

 Research Article

Innovative Teaching Strategies for Information Technology and Engineering Students

Muhini L. Kahare¹ , Emmanuel L. Howe² 

¹Engineering and Technology, Botho University, Windhoek, Namibia

²Business Management, NWU Business School, Mahikeng, South Africa

Abstract

In our technologically globalized world, higher education teachers need to adjust themselves to modern teaching techniques to help students learn easily and be innovative. Integration of Information, Communication, and Technology (ICT) assists teachers in meeting the demand for technology-based teaching and learning tools. Innovative teaching tools are facilities that are currently replacing traditional teaching methods. In the fields of computer science and engineering, information and communication technology (ICT) innovative teaching approaches are regarded as one of the most crucial components for advanced teaching and learning. Teaching in Higher education is facilitated by a variety of software programs, apps, and information management systems. Innovative teaching encourages students' engagement and cultivates the spirit of creativity. For engineering students to succeed in their fields of study, they need to have intrinsic motivation toward learning. Educators who are teaching computer science and engineering courses are required to be creative and use innovative teaching approaches to engage every student. The purpose of this paper is to share strategic knowledge with fellow lecturers in the field of computer sciences and engineering on how to effectively teach and engage students using various tools that are available on the internet and at our disposal. The focus of this paper was on innovative teaching strategies that students prefer to use in their studies. Findings from the study highlighted that most of the students preferred practical teaching methods and industry projects. Evidence was gathered from students enrolled under the Faculty of Engineering and Technology from Eswatini, Botswana, and Namibia campuses using a purposive sampling.

Keywords: Engineering, ICT, Innovative Teaching, Teaching

✉ Correspondence

Lukas Kahare

lukas.kahare@gmail.com

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1. INTRODUCTION

There are various tools, platforms, and approaches, such as blended learning environments, flipped classrooms, social media in education, iPad & computers, Simulations Software and Models, efficient assessment tools, video games, and live streaming, which are designed to make teaching and learning flexible, adjustable, and an enhancement to traditional face-to-face teaching. It is common knowledge in academia that COVID-19 brought new challenges across the world's education system, and online teaching tools are the future educational resources that would replace physical hardware laboratory tools to effectively transmit skills and knowledge to students.

The overall goal for higher education institutions is to produce high-quality university graduates in technical fields like computer science and engineering, to foster lifelong learning, and to train students who are ready to be responsible citizens. Therefore, there is a need to adopt innovative teaching and learning strategies that would increase students' attendance and participation in both synchronous and asynchronous online teaching. When educators speak about students' engagement, this refers to the level of attention, curiosity, enthusiasm, optimism, and passion when learning or being taught, as well as the motivation to study. (Davis, n.d.). Various educationists argue that students learn and recall better when they are actively

involved. Enthusiastic students are more likely to persevere and enjoy the process of learning. Computer science and engineering students prefer practical application, teaching, and working along with their peers. Teaching computer science and engineering requires innovative teaching strategies such as interactive learning, application-based learning, practical learning, hi-tech classroom learning, and other innovative teaching methods based on teachers' teaching experience.

For students to benefit from innovative teaching and learning, particularly in computer science and engineering, teachers need to use various approaches and teaching materials (Naz & Murad, 2017), such as virtual laboratories consisting of learning activities like real-life practical Laboratories. The virtual laboratories' learning environments have the equipment, materials, audiovisual, and learning guides for students and lecturers. Innovative learning tools combined with teaching strategies assist teachers who are teaching computer science and engineering to employ active teaching techniques to help students improve their learning capacities. Such techniques allow students to set choices and clear expectations, and there is provision for lecturers to be available and approachable to guide students. Innovative teaching strategies in computer science need teachers who are reflective practitioners. Reflective practitioner teachers engage and analyze students' background information, such as their culture and curricula they studied, and the teaching environments to reflectively stimulate innovative teaching (College, n.d.). Such practice enables teachers to renew, energize, and at the same time maximize the teaching process.

The main challenge lecturers face in all fields of study is capturing students' attention to focus on learning materials or classroom exercises. Lack of classroom attention happens if teaching and learning do not involve practical classroom engagements. Classroom teaching engagement should be redefined according to innovative ideas that imply teaching and learning are more effective and enjoyable to both teachers and students. The use of innovative teaching methods in higher education does not focus only on students' learning improvement but also empowers and strengthens the governance of various organizations to achieve the human development goal for the country.

