Exploring the impact of co-teaching biological science modules at the University of Namibia at Hifikepunye Pohamba campus: An autoethnographic inquiry

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Abstract
This study was aimed at exploring the impact of co-teaching biological science's modules at the University of Namibia, Hifikepunye Pohamba campus. The main objective of the study was to contribute to the field of education by enhancing the understanding, implementation, and the impact of co-teaching practices of biological science modules at the University of Namibia, Hifikepunye Pohamba campus. This paper was governed by the autoethnographic inquiry by employing three prominent educational theories: Constructivist Theory, Social Learning Theory, and Collaborative Learning. The population of this study was secondary level lecturers teaching biological science subjects and all secondary level students who were registered in the biological sciences' modules at the University of Namibia, Hifikepunye Pohamba campus. The sample of this study consisted of two (2) Secondary level lecturers who were co-teaching biology modules (introduction to genetics and structural biochemistry) at the University of Namibia, Hifikepunye Pohamba campus and ten (10) secondary level students (registered for Bachelor of Education Honours degree), five (5) from introduction to genetics and five (5) from structural biochemistry modules. The two lecturers were selected by purposive sampling, while the ten secondary level students were selected randomly, Face to - face, interviews were used to collect data from the study participants. Subsequently, qualitative data from interviews were transcribed and organised into themes. The study found that, co-teaching enhanced subject integration of knowledge as it has been confirmed by both teachers and learners in the two subjects: introduction to genetics and structural biochemistry where co-teaching was done. In addition, the findings established that, co-teaching lead to enhanced student learning and understanding by providing diverse instructional strategies and perspectives. Furthermore, the findings indicated that, co-teaching help co-teachers to develop a positive working environment through trustworthiness and accountability. Finally, identifying and addressing the challenges associated with co-teaching such as misunderstandings, different teaching methodologies, time management and conflicts among co-educators might inform better implementation and support systems for co-educators. For co-teaching to be effective, it is proposed that co-teachers should establish regular planning meetings and use collaborative tools such as shared documents and calendars to facilitate coordination. The study recommends the University Management to implement a robust system for evaluating co-teaching practices through observations, student feedback, and co-teacher's self-assessments and use data from evaluations to inform decisions on co-teaching practices. By implementing these recommendations, co-teaching practices of biological modules might effectively be employed at the University of Namibia at large.

Keywords: *co-teaching, autoethnographic inquiry, collaborative teaching, impact*

Background of the study

Co-teaching or collaborative teaching occurs when two or more educators collaboratively design a learning environment with shared planning, instruction, and assessment for students preferably in the same module (Rooks et al., 2022). According to Haag et al. (2023), co-teaching is a term that can be used in many ways and various terminologies may be used to describe co-teaching. For example, collaborative teaching, team teaching, partnered teaching and paired teaching. Studies done by different researchers elsewhere, showed that, co-teaching might benefit students in different fields by gaining more assistance with content, problem solving and perspectives from different disciplinary knowledge (Rooks et al., 2022). However, a little has been done on the impact of co-teaching at tertiary level in most of the studies, only from kindergarten to senior secondary level (Katukula, 2018; Liswaniso, 2019; Morelock et al., 2017). The University of

Namibia has restructured and reformed the curriculum to meet the dynamic needs of the stakeholders in education. However, most of the biological science modules are congested with content that need re-orientation. In this study, the two lecturers for Introduction to genetics and Structural biochemistry explored the impact of co-teaching and how it helped them in overcoming the congested curriculum. Some biological science modules require co-teaching, because they are a combination of different core subjects like biology and chemistry (Structural Biochemistry), integrated Natural Sciences (Biology, Chemistry and Physics).

The researchers are lecturers at the University of Namibia (UNAM), Hifikepunye Pohamba (HP) campus. They have for the past 2 years been involved in co-teaching or collaborative teaching and they have been co-teaching two modules namely, Introduction to Genetics and Structural Biochemistry. In this study, they share their reflexive praxis by means of autoethnographic inquiry about the issue of co-teaching as similarly done by other educators (Chang, 2018; Chanmugam & Gerlach, 2013; Fateye et al., 2022; O'Reilly, 2016).

