Preparedness on Outcome-Based Education Instructional Methods: Foundations for Formulating an Effective Preservice Science Teacher Preparation and Scaffolding Model in Botswana

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ABSTRACT

This study explored the extent of preparedness of science lecturers and completing preservice teachers enrolled on science education programs at teacher preparation institutions in Botswana on implementing exemplary instructional methods following the national adoption of Outcome-Based Education (OBE) curriculum. Using a descriptive survey design, data was collected from a diverse sample of science lecturers and final-year preservice science teachers to evaluate their readiness to apply contemporary, exemplary instructional methods. Findings reveal a sub-optimal level of preparedness, with notable gaps in pedagogical content knowledge, technology integration, and the practical application of OBE principles in both science lecturers and student teachers. Although science lecturers reported being adequately prepared to support learning through collaborative, inductive, and experiential instructional methods, their classroom practices suggested low frequency of using these methods, with few activities that provoked critical thinking or problem-solving skills. Final-year student teachers were found to be minimally prepared to teach using these exemplary instructional methods, rarely engaged in inductive instructional activities, and mostly involved in teacher-directed instructions, implying that lecturers did not model these methods consistently during teacher preparation. The narrative evidence that contextualized the numerical data further revealed that large class sizes, heavy workloads, shortages of teaching and learning resources, and pressure to complete the syllabus constrained both lecturers' and student teachers' ability to implement collaborative, inductive, and experiential learning approaches. These insights highlight contextual and systemic factors which require an urgent need for targeted professional development initiatives, mentorship programs, curriculum revisions in teacher education, and stronger school-university partnerships to bridge the gap between preservice teacher preparation and classroom practice, support early-career teacher development and promote sustained improvements in instructional quality. Enhancing teacher preparedness in line with OBE objectives holds significant implications for improving student outcomes, advancing educational equity, and strengthening Botswana's position in global STEM

Keywords: Preservice teachers, Outcome-Based Education, Exemplary Instructional Methods, Self-Efficacy

INTRODUCTION

Outcome-Based Education (OBE) is an innovative educational approach that places a strong emphasis on defining specific learning outcomes for students, thus reshaping the traditional educational landscape (Spady, 1994). Successful implementation of OBE requires systemic changes within educational institutions. This encompasses aligning policies, curriculum, and assessment practices to ensure coherence and effectiveness. There is a strong emphasis on accountability, holding schools and educators responsible for guiding students towards the attainment of specified outcomes. Outcome-Based Education represents a visionary approach to education which emphasize student learning outcomes as the linchpin of effective teaching. By emphasizing clear objectives, individualized learning, and a practical application of knowledge, OBE empowers students to become adept problem solvers and lifelong learners. In scientific disciplines, where both theoretical knowledge and practical skills are crucial, OBE has shown to improve student performance significantly. Machila et al. (2023) conducted a meta-analysis of OBE reforms in secondary school history curriculum in Zambia, concluding

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that the implementation of OBE led to significant improvements in students' academic performance. OBE's focus on clear, measurable learning outcomes ensures that students acquire the competencies they need, from basic scientific knowledge to more advanced problem-solving skills, which are necessary for professional success in science and engineering fields. In addition to improving academic performance, OBE has been linked to greater student engagement and deeper learning. Koketso (2020) observed that OBE-led reforms improved learning outcomes by promoting active, student-centered teaching methodologies such as project-based learning, peer collaboration, experiential learning and continuous assessment. Researchers have used terms like reform-based to refer to such instruction (Veal et al., 2016), inquiry-based (Furtak et al., 2012), and constructivist teaching (Haney & McArthur, 2002), among many other variations. Here, we refer to these methodologies as exemplary instructional methods, as this term carries specific meaning with respect to key instructional principles. First among these principles is that they focus on developing a small set of core ideas over a long period of time (Fortus & Krajcik, 2012). Second, they are contextualized in connected explorations of meaningful phenomena and problems (Canrinus et al., 2017). Third, they motivate a need to know about new ideas based upon their utility in making sense of the phenomena that drive learning (Schneider et al., 2020). Importantly, exemplary instructional methods support students in taking a primary role in connecting activities and ideas (Sikorski & Hammer, 2017). Effective science instruction blends inductive learning, collaborative learning as well as experiential learning with authentic, formative, and differentiated assessments (Bwembya et al, 2024); Daka et al., 2017; Masaiti et al, 2023). These teaching methods link science to real-world problems, fostering creativity, collaboration, and relevance which Bwembya et al. (2024) and Iloanya (2019) described as key 21st century skills. These methods encourage students to take ownership of their learning, collaborate with peers, and apply their knowledge in practical situations. When students are actively engaged in the learning process, they are more likely to retain knowledge, develop critical thinking skills, and achieve higher academic standards.

The educational landscape in Africa has been undergoing significant reforms in recent years, with many nations adopting the Outcome-Based Education (OBE) curriculum as a model to address the persistent challenges of quality, accessibility, and relevance in education. Several African countries including South Africa, Rwanda, Kenya, and Zambia, have been at the forefront of implementing outcome-based pedagogy, focusing on critical thinking, problem-solving, and skills development. Since gaining independence, Botswana has made remarkable strides in the development of its education system. A key feature of these advancements is the emphasis on Outcome-Based Education (OBE) which focuses on achieving specific learning outcomes that reflect the nation's broader developmental goals. This shift towards OBE has been underpinned by various legal and policy frameworks, most notably the Education and Training Sector Strategic Plan (ETSSP 2015-2020), and the National Development Plan 11 (Government of Botswana, 2017). These documents have been instrumental in shaping the educational landscape in Botswana, facilitating a student-centered approach that emphasizes equity, access, and quality education. Teacher preparation in Botswana is a critical component of the country's educational development, therefore, critical to this transformation are the policy directions focused on teacher preparation, inclusive education, teacher deployment, and classroom instructional strategies. ETSSP places a strong emphasis on teacher professional development as a crucial element for the successful implementation of OBE. As OBE requires teachers to adopt more innovative and student-centered teaching methods, the ETSSP recognizes that ongoing teacher training is vital to ensuring that educators can effectively deliver an outcome-based curriculum. According to Motlhabanyane and Tsheko (2023), teacher professional development is critical to the successful implementation of OBE, as teachers must be equipped with the necessary skills to design, teach, and assess outcome-based curricula. The ETSSP's focus on teacher development aligns with the need to equip teachers with the necessary skills to implement OBE effectively, ensuring that they can design and assess learning outcomes that are aligned with the country's development goals.