The changing university landscape has changed the student perception in acquiring and applying knowledge, more especially on how lecturers use innovative ways to deliver content to students. Therefore, this study was conducted to assess awareness of innovative teaching strategies at Botho University.

2. PROBLEM STATEMENT

The conventional lecture approach (face-to-face) has faced some challenges because students adopt the role of listening to a lecture and therefore contribute very limited knowledge in their learning process. This approach further affects the concentration span of students, which normally lasts between 15 and 20 minutes, affecting the achievement of lesson objectives. The learning space, especially in the classroom setup, is represented by student diversity, which includes cultural differences, student background, and adoption of teaching and learning methods. Ubiquitous access to the Internet for information and knowledge has impacted the way teaching and learning are conducted, whereby students have demanded flexibility in their learning journey. To respond to this diversity, innovative approaches to teaching and learning need to be adopted to mitigate the gap created. This study aims to identify different teaching and learning strategies that computer and IT students use for the learning process, and to answer the question *"What are the various innovative teaching strategies that are used at Botho University?"*

2.1. Innovative Teaching - Literature Review

Innovative teaching strategies require innovative teachers to enforce students' learning. The emergence of ICT in the 21st century changed the paradigms of teaching and learning methods in higher education. Traditional teaching and learning methodologies have become outdated, prompting teachers and students to seek an interactive alternative using numerous methods and strategies to achieve the desired result. Innovative teaching is when technology is incorporated into teaching and learning strategies to create a conducive learning atmosphere for students (Puranik, 2020). A question that often arises is the custodian of innovative teaching, and it often depends on modern technology like ICT to assist teachers in teaching; however, innovative teaching is created by good teachers. Innovative teachers think about their students' learning challenges, such as how students should learn, before they can search for teaching and learning

resources. Innovative teachers assess students' prior knowledge, levels of thinking, research skills, study skills, and learning strategies (Marshall & Marshall, 2003).

2.1.1. Importance of Innovative Teaching

There is huge potential in the education environment in developing, empowering, and supporting learners towards achieving the human development targets of a country (Jayashree, 2017). Innovative teachers strive to find new teaching techniques to keep students active in learning, to like and enjoy the module being taught, to motivate students to do their best, and to encourage them to succeed in their future careers. Innovative teaching requires teachers to be inventive and creative, and they continue to learn and discover new methods and resources to help them teach effectively. Innovative teachers are confident in themselves and in whatever they do, and are able to implement new methods and content of teaching to engage students. Various innovative teaching tools will be discussed in the paper, such as the lecturer method and interactive learning, Application-Based Learning, practical learning, and a hi-tech classroom. Innovative teaching involves using innovative methods and teaching materials that benefit the student learning process (Mandula, Meda & Jain, 2012). It includes virtual labs, learning activities based on real-life problems, audiovisual resources, and learning guides (Anderson and Neri, 2012). Innovative teaching focuses on the trust that every learner can learn based on a practical application that can be applied in real-world scenarios (Naz & Murad, 2017). Innovative teaching methods include a change in attitude, self-reflection, open-ended question conversation, problem-finding learning approaches, risk-taking approach, flipped learning approach, and guest lecturing (Shulman, 2018). However, Senthilkumar & Kannapa (2017) mention the single transmission of content, the lack of student feedback consolidation, course material access limitations, and issues in addressing student engagement as some of the problems that encompass innovative teaching.

2.2. Innovative Teaching Methods

Teaching methods could be classified into traditional and innovative techniques. Traditional methods include lecturing, discussion, demonstration, questioning, and projects (Mbia & Nsungu, 2019), while innovative ways are peer tutoring, problem-based learning, discovery learning, and cooperative learning. Senthilkumar & Kannapa (2017) affirm that these innovative teaching methods provide an extra advantage for students to tackle problems.

2.2.1. Flipped Classroom

This model is based on inverting the traditional teaching approach, promoting the engagement of the content prior to attending a lecturer (Nouri, 2016). Students have more responsibility in attempting their school work, and it gives them greater impetus in the learning process (Du, Fu & Wang, 2014). One of the advantages of the flipped classroom is that it incorporates problem-based, project-based, active, and collaborative learning approaches (Prince, 2004). Furthermore, the flipped classroom approach allows students to learn at their own pace, engage actively with other students, and strengthen communication with teachers and other learners (Gilboy, Heinrichs & Pazzaglia, 2015).

