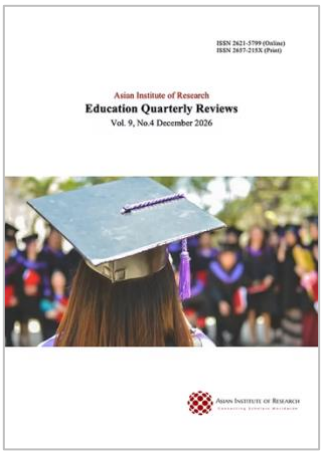


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Changes in Physics Student Teachers' Teaching Competencies Following Lecturer Feedback

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Abstract
This study examined changes in teaching competencies among physics student teachers following lecturer feedback during school-based practicum in Zambia. Guided by Hagger and McIntyre's model of teacher development and Vygotsky's social constructivist theory, a concurrent mixed methods design was employed. The sample comprised 25 fourth-year student teachers observed twice by five lecturers using a structured lesson observation rubric. Results indicated statistically significant improvements in selected domains, particularly teaching facilitation skills and methodology ($Z = -2.62$, $p = .009$, $r = .52$) and planning and preparation ($Z = -2.07$, $p = .038$, $r = .42$). For example, the use of teaching aids increased from $M = 2.60$ to $M = 3.16$. However, no statistically significant changes were observed in class management, communication skills, or knowledge of subject matter. Correlation analysis revealed strong relationships among competencies (e.g., $\rho = .63$, $p < .01$), suggesting interconnected development. Qualitative findings showed reduced feedback frequency over time but persistent challenges, particularly in teaching facilitation ($n = 31$) and class management ($n = 11$). The findings suggest that lecturer feedback is associated with improvements in observable teaching practices, while more complex competencies may require longer periods of development. The study highlights the need for extended practicum duration and sustained mentoring to support student teacher development.

Keywords: Lecturer Feedback, Mentor, Physics Education, School-Based Practicum, Teaching Competency, Zambia

1. Introduction

School-based practicum, is an important component of teacher education that bridges theory and practice while supporting student teachers' academic, personal, and professional development. During this period, host schools and university lecturers play a key role in guiding students, with lecturers providing constructive feedback on teaching methods, lesson delivery, and classroom management. The university evaluates student teachers during their school-based practicum using a rating rubric that covers key teaching domains of planning and preparation, teaching facilitation skills and methodology, class management and organisation, assessment, communication skills, knowledge of subject matter and professionalism. These domains align widely with recognised core teaching competencies, particularly those identified by González-Fernández et al. (2024). While the study focuses on classroom practices such as planning, methodology, communication, evaluation, and professionalism, the

González-Fernández et al framework includes additional dimensions like intercultural competence, innovation, and research, highlighting emerging aspects of teacher development.

This highlights the importance of the present study, as complexities in the acquisition and demonstration of teaching competencies remain evident. For example, Großmann et al. (2024) emphasise lesson planning as a multifaceted competence, while Kunter et al. (2013) call for more research into the developmental trajectories of teacher competencies. Li et al., (2024) argued that effective classroom management, particularly in large classes, is critical for creating an effective learning environment, yet pre-service teachers still find it challenging to acquire this competency through traditional methods of intervention.

Accordingly, this study situates the practicum as the key context of inquiry but defines its central problem as the development of teaching competencies and the role of lecturer feedback in that process. The significance of this investigation also lies in the recognition that, although the practicum is widely acknowledged as the "real interface between studenthood and membership of the profession" (Ranjan, 2013, p. 24), there is limited empirical evidence on how physics student teachers in Zambia develop these competencies during school-based experiences.

Although prior research (e.g., Al-Najjar et al., 2024) shows that practicum experiences enhance key teaching competencies, it remains uncertain whether similar improvements occur in Zambia given contextual constraints such as limited resources, large class sizes, and restricted access to technology. Addressing this gap is vital for strengthening teacher preparation and improving educational outcomes.

2. Context of school-based practicum in initial teacher education

Initial teacher education for science teachers in Zambia lasts four years and includes a three-month school-based practicum. During this period, student teachers gain experience in real classroom settings (Maxwell, 2013). However, this short practicum period may be insufficient for substantial development of teaching competencies. According to Linda Darling-Hammond et al. (2017), effective teacher development is a long-term, continuous process. Meaningful improvements occur over time and through ongoing engagement in teaching practice itself (Copur-Gencturk 2024).

In Zambia, initial teacher education programme for science teachers span four-year, with a three-month segment dedicated to school-based practicum Student teachers select the schools within Zambia where they will undertake their school-based practicum. This period serves as an opportunity for student teachers to continue learning how to teach in an already established teaching workplace (Maxwell, 2013). Improvements in teaching competencies may require more time than that afforded to student teachers during the practicum period. According to Linda Darling-Hammond et al. (2017), effective teacher professional development is a sustained process and meaningful changes in instructional practice cannot occur over a short timeframe. Additionally, Copur-Gencturk (2024) highlighted the significant potential for professional learning embedded within the act of teaching. This suggests that teachers continuously develop their knowledge and practice through the very process of teaching.

During the practicum, experienced teachers mentor student teachers while lecturers observe lessons, engage with school staff, and assess student performance using a five-point rating rubric. Student teachers gradually assume full professional responsibilities during their school-based practicum. This includes teaching, community service, and extracurricular roles. After about a month, they are expected to be familiar with school life, after which university lecturers conduct monitoring visits to their assigned schools.