Several studies in Botswana indicate that the teacher training system often prioritizes theoretical knowledge over practical teaching skills. For instance, studies by Bulawa and Pansiri (2013) and Ketlhoilwe and Silo (2016) revealed that Botswana's teacher education programs tend to focus heavily on academic theory rather than the application of effective practices in the classroom. This imbalance between theory and practice hinders the ability of teachers to effectively implement effective strategies. Teacher preparedness and ongoing professional development stand out as critical areas requiring attention. Many educators encounter obstacles stemming from inadequate training, limited access to professional development opportunities and a lack of deep content knowledge. These challenges significantly impact their ability to effectively convey complex scientific concepts and employ innovative teaching strategies. Daka et al. (2017) underscore the necessity of continuous professional development programs focusing on content knowledge enhancement and pedagogical skills development for science educators. Their study further point that shortage of resources and insufficient laboratory facilities impedes the implementation of hands-on, inquiry-based learning experiences. The dearth of proper equipment and materials limits students' practical exposure to scientific experimentation, hindering their deeper understanding of scientific principles. Chizyuka and Daka (2021) stress the significance of well-equipped science laboratories in fostering effective science learning experiences in schools. Engaging students and fostering a genuine interest in science poses another significant challenge. Abstract concepts, traditional teaching methods, and a lack of hands-on opportunities often contribute to student disengagement and reduced motivation toward science subjects. Addressing this challenge requires innovative teaching approaches and real-world applications within science education as advocated by Omenka and Otor (2015) and Zeichner (2010) who emphasize that inquiry-based methods enhance student engagement and motivation. This study therefore explored the preparedness of science lecturers and completing preservice science teachers at teacher preparation institutions in Botswana on using pedagogical practices that are aligned with exemplary instructional methods following the national adoption of Outcome-Based Education (OBE) curriculum for the purpose of formulating an effective preservice science teacher preparation and scaffolding model. This is expected to leverage the status of preservice teacher preparation and science education in response to the results of world ranking studies.

Theoretical framework

This study was anchored on Bandura’s (1977) Social Learning Theory which emphasizes the importance of learning through observation, modelling, imitation, and social interaction. The theory asserts that individuals acquire new behaviors and competencies not only through direct instruction but also by observing others and internalizing their actions. Central to this theory is the concept of self-efficacy, which refers to an individual’s belief in their capability to perform tasks successfully. Bandura (1977) proposed four primary sources of self-efficacy: mastery experiences, vicarious experiences, verbal persuasion, and emotional and physiological states. Self-efficacy shapes how people think, feel, and behave when facing challenges. In teacher education, it determines how confident educators feel about their ability to implement instructional strategies effectively especially new roles during reforms that brings new changes in their routine tasks. These experiences help shape educators’ confidence to apply knowledge and skills in authentic teaching situations. The concept of self-efficacy provided a framework for understanding the preparedness of science lecturers and preservice science teachers to implement pedagogical practices aligned with Outcome-Based Education (OBE) for this study. Preparedness in this context involves not only possessing pedagogical and content knowledge but also believing in one’s ability to apply them successfully on exemplary instructional practices in science classrooms. Science lecturers with high self-efficacy are more likely to model and support innovative, exemplary instructional practices while preservice teachers with high self-efficacy demonstrate greater confidence and persistence in applying OBE-aligned practices in classrooms upon completion of their teacher preparation program. Thus, variations in preparedness may be explained by differing levels of self-efficacy highlighting the importance of fostering confidence through effective training, mentorship and practical teaching experiences to enhance the quality of science education in Botswana.

METHODOLOGY AND FINDINGS

The descriptive survey design was used in this study. This study was conducted at three teacher preparation institutions in Botswana, and the respondents were science lecturers and final-year students enrolled in the science teacher education program at these selected institutions. These sites were documented to be in the realm of improving science education with the provisions of exemplary instructional methods. They were chosen based on the idea that an effective preservice teacher preparation and science education shall start in the foundation level. Thus, their standpoints are necessary in developing better programs that can bolster the practices and procedures in preservice teacher preparation and science education. The total number of science lecturers and final-year science student teachers in the research locale were requested from the different institutions’ principals. The sample of 32 science lecturers and 130 final-year student teachers was determined using the Taro Yamane sample size calculator using a level confidence of 95% and an error of 5%. Stratified random sampling technique was employed to ascertain the representativeness of the population per strata for the final year student teachers. The instruments used to gather the needed data were a validated researcher-made questionnaire, interview guide for science lecturers and focus group discussion protocol for student teachers. The instruments covered the following concepts: student-centered pedagogy, hands-on learning, scaffolding, assessment and feedback, and professional development. Indicators of the known parameters were formulated based on the frames of the Albert Bandura's Self-Efficacy concept (Bandura, 1977). The questionnaire was field tested on 25 respondents who were outside the research locale. This pre-testing helped identify issues that could potentially affect the reliability of the data. To assess the internal consistency of the survey instrument, Cronbach's Alpha was applied to measure how closely related a set of items were as a group, with a score of 0.70 or above considered acceptable. Descriptive statistics were employed in determining the conformity of the respondents on the formulated problems of the study. The transcripts of interviews and focus group discussions were coded and refined, leading to the development of broader themes. These became the basis of the aim of the study to determine the extent of preparedness of science lecturers and completing science student teachers on the use of exemplary instructional methods for formulating an epistemic preservice science teacher preparation and scaffolding model.