2.2.2. Personalised Learning

Personalized learning is an active learning process focusing on the students' ability to access learning experiences based on their desired learning needs (Hamdan *et al.*, 2015). Personalized learning combined with access to online technologies creates an enriched interaction between students, promoting the sharing of information regardless of their location and time (Howe & Kekwaletswe, 2012).

2.2.3. Project-Based Learning

Project-based learning is a dynamic teaching approach where students explore real-world problems and challenges while at the same time developing future skills by working in small collaborative groups (Goodman, 2010). Under project-based learning, students assume the role of a teacher and coach, guiding students on what to do and helping them engage in learning activities. Project-based teaching is innovative because the learning of students is based on cooperative learning. When students have applied their learning to the project or assignment given, then they are allowed to present the results they have learned in the form of a group. Project-based learning encourages students to apply technology to solve intricate problems (Goodman, 2010).

2.2.4. Inquiry-Based Learning

According to Ampa and Nurqalbi (2021), this approach supports students in determining ways of understanding observations and investigations under the guidance and monitoring of the lecturer. Inquiry-based teaching is a method of challenging students' thinking and creativity by posing questions and queries before a teacher starts explaining the topics of the lesson. A teacher should ask students to find out students' experiential knowledge of the project under study. Inquiry-based learning encourages students to apply their previous knowledge to engage in real-world problem-solving.

2.2.5. Problem-Based Learning

A student-centered pedagogical strategy that enables students to learn by themselves (Ng et al., 2020). Problem-based learning (PBL) is a teaching approach where students are encouraged to work together to solve a complex problem. In problem-based learning, students are taught to be constructive, collaborative, self-directed, and to contextualize their learning (Ferreira & Trudel, 2012). Problem-based learning is effective for engaging students in information technology and engineering. Students in these technical fields tend to love problem-solving exercises, whereby they are encouraged to solve cognitive world-related challenges like what they might experience in a real-world setting (Barrows, 2021).

2.3. Innovative Teaching Competencies

Teaching competencies are a crucial factor, especially in the current paradigm shift of various learning environments. Competency is defined as the stage of integration of knowledge, skills, and attitudes (Tigelaar *et al.*, 2004). On the positive side, these competencies can be nurtured and developed in teachers' learning paths (Brouwer & Korthagen, 2005) and can be presented in actual teaching practices (Zhu, Wang, Cai & Engels, 2013). Competences are a dynamic and complex category that undergoes continual development, enhancement, and refinement driven by different interrelated circumstances (Simonovc, 2021). Lecturers are facing an uphill battle in meeting the demands of ensuring that quality learning is maintained in the ever-changing education space. This also addresses the curious nature of students to learn and acquire new knowledge.

2.4. Theoretical Framework

The theoretical basis of this study is the constructivist theory, based on the idea that learners are active participants in their learning journey (Kurt, 2021). Constructivism encourages active learning or learning by doing, where the active participation of the learner is advocated. The key element of constructivism is that learners learn by actively constructing their knowledge, comparing new knowledge against the previous understanding with a new understanding that has been obtained (Chellammal, 2016). The major feature of constructivism is more student-focused than teacher-focused (Nwaeze, Onuoha & Ukogo, 2016). Examples of constructivist classroom activities include reciprocal teaching, inquiry-based learning, problem-based learning, and two-way learning (Kurt, 2021). An important goal of constructivism is focusing on students' critical thinking skills, which works well in a conducive classroom environment (Khan, 2019).

3. METHODOLOGY

The study preferred a case study approach for data collection, and the interpretive research was implemented with qualitative methods. Evidence for this study was obtained at Botho University from a total of thirty-one (31) students enrolled from the Eswatini, Botswana, and Namibia campuses, using a purposive sampling technique. The sample used was homogeneous, since all the participants were students across the different years and semesters. This qualitative approach ensured that the study findings are contextual and aligned with the research question.

3.1. Participants

The primary respondents of this study were students who have enrolled at Eswatini, Botswana, and Namibia campuses. The programmes that the students were enrolled in were Bachelor of Science in Computing, Bachelor of Science in Mobile Computing, and Bachelor of Science in Network Security and Computer Forensics. There were thirty-one (31) students selected from year 1 to year 4 who took part in the study.