Each student teacher is observed twice during this session. Therefore, there are two evaluations per student. The rating rubric ensures that student teachers are evaluated fairly based on predetermined criteria. In this case the focus is on the domains of teaching competency illustrated in Figure 1. Feedback is delivered through one-on-one discussion sessions. This allow student teachers to engage in reflective dialogue about their performance. Written feedback comments are also provided to student teachers, allowing them to revisit and reflect on the feedback at their own time.

3. Literature review

This section gives an overview of selected studies that have contributed to the current study. It comprises the following; school-based practicum, expected competencies, student teacher's lesson presentation and feedback after lesson presentation.

3.1. School-based practicum

School-based practicum is widely recognised as essential in teacher education, particularly in preparing workforce-relevant skills in a globalised context (Vidergor et al., 2018). However, its implementation varies across regions, with Europe emphasising research-based approaches and the USA adopting alternative models to address teacher shortages. Additionally, traditional linear models of teacher learning are criticised for oversimplifying the complex relationship between learning and practice (Li et al., 2023, p. 1).

In Zambia, the focus is on providing practical exposure to bridge the gap between theory and practice. This approach aligns with Toledo-Figueroa et al., (2017), who conceptualise procedural knowledge as "knowing how" and argues that it is most clearly demonstrated through its application in practice. Such knowledge is typically reflected in professional teaching standards within structured and observable domains, including lesson planning and instructional strategies. Similarly, Kakazu and Kobayashi (2023) highlight that school-based practical play a crucial role in helping student teachers recognise the practical significance of their university-based theoretical learning.

Therefore, heads of departments in schools hosting the student teacher take the role of mentors. School-based role of the mentor is a significant but often inadequately planned role and dialogues within mentoring lack depth and reflection (Dunne & Bennett, 1997). Therefore, promoting a genuine connection and creating a safe space for open dialogue could help enhance the mentoring relationship. This can lead to a more meaningful guidance for student teachers. Mentorship in this case is extended to include allowing student teachers to observe lessons being conducted by experienced teachers. Magaji and Ade-Ojo (2023) highlighted that observing experienced teachers and adopting their strategies could help enhance student teachers' teaching skills. By focusing on bridging the gap between theory and practice, fostering reflective practices, and encouraging active participation in observing experienced teachers, the mentorship process is expected to greatly enhance student teachers' professional growth and confidence.

Van Wyk and De Beer (2019) found that participation in a school community of practice enhances student teachers' content knowledge, pedagogical skills, and ability to apply theory. Similarly, Kakazu and Kobayashi (2023) emphasised that school-based practicum helps student teachers to think and act like professionals, while Leeferink et al. (2015) highlighted that practicum experiences are actively transformed into learning opportunities. Previous studies also show that student teachers play multiple roles in secondary schools and both contribute to school functioning and benefit from school-based training. For instance, Hurd (2008) found that student teachers have a modest impact on school performance and emphasised the importance of effective management by higher education institutions to maximise these benefits. Therefore, these studies underscore the critical role of school-based practicum in enabling student teachers to translate theoretical knowledge into practical teaching competence.

3.2. Expected competencies

Teacher training entails both orienting student teachers to the profession and developing important teaching skills. It includes the initial socialisation that happens when student teachers are exposed to the realities of classroom teaching and the school environment (Anderson & Stillman, 2010). It also focuses on the cognitive and emotional aspects of learning to teach (Brown et al., 2014). Therefore, teacher training should take a comprehensive approach to help student teachers acquire essential teaching abilities and competencies.

While this study focuses on student competencies outlined in the rating rubrics and aligned with those identified by González-Fernández et al. (2024) and Fitzsimons et al. (2024), the study still recognise that learning to teach

goes beyond a list of competencies. As Liu et al. (2017) observed, learning to teach extends beyond merely mastering a set of competencies. It involves the holistic development of students by encompassing their knowledge, experiences, beliefs and values. Specifically, this study uses seven domains of teaching competencies as the analytical framework for examining school-based practicum. Each of these domains is briefly outlined. This forms the basis of the rubric employed at the university. Each domain is briefly outlined below:

i. *Planning and Preparation*

This domain reflects a student teacher's ability to design lessons that align with the curriculum, set clear and measurable learning objectives, and prepare appropriate teaching aids. Therefore, effective lesson planning involves more than procedural design; it represents a pedagogical act that shapes instructional quality and student outcomes. Foregrounding pedagogy in lesson planning, supported by digital tools (Børte & Lillejord, 2024), promotes coherence, collaboration, and reflective inquiry (Großmann et al., 2024).

ii. *Teaching Facilitation Skills and Methodology*

This domain encompasses the pedagogical practices that teachers use to actively engage learners in class. It concerns the ability to student teachers to apply learner-centred pedagogies, promote inquiry, and adapt strategies to diverse learners. Therefore, teaching practicums are emphasised as crucial in bridging theoretical preparation with classroom realities (Grossman at el., 2009).

iii. *Class Management and Organisation*

This domain entails the teacher's ability to establish clear routines, articulate expectations for behaviour, and learning environment. Effective class management and organisation is often associated with structured routines, clear expectations, and well-organised learning environments that minimise disruptions and support engagement (Clark et al., 2023; Marder et al., 2023). Novice teachers, however, often feel underprepared in this domain (Shank & Santiague, 2021). Therefore, Class Management and Organisation is considered important in the rating rubric.