Problem statement

Many tertiary institutions and the University of Namibia is no exception, are slowly transforming into a new curriculum, with newly acquired semester modules that have congested content especially, in the School of Science. The University of Namibia, specifically the Hifikepunye Pohamba Campus, has implemented a co-teaching approach in its biological science modules in order to improve educational results. Although co-teaching and collaborative teaching approaches are being used more frequently in educational settings globally, there is a lack of research on how these approaches are being implemented and their effects on higher education institutions in developing countries, including Namibia (Fateye et al., 2022). Despite the recognised theoretical benefits of co-teaching, there is a lack of comprehensive research evaluating its impact on the teaching and learning of biological science modules in higher education such as UNAM, that is, empirical evidence regarding its effectiveness in biological science modules remains limited. There is a paucity of data on the impact of co-teaching at the University of Namibia. Although co-teaching is a common practice at the University of Namibia, to the knowledge of the researchers, there are no documented reports indicating the impacts of co-teaching in Namibia. This study was therefore carried out to assess the impact of co-teaching, particularly of the two modules biological science modules, Introduction to genetics and Structural Biochemistry.

Objectives of the study

The objectives of this study were:

1. To define co-teaching and learning paradigm.
2. To showcase how co-teaching of teacher-educators is impacted in terms of area of expertise.
3. To qualitatively delineate how the learning of the students is supported by this paradigm.
4. To outline the relationship between subject-content orientation and co-teaching methods.

Significance of the study

The significance of this study lie in its potential to contribute valuable insights and practical implications to the field of education, particularly in the context of higher education in developing countries, such a Namibia. This study aims to add to the body of knowledge on co-teaching by providing context-specific insights from the University of Namibia, Hifikepunye Pohamba Campus, thereby enriching the global understanding of co-teaching in diverse educational environments. By exploring the implementation of co-teaching in biological science modules, the study might offer practical insights into how these strategies might effectively be applied in higher education settings. Furthermore, the study might highlight how co-teaching impacts the professional development of teacher-educators, enhancing their instructional practices and subject-matter expertise. Moreover, insights into the benefits and challenges of co-teaching would inform teacher-educators on how to engage in effective collaborative practices, fostering a culture of mutual learning and support.

Theoretical framework

The study's theoretical framework was based on three prominent educational theories: Constructivist Theory, Social Learning Theory,

and Collaborative Learning Theory. These theories established a basis for comprehending how co-teaching and collaborative teaching might improve the learning experiences and results for students in biological science modules at UNAM.

Constructivist Theory

Constructivism asserts that individuals acquire knowledge by actively constructing it through their personal experiences and interactions with the surrounding environment. Piaget (1954) emphasised that learning is a dynamic process in which learners actively construct new information and understanding based on their existing cognitive framework. Vygotsky (1978) expanded on this notion by introducing the concept of the Zone of Proximal Development (ZPD). According to Vygotsky, learners can attain greater levels of comprehension when they get direction and assistance from someone who possesses more information, such as a teacher or a peer. In co-teaching, constructivist concepts are put into practice using active learning tactics, hands-on activities, and collaborative problem-solving projects. Co-teaching facilitates the use of various teaching methods, allowing teachers to effectively support and guide learning experiences. Through collaboration, educators may establish a stimulating educational setting that fosters student curiosity, inquiry, and active involvement with the subject matter.

Social Learning Theory

Social Learning Theory, as established by Bandura (1977), highlights the significance of observational learning, imitation, and modelling. According to this theory, individuals acquire knowledge by observing, imitating, and modelling the behaviours, attitudes, and emotional responses of others. Within a co-teaching environment, students gain advantages by witnessing the cooperative exchanges between educators, which serve as an exemplar for proficient communication, resolving issues, and analytical reasoning. The inclusion of many educators in the classroom offers students a diverse range of role models and teaching approaches, hence augmenting their capacity to comprehend and employ novel concepts. In addition, the social interactions that naturally occur in co-teaching foster a supportive learning atmosphere in which students feel at ease to actively engage and participate.

Collaborative Learning Theory

The theory of Collaborative Learning posits that the most efficient way of learning occurs when individuals collaborate towards a shared objective (Dillenbourg, 1999). This hypothesis is based on the concept that social interaction is crucial for cognitive growth and that learning is a social phenomenon. Co-teaching facilitates collaborative learning by providing students with opportunity to engage in cooperative work in pairs or small groups. Teachers have the ability to create collaborative assignments that necessitate students to exchange their knowledge, engage in discussions about various viewpoints, and work together to solve challenges. This method not only improves students' comprehension of the subject matter but also fosters the development of crucial social and interpersonal abilities.