Survey Questionnaire

Lecturers were required to rate their level of preparedness to support the student teachers in the use of exemplary science instruction that included collaborative, inquiry-based and experiential learning. A Likert scale was used with 1=not at all, 2=minimally prepared, 3=adequately prepared and 4=fully prepared as shown in Table 1. The average percentage show that 52.0% of the science lecturers were adequately prepared, and 24.0% were well prepared while the other 24.0% were minimally prepared. On a cross-tabulation of the distribution of the science lecturers according to their respective institutions also measured the views of the lecturers on their preparedness to support the preservice teachers on the use of exemplary science instruction through collaborative, inductive and experiential learning. A Likert scale with 1=minimally prepared, 2=adequately prepared and 3=well prepared. The findings of the study shows that most the lecturers from the three institutions indicated that lecturers were adequately prepared for exemplary instructional methods that include collaborative and inductive learning methods but minimally prepared to support student teachers with experiential learning methods.

Table 1: Responses of science lecturers on their preparedness to support preservice science teachers on collaborative, inductive and experiential learning (n =32)

ITEM	Not at all prepared	Minimally prepared	Adequately prepared	Very well prepared
Collaborative learning (Jigsaw method, peer instruction and think-pair-share)	0 (0.0%)	6 (18.8%)	18 (56.2%)	8 (25.0%)
Inductive learning (Inquiry-based learning, discovery learning and project-based learning)	0 (0.0%)	7 (21.9%)	15 (46.8%)	10 (31.3%)
Experiential learning (Simulations, problem-based learning and field trips)	0 (0.0%)	10 (31.3%)	17 (53.1%)	5 (15.6%)
Average	**0.0%**	**24.0%**	**52.0%**	**24.0%**

The study used Kruskal-Wallis T Test to test for the difference between the science lecturers from the three institutions on their preparedness to support student teachers on collaborative, inductive and experiential learning methods. The results showed that lecturers' preparedness to support student learning that requires collaborative learning did not differ significantly across the three institutions, $\chi^2(2) = 1.289$, $p = 0.525$. The mean rank preparedness scores were 14.61 for Institution 1, 12.63 for Institution 2, and 10.50 for Institution 3. Similarly, for inductive learning, the Kruskal-Wallis T Test revealed no significant difference, $\chi^2(2) = 0.942$, $p = 0.625$. The mean ranks were 13.75 for Institution 1, 12.20 for Institution 2, and 11.05 for Institution 3. For experiential learning, the result was also not statistically significant, $\chi^2(2) = 1.102$, $p = 0.576$, with mean ranks of 14.20 for

Institution 1, 12.10 for Institution 2, and 10.70 for Institution 3. These findings suggest that the science lecturers across all three institutions perceived themselves as similarly prepared to support student learning that involves collaborative, inductive, and experiential approaches.

The study also collected information from lecturers on professional development opportunities related to learner-centered teaching. Responses from lecturers were rated on a 5 Likert scale of Strongly Disagree (5), Disagree (4), Neutral (3), Agree (2), and Strongly Agree (1) based on four items as presented in Table 2. The data in Table 2 reveal a concerning gap between science lecturers' interest in professional development related to outcome-based education (OBE) and the actual availability and support for such opportunities. While a cumulative percentage of 90.6% of lecturers expressed a strong interest in pursuing professional development focused on OBE, only a cumulative percentage of 28.1% felt that they currently have access to such opportunities, with 68.7% either disagreeing or strongly disagreeing with the statement. Dissatisfaction with existing professional development opportunities was also high, with a cumulative percentage of 65.6% expressing discontent and only 18.8% expressing satisfaction. Moreover, only a cumulative percentage of 25.0% of lecturers felt they were receiving the necessary professional development to implement OBE practices in their classrooms, indicating a significant gap between institutional support and lecturers' professional development needs.

Table 2: Lecturers' responses to items related to their professional development opportunities (n =32).

Professional development in Exemplary instructional methods and OBE					
ITEM	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
I feel that I have many professional development opportunities focused on outcome-based education.	18 (56.2%)	4 (12.5%)	1 (3.1%)	4 (12.5%)	5 (15.6%)
I am interested in pursuing professional development opportunities focused on outcome-based education.	0 (0.0%)	1(3.1%)	2 (6.3%)	9 (28.1%)	20 (62.5%)
I am satisfied with the opportunities I have for professional development.	9 (28.1%)	12 (37.5%)	5 (15.6%)	2 (6.3%)	4 (12.5%)
I am receiving the professional development I need to implement outcome-based education practices	7 (21.8%)	14 (43.8%)	3 (9.4%)	4 (12.5%)	4 (12.5%)

The study also required science lecturers to respond to items that asked them to indicate the frequency with which they provided instruction encouraging exemplary instructional approaches through collaborative, inductive, and experiential learning activities. Lecturers indicated their responses using a four-point scale: Never (1), Occasionally (2), Often (3), or All the time (4), as presented in Table 3. The results showed that when providing instructional opportunities requiring students to engage in collaborative learning activities such as jigsaw method, peer instruction, and think-pair-share, 9 lecturers (28.1%) reported doing so occasionally, 17 (53.1%) said often, and 6 (18.8%) reported doing so all the time. For inductive learning approaches such as inquiry-based learning, discovery learning, and project-based learning, 14 lecturers (43.8%) reported occasionally using them, another 14 (43.8%) said they used them often, while 4 lecturers (12.5%) reported using them all the time. Regarding experiential learning strategies including simulations, problem-based learning, and field trips, 4 lecturers (12.5%) reported never using such methods, 15 (46.9%) reported using them occasionally, 11 (34.3%) indicated often, and only 2 (6.3%) reported using them all the time. On average, across the three instructional strategies, 4.2% of lecturers indicated never using the methods, 39.6% reported occasional use, 43.7% reported using them often, and 12.5% reported using them all the time.