iv. *Assessment (learning/progress)*

According to Tai et al. (2022), assessment serves multiple purposes, including evaluating whether students have achieved the intended learning outcomes at the required standard. Within this framework, the ability to monitor and evaluate student learning is an important teaching competence. Assessment not only measures progress but also informs instruction, linking closely with planning and feedback practices. Therefore responsive assessment practices are central to meaningful learning (Schildkamp et al., 2020; Tai et al., 2022).

v. *Communication*

Communication is central to quality education, as it helps students understand what to learn, how to learn, how well they have learned, and how to improve further (Ley et al., 2019). Positive teacher–student communication, grounded in positive psychology and rhetorical–relational goal theory, enhances a range of academic outcomes (Xie & Derakhshan, 2021). This domain therefore encompasses clarity of instruction, effective questioning, and constructive feedback. Although feedback can improve achievement, its impact depends on how it is delivered (Ley et al., 2019; Mandouit & Hattie, 2023), underscoring the importance of including communication in the rating rubric.

vi. *Knowledge of Subject Matter*

Teachers must demonstrate mastery of knowledge of subject matter or content they teach. Teachers must demonstrate mastery of content and the ability to integrate this with pedagogical strategies to make learning accessible and meaningful (Shulman, 1987). Therefore, student teachers can improve their knowledge of subject matter over a short period. For example, Brownlee et al. (2017) noted that brief, targeted interventions can promote changes in student teachers' epistemic cognition.

vii. *Professionalism*

For student teachers on practicum, professionalism involves a commitment to ethical teaching practice, active collaboration with mentors and peers and ongoing professional growth. Therefore, ethical commitment, collaboration and reflective practice are integral to professional growth. Continuous professional

development has been shown to strengthen classroom management and engagement, though evidence on the most effective approaches remains mixed (Hirsch et al., 2021).

Collectively, these domains underscore the holistic nature of teacher preparation. They move beyond a checklist of skills to encompass the complex interplay of knowledge, pedagogy, ethics and reflective growth that defines effective teaching. Within this framework, the current study examines how student teachers demonstrate such competencies in practice during practicum and how lecturer feedback supports their development in a Zambian context. These issues discussed in this section highlight the necessity of conducting this study.

3.3. Student teacher's lesson presentation

Student teachers are encouraged to use diverse teaching methods to improve learners' comprehension and critical thinking. Fischer and Kauertz (2021) observe that physics teachers' competence goes beyond subject knowledge to include social and pedagogical skills needed for effective teaching, such as motivating learners. This highlights the need for a holistic approach in initial teacher education that equips student teachers with both content knowledge and interpersonal skills required to inspire learners in schools.

Struyven et al. (2010) found that student teachers' teaching methods are shaped by factors such as self-esteem, workload, and learning techniques, which vary across different teaching environments. They also observed that student teachers tend to adapt teaching strategies they previously observed and later incorporate them into their own practice. Similarly, Lindqvist et al. (2023) emphasize the important role of mentors in supporting student teachers through the complex and emotionally challenging aspects of work-based learning, recommending a stronger role for heads of department in developing key professional skills.

Further, it can be seen that while various teaching approaches are vital for improving learning, student teacher support systems are equally important. By offering more consistent and high-quality assistance, student teachers can be better equipped to fulfill the demands of the teaching profession and encourage professional progress. Therefore, experienced teachers can play an essential role in helping student teachers navigate the emotional complexities of teaching. This highlights the need for enhanced support structures in teacher education.

3.4. Feedback after lesson presentation

The role of feedback in supporting educational processes has been recognised by various scholars. Feedback has been recognised as a valuable tool for enhancing learning (Luchembe & Shumba, 2020; 2022). Nikoçeviq-Kurti and Saqipi (2020) emphasise that professional identity that includes teaching is shaped by various knowledge sources and feedback plays a critical role. Feedback enhances teaching practices, promotes teacher reflection and facilitates meaningful dialogue about classroom challenges (Mandouit, 2018). This aligns with Hudson's (2014) findings, which demonstrates how student teachers rely on their mentors' feedback for valuable guidance in improving their teaching.

During school-based practicum, university lecturers provide feedback that promotes reflection, motivates growth, bridges the gap between theory and practice, and is tailored to the specific teaching context. This is supported by Asregid et al. (2023), who showed that lecturer feedback must be structured to scaffold reflective practice if student teachers are to convert feedback into improved classroom performance.

Yee et al. (2022) found that pedagogical feedback incorporating contextualisation leads to greater improvements in student teachers' scores than feedback without contextualisation. Similarly, Talbot (2025) highlights that well-scaffolded practicum experiences support student teachers in constructing knowledge that bridges theory and practice, with reflective practice playing a key role in their development. In this context, lecturer feedback is expected to enhance these reflective and learning processes. Additionally, Tang & Zhan (2021) note that feedback also functions as a diagnostic tool for identifying learners' strengths and areas for improvement.

After observing a student teacher's lesson, the lecturer provides both oral and written feedback. According to Hudson (2014) and Schwartz et al., (2018), student teachers rely on this feedback for guidance on improving their teaching. As noted by Puttick and Wynn (2021), while much research focuses on post-lesson discussions, there has been little attention on written feedback. However, oral feedback is guided by written feedback, which can serve as a reference when providing oral comments. Therefore, in this study, written and oral feedback are considered as a unified activity.