Application of Theoretical Framework

The incorporation of Constructivist Theory, Social Learning Theory, and Collaborative Learning Theory into the co-teaching approach at the University of Namibia, Hifikepunye Pohamba Campus, offers a strong framework for improving educational results. By utilising these three theories, this study was seeking to:

Improve student engagement and learning outcomes: Co-teaching methodologies grounded in constructivist principles will foster active involvement and facilitate a more profound comprehension of biological scientific subjects. The classroom environment, characterised by collaboration and assistance, will enhance students' motivation to actively interact with the topic.

Enhance professional development for educators: Teachers will get advantages from the collaborative teaching approach through the exchange of expertise, mutual learning, and improvement of their instructional practices. This is consistent with the ideas of social learning and collaborative learning, which encourage ongoing professional development.

To overcome implementation issues, it is important to have a deep understanding of the theoretical principles behind co-teaching. This knowledge will enable educators to recognise and effectively deal with potential obstacles, such as disparities in teaching methods or classroom control. Using these three theories, educators can formulate efficient techniques to facilitate fruitful collaboration.

Literature review

Understanding the impact of co-teaching is crucial given its growing adoption in higher education institutions and the significant resources required for its implementation (Zach & Avugos, 2024). Despite its increasing popularity, there is a need for a comprehensive examination of its effectiveness in improving educational outcomes. This literature review aims to explore the current body of research related to the impact of co-teaching on various aspects of the educational process, including student academic performance, engagement, teacher professional development, challenges and the overall classroom environment.

The impact of co-teaching biological science modules

Increased student engagement

According to Zach and Avugos (2024), co-teaching and collaborative teaching in higher education emphasizes the importance of collaboration among instructors in promoting student-centred learning environments and fostering active engagement. Previous studies have highlighted the benefits of co-teaching in various disciplines, including increased student participation, improved academic performance, and enhanced critical thinking skills. In the field of biological science education, collaborative teaching models have been shown to facilitate deeper learning, interdisciplinary connections, and the development of scientific inquiry skills (Buckingham et al., 2021; Simpson Steele et al., 2021).

In a more recent study that was carried out by Haag et al. (2023), the results of the study showed increased student engagement, that is, co-teaching promotes active engagement among students by providing opportunities for interaction, discussion, and collaboration. Students reported feeling more motivated and involved in their learning when exposed to multiple teaching styles and perspectives. Given the findings above, the study planned on exploring benefits of co-teaching the two biological science modules, to see if they might also contribute to increased student participation, improved academic performance, and enhanced critical thinking skills and to explore whether the selected students from Hifikepunye Pohamba campus also experienced similar effects.

Enhanced learning outcomes

In a study carried out at the University of Calgary by Lock et al. (2017), it was found that co- teaching can lead to improved academic performance and mastery of course content. Lock et al. further reported that, by incorporating diverse instructional strategies and approaches, co-teachers could cater to the diverse learning needs and preferences of students, resulting in deeper understanding and retention of material. Hence, the current study aimed to investigate some of these impacts and see if they were the same as the ones experienced by the participants that took part in a study that was done by Lock et al. (2017).

Opportunities for professional development

Moreover, Stortenbecker (2021) carried out a study at North-western college to assess the effectiveness of co-teaching and reported that co-teaching may provide opportunities for professional growth and collaboration among educators. In the same study, it was found that co-teachers engage in collaborative planning, curriculum development, and instructional design, allowing them to share expertise, exchange ideas, and learn from each other's teaching practices. In addition, this collaborative professional development enhances teaching effectiveness and fosters a culture of continuous improvement because educators benefit from shared expertise and collaborative planning, leading to professional growth and innovation in teaching practices (Bacharach et al., 2008). Thus, co-teaching can ensure effective comprehensive and continuous professional development among the co-educators when it is done properly.

Effective classroom management and behaviour support

Also, Rooks et al. (2022) explained that co-teaching can lead to more effective classroom management and behaviour support. With two instructors present, classroom routines and procedures can be implemented more smoothly, and disruptions can be addressed promptly. Co-teachers can also provide additional support and encouragement to students, leading to a positive and inclusive learning environment. Additionally, teachers can model positive behaviour and collaboration for students, that is, by seeing adults work together respectfully and effectively can influence students to mirror these behaviours (Rooks et al., 2022). Hence, this study aimed to explore how co-teaching

can impact classroom routines and procedures and discover how lecturers can model positive behaviour and collaboration in students.