Table 3: Science lecturers' responses to items related to how often they provided instruction that requires collaborative, inductive, and experiential learning (n =32).

ITEM	Never	Occasional	Often	All the time
Collaborative learning (Jigsaw method, peer instruction and think-pair-share)	0 (0.0%)	9 (28.1%)	17 (53.1%)	6 (18.8%)
Inductive learning (Inquiry-based learning, discovery learning and project-based learning)	0 (0.0%)	14 (43.8%)	14 (43.8%)	4 (12.5%)
Experiential learning (Simulations, problem-based learning and field trips)	4 12.5%)	15 (46.9%)	11 (34.3%)	2 (6.3%)
Average	**4.2%**	**39.6%**	**43.7%**	**12.5%**

Table 4 presents the responses of science lecturers regarding instruction and assessment activities that took up most of their time over the course of a typical week. The first instructional activity examined how often science lecturers led a class of students engaged in investigations that demanded complex reasoning such as solving problems without a single correct answer, applying previously learned content to new contexts, or supporting ideas with evidence. The results show that 10 science lecturers (31.3%) reported rarely engaging students in such complex reasoning activities, while another 10 (31.3%) indicated that they never did so. Only 7 (21.8%) indicated that they always led such investigations, and 5 (15.6%) reported doing so frequently. This pattern suggests that most science lecturers had limited opportunities to facilitate inquiry-based lessons that promote higher-order thinking and problem-solving skills among learners. In terms of providing instruction through extended formal presentations or lectures, most science lecturers reported frequent use of this traditional approach. Thirteen (40.6%) indicated using lectures frequently, and 11 (34.4%) reported always doing so. In contrast, only 3 (9.4%) said they rarely used this method, and 5 (15.6%) indicated never doing so. These findings demonstrate a continued reliance on lecturer-centered instructional approaches, despite the expectations of Outcome-Based Education (OBE) and exemplary instructional methods, which emphasize active and student-centered learning.

Regarding the facilitation of whole-class discussions where students present ideas or give and receive feedback, 12 science lecturers (37.5%) reported rarely using this method, and 7 (21.8%) stated that they never used it. Only 6 (18.8%) indicated that they always facilitated such discussions, while 7 (21.8%) reported doing so frequently. Similarly, when asked about organizing and facilitating student-led activities, 11 (34.4%) said they rarely engaged in such practices, 10 (31.3%) never did, 7 (21.8%) always did, and 4 (12.5%) reported doing so frequently. These findings suggest that opportunities for learners to take leadership roles in the classroom remain limited among science lecturers. As for provision of in-depth guidance on students' work, the responses were even more concerning. Thirteen science lecturers (40.6%) indicated that they never provided such guidance, while only 8 (25.0%) said they always did, and 5 (15.6%) reported doing so frequently. Similarly, when asked about answering procedural questions or helping students stay on task during group work, 13 (40.6%) indicated never doing so, 6 (18.8%) said they always did, and 8 (25.0%) reported doing so frequently. These results point to a possible lack of scaffolding and instructional support for learners during active learning sessions.

In terms of promoting engagement with big ideas through open-ended questioning, 13 science lecturers (40.6%) reported rarely asking such questions, and 5 (15.6%) said they never did. Only 5 (15.6%) reported always asking open-ended questions, and 9 (28.1%) said they did so frequently. This suggests limited use of questioning strategies that stimulate deep reasoning and conceptual understanding. On the other hand, the use of feedback appeared to be more frequent. Fourteen science lecturers (43.8%) reported frequently giving written feedback on student work, and 7 (21.8%) said they always did, while 8 (25.0%) never did so. Similarly, 10 (31.3%) reported frequently providing oral feedback, and 9 (28.1%) indicated always doing so, suggesting moderate attention to feedback practices. Other instructional activities were used less often. For instance, 12 science

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lecturers (37.5%) reported never having students explore alternative methods for solving problems or conducting investigations, and 12 (37.5%) also reported never modifying or adjusting instruction based on informal assessment. Similarly, 12 (37.5%) indicated rarely modelling for students how to approach a problem or task, while 9 (28.1%) reported rarely differentiating instruction to meet individual needs. Finally, a large proportion, 13 (40.6%) reported rarely connecting lesson content to students' personalized learning pathways, while 10 (31.3%) never made such connections.

Table 4: Science lecturers' rating of instructional activities which took up most of their lessons (n=32).