However, the reception of feedback varies among learners. For example, Carless (2006) observed that "assessment process risk invoking negative emotions, which may form a barrier to learning from feedback" (p.229). This demonstrates that, learners with low self-esteem are more likely to interpret feedback as a personal critique, while those with higher self-esteem are more inclined to view it as constructive criticism from the lecturer. This also underscores the importance of investigating feedback provision when studying student teacher's school practicum.

3.5. Policies on Teacher Education

UNESCO (2016) highlights the need to "develop capacities at national and sub-national levels for monitoring and evaluation of teaching and learning processes, through improved teaching practice opportunities in pre-service programmes... (p. 23)" This observation emphasises importance of strengthening student teacher teaching practice through structured, supervised and reflective experiences to help improve teaching competencies and learning outcomes.

According to the Zambian Ministry of General Education (2019), teaching competence is a holistic integration of knowledge, skills, and professional dispositions organised into six key domains of practice, including areas such as culture, teaching and learning, and research. In addition, the Ministry of Education (2023) states that "the School Experience is an integral part of teacher preparation, offering student teachers the opportunity to immerse themselves in a real school environment. Student teachers shall be required to undertake school experience in the second and third years of their training. School experience shall last not less than one full School Term" (p.31). Although this extended school experience has not yet been implemented in many institutions, the Ministry emphasises its importance for strengthening student teacher competencies by bridging theory and practice during teaching practicum to improve teacher education quality in Zambia. However, higher learning institutions, including the one in this study, have not fully adopted this recommendation, as they still offer only a one-term practicum with just two lecturer observation sessions per student during the school experience period.

4. Theoretical and conceptual framework

This part of the study covers the underlying theories and the conceptual framework.

4.1. Theoretical framework

The theoretical framework for this research is grounded in Hagger and McIntyre (2006) and Vygotsky's (1978) social constructivist theory. Hagger and McIntyre identify three key processes in student teachers' school-based practicum: modelling, practice, and feedback, which help them develop both concrete and mental representations of effective teaching through observation and interaction with experienced teachers, including university lecturers. Practice provides opportunities to apply various teaching strategies in real classroom settings. In this case feedback supports pedagogical development by encouraging reflection and identifying ways to improve teaching practice. Vygotsky's (1978) social constructivist theory emphasises the importance of social interaction and collaborative learning. This theory considers learning as a socially mediated process where learners construct knowledge through interactions with more knowledgeable others, such as lecturers and mentors. In this case, lecturer feedback during school-based practicum serve as scaffolding that help student teachers to develop their teaching competencies.

Therefore, in this study, Hagger and McIntyre's (2006) model of teacher development and Vygotsky's (1978) social constructivist theory are used to examine how student teacher's lesson presentation change during school-based

practicum. By integrating practice and scaffolding, these frameworks provide a foundation for understanding university-based training and the demands of real-world classroom.

4.2. Conceptual framework

Figure 1 presents the conceptual framework guiding the study, grounded in Hagger and McIntyre's (2006) model. The model conceptualises lecturer feedback as a pedagogical tool that serves multiple roles across domains of teaching competencies, highlighting the interaction between lecturer and student teacher. This is further supported by Vygotsky's (1978) social constructivist theory, which emphasises mentorship and scaffolding in learning. This framework shows the interconnected relationship between university-based instruction, school-based experiences, and feedback mechanisms in shaping teaching competency development.