3.2. Research Instruments

The research instrument used was a questionnaire, with the main aim to cover a range of different learners with different learning backgrounds. The objective was to represent the population of learners in a typical university setting. The data was collected over a duration of two (2) weeks and was conducted towards the end of the semester.

3.3. Data Analysis

Neuman (2014) defines data analysis as a means to systematically organize, integrate, and examine relationships and patterns in data in order to connect concepts, themes, and generalizations. This study acknowledges types of qualitative data analysis tools such as narrative analysis, content analysis, thematic analysis, and grounded theory. For this study, in analysing the data, the thematic analysis method was adopted. The overall objective was to formulate themes related to a particular phenomenon (Archer, 2018), and for this case study, the data analysed using thematic analysis was considered most appropriate.

4. FINDINGS

Types of innovative teaching methods that would increase students' learning participation are represented in the graphs below. The results of data analysis collected through the questionnaire show that various teaching methods are preferred by students at campuses for effective learning.

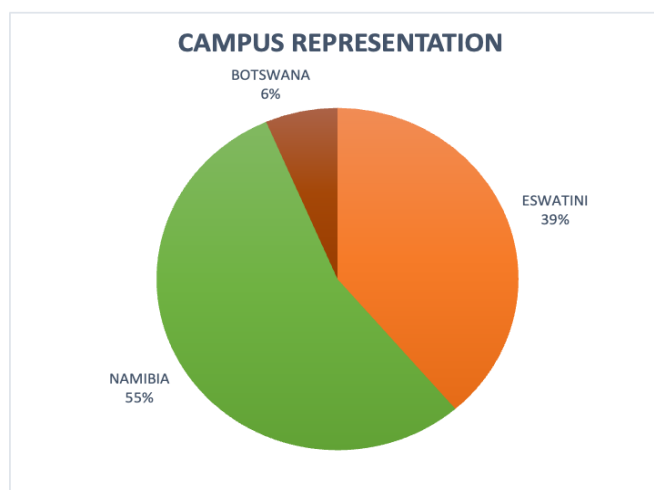


Figure 1. Student Representation per Campus

Figure 1 shows the representation of students across the three campuses. The Namibian campus represents the largest number of participants at 55%, followed by the Eswatini campus with 39%, and Botswana representing 6%. The Lesotho campus did not respond to this questionnaire.

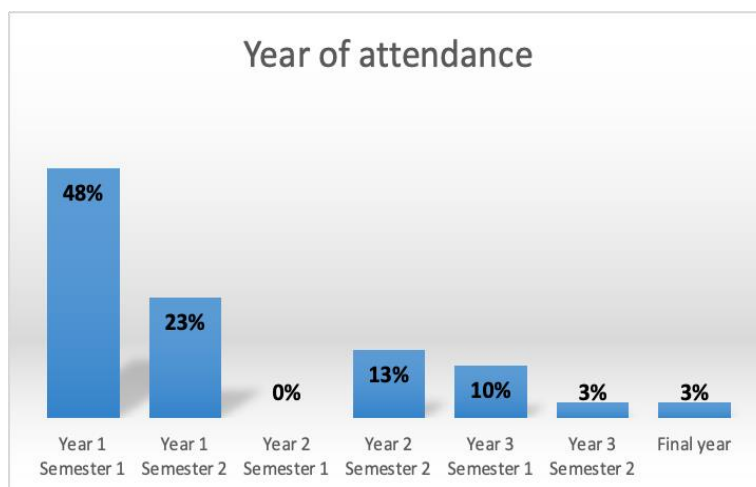


Figure 2. Student Enrollment per Year

Figure 2 displays students' year of study with their respective semesters. Year 1 semester 1 and semester 2 students have the highest number of participants in the survey, with 48% and 23% respectively. Year 2 and year 3 represent 13% of participants in the survey, and only 3% of students represent final year students, which is year 4.