Greater job satisfaction and professional fulfilment among educators

Similarly, Bacharach et al. (2007) and Morton and Birky (2015) found that co-teaching can lead to greater job satisfaction and professional fulfilment among educators. Co-teachers often report feeling more supported, valued, and empowered in their roles, as they work collaboratively to meet the needs of their students and achieve shared instructional goals. It was hoped that this study might identify whether co-teaching by lecturers might lead to greater job satisfaction and professional fulfilment among educators.

Challenges and limitations

Despite its benefits, co-teaching also presents several challenges. Logistical issues, such as coordinating schedules and aligning teaching methods of co-educators can be a challenge and may hinder the effective implementation of co-teaching (Katukula, 2018). Katukula further explained that potential conflicts or misunderstandings could result from challenges caused by not clearly defining the roles and responsibilities of each teacher. Studies by Morelock et al. (2017) and Ricci and Fingon, (2018) highlighted the fact that, inadequate financial resources and technological support to support co-teaching at universities can hamper the effectiveness of the co-teaching process. Furthermore, resistance to change from traditional solo-teaching methods can hinder the successful implementation of co-teaching.

Moreover, biology and chemistry often have distinct teaching styles. Biology may emphasize hands-on experiments and fieldwork, while chemistry focuses on theoretical concepts and laboratory techniques. This can create a mismatch on how content is delivered (Thomas & Harden, 2008). As a result, students often struggle to see the connections between biology and chemistry, treating them as isolated subjects. This can hinder their ability to understand complex scientific concepts that require an interdisciplinary approach. In addition, with two subjects to cover, there is a risk of either overwhelming students with too much content and assessments or not covering enough depth in either subject (Morelock et al., 2017). According to the findings from the studies above, this study considered exploring whether the selected participants at Hifikepunye Pohamba campus also encountered the same challenges and limitations. The study was therefore conducted so that recommendations can be made, to ensure the effective implementation of co-teaching biological modules and sensitize educators on some challenges facing this practice so that these challenges can be overcome in the future.

Methodology

Research design

The study employed qualitative research in the form of autoethnographic. The inquiry approach was used to collect information through interviews, using open-ended questions. According to Bell (2010) autoethnographic research is where personal experiences are used by the researcher(s) to interpret and describe practices, cultural texts and beliefs. The researcher(s) is the subject of the research itself; such personal experiences are immersed with political or cultural norms as well as expectations. In this study, the two lecturers who were co-teaching at HP Campus used their personal experiences to interpret and describe their practices. Autoethnographic inquiry is embodied by reflexivity praxis where intersections between the self as a researcher and social life are distinctly considered. In this study, the two lecturers who were co-teaching biology science modules (introduction to genetics and structural biochemistry) shared their reflexive praxis by means of autoethnographic inquiry about the issue of co-teaching.

Autoethnographers aim to figure out what to do, how to live, and what are the pros and cons of living and what do to. Moreover, autoethnographic research is a method that engages the individual in cultural analysis and interpretation. Where individuals construct knowledge based on life experiences discourse (Poulos, 2021; Tarisayi, 2023; Wall, 2006). Autoethnographic research is crucial in educational settings as it draws on the concept of conscientization, which involves the individual becoming aware of one's position and creating a space to change the perception of the resultant reality. For a theory to find its place in educational setting, it must inevitably have practical value that is constructed from personal experience (Poulos, 2021). Thus, autoethnographic as a mode of inquiry in this

study plays a tantalizing role in analysing the impact of co-teaching in biological science modules at the University of Namibia, Hifikepunye Pohamba campus.

Population

The population of this study was all secondary level lecturers teaching biological science modules and all secondary level students who were registered in the biological sciences modules at UNAM, HP Campus.

Sample and sampling procedure

The sample for this study consisted of two (2) Secondary level lecturers who were co-teaching biology science modules (introduction to genetics and structural biochemistry) at UNAM, HP campus and ten (10) secondary level students (registered for Bed Hons degree), five (5) from introduction to genetics and five (5) from structural biochemistry modules at UNAM HP Campus. The two lecturers were selected by purposive sampling, while the ten secondary level students were selected randomly. Both the lecturers and the students were from UNAM, Hifikepunye campus, situated in Ongwediva, Oshana region.