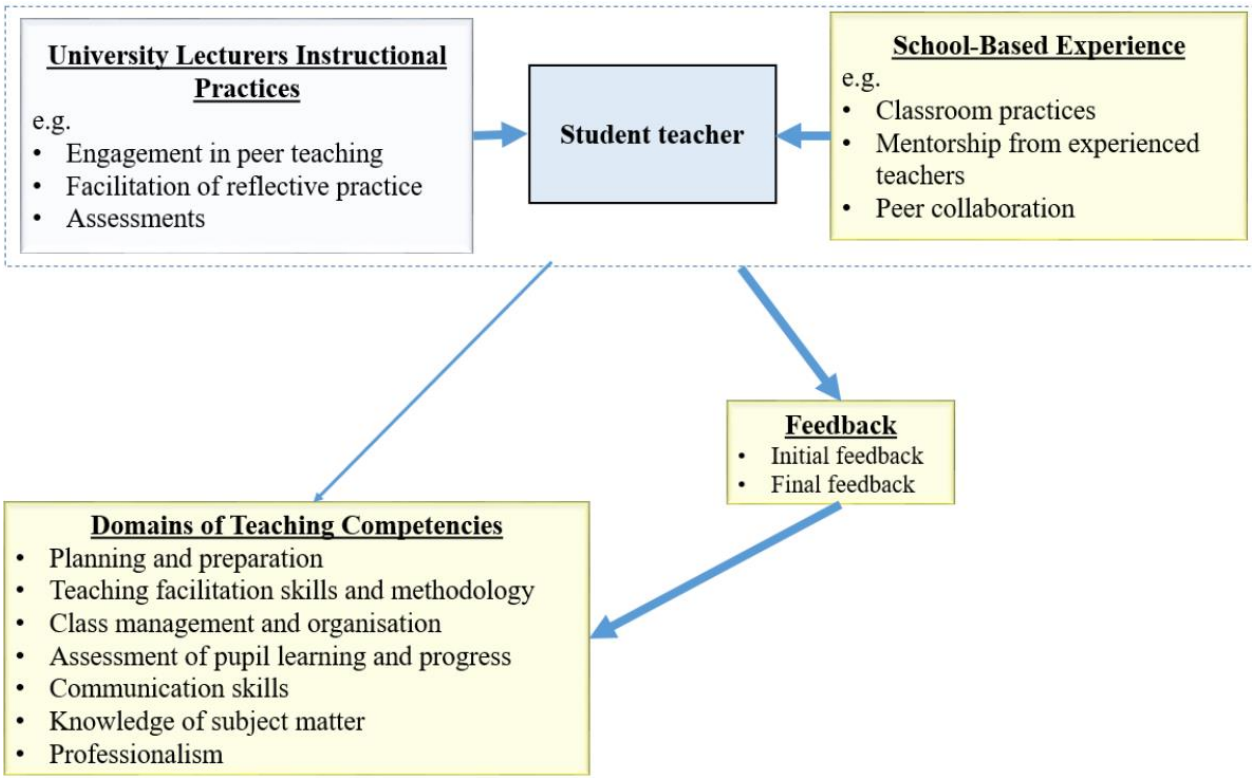


Figure 1: Conceptual framework for the study

ALT-text

A conceptual framework illustrating the relationship between university lecturers' instructional practices and school-based experiences in shaping student teachers' development across domains of teaching competencies. The model shows that university lecturers' practices, such as facilitating peer teaching, reflective practice, and assessments, interact with school-based experiences, including classroom practice, mentorship, and peer collaboration. These are associated with student teachers' competencies in planning, facilitation, classroom management, assessment, communication, subject knowledge, and professionalism. These are mediated by initial and final feedback.

The conceptual framework places the student teacher at the centre of professional development, shaped by interactions between University Lecturers' Instructional Practices and School-Based Practicum. Both contexts are supported by a feedback system that reinforces learning, with lecturer feedback occurring at initial and final stages. The framework further indicates that both university instruction and school practicum can directly contribute to the domains of teaching competency. It is the performance across competency domains that lecturers assess, score, and grade.

Therefore, student teacher's areas of growth listed in the domains of teaching competency is facilitated through mentorship, classroom practices, peer collaboration and facilitation of reflective practice in learners. This aligns with educational frameworks such as Hagger and McIntyre's (2006) model which highlights the importance of mentoring and practical experience in teacher education and Vygotsky's (1978) theory of social constructivism which focus on social engagement.

5. Problem statement

Teaching competencies are at the core of effective teaching as they shape the ability of student teachers to plan, deliver, and critically reflect on their instructional practices (Ministry of General Education, 2019). In the Zambian context, these competencies are assessed during teacher training in the school-based practicum, which provides an authentic setting where theoretical knowledge is applied in practice. Thus, while the practicum provides the **context**, the **central research problem** of this study concerns the development of *teaching competencies* and the role of lecturer feedback in supporting that development.

It should also be noted that, despite the recognised importance of practicum-based supervision in enhancing teaching competencies (Schwartz et al., 2018; Mulenga & Bwalya, 2022), challenges persist in specific competency domains such as classroom management, use of teaching aids, and instructional methodology. Literature has largely examined the role of feedback in shaping *general self-efficacy* or broad teacher confidence (Joo et al., 2018; Yurekli et al., 2020), but has paid limited attention to how **lecturer feedback contributes to growth in specific teaching competencies across multiple domains**.

6. Research questions

The study was guided by three research questions which were aimed at evaluating how science student teachers improve their lesson delivery after receiving feedback from their lecturer. The following are the research questions:

1. What changes are observed in the teaching competencies of physics student teachers following lecturer feedback during the teaching practicum?
2. What relationships exist among teaching competencies within each domain, and how do these interdependencies inform instructional development?
3. Which instructional challenges persist in student teachers' lesson delivery despite receiving lecturer feedback, and in which domains are these challenges most frequent?

7. Methods

The study employed a concurrent mixed methods design, consistent with the approach used by Birhan et al. (2021). This approach enabled the researchers to collect and analyse quantitative and qualitative data simultaneously. This method was use so as to provide a more holistic understanding of the role of feedback during student teacher practicum. This approach aligns with that of Zhang et al. (2025), who employed a small sample of 25 participants in their study

7.1. Study sample

This study was conducted in 2024 and five lecturers participated in the observation process. The study comprised 25 student teachers who were studying Bachelor of Education in physics. Of the 25 student teachers, 2 were female and 23 were male, with ages ranging from 22 to 26 years. These participants represented the **entire cohort of fourth-year physics student teachers** who were undertaking their school-based practicum. Therefore, a **whole population sampling** was used, since all eligible physics student teachers in the cohort were included. This ensured full representation of the group and avoided selection bias. The group was also chosen because one of the authors taught them a physics education course, which facilitated access and coordination during the study. Prior to participation, the students were briefed about the study and assured of confidentiality. Informed consent was obtained from all participants.

7.2. Data collection

The study collected data through class observations. These observations utilised a school of education designed tool called lesson observation instrument. The instrument consists of two sections: Section A features a five-point rating rubric, while Section B provides space for lecturers to write feedback comments. This instrument has been utilised at the university for the past 13 years. Over this time, the instrument has undergone several refinements to enhance its effectiveness.