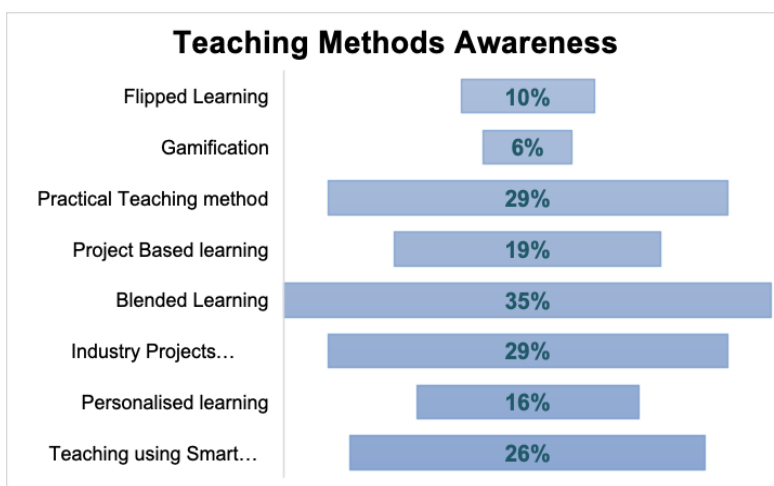


Figure 2. Awareness of Innovative Teaching Methods

Figure 3 shows different teaching methods of awareness. 35% of students prefer blended learning, and 29% prefer industry projects and practical teaching methods, respectively. 26% of the students prefer teaching using smart boards, and 19% prefer project-based learning methods. Figure 3 further shows that students in the 21st century prefer constructive teaching methods in which they can apply learning to real-world environments.

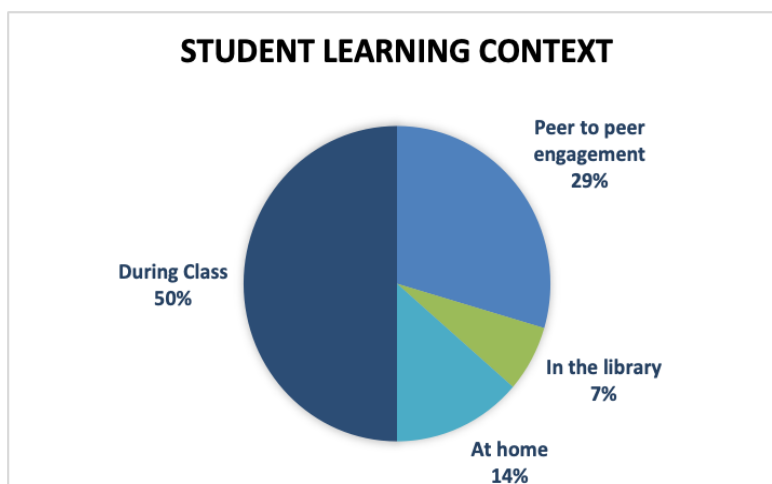


Figure 3. Learning Context Preference

Figure 4 shows students' preferences for learning context. Students were asked where they felt they gained meaningful learning in the programs they enrolled in. 50% of the students mentioned physical class attendance, 29% said peer-to-peer engagement, 7% preferred going to the library, and 14% of the students chose the home setup as ideal for them.

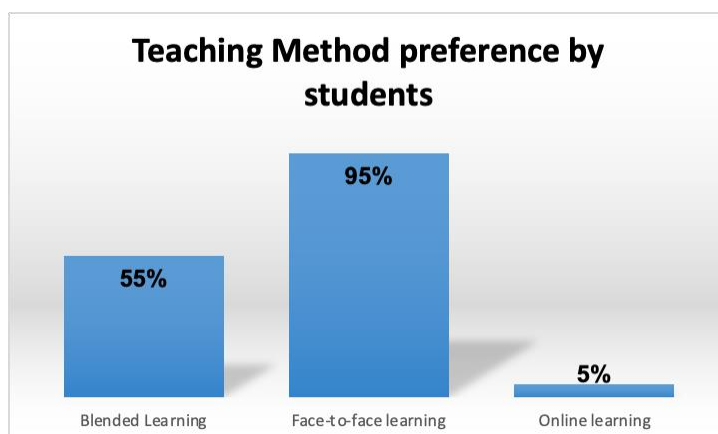


Figure 4. Teaching Method Preference

Figure 5 indicates teaching methods preferred by students on the three campuses of Namibia, Botswana, and Eswatini. 95% of the students prefer face-to-face teaching methods, 55% prefer blended learning, and only 5% prefer online learning. This indicated that the survey was taken on full-time study students, and lecturers do engage students daily. Some modules were taught using both face-to-face and online learning, called blended learning.