	Responses			
ITEM	**Always**	**Frequently**	**Rarely**	**Never**
Lead a class of students doing an investigation that demands complex reasoning	7 (21.8%)	5 (15.6%)	10 (31.3%)	10 (31.3%)
Provide instruction through extended formal presentation/lecture	11 (34.4%)	13 (40.6%)	3 (9.4%)	5 (15.6%)
Facilitate a whole discussion where students present ideas or give/receive feedback	6 (18.8%)	7 (21.8%)	12(37.5%)	7 (21.8%)
Organize and facilitate a student-led activity	7 (21.8%)	4 (12.5%)	11(34.4%)	10 (31.3%)
Provide students with in-depth guidance on the content or organization of their work	8 (25.0%)	5 (15.6%)	6 (18.8%)	13 (40.6%)
Answer procedural questions about individual or group work and/or help students stay on task	6 (18.8%)	8 (25.0%)	5 (15.6%)	13 (40.6%)
Ask open-ended questions to promote engagement with big ideas	5 (15.6%)	9 (28.1%)	13(40.6%)	5 (15.6%)
Give written feedback on student work	7 (21.8%)	14 (43.8%)	3 (9.4%)	8 (25.0%)
Give oral feedback on student work	9 (28.1%)	10 (31.3%)	4 (12.5%)	9 (28.1%)
Have students explore alternative methods for solving problems/conducting investigations	5 (15.6%)	6 (18.8%)	9 (28.1%)	12 (37.5%)
Modify or adjust instruction based on informal class assessments	3 (9.4%)	6 (18.8%)	11(34.4%)	12(37.5%)
Model for students how to approach a problem or task	5 (15.6%)	6 (18.8%)	9(28.1%)	12(37.5%)
Differentiate activities or instruction to meet individual students' needs	7 (21.8%)	4 (12.5%)	12 (37.5%)	9 (28.1%)
Make connections between content and/or activities and students personalized learning plans of pathways	3 (9.4%)	6 (18.8%)	13(40.6%)	10(31.3%)

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The study also required completing preservice science teachers to rate their level of preparedness to use exemplary instructional methods that included collaborative, inquiry-based and experiential learning. A Likert scale was used with 1=not at all, 2=minimally prepared, 3=adequately prepared and 4=fully prepared as show Table 5. The average percentages show that 27.2% of the completing preservice science teachers were adequately prepared, 20.7% were well prepared, while 29.0% were minimally prepared, and 23.1% were not at all prepared. A cross-tabulation of the distribution of the preservice teachers across their respective institutions also measured their views on preparedness to implement exemplary instructional methods through collaborative, inductive, and experiential learning. Using a Likert scale with 1=not at all prepared, 2=minimally prepared, 3=adequately prepared, and 4=very well prepared. The findings show that most preservice teachers from the three institutions indicated they were adequately or very well prepared to apply collaborative learning methods. They showed moderate preparedness for inductive learning methods. However, the majority reported being minimally or not at all prepared to use experiential learning strategies such as simulations, problem-based learning, and field trips. This suggests that while completing preservice teachers feel relatively confident about using collaborative and some inductive strategies, there is a notable gap in their readiness to implement experiential learning approaches in alignment with Outcome-Based Education (OBE) principles.

Table 5: Final-year student teachers' responses on their preparedness to use collaborative, inductive and experiential learning (n =130)

ITEM	Not at all prepared	Minimally prepared	Adequately prepared	Very well prepared
Collaborative learning (Jigsaw method, peer instruction and think-pair-share)	9 (6.9%)	25(19.3%)	48 (36.9%)	48 (36.9%)
Inductive learning (Inquiry-based, discovery learning and project-based learning)	38 (29.2%)	32 (24.6%)	43 (33.1%)	17(13.1%)
Experiential learning (Simulations, problem-based learning and field trips)	43 (33.1%)	56 (43.1%)	15 (11.5%)	16 (12.3%)
Average	**23.1%**	**29.0%**	**27.2%**	**20.7%**

The study used the Kruskal-Wallis H test to test for differences in completing preservice teachers' views on their preparedness to teach using exemplary science instruction after program completion across three different institutions. The Kruskal-Wallis H Test results revealed that there was no statistically significant difference in preservice teachers' views about their preparedness to teach using exemplary instructional methods among the three institutions, $\chi^2(2) = 0.370$, $p = 0.831$, with a mean rank preparedness score of 287.51 for Institution 1, 276.42 for Institution 2, and 280.74 for Institution 3. This means that the differences in preservice teachers' views regarding their preparedness to teach using exemplary instructional methods did not differ statistically. In other words, there was no significant difference in the way preservice teachers from the three institutions felt about their preparedness to teach using exemplary science instruction. Therefore, it can be concluded that preservice teachers across the three institutions felt similarly underprepared to effectively teach using exemplary instructional approaches that included collaborative, inductive, and experiential learning.

Interviews and Focus Group Discussions

The findings from both the Focus Group Discussions with student teachers and the interviews with science lecturers revealed several interconnected barriers that impede the effective use of exemplary instructional methods and performance-based assessment in preservice teacher preparation and in the implementation of these approaches during teaching practice by student teachers. Although the science teacher education curriculum promotes Outcome-Based Education (OBE), which emphasises inquiry, hands-on exploration, collaborative learning, and performance-based assessment, the practical realities experienced by lecturers and student teachers often prevent these methods from being fully realised. Four major barriers emerged from the lived experiences of participants: lack of modelling by science lecturers, large class sizes, shortage of resources, and pressure to complete the syllabus. These barriers significantly influence the ability of science lecturers and student teachers to internalise and implement exemplary teaching approaches in their classrooms.

Lack of Modelling by Science Lecturers

A key barrier identified was the inconsistent modelling of exemplary instructional methods by science lecturers within teacher training institutions. While student teachers described their coursework as heavily emphasising learner-centred and inquiry-based pedagogies, they felt that the actual teaching practices they observed in college classrooms often contradicted what was being taught theoretically. This created a pronounced gap between theory and practice. Student teachers articulated their misgivings in detail:

Student Teacher 5:

"We spend a lot of time learning about all these different exemplary instructional approaches, like guided discovery, inquiry, and doing practical investigations. But when you look at how most science lessons are taught in the college, the lecturer just comes in and talks for almost the whole period. It becomes copying notes, listening, and then rushing off. So even though we hear about exemplary methods, we don't really see them in action, and that makes it hard to understand how they should work practically."