The items on the rating rubric were based on the competencies outlined in Table 1. Two lesson observations were conducted for each student teacher. The first observation provided a baseline assessment and the second was conducted within two to three weeks of the initial observation in order to assess progress in response to the initial feedback. Therefore, the second observation allowed the lecturer to give a final performance rating and feedback in an authentic environment. These assessment processes were part of standard practicum requirements and were conducted independently of the research component.

Between these two observations, student teachers continued teaching physics lessons as part of their normal practicum responsibilities in their respective host schools. Student teachers continued having access to general professional support from the mentors. This support involved routine guidance related to lesson preparation, classroom management, and school procedures. The specific lesson topics taught during the two observations varied according to the school timetable and curriculum progression at the stage of the observation. These observations were conducted within comparable instructional contexts (e.g. government secondary schools, senior secondary school level, and all were physics lessons). In addition, the same lecturer observed and assessed each student teacher across both observation sessions. This approach was intended to reflect authentic teaching practice within the country's teaching practicum environment.

The observation of student teachers' lessons was conducted by lecturers assigned to assess students during the school-based phase of their Bachelor of Education in physics programme. Because the lecturers also played a formal role in student assessment, specific measures were implemented to separate academic evaluation from research participation. Data used in the study were derived from routine practicum assessments and lecturer feedback processes, which were conducted independently of the research. Students were informed that the use of their data for research was voluntary and would have no influence on their academic grades or evaluation outcomes.

Lecturers rated student teachers' performance in each competency area on a five-point scale, ranging from 'Unsatisfactory' (0) to 'Excellent' (4). These ratings were on the first section of the observation instrument. The rating helped identify student areas of strengths and areas that required improvement.

After each lesson observation, the lecturer provided both oral and written feedback to the student teacher. The feedback was written in the second section of the rubric and it provided guidance during the discussions. The feedback emphasised both areas requiring improvement and areas where the student teacher demonstrated effectiveness. To examine relationships between the quantitative variables, Spearman's rank correlation was applied. Qualitative data were subsequently analysed to further explain and deepen the interpretation of the quantitative results.

7.3. Minimising biases in teaching observation

Measures were put in place to minimise rating bias. Lecturers were first familiarised with the observation rubric and then trained using pre-recorded teaching videos. Lecturers independently scored before discussing their ratings. This process continued until scoring consistency improved. The structured rating process reduced the likelihood that a general impression of a lesson would influence scores across several categories. This bias is referred to as the halo effect (Schmidt et al., 2023).

Separating competencies into clear criteria through rubrics enhances objectivity, consistency, and scoring reliability, particularly when supported by assessor training (Schmidt et al., 2023; Jonsson & Svingby, 2007; Fadillah & Ha, 2024). Although inter-rater reliability was not formally analysed, the use of a standardised rubric and consistent assessors across observations improved reliability and measurement consistency. Additionally, procedural safeguards such as accessing data only after student final examinations and publication of results minimise potential bias arising from the dual role of lecturer and researcher.

8. Data analysis procedures

This section highlights data analysis procedure employed in the study. The analysis was structured to address the three research questions.

RQ1: What changes are observed in the teaching competencies of physics student teachers following lecturer feedback during the teaching practicum?

This research question was investigated quantitatively. Descriptive statistics (means, SDs) were computed for each competency. Inferential statistics were used to help assess whether these changes were statistically significant ($p \leq .05$). In addition, effect sizes (Cohen, 1988) were calculated to evaluate the magnitude of observed changes. Competency scores were aggregated into domain-level composites to allow the study to assess not only individual competencies but overall change within each domain.

RQ2: What relationships exist among teaching competencies within each domain, and how do these interdependencies inform instructional development?

This research question was also investigated quantitatively. Spearman's rank-order correlation coefficients (ρ) were calculated to examine the relationships between competencies within domains. This tested whether strengths or weaknesses in one area were systematically related to others, highlighting interdependent development patterns. Moreover, given the small sample size, correlation analysis served as a valuable complementary method to identify patterns of association among teaching competencies investigated in this study.

RQ3: Which instructional challenges persist in student teachers' lesson delivery despite receiving lecturer feedback, and in which domains are these challenges most frequent?

Lecturer-written feedback ($N = 50$ observation forms) was analysed qualitatively using content analysis, following the approach of Hsieh and Shannon (2005) and Rouhshad et al. (2024). Feedback comments were deductively coded into seven predefined teaching competency domains: Planning and Preparation, Teaching Facilitation and Methodology, Class Management and Organisation, Assessment, Communication, Professionalism, and Knowledge of Subject Matter.

Frequencies of coded comments were then computed separately for the initial and final evaluations to identify shifts in emphasis and areas of improvement over time. Supporting this approach, Puttick and Warren-Lee (2020) analysed written feedback from 31 geography lesson observations during student teachers' practicum using thematic analysis. Their study illustrates how frequency analysis of feedback can provide meaningful insights into patterns of lecturer emphasis.

8.1. Integration of Findings

The quantitative results (improvements and correlations) and qualitative findings (persistent challenges) were integrated at the interpretation stage. This enabled the explanation of statistical results through qualitative themes.

9. Results

This section presents results from the rating rubric and lecturer-written feedback. The study involved the analysis of initial and final lecturer-written feedback and identification of student challenges after receiving feedback from lecturers.