5. DISCUSSIONS

5.1. How Students Engage in Different Innovative Teaching Methods

Various teaching and learning methods were implemented by lecturers in the Engineering and Technology Faculty at Ongwediva, Gaborone Campus, and Eswatini Campus at Botho University. Students were asked which teaching method they were familiar with or preferred for their learning. The suitable teaching method is when the lecturer is a facilitator of the learning and students actively engage with the course content (Prince, 2014).

According to the results posted in Table 1 and Figure 2, students support various innovative teaching methods. The most preferred innovative teaching method, according to students, is blended learning, with

35% of the total survey. Blended learning is a combination of traditional face-to-face teaching and e-learning methods (Lalima & Kiran Lata Dangwal, 2017). The COVID-19 outbreak in the early months of 2020 in Southern Africa forced various higher education institutions to combine online learning and face-to-face teaching methods. Some institutions even offered 100% online learning.

The second most supported teaching and learning methods among students across the three campuses are practical teaching methods and industry projects. About 29% of the students mentioned practical teaching methods and industry projects as their preferred methods of learning. Based on the survey data collected, it is evident that practical learning encourages students to develop active learning skills in which they can apply levels of Bloom's taxonomy, such as analyzing, applying, evaluating, and creating (Edem & Boafo, 2020). An industry project is considered a teaching method in which students learn key skills by undertaking actual industrial projects (Holubova, 2008). Industry Projects learning encourages creativity and gives the student a feeling of accomplishment and self-worth. It motivates students to strive and do their best to learn and master their future possible jobs. The other teaching and learning methods students preferred are teaching using Smart (26%), Project Learning (19%), Personalized Learning (16%), Flipped learning (10%), and Gamification (6%).

5.2. How Students Engage in Different Learning Contexts

The effectiveness of learning in a university environment is a result of the social interaction and the context of the engagement (Kekwaletswe & Ng'ambi, 2006). Students learn through interaction with one another to share and gain knowledge. The findings show that 50% of the students preferred the classroom environment and peer-to-peer engagement (29%) for their learning interaction. It also aligns with the preference for the teaching methods, which are online learning (95%) and face-to-face learning (55%).

Furthermore, awareness of innovative teaching methods includes practical teaching methods (29%), blended learning (35%), industry projects (29%), and the usage of smartboards (26%). This suggests that innovative teaching methods are a necessity. The variety of awareness of innovative teaching methods is a good foundation for students to build on. Aligning the methods to the different learning contexts is beneficial for students' learning.

5.3. Preference of the Assessment Type by Students

The students highlighted that group discussion, learning management system usage, discussion forums, projects, and assignments were the common assessment methods. The students were asked what other methods their lecturers use to enhance their understanding of the respective modules. One student's response was;

"They should give us topics that will be covered before the actual class so we get ourselves around what we will be learning other than coming blank to class. It would also be helpful if like they always promise, they send the lecture slides they say they will send." Student A, Year 1, Semester 1

From this response, the importance of applying innovative approaches enhances the student learning process. This ensured that the content is available for students in the appropriate learning platform. This is also deduced by the response below;

"If the lecturers can upload many assignments in Blackboard, we will be able to apply ourselves and understand the objectives of the modules." Student F, Year 1, Semester 2

The importance of learner interaction needs to be seen as an important factor in a student's learning experience, and by incorporating innovative learning initiatives, it will ensure that such interaction continues to add value. A response from a student supports this.

"I wish the university can concentrate more on student exchange programs because I feel if I engage with other students from different universities, we can learn from each other." Student C - Year 3 Semester 1.

5.4. Methods to Enhance Innovative Teaching

Students were asked about other methods that the lecturers could use to enhance their understanding of enrolled modules.

5.4.1. Practical and Hands-on learning

A majority of the students mentioned that lecturers should incorporate more practicals and assignments into the modules. This is supported by the following responses;

“Practicals” Year 1 Semester

“Practical assessments on topics covered(projects)” Year 3 Semester 2

“Teach and give a practical of the subject they were teaching” Year 2 Semester 2

“Adding more practice assignment” Year 1 Semester 2

The consistent request from students for more practical sessions and assessments emphasizes the importance of applying theory to practical hands-on activities. Additionally, the comments show that there is a positive attitude from the students toward adopting innovative teaching methods.

5.4.2. Blended and Flexible Learning

Students appreciated the integration of blended learning methods that include Webinars; however, students emphasized the need for balance with face-to-face interaction.