Research instruments

An open- ended interview instrument was used to collect data in this study. An open-ended interview was carried out with student teachers who were registered in the Introduction to genetics and Structural Biochemistry, to reflectively discuss their experiences of co-teaching of the modules by their lecturers. On the other hand, a narrative interview was carried out with the two Biology lecturers with the aim to gathering data on an individual's particular experiences on co-teaching, by asking them questions designed to have response in a narrative or a summary of events that were bound together by a common theme or meaning, which was the impact of co-teaching biological science modules at the University of Namibia, HP campus.

Data collection procedure

The researchers obtained the ethical clearance certificate from the University of Namibia Decentralized Ethics Committee (DEC) to carry out the study. After having obtained permission, the researchers, being the lecturers who were co–teaching biology science modules (introduction to genetics and structural biochemistry) then shared their reflexive praxis by means of autoethnographic inquiry on their experiences on co–teaching the two biological modules. Another lecturer who was not involved in the co-teaching of the two biological modules (and as such was not a participant) then had an interview with (10) students who were part of the two co-lecturers' class. The interview schedule contained questions on the experiences and perceptions of the students on co-teaching of the two biological science modules (introduction to genetics and structural biochemistry) by the two lecturers.

Data analysis

In this study, data analysis involved several steps as stipulated below, to ensure a thorough and nuanced understanding of the co-teaching process:

Thematic analysis: This was applied to discern, examine, and communicate recurring patterns (themes) present in the data. The data were coded, categorised into themes, and subsequently interpreted in connection with the study questions by the researchers (McAllum et al., 2019).

Narrative Analysis: The reflective diary from the lecturers and interview transcripts from both lecturers and student teachers went through a narrative analysis to create a comprehensive and complete record of the co-teaching experiences in the two biological science modules. This technique effectively emphasised personal narratives, first-hand encounters, and thoughtful contemplations that are fundamental to the autoethnographic method (McAllum et al., 2019).

Ethical considerations

Ethical considerations were paramount in this study. The Ethical clearance certificate was obtained from the University of Namibia Decentralized Ethics Committee (DEC). The researchers then used the obtained ethical clearance certificate to apply for a research permission letter from UNAM, the Centre of Research Services, to carry out the study. Through a consent letter, the researchers then obtained the participants' consent to take part in the research. Before data collection, the researchers clearly explained to the participants that participation in the study was strictly voluntary and the participants were assured of their rights to withdraw from this study anytime they wished to, without any

harm. To maintain the confidentiality of the participants, no names were written on the research instruments. The researchers used pseudo names instead of their real names. The data collected in this study were treated with utmost confidentiality as only the researchers had access to them. Data collected will be kept for three years after the completion of the study and thereafter, destroyed by erasing the hard drive and destroying the hard copies.

Results and discussions

This section presents and discusses the results, from interviews (with the students) and narrative interviews (with the lecturers). Data collected from the interviews were presented through discussions to highlight the different views shared by the participants. These discussions involved the participants' experiences in executing the co-teaching process. The specific objectives for the current study were attained through qualitative methodology, whereby, the data went through thematic analysis, and the outcomes were organized into 5 themes affiliated with the research objectives, namely:

1. Content orientation/area of expertise.
2. Interconnection and holistic understanding of different fields.
3. Student engagement.
4. Robust trustworthiness and accountability.
5. Switching between different teaching methodologies.

These themes are presented in the discussion section below after presentation of results. Subsequently, appropriate literature and the researchers' explanations and analyses were combined to support the identified themes in this section. Table 1 provides biographies of the study's participants.

Table 1: Biographical information of the participants

Participant	Gender	Position	Qualification	Working experience
A	Male	Lecturer	PhD in Chemistry(candidate)	20 years teaching experience
B	Female	Lecturer	Master in Biology	6 years teaching experience
C	Male	Student	B. Ed. (Honours)-year 2 in Structural Biochemistry	13 months relief teacher (Natural Sciences)
D	Female	Student	B. Ed. (Honours)-year 2 in Structural Biochemistry	None
E	Male	Student	B. Ed. (Honours)-year 2 in Structural Biochemistry	None
F	Female	Student	B. Ed. (Honours)-year 2 in Structural Biochemistry	8 months contract teacher (Maths)
G	Female	Student	B. Ed. (Honours)-year 2 in Structural Biochemistry	None
H	Male	Student	B. Ed. (Honours)-year 1 in Introduction to Genetics	None
I	Female	Student	B. Ed. (Honours)-year 1 in Introduction to Genetics	None
J	Female	Student	B. Ed. (Honours)-year 1 in Introduction to Genetics	10 Months relief teacher (Life Sciences)
K	Male	Student	B. Ed. (Honours)-year 1 in Introduction to Genetics	None
L	Female	Student	B. Ed. (Honours)-year 1 in Introduction to Genetics	None