9.1. Results from the analysis of the rating rubric

Since the rubric employed a 0 - 4 rating scale, normality was evaluated using the Shapiro-Wilk test, which revealed that the data significantly departed from a normal distribution ($p < .05$). Therefore, non-parametric Wilcoxon signed-rank was employed. Effect sizes were calculated using $r = Z/\sqrt{N}$.

9.1.1 Performance of student teachers in the initial and final lesson presentation

Based on the comparisons between initial and final evaluation of lesson observations, the results show an overall improvement in student teachers competencies. For example, in teaching facilitation skills, the use of teaching aids improved notably (initial: M = 2.60, SD = 1.00; final: M = 3.16, SD = 0.99). However, a few areas showed slight declines, such as time management (initial: M = 3.04, SD = 0.84; final: M = 2.84, SD = 1.07).

Table 1: Analysis of scores based on various areas of student teachers' competencies

Domain	Teaching competency	Initial evaluation				Final evaluation				Diff.
		Min	Max	M	SD	Min	Max	M	SD	M
Planning and preparation	Lesson planning	1.00	4.00	2.28	0.79	1.00	4.00	2.40	0.82	-0.12
	Preparation of materials	1.00	4.00	2.24	0.78	1.00	4.00	2.56	0.71	0.32
	Preparation of teaching file	1.00	4.00	2.64	0.76	1.00	4.00	2.80	0.82	0.16
Teaching facilitation skills and methodology	Introduction of the lesson	1.00	4.00	2.56	0.92	1.00	4.00	2.52	0.96	-0.04
	Teaching strategies	1.00	4.00	2.60	0.87	1.00	4.00	2.92	0.86	0.32
	Questioning techniques	1.00	4.00	2.24	0.88	1.00	4.00	2.60	0.87	0.36
	Use of teaching aids	1.00	4.00	2.60	1.00	1.00	4.00	3.16	0.99	0.56
	Problem solving	1.00	4.00	2.48	1.05	1.00	4.00	2.60	0.91	0.12
	Use of technology	1.00	3.00	1.48	0.59	0.00	4.00	2.00	1.12	0.52
Class management and organisation	Positive learning environment	1.00	4.00	2.88	0.97	2.00	4.00	3.12	0.83	0.24
	Creation of safe learning environment	2.00	4.00	3.04	0.89	2.00	4.00	3.16	0.90	0.12
	Class discipline	1.00	4.00	2.72	0.94	1.00	4.00	2.80	1.12	0.08
	Time management	1.00	4.00	3.04	0.84	1.00	4.00	2.84	1.07	-0.20
	Organisation	0.00	4.00	2.00	1.12	1.00	4.00	2.32	1.07	0.32
Assessment (learning/progress)	Monitoring for pupil understanding	1.00	4.00	2.76	0.93	2.00	4.00	3.00	0.71	0.24
	Assessment strategy	1.00	4.00	2.56	0.77	1.00	4.00	2.88	0.83	0.32
Communication skills	Language	1.00	4.00	3.04	0.73	1.00	5.00	3.24	0.72	0.20
	Non-verbal communication	2.00	4.00	2.80	0.58	2.00	4.00	3.08	0.70	0.28
Knowledge of subject matter	Accurate information	1.00	4.00	2.96	0.93	1.00	4.00	3.12	0.88	0.16
	Connect to real life situation	0.00	4.00	2.20	1.22	1.00	4.00	2.68	1.11	0.48

	Confidence with subject matter	2.00	4.00	3.04	0.73	2.00	4.00	2.96	0.79	-0.08
Professionalism	Appearance	2.00	4.00	3.16	0.80	2.00	4.00	3.44	0.71	0.28
	Enthusiasm	1.00	4.00	2.92	0.81	2.00	4.00	3.20	0.71	0.28
	Knowledge of pupil	2.00	4.00	2.92	0.76	2.00	4.00	3.08	0.70	0.16
	Commitment	2.00	4.00	3.32	0.85	2.00	4.00	3.36	0.81	0.04

Student teachers' competencies were aggregated into the seven domains and analysed, as summarised in Table 2. A Wilcoxon signed-rank test was conducted to examine the differences between initial and final lesson evaluations across the domains of teaching competency.

Table 2: Analysis of scores based on the domains

Domain	Z	p-value	Effect Size (r)	Interpretation of r
Planning and preparation	-2.07	.038	-0.415	Medium
Teaching facilitation skills and methodology	-2.62	.009	-0.523	Large
Class management and organisation	-1.30	.192	-0.261	Small–Medium
Assessment (learning/progress)	-2.15	.032	-0.430	Medium
Communication skills	-1.12	.261	-0.225	Small
Knowledge of subject matter	-1.67	.095	-0.334	Medium
Professionalism	-2.46	.014	-0.45	Medium

The analysis revealed statistically significant improvements in several domains. For example, significant differences were observed in planning and preparation ($Z = -2.07$, $p = .038$, $r = .42$), and professionalism ($Z = -2.46$, $p = .014$, $r = .45$). The largest effect size ($r = .52$), was under teaching facilitation skills and methodology demonstrated. In contrast, no statistically significant differences were found in class management and organisation ($Z = -1.30$, $p = .192$, $r = .26$) and communication skills ($Z = -1.12$, $p = .261$, $r = .23$), although both domains exhibited small to near moderate effect sizes.