“Face to face” Year 1 Semester 1

“Face-to-face teaching” Year 1 Semester 1

“Teaching face to face” Year 1 Semester 1

“More face-to-face sessions” Year 1 Semester 2

The students expressed a need for more lecturer-to-student interaction to enhance their learning and understanding. Furthermore, the comments show that the first-year students were the majority who preferred blended learning. The emerging themes highlighted positive aspects of innovative teaching methods that addressed student-centred engagement.

6. RECOMMENDATIONS

Innovative teaching in the technical fields, such as engineering and information technology, should be employed in higher education. The study revealed that 21st-century students prefer innovative teaching strategies to enrich their learning and constructive thinking (Ghavifekr, Rosdy & Wan, 2015). Innovative teaching strategies do not mean only employing the latest technology in the classroom, but innovative teaching involves being proactive by implementing new teaching strategies and methods in lesson facilitation.

The study recommends that innovative teaching strategies should be employed in all Botho University campuses, since the programme offering is similar across all the campuses. Students at Ongwediva campuses in Namibia and Eswatini preferred the latest teaching and learning strategies, such as using problem and project-based learning (PBL), blended learning, and peer teaching, as highlighted in the data analysis results. Therefore, the study encourages lecturers to exercise innovative teaching using available resources such as Blackboard, software simulations, and YouTube videos, and better teaching methodologies such as peer tutoring, project-based assessments, and industrial collaboration teaching by inviting guest lecturers or taking students to companies to experience real-world problem-solving. It is

recommended that innovative teaching methods, such as practical teaching methods, industry projects, and Smartboard technology, should be incorporated in the development and review of the curriculum.

7. CONCLUSION

Innovative teaching methods provide supplementary support to the traditional method of teaching. Lecturers must adopt a positive mindset when adopting different teaching methods to widen the confidence spectrum in students. Equally important is to note that innovative teachers or educators always advocate effective teaching models for students. Based on the data analysis, students stipulated the teaching strategies lecturers should use to interact with them successfully and which teaching methods they do not need. The study aligns with the constructivist theory, which emphasizes the importance of active learner participation. The outcome of this study can be used as a scaffolding platform for students in the Faculty of Engineering at Botho University.

7.1. Practical Implications

There will be more opportunities for students to tailor their learning needs and experiment with different learning styles, which will further enhance their engagement with the content and fellow students. Furthermore, there will be more opportunities for students to embrace and integrate technology into the learning process. For curriculum designers, the opportunity to regularly review and evaluate the curriculum in order to respond to changing societal and institutional needs. For lecturers, the diversity towards incorporating hands-on activities and adopting innovative teaching methods will further enhance teaching and learning.

7.2. Policy Implications

The Head of Departments will be able to ensure that curriculum development and policy implementation align with the vision and mission of the programmes. It is imperative that institutions of higher learning migrate beyond the traditional lecture-based approaches and adopt inclusive, student-centered, and agile teaching methods. This approach should be included during programme reviews, student evaluations, and meetings. The findings from this study offered insights into current practices but also provided a foundation for recommending and formulating practical and evidence-based strategies for improving the application of innovative teaching methods.

8. LIMITATIONS AND FUTURE RESEARCH

The study focused on student perception and lacked input from lecturers, heads of departments, and curriculum or programme development committees. Such input will have a greater impact on policy development and review. Future research should utilize the contextual inquiry methodology to allow the researcher to observe the application of the innovative teaching and learning methods in their learning context.

Future research should examine the impact of industry needs and expectations and the application of different teaching and learning methods. The lecturers' teaching philosophy is another area for future research that will establish the level of appropriateness of the teaching philosophy and teaching methods. The results should contribute to more focused and aligned programme and learner outcomes. Overall, this study advocates for a clear, structured approach for incorporating innovative teaching methods into higher education contexts. This is crucial in the current state of aligning and adapting to student-centered learning approaches, as well as adhering to the industry and socioeconomic needs of countries.

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Research Ethics. All research procedures were conducted in accordance with the institutional and national ethical standards for research involving human participants. Ethical approval for this study was granted by the Botho University Research Ethics Committee (Reference No.: BU/ETH/2025/06/14). Participation was voluntary, and informed consent was obtained from all participants.

Data Availability Statement. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest. No conflict of interest.

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