Student Teacher 9:

"When we go to teaching practice, it feels like we are expected to perform something we have only read about in books. You are told to use group work, to make learners explore ideas, to assess their skills, but because we never saw the lecturers demonstrating these things, you end up doubting whether you are doing it the right way. Sometimes I felt embarrassed because I wasn't sure if the lesson was supposed to run like that. It's like having theory without real-life examples."

Lecturers themselves admitted and acknowledged the challenge in modelling these methods consistently:

Science Lecturer 3:

"We fully understand that we should be demonstrating the exemplary instructional methods that the curriculum expects the student teachers to apply. But the truth is that with our workload, the size of classes, and the content we are expected to cover, it becomes very difficult to model these methods every time we teach. Sometimes you want to do an inquiry activity to show them, but you look at the time, and you know it won't be possible. So, you resort to lecturing even though you know it is not ideal for their learning."

Science Lecturer 8:

"There are days when you really want to give a practical demonstration or involve the students in an investigation to show how the method works, but the timetable is very tight. You might have three classes back-to-back, and by the end, the easiest method is just to explain. So, although we value exemplary methods, the institutional structure doesn't always allow us to practise them."

The lack of consistent modelling limits opportunities for student teachers to observe how exemplary instructional methods and assessment unfold in authentic contexts. As a result, they enter teaching practice with theoretical understanding but limited practical exemplars to guide their instructional choices.

Large Class Sizes

Large class sizes in both teacher training institutions and secondary schools were identified as a significant barrier to implementing exemplary instructional methods. While large groups in the teacher training institutions hinder lecturers' ability to model exemplary instructional strategies, the overcrowded classrooms in secondary schools make it even more difficult for student teachers to practise these methods effectively. Student teachers described this challenge in depth as follows:

Student Teacher 7

"The class I was assigned to had about thirty-eight learners. When you think of doing group work or letting them do experiments it becomes a nightmare. You have groups squeezed together and sharing one book. Even if you try your best, you can't reach all the groups to give support, and the noise level becomes too much. At the end you realise that managing the class takes all your energy, so you just go back to lecturing because it feels safer and more manageable."

Student Teacher 2:

"In principle, inquiry-based learning is a very good approach. But try doing an investigation with thirty learners in a very small laboratory. You can't even move between the rows, and the learners don't have materials. Some groups will just sit waiting for you while others get frustrated. It becomes chaotic, and the learners lose focus. So even though you want to do what we were taught in college, the reality forces you to stick to old teaching methods so that the lesson can at least flow."

Lecturers also confirmed that large class sizes also limit their ability to model exemplary instructional methods:

Science Lecturer 4:

"When you are teaching over thirty student teachers in one lecture hall it becomes almost impossible to organise demonstrations or experiments. You want to show them how a particular investigation works, but there is no space or time to manage such a large group in an active lesson. This means that our teaching becomes more theoretical and that affects what student teachers can practise when they go into schools."

Large class sizes therefore undermine both the training and the implementation of exemplary pedagogies as they restrict experimentation, interaction, movement and opportunities for performance-based assessment.

Shortage of Resources

The shortage of resources emerged as another key barrier restricting the use of exemplary instructional methods and performance-based assessment. Science teaching especially when aligned with OBE, requires materials for experimentation, observation, measurement, and demonstration. However, student teachers reported that many of the schools where they were placed lacked the basic materials necessary to conduct even simple investigations. Student teachers emphasised how resource shortages forced them to abandon exemplary instructional methods:

Student Teacher 11:

"We were taught that science must be practical, but when we got to the school there were literally no resources. No chemicals, no measuring instruments and so on. You can't tell learners to investigate something when there is nothing for them to use. So, the lesson becomes just explaining and drawing diagrams. I felt frustrated because I wanted to use the methods we learned, but the environment did not support it."

Student Teacher 1:

"Even for basic activities, we didn't have materials. Things like beakers, Bunsen burners balances, starch solutions, even rulers sometimes were not available. And when there are over thirty learners and only one or two items you can't let them explore. So, you end up telling them what should have happened instead of letting them experience it."

Lecturers also lamented of resource shortages within the teacher training institutions and how it affected their instructional planning:

Science Lecturer 2:

"We also face shortages in the college. Sometimes you want to demonstrate an investigation or model an activity that they can repeat in the schools, but we don't have enough equipment. We may have only one set of apparatus for an entire class. That limits how much we can show them, and consequently how much they can practise later."

These shortages also compromise assessment practices. Performance-based assessment, practical tests and process evaluations require materials for learners to manipulate and without resources, assessments become limited to written tasks which contradicts the aims of Outcome-Based Assessment.

Pressure to Complete the Syllabus

The pressure to complete the syllabus was consistently identified as a major barrier on both the lecturers' and the student teachers' side. The time-intensive nature of learner-centred and inquiry-based teaching clashes with the demand for rapid coverage of content. This creates an environment where exemplary instructional methods are perceived as impractical or unrealistic. Student teachers described how this pressure affected their instructional choices:

Student Teacher 7:

"When you reach the school, the headteacher and the mentor immediately tell you that you must finish these topics before you finish your teaching practice. If you take time doing group work or investigations, you fall behind. So even if you want to do a learner-centred lesson, you stop yourself because you know you will be blamed for not finishing the work."

Student Teacher 14:

"Inquiry lessons take a long time and sometimes the school wants fast coverage. I tried doing an investigation in my first week and the mentor told me that I was wasting time and that the learners needed to move faster. After that I just lectured because I didn't want problems."

Lecturers also described suffering the same pressure at their institutions:

Science Lecturer 5:

"Our syllabus is packed. If we taught every lesson using exemplary instructional methods, we would not finish the content for the term. The system is structured around coverage rather than depth. Even though we want to model the methods for student teachers, the timetable pushes us toward more direct instruction."