9.1.2 Correlation of competencies in Lesson Planning and Preparation

Lesson planning and preparation domain focus on student teacher's ability to design effective lessons and organise relevant materials. It includes the development of a teaching file and the selection of appropriate instructional strategies.

Table 3: Spearman correlations among lesson planning and preparation competencies

	ILP	IPM	IPTF	FLP	FPM	FPTF
ILP	—					
IPM	.36	—				
IPTF	.42*	-.09	—			
FLP	.50*	.33	.40*	—		
FPM	-.16	-.00	-.18	.12	—	
FPTF	.49*	-.28	.63**	.36	.14	—

Note.
* $p < .05$, ** $p < .01$ (two-tailed).
ILP = Initial lesson planning; IPM = Initial preparation of materials; IPTF = Initial preparation of teaching file; FLP = Final lesson planning; FPM = Final preparation of materials; FPTF = Final preparation of teaching file.

The results showed several significant associations (Table 3). There was a strong, positive, and statistically significant correlation between initial and final 'preparation of teaching file' ($\rho = .63$, $p < .01$), indicating that student teachers who performed well initially tended to maintain strong performance in the final lesson. This reflects consistency in this competency. A moderate, significant correlation was also found between initial 'lesson

planning' and initial 'pupil-teacher facilitation' ($\rho = .42$, $p < .05$), suggesting alignment between planning and facilitation skills. However, final 'preparation of materials' did not show significant correlations with other competencies. For example, with initial 'lesson planning' ($\rho = –.16$, $p > .05$) and final 'preparation of materials' ($\rho = –.18$, $p > .05$). This indicates that this competency may operate independently of others.

9.1.3 Correlation of competencies in Teaching Facilitation Skills and Methodology

Teaching facilitation skills and methodology domain focus on student teachers' ability to effectively introduce lessons, apply appropriate teaching strategies, use effective questioning techniques, integrate teaching aids, promote problem-solving, and incorporate technology in their lessons.

Table 4: Spearman correlations among teaching facilitation skills and methodology competencies

	IIL	**ITS**	**IQT**	**IUTA**	**IPS**	**IUT**	**FIL**	**FTS**	**FQT**	**FUTA**	**FPS**	**FUT**
IIL	—											
ITS	.16	—										
IQT	.29	.37	—									
IUTA	.22	.34	.52**	—								
IPS	.04	.59**	.60**	.41*	—							
IUT	.05	.17	-.18	.01	-.04	—						
FIL	.14	.12	.30	.50*	.01	-.04	—					
FTS	.48*	.43*	.61**	.47*	.30	-.05	.46*	—				
FQT	.18	.07	.15	.20	.36	-.21	.30	.12	—			
FUTA	.37	.30	.56**	.62**	.41*	-.10	.65**	.59**	.44*	—		
FPS	.21	.31	.31	.22	.66**	-.25	.14	.12	.63**	.43*	—	
FUT	.04	.02	.13	.29	.33	.17	.25	.06	.37	.54**	.22	—

Note.

* $p < .05$, ** $p < .01$ (two-tailed).

IIL = Initial introduction of the lesson; ITS = Initial teaching strategies; IQT = Initial questioning techniques; IUTA = Initial use of teaching aids; IPS = Initial problem solving; IUT = Initial use of technology; FIL = Final introduction of the lesson; FTS = Final teaching strategies; FQT = Final questioning techniques; FUTA = Final use of teaching aids; FPS = Final problem solving; FUT = Final use of technology.

Statistically significant positive correlations were revealed among teaching facilitation skills and methodology competencies as shown in Table 4. This indicates consistency and interrelatedness in student teacher's teaching facilitation skills and methodology. For example, 'initial use of teaching aids' was strongly correlated with 'initial questioning techniques' ($\rho = .52$, $p < .01$), 'final introduction of the lesson' ($\rho = .50$, $p < .05$), 'final teaching strategies' ($\rho = .47$, $p < .05$), and 'final use of teaching aids' ($\rho = .62$, $p < .01$).

'Initial problem solving' showed moderate to strong correlations with 'initial teaching strategies' ($\rho = .59$, $p < .01$), 'initial questioning techniques' ($\rho = .60$, $p < .01$), 'initial use of teaching aids' ($\rho = .41$, $p < .05$), and 'final use of teaching aids' ($\rho = .41$, $p < .05$). This highlight a meaningful relationship between early problem-solving skills and multiple teaching strategies.

9.1.4 Correlation of competencies in Class Management and Organisation

Table 5 presents the Spearman correlations among class management and organisation domain assessed at both the initial and final phases of lesson presentation.

Table 5: Spearman correlations among class management and organisation competencies (n = 25)

	IPLE	ICSLE	ICD	ITM	IO	FPLE	FCSLE	FCD	FTM	FO
IPLE	—									
ICSLE	.78**	—								
ICD	.19	.51**	—							
ITM	.27	.27	.30	—						
IO	-.30	-.42*	.06	.29	—					
FPLE	.70**	.89**	.52**	.42*	-.22	—				
FCSLE	.66**	.93**	.56**	.33	-.32	.92**	—			
FCD	.44*	.64**	.61**	.48*	.10	.61**	.71**	—		
FTM	.60**	.52**	.23	.51**	.06	.65**	.48*	.50*	—	
FO	.37	.32	.23	.35	.22	.31	.29	.33	.09	—

Note.
* p < .05, ** p < .01 (two-tailed).
IPLE = Initial positive learning environment; ICSLