depth understanding and multiple facets of the case under study to be revealed and understood (Baxter & Jack, 2008). The case study approach aligns with the goals of this research in that the focus of the study is to explore and explain the

challenges of Pedagogy in an ODeL Setting and how technology influences engineering pedagogy and it covers the contextual conditions in which the phenomenon (i.e., the impact of technology on industrial engineering pedagogy) under study occurs.

The unit of analysis (case) in this study is the current challenges of pedagogy in an ODeL Setting and how technology influences engineering pedagogy in the universities. This is a phenomenon occurring due to the impact of technology on industrial engineering pedagogy and is bound to the current impact of technology in the University of Technology setting. The attributes of this research satisfy the definition of a case as stipulated by Miles and Huberman (1994) and they are in line with Yin (2003), Stake (1995) and Miles and Huberman (1994) stipulations concerning setting boundaries for cases in a case study research approach (Baxter & Jack, 2008).

The research also appeals to boundaries stipulated by Creswell et al. (2003), those of time and place (Baxter & Jack, 2008). In line with the boundaries of the definition and context, and the research question (How technology affects engineering pedagogy?), the type of case study this research adopts aligns with explanatory and exploratory or descriptive case studies as categorized by Yin (Baxter & Jack, 2008).

This research will lead to the development of solutions or recommendations that will address the following propositions/ issues: (1) Current engineering education and tools are rooted in an epoch that is in itself outdated for today's needs, not to mention the future; and (2) Engineering curriculum for Universities cannot remain the same as it was for the past decades and not respond to the challenges of globalization and diversity; world culture and ethics and, provide a foundation necessary for the profession to remain competitive; and (3) The practice of engineering must be changed and this change can be accomplished through engineering education. Propositions and/or issues are necessary elements in case study research in that both lead and precede the development of a conceptual framework that guides the research (Baxter & Jack, 2008).

Baxter & Jack (2008) stipulate that a hallmark of case study research is the use of multiple data sources, a strategy that also enhances data credibility (Baxter & Jack, 2008). This case study will apply the following triangulation of data sources i) document analysis; ii) archival records and; iii) field notes. It is rational to apply document analysis in this research since it is often used in combination with other qualitative research methods as a means of triangulation. The combination of methods in the study of the same phenomenon enables a researcher to draw upon multiple sources of evidence and, to seek convergence and corroboration using different data sources (Bowen, 2015).

Rossman and Wilson (1985), in their study of evaluating regional education service agencies, designed document reviews to identify the mission of agencies as described in documents and reports (Bowen, 2015). Sogunro (1997) provided exemplary clarity concerning the use of document analysis, he reported that the use of document analysis provided information on the history, goals, objectives, and substantive content of the phenomenon under study (Bowen, 2015). Stake (1995) found that document analysis is particularly applicable in qualitative research for intensive studies producing rich descriptions of a single phenomenon (Bowen, 2015). Patton (2002) stipulates that field notes are rich, detailed descriptions, including the context within which the observations were made, and they consist of activities, behaviors, actions, conversations, interpersonal interactions, organizational or community processes, or any other aspect of documented human experience in the field (Patton, 2002).

The rationale for applying field notes is supported by Patton's (2002) reflections that field notes are applied in qualitative research to understand the true perspective of the subject being studied, and that they allow the researcher to access the subject and record what they observe in an unobtrusive and nonreactive manner. This research requires an in-depth understanding of the researcher's experiences and observations while participating in an intense and involved manner, thus field notes will be applied as data sources in this research. The decision to gather and analyze archival records is linked to the research propositions developed in the conceptual framework of this study.

The use of archival data is supported by the claim that archival data is an increasingly viable resource because an ever-greater amount of archival verbal and visual material has become universally available with the information proliferation attributes of the internet. Archival data comprises of wide array of empirical data created by researchers for their personal use or on behalf of an organization. Contents of an archive that is applicable in this research consist of various material (e.g., letters and diaries; weblogs and discussion list posting; press releases and reports; magazine articles and rating websites; etc.). Archival data will be used to

develop an understanding of the research context and where applicable to inform the development of concepts and theories.