In Table 1, the participants were allocated unique alphabetical letters identifiers ranging from A-L. Table 1 shows that both lecturers seemed to possess some knowledge of teaching and learning. However, only 3 out of 10 students had a bit of teaching experiences, which was understandable because most of the students enrolled in the two courses were directly from high school. Student teaching experiences is also important in terms of the integrated co-teaching setup of these two biological sciences. Thus, their responses were also compared to the autoethnographies of their respective lecturers. Table 2 shows the

autoethnographies of the two lecturers about their experiences on co-teaching.

Table 2: Autoethnographies for the two lecturers about their experiences on co-teaching

Lecturer	Narrative
A	"When I first started co – teaching (with my colleague) the two modules known as Introduction to Genetics for first year and Structural biochemistry for second year students, who are doing Bachelor of Education (Honours) at a secondary level, I was unsure of my readiness. The modules were being taught for the first time at University of Namibia in our department. However, upon embarking on the journey of co-teaching I have learned a lot namely: (1) When co-teaching with my co-lecturer, I had an opportunity to combine my area of expertise and knowledge of chemistry applications especially in structural biochemistry module and my co-lecturer has a strong foundation in biological processes, while I was able to interpret the chemical processes of these biological processes. (2) I have also learnt how to collaborate in sharing ideas with my co-lecturer as well as resources, such as how to set up tests, how to mark and assign a particular assignment to students. (3) I also had plenty of time to do research on those two subjects as I felt that my work was secured due to shared responsibilities in each module. (4) I was also motivated since each of us had different perspective of understanding, which makes our approach to students more interesting in terms of understanding the two modules. In total, I was fascinated by the whole notion of co-teaching, as all of us with my co-lecturer had the common goal and understanding of one another. This helped students to develop good skills in the area of communication, co-operation and fostering together as a team to form a positive environment for teaching and learning at University of Namibia, HP Campus.
B	"When the semester started, I was assigned to co-teach Structural Biochemistry, a new integrated science course that combined biology and chemistry. My co-lecturer is a seasoned chemist known for his rigorous and detailed lectures. I, on the other hand, was just a biologist with a passion for fieldwork and hands-on learning. We both understood the importance of our collaboration, yet we were unsure how to blend our distinct teaching styles and subject matter in teaching the above module. Our task was to create a cohesive curriculum that would engage students and highlight the interconnectedness of biology and chemistry. For instance, my co-lecturer would explain the biochemical pathways with precision, and I followed up by discussing how these processes are important in living organisms. The students seemed interested but somewhat overwhelmed by the switch between our teaching styles. At first, when we started with co-teaching, students were struggling to see the connections between the detailed chemical processes and their biological implications. To address this, we decided to incorporate case studies and real-world applications in our lessons. One successful example was a case study on DNA replication and protein synthesis. My co-teacher covered the chemical structure of nucleotides and the mechanics of DNA polymerase. I followed with the biological processes of transcription and translation, highlighting how these mechanisms ensure genetic continuity and expression. During a class discussion, a student named Alex (not a real name) asked a question that perfectly encapsulated our teaching goals: "How do the mutations in DNA at the chemical level affect the entire organism?" This question led to a deep and insightful discussion that bridged both our areas of expertise. It was evident that the students were beginning to see the interconnectedness of biology and chemistry. As the semester ended, we (co-lecturers) reflected on our journey, we faced numerous challenges but had grown as educators through the process. Our students had developed a more holistic understanding of science because of our co-teaching, appreciating how chemical reactions underpin biological functions. In our final lesson, we asked the students for feedback on co-teaching. Many expressed their appreciation for the integrated approach, noting how it had enriched their learning

	experience. One student remarked, "I never realized how much chemistry is involved in biological processes. This course has helped me see the bigger picture "Our journey of co-teaching had transformed our teaching practices, fostering a more integrated and dynamic learning environment. It also underscored the importance of collaboration and interdisciplinary learning in helping students appreciate the complexities of science. As we were planning for the next semester, we were excited to build on our successes and tackle new challenges together. Our partnership had shown us the power of combining different perspectives to create a richer and more meaningful educational experience."