This pressure limits opportunities for both exemplary instructional experimentation and the use of formative, process-based assessment as school administrators prioritise speed over depth.

DISCUSSION

The objective of the study sought to examine science lecturers' preparedness to support learning using exemplary science instructional practices that requires collaborative, inductive, and experiential learning in teacher preparation institutions in Botswana. The study also examined the completing preservice science teachers on their preparedness to teach using exemplary science instruction that requires collaborative, inductive and experiential learning. Data collected from the survey indicated most of the science lecturers were either adequately prepared (52.0%) or very well equipped (24.0%) to support student learning that required collaborative, inductive, and experiential learning. Cross tabulations of lecturers' views by institutions showed that lecturers across the three institutions felt similar in their preparedness to support learning that requires collaborative, problem-solving, and experiential learning. Kruskal-Wallis H test was used to test for differences in lecturers' preparedness to support student learning that requires collaborative, inductive, and experiential learning across the three institutions. Empirical evidence from the survey showed that science lecturers' level of preparedness to support student learning that requires collaborative, inductive, and experiential learning was similar across the three institutions. The lack of difference implies that the challenge may be systemic, pointing to a general need across institutions to strengthen opportunities that enhance preservice teachers' confidence and competence in implementing exemplary instructional methods.

Survey findings revealed that 25.0% of the lecturers surveyed received the professional development they needed to implement Outcome-Based Education (OBE) principles. 18.3% of the lecturers expressed satisfaction with the opportunities for professional development on Outcome-Based Education (OBE). Regarding lecturers' interest in pursuing professional development opportunities focusing on Outcome-Based Education (OBE), the study found that most of the lecturers (90.6%) responded in affirmative. Generally, the study found that even though lecturers reported being prepared to facilitate learning through exemplary science instruction such as collaborative, inductive, and experiential teaching strategies, their ratings of classroom instruction activities suggested that the use of exemplary science instruction were low. Specifically, there were little instructional activities that provoked critical thinking or that cultivated problem-solving skills in student teachers during their course of teacher preparation. The emerging picture from the findings pointed to the fact that instructional activities requiring the use of inductive methods were used only occasionally. This finding affirms the *UNICEF Teachers for All: Botswana Report* (2024), which indicated that novice teachers in Botswana struggle to apply the pedagogical tools and approaches emphasized during their preservice science teacher education. Similarly, Moyo and Mwanza (2025) found that most newly trained teachers failed to engage learners in activities that promote critical thinking and problem-solving. The limited modelling of exemplary science instructional approaches by science lecturers likely constrained preservice teachers' self-efficacy development contrary. The findings of this study reveal that the preparedness of both science lecturers and completing preservice science teachers is intricately connected to their levels of self-efficacy, as conceptualized by Bandura's (1977) Social Learning Theory and its concept of Self-Efficacy. This theory posits that individuals' confidence in their ability to perform specific tasks strongly determines the quality of their performance, particularly when facing complex, demanding situations such as implementing exemplary science instruction. This means that when lecturers themselves lack mastery in implementing exemplary teaching strategies, preservice teachers are deprived of meaningful modelling experiences, which weakens their belief in their ability to apply such methods effectively in their future classrooms.

Consistent with expectations, results revealed that only 27.2% of the preservice teachers felt adequately prepared and 20.7% felt very well prepared to teach using exemplary science instruction, while nearly half (52.1%) reported being minimally or not at all prepared. These findings indicate generally low levels of teaching self-efficacy among the student teachers, suggesting limited opportunities to gain mastery experiences, observe effective role models, or receive supportive feedback during training which are key factors that Bandura identified as sources of self-efficacy. The Kruskal-Wallis H test further revealed no statistically significant difference in preservice teachers' views about their preparedness to teach using exemplary science instruction across the three institutions, $\chi^2(2) = 0.370$, $p = 0.831$. This suggests that preservice teachers, regardless of institutional affiliation, shared similar perceptions of low preparedness. The inadequate preparedness of science lecturers in modelling exemplary instructional practices limits preservice teachers' access to mastery and vicarious learning experiences which in turn constrains their own preparedness and confidence to teach effectively. These findings are consistent with research showing that when teacher educators lack the confidence and capacity to model exemplary instructional practices, preservice teachers fail to develop the competence needed to apply them in real classrooms. Loughran et al. (2008) and Zeichner (2010) emphasize that bridging the theory-practice divide requires intentional modelling and opportunities for guided reflection, while Nilsson and Karlsson (2019) similarly found that preservice teachers struggle to adopt inquiry-based or constructivist approaches when these are not demonstrated by their lecturers. Canrinus et al. (2017) also confirmed that preservice teacher self-efficacy develops most strongly through observation, practice, and mentorship in authentic teaching contexts. Correspondingly, this study's finding that differences in preservice teachers' preparedness across institutions were statistically insignificant aligns with prior research showing that self-efficacy depends more on the quality of experiential learning than on the institution. Mangope and Mukhopadhyay (2015) and Windschitl et al. (2018) report that preservice teachers who participated in hands-on, inquiry-based methods courses and sustained practicum experiences developed stronger self-efficacy and overcame initial teaching anxiety. Likewise, Koosimile and Suping (2011) found that preservice teachers' confidence and preparedness were shaped primarily by engagement in authentic, practice-oriented learning opportunities. These results reinforce that self-efficacy and consequently preparedness can only be enhanced through meaningful, structured, and reflective teaching experiences supported by capable mentors. Therefore, the limited mastery of exemplary science instructional activities among preservice teachers can be attributed to lecturers' insufficient self-efficacy and modelling, which weakens the transmission of exemplary pedagogical practices. Strengthening the self-efficacy of both science lecturers and preservice science teachers through professional development, mentorship, and authentic practice opportunities is thus essential for improving overall preparedness and ensuring the effective implementation of Outcome-Based Education (OBE) principles in Botswana's science classrooms.

Converging evidence from interviews and focus groups provide deeper insight into why lecturers' reported preparedness did not translate into consistent instructional practice and why preservice teachers reported low preparedness. Student teachers also repeatedly described a lack of observable modelling of exemplary instructional methods during coursework. As one student teacher stated, *"We spend a lot of time learning about all these different exemplary instructional approaches… but when you look at how most science lessons are taught in the college, the lecturer just comes in and talks for almost the whole period."* This inconsistency between espoused pedagogical knowledge and enacted practice helps explain the low frequency of exemplary instructional activities that promote critical thinking and problem-solving in student teachers' lessons. Lecturers themselves acknowledged systemic constraints that limited their ability to model exemplary instructional practices. One lecturer explained, *"With our workload, the size of classes, and the content we are expected to cover, it becomes very difficult to model these methods every time we teach."* Such accounts suggest that lecturers' sense of preparedness may be rooted in theoretical understanding rather than sustained pedagogical enactment, thereby limiting preservice teachers' access to mastery and vicarious learning experiences that build self-efficacy.

Large class sizes and shortages of teaching and learning resources further compounded these challenges, particularly during teaching practice. Student teachers described overcrowded classrooms and limited materials as forcing them to abandon inquiry-based and collaborative methods in favour of lecture-based instruction. As one student teacher noted, *"At the end you realise that managing the class takes all your energy, so you just go back to lecturing because it feels safer."* These experiences directly align with the findings from the survey that inductive and experiential instructional activities were used only occasionally. In addition, the pressure to complete the syllabus emerged as a critical factor shaping instructional decision-making. Both lecturers and student teachers reported that learner-led and inquiry-based approaches were perceived as time-consuming and incompatible with expectations for rapid content coverage. One student teacher stated, *"If you take time doing group work or investigations, you fall behind… so even if you want to do a learner-led lesson, you stop yourself."* This pressure helps explain the limited use of exemplary instructional practices, despite their centrality to OBE principles. Taken together, the triangulated narrative evidence from interviews with science lecturers and focus group discussion with student teachers provide a coherent explanation for the apparent contradiction between lecturers' reported preparedness and the limited enactment of exemplary instructional practices. The barriers identified operate systemically, constraining lecturers' capacity to model exemplary practices and limiting preservice teachers' opportunities to develop confidence and competence in implementing them.

CONCLUSION

The study concluded that science lecturers were adequately prepared to support student learning through exemplary instructional methods that requires collaborative, inductive and experiential learning. However, although science lecturers reported being adequately prepared, they still expressed strong willingness to pursue professional development opportunities focusing on exemplary science instructional practices. The implication of these findings is that there is still need for targeted professional development related to exemplary instructional methods. The study however cautions that a mere expression of preparedness by lecturers does not necessarily translate into practice. The study also concluded that even though lecturers reported being prepared to facilitate learning through exemplary instructional methods such as collaborative, inductive and experiential teaching strategies, their ratings of classroom instructional activities suggested that the frequency of using those methods were low. There were little instructional activities that provoked critical thinking or that cultivated problem-solving skills in student teachers during their course of teacher preparation. It is therefore argued in this study that the reported lack of practice of inductive and other methods could be a result of lecturers not frequently using these methods during teacher preparation. These conclusions are supported by the emic perspectives which revealed that large class sizes, heavy workloads, limited teaching and learning resources, and pressure to complete the syllabus constrained lecturers' ability to consistently model exemplary instructional methods, often resulting in reliance on lecture-based instruction despite an awareness of the value of collaborative, inductive and experiential learning. The study therefore concluded that there was a persistent presence of lecturer-led instructional practices that left little or no room for innovation and which did not guarantee implementation of exemplary instructional methods in practice as demanded by the Education and Training Sector Strategic Plan (ETSSP 2015–2020). Final-year student teachers were found to be minimally prepared to teach using the exemplary instructional methods through collaborative learning, inductive learning and experiential learning. The study concluded that student teachers were rarely engaged in inductive instructional activities related to critical thinking. The study therefore concluded that student teachers were mostly engaged in teacher-directed instructions and activities and this largely implied that the science lecturers did not model exemplary instructional methods in teacher preparation. This conclusion is further reinforced by explanatory evidence showing that preservice teachers experienced uncertainty and low confidence during teaching practice because they were expected to implement instructional approaches they had learned theoretically but had rarely observed in practice and that limited their opportunities to apply exemplary instructional methods effectively.

RECOMMENDATIONS

The study recommended the following:

1. Develop and effectively implement targeted professional development programs that enhance teachers' skills and knowledge in science teaching using exemplary instructional methods that include collaborative, inductive and experiential learning methods. Such professional development should prioritise opportunities for both preservice teachers and in-service teachers to engage in hands-on practice, reflection, and feedback to strengthen mastery experiences which are central to the development of teaching self-efficacy.

2. Establish continuous mentorship programs where experienced science teachers can guide less prepared and novice teachers to foster collaboration among teachers in sharing their best practices and resources in schools. These mentorship and peer-support arrangements should include structured peer observation and co-teaching opportunities to provide vicarious experiences, allowing less experienced teachers to observe exemplary instructional methods in authentic classroom contexts and build confidence in applying them.

3. Explore the integration of cutting-edge digital tools and platforms to support immersive learning that can enhance science teaching and learning. The use of digital platforms can create supportive instructional environments that enable collaborative learning, simulation-based experimentation, and ongoing feedback, thereby reinforcing teachers' self-efficacy through social persuasion and sustained instructional support.

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