An extensive archival document analyses research and a literature review relevant to research work completed in this area is conducted and information related to the research problem is gathered and analyzed. Students in a specific program were divided. Students in the program are grouped into two groups based on their preference for a teaching and learning (T&L) method. There are two distinct groups, i.e., a group that engages in technology-mediated learning through Unisa's LMS and a group that engages the print-based tutorial material. These two groups are formed without the student's knowledge and throughout the year they are not made aware that they are participating in a research project. The reason for this anonymity is to allow students flexibility to change from one mode to another and back to the first one, freely.

Therefore, their preference is captured untainted. In the 3rd quarter, both groups are requested to complete an e-learning assignment, which is not mandatory. The approach of data gathering is significantly exploratory and comparative and in the development of insight, the research employs comparative analysis of the results. Data collection tools and techniques are applied to each T&L method exclusively and the results are measured and compared to the results obtained when the approach is applied. This inclusive approach engages both the T&L methods. Analysis and comparison of the results in the two approaches lead to a validation of the apparent barriers of transitioning from print base method to electronic base engagement.

4. Discussion

4.1 Distance Learning to Bring About a "New Order" in the Teaching and Learning Environment

It is no longer necessary to use distance education techniques to bring people together at a specific location, either for training or the activity itself (with the dual goals of ensuring professionalization and reducing travel costs), it is no longer always a limitation. This methodology is appropriate for both initial and continuing training. Training schedules and training techniques are inextricably linked.

This well-known combination of theory-practice, scientific learning professional learning, and mutual contribution is typically completed by a succession of distinct periods without, in most cases, the emergence of measures that promote integration or the transfer of learned information. Not to mention how the assessment techniques employed in these situations had no counter-training effect).

The use of distance learning in teaching and learning preparation programs allows for consistency in the training process. Regardless of the time and place of the training, the student or trainee has access to resources, training support, and the opportunity to share ideas, experiences, and information with other trainees and students. Based on this, it will be possible to extend the training period without encountering any issues.

This brings us to the second benefit of distance learning for teaching and learning preparation: the development of real training networks that ensure innovation, system mobility, and training continuity. Most managers of educational policies concur that excellent teaching and learning preparation programs need to provide both a strong educational background and appropriate training for the position.

On the other hand, a strong professional foundation and engagement with research are prerequisites for a high level of University qualification. Beyond the question of whether the two approaches are intellectually compatible, there is also the matter of whether they are materially and chronologically feasible. Being in close intellectual proximity to a research group's discussions does not equate to conducting research itself.

Additionally, and this is a difficult task, the work of these networks can facilitate future students' acclimatization to working with others. Everyone there also stresses the need and duty to practice teaching and learning in a less isolated way, and significant advancements have been made in this domain. But there's still some work to be done.

We can assume that electronic communications will contribute to this reflective process and provide additional support to engineering students who are frequently confined within the walls of their establishment. Training that is part of long-term procedures, with more contracted periods (which enable the construction of job-related transposition forms), more interaction, and a greater range of references.

4.2 Challenges and why These Solutions Have not Worked

The case of this research is the high failure rate in STEM fields and undergraduate programs are being addressed by a number of efforts, however, their efficacy is hampered by major obstacles. In order to overcome these obstacles, a concentrated effort must be made to provide fair access, sufficient money, all-encompassing teacher support, and systemic adjustments to educational methods and regulations.

Inclusive and Equitable Access to STEM Education:

Digital platforms such as Lab-X-Change provide free online learning tools for collaboration amongst students, educators, scientists, and researchers, which is one example of how efforts are being made to make STEM education more accessible. By offering resources globally, particularly to underserved communities, this program helps close educational gaps (Penprase & Penprase, 2020).

Stem Focused High schools

High schools with a STEM concentration aim to improve students' preparedness for STEM-related higher education. To provide students with a solid STEM foundation from an early age, these institutions provide demanding STEM curricula and experiential learning opportunities (Means et al., 2017).

Teacher Support and Professional Development:

It's critical to provide teachers with financing and professional development opportunities. One way to help teachers better engage kids in STEM courses is by offering resources for biotechnology and robotics labs (Harvard Gazette).

Summer Programs and Extracurricular Activities:

High school students are exposed to STEM disciplines through summer programs conducted by colleges and universities, which are designed to maintain their interest and aspirations in pursuing STEM jobs. According to Kitchen, Sadler and Sonnert (2018), these programs provide immersive experiences that can increase students' interest in STEM disciplines.

STEM Integration in Basic Education:

The Next Generation Science Standards (NGSS) are one of the initiatives being taken to integrate STEM education into K–12 curricula. By encouraging inquiry-based learning and the development of critical thinking abilities, these standards seek to guarantee a comprehensive and consistent STEM education (National Research Council, 2013).

4.2.1 Challenges and Why These Solutions Have Not Worked

Unfair Access and Opportunity:

Notable differences still exist in spite of efforts to increase access. The lack of advanced STEM courses and resources for students from low-income, minority, and rural backgrounds sometimes restricts their preparation and chances in STEM careers. For instance, barely 20% of high school graduates are equipped for college-level STEM coursework, and less than half of American high schools provide computer science courses

Financial Restraints:

In order for many efforts to be successful, significant cash is generally required, but this funding is frequently insufficient. Public schools, especially those that serve underprivileged areas, have difficulty raising the funds required to carry out and sustain these initiatives (Whicker, 1999).

Teacher Preparation and Retention:

There is always a challenge in making sure that educators are adequately prepared to teach STEM courses. The continuity and caliber of teaching are disrupted by the high turnover rates among STEM teachers and the unavailability of professional development programs. The efficacy of STEM education programs is hampered by this lack of continuity and support (Whicker, 1999).

Systemic Problems in Education:

More entrenched systemic problems, like curricular restrictions and standardized testing, impede creative STEM education approaches. These problems restrict the flexibility required to put into practice inquiry-based and hands-on learning strategies, which are essential for successful STEM education. To remove these

obstacles and encourage a STEM learning environment that is more productive, systemic adjustments are needed (National Research Council, 2014).

Social and Cultural hurdles:

Stereotypes and a lack of role models in STEM professions are only two examples of the social and cultural hurdles that prevent some groups from pursuing STEM jobs. Due to cultural expectations and a dearth of visible representation in STEM fields, girls students of color may feel disinclined to fully engage with STEM courses, making these hurdles more important to them (SpringerLink, 2015).

Technology Enhanced Learning (TEL)

Current Pedagogy (in HE) has a low integration with teaching and learning strategies and faculty is still not fully applying available technology. Although in some institutions of higher learning effort to integrate technology into T&L is visible, there is a lot of work that needs to be done for innovation to transform pedagogy.

4.3 Execution of Teaching and Learning in a DE Environment (Applying the Mechanic)

The solution proposed to the challenges of pedagogy in an ODeL Setting is a technology-enhanced innovation that enables the creation of a dynamic learning environment that supports personalized learning, fosters critical thinking, and promotes collaboration (Schneckenberg, 2009). It adheres to the principles of constructivism, which emphasizes active learning and knowledge construction through experience, and connectivism, which highlights the importance emphasizes networks and digital literacy in the modern world (Mattar, 2018).

By integrating these theories, the innovation facilitates a learning experience that is engaging, flexible, and relevant to the needs of diverse learners. This learning innovation will improve throughput and the quality of the graduates. Many studies have shown that it is no longer possible to treat all students in the proliferating range of e-learning users with very different prior knowledge, backgrounds, learning styles, interests, and preferences, with the one-size-fits-all approach (Kusurkar et al., 2021).

This educational online system with the ability to adapt intelligently to the goals, tasks, interests, and other features of individuals and groups of users, is mission-critical for the ODeL environment (Kabudi et al., 2021). Thus, in an attempt to bridge the gap between pedagogy and technology, the potential of new technologies is used as a means to enhance Teaching and Learning.

A framework for thought and execution of pedagogical strategies is designed and developed, and a consideration of the four key components of a classical intelligent tutor system is deliberated on as a key success factor (Nguyen et al., 2020). The key components required and inspired by Bloom's learning theory, and the comprehensive framework components are the learner, the domain, the pedagogy, and the interface (Rathore & Arjaria, 2020). The learner is the main focal point of the intended innovation, the domain is the representation of the material that the learner must learn, the pedagogy deals with what, how, and when to learn, and the interface is the learning platform.

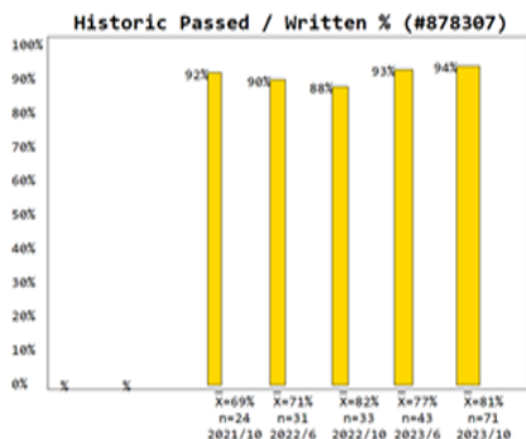
In the process of modeling a learning framework, a hybrid model is adopted (Wu, 2020). The model consists of two broad domains; the first domain consists of a cognitive description component and a stereotype component. The second domain consists of a geographic discriminant component and an overlay component of the model. The cognitive description model is used to classify learners based on their entry test performance scores and the stereotype model is used to classify learners based on the deduced behavior/attitude/characteristics (Shen et al., 2024). The geographic description model classifies students geographically and the overlay model classifies learners based on their knowledge of the subject content.

Then, the learner's learning style is modelled using the classical Jackson's Learning Style Profiler (LSP) (Ghadirli & Rastgarpour, 2013). The Jackson LSP proposes five learning styles, these are (i) Sensation seeker; (ii) Goal-oriented achiever (iii) Emotional intelligent achiever; (iv) Deep learning achiever; and (v) Conscientious achiever (Siadaty & Taghiyareh, 2007). Learners are classified into these learning styles based on their approach and their performance on the weekly tests and quizzes. This classification is dynamic and not static (Siadaty & Taghiyareh, 2007) for the period of the module tuition, i.e., for the semester or the year.

The innovation matches the educational content and the complexity or simplicity of the material, with the learning style of the learners along with giving consideration to the underlying pedagogical principles. The effect of the combination of strategies is observed and comprehended by analyzing the test scores of learners and therefore, making a decision to adapt learning content. The innovation is modeled to enable high-

performing students to excel (not held back) and to support Struggling students by pacing them through their studies. The mechanic of the innovation is designed to ensure throughput improvement and to increase the quality of the pass rate and the pass percentage.

5. Results



Assessment performance results from 2021 when the technology-enhanced innovation was first implemented. The results are a reflection of the impact of technology on pedagogy. The failure rate in STEM programs is eliminated by the application of a technology-enhanced innovation that is modeled to enable high-performing students to excel (not held back) and to support Struggling students by pacing them through their studies.

6. Conclusion

The research into the challenges of pedagogy in an Open Distance and e-learning (ODEL) setting highlights the complexity and multifaceted nature of delivering quality education in a virtual environment. Key challenges include fostering student engagement and retention, providing effective and timely assessment and feedback, and ensuring both students and instructors possess the necessary technical skills and access to technology. These challenges underscore the need for innovative and adaptive pedagogical strategies tailored to the unique demands of ODeL. Technology infused plays a crucial role in addressing these pedagogical challenges. Interactive and adaptive learning technologies enhance student engagement by offering personalized and immersive learning experiences. Social media and collaborative tools help build a sense of community, mitigating feelings of isolation among students.

Automated assessment tools and plagiarism detection software improve the efficiency and integrity of assessments, providing students with prompt and constructive feedback while maintaining academic standards. The results reflect an improved pass rate of above 80%, consistently for five assessment periods. While significant challenges remain, the strategic use of technology offers solutions to enhance the effectiveness of pedagogy in an ODeL setting. Future research should explore innovative technological approaches and outcomes, aiming to create a more inclusive, engaging, and effective distance learning environment. By addressing these challenges head-on and leveraging the potential of technology, ODeL can fulfill its promise of providing flexible and accessible education to a diverse and global student population.

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