Table 3 shows students' responses on their experiences and perceptions of co-teaching by the two lecturers.

Table 3: Students' responses

Students	What is co-teaching?	Do you like Introduction to Genetics/ Structural Biology being taught by two lecturers? Why?	What is your experience of being taught by two lecturers in this module?
C	"When two or more teachers teach one subject"	"Yes, it helps me to see diversity in teaching one module, in different topics"	"Interesting, each lecturer has a different personality"
D	"Is like what you did in Structural Biochemistry. Sharing topics to teach"	"No, too much difficult topics are covered in short period by each lecturer"	"Complexity, each lecturer wants things to be done based on his/her philosophy"
E	"To collaborate on one subject when teaching"	"Yes, Structural Biochemistry is complex and needs diversity of lecturers"	"Different areas are covered differently and each lecturers have a different pronunciation of biological terms"
F	"I think is to share responsibility in one subject"	"Yes, it helps us learning more variety of topics"	"I learn different methods of teaching and communication by my lecturers"
G	"Working together to attain common objective in each topic"	"No, each lecturer is different and might disrupt us, if one of the lecturers is rude, we might fail the module"	"Lecturers has different personality, which makes the module to be complex"
H	"When two lecturers are teaching one module"	"Yes, it helped me to see the interrelationship of biology and chemistry"	"It increases discussion in the class because we were always trying to connect biology and chemistry"
I	"When two lectures share a module"	"Yes, it helped me understand the module content better because of various teaching strategies used by two lecturers"	"It makes life easy because we had enough attention, when one lecturer is busy / not around the other, one was around"
J	"When a module is being taught by 2 lecturers"	"It helped me to think critically on how chemical reactions support biological functions"	"We felt motivated because every lecturer will teach us differently and push us to do our bests"
K	"When two lecturers work together to teach a	"No, it increased my workload because each lecturer came up	"Being exposed to two lectures gave us

	module"	with different tests"	confidence about the module because of their areas of expertise"
L	"Module being taught by two educators by dividing content among themselves"	"Somehow, switching from different lectures was a challenge, because they all teach differently but it made the modules interesting"	"Connecting biology and chemistry was a struggle at first but it got better with time"

From the reflective praxis of both lecturers A and B, and the responses from the 10 student teachers on their experience about co-teaching, five paradigms associated with co-teaching emerged which can be extrapolated as follows:

Content orientation/area of expertise: Co-teaching enhanced subject integration knowledge as both lecturers acknowledged an amalgamated knowledge in both introductions to genetics and structural biochemistry where knowledge was shared. Many of the studies postulates that co-teaching allows teachers to vary the content presented to students and aid in supplementing both lecturers' areas of strength and weaknesses (Katukula, 2018; Morelock et al., 2017; Sachs et al., 2011; Smith & Winn, 2017). This was also supported by students C, E, F, G and L's responses who emphasized issues such as accepting the demarcation of contents by different lecturers.

Interconnection and holistic understanding of different fields: Co-teaching supplements the vision of linkage between different fields of educational sciences hence chemistry and biological processes as reflected by lecturer B, such as how biological processes and chemical processes are connected. Based on Ricci & Fingon, (2018) co-teaching enables students to reckon interconnections between different fields of study in a given module to create a holistic view of the module. The interconnection also enables students in a mixed ability setting to augment the lesson link across different fields such as the relationship between biological processes and chemistry processes in one module. Although student D, felt that co-teaching covered a lot in a short period, the student was able to distinguish between the link of chemistry and biology in structural biochemistry where this student used the term "complexity of one link to another".

Student engagement: All students (C to L) acknowledged a fully alive participation and engagement in all biological science modules. Simpson Steele et al. (2021) postulate that co-teaching harnesses student participation during teaching as there is an involvement of different teaching abilities that aid in mixed ability classroom settings.

Robust trustworthiness and accountability: Both lecturers A and B, felt that when co-teaching, positive working environment attained as well as high motive as each lecturer is in account of the deeds. Chang (2018), Haag et al.(2023), Lock et al. (2017), Ricci & Fingon (2018) and Rooks et al. (2022) delineate that when teachers/educators are co-teaching, they develop a high sense of trusting each other as well as culminating in extrinsic motivation. Student I confirmed that co-teaching aim to help covering topics within a given time such that when one lecturer was not around the other might proceed to cover the content and this might build positive relationship among the co-teachers.

Switching between different teaching methodologies: Switching between different teaching methodologies in a co-teaching environment can have both positive and negative effects (Buckingham et al., 2021). In this study, student D and E said, "they sometimes got confused by the different learning methodologies of the two lecturers." Student L also mentioned increased workload and assessments. Both lecturers mentioned that "proper communication is key for effective co-teaching and to avoid misunderstandings". These findings are consistent with the research conducted by Rabin (2020) who noted that educators may have different teaching styles, philosophies, or personalities, which may lead to potential conflicts or misunderstandings.

Furthermore, the findings presented above aligned with the research conducted by Buckingham et al. (2021), which reported that students might become confused if the co-teachers have different expectations or if there was a lack of consistency in classroom management and instructional strategies. Bacharach et al. (2008) found that evaluating student performance can become more complicated when multiple teaching

methodologies are used, thus, teachers need to ensure that assessments are fair and reflective of all the methods employed, which can be challenging to design and implement. In the present study, the two lecturers indicated that co-teaching enabled them to share best teaching strategies, while, student F, K and I acknowledged having two lecturers as a way of motivating and enhancing their learning and engagement. These findings are supported by Stortenbecker (2021) who in his study indicated that, different methodologies could address diverse learning styles, allowing for a more inclusive and comprehensive learning experience. Stortenbecker further noted that variety in teaching methods can keep students engaged and interested, preventing monotony as well as encouraging active participation. These results also agree with Rabin (2020) who showed that teachers can learn from each other, adopting and refining new techniques that they may not have used before, thereby improving their overall teaching skills.

Conclusion

In conclusion, this study has shown that, co-teaching could enhance the learning experience but also come with unique challenges and considerations. This study showed that co-teaching could create a more dynamic, supportive, and effective learning environment, benefiting students, teachers, and the entire educational community. The participants highlighted some co-teaching benefits such as, content orientation/area of expertise, interconnection and holistic understanding of different fields, enhanced student engagement, robust trustworthiness and accountability, as well as switching between different teaching methodologies, which can have both positive and negative impacts.

According to the results of the current study, co-teachers can have different teaching styles, philosophies, or personalities, which may lead to potential conflicts or misunderstandings. The participants also indicated some of the challenges involved in co-teaching such as, increased workload and assessments as well as, confusions because of switching between lecturers' different teaching methodologies. On the other hand, it can be concluded from this study that, being exposed to different teaching methods could motivate and enhance students' learning and engagement, could address diverse learning styles and allows sharing of the best practices between co-educators. The participants further suggested that, for co-teaching to be effective, regular and open communication between co-teachers was essential to coordinate and align teaching methodologies effectively.

Recommendations

Based on the findings of the study, the following recommendations are proposed for ensuring that the implementation of co-teaching of biological science modules at UNAM, HP campus would be effective.

The university management should:

- Establish a clear framework that outlines the goals, models, roles, and responsibilities of co-teaching. This framework should include guidelines for planning, instruction, and assessment.
- Provide extensive professional development for co-teaching pairs like, training that should cover collaboration strategies, conflict resolution, differentiated instruction, and effective classroom management.
- Implement a robust system for evaluating co - teaching practices. This should include observations, student feedback, and co-teacher's self-assessments and use data from evaluations to inform decisions about co-teaching practices and professional development needs.
- Provide administrative support to handle logistical aspects, such as scheduling, room assignments, and resources allocation.

The co- teachers should:

- Establish and agree upon individual roles and responsibilities within the classroom, for instance, who will lead certain activities, how to share instructional time and how to coordinate and align teaching methodologies effectively.
- Schedule regular planning meetings to discuss lesson plans, students' progress, and any challenges to prevent misunderstandings and build a trusting partnership.
- Clearly communicate the benefits of co-teaching and provide students with a consistent structure, regardless of who is leading a particular session.
- Develop shared rubrics and grading criteria and regularly discuss student progress to ensure alignment in assessments.

- Co-teachers need to be highly coordinated by using collaborative tools such as shared documents and calendars to facilitate coordination, to ensure smooth transitions between methodologies because lack of communication and planning can result in disjointed lessons and ineffective instruction.

Recommendations for further research

- Because the study was limited to Hifikepunye Pohamba campus and biological science modules, further research at other UNAM campuses is recommended to broaden the understanding of co-teaching different modules at UNAM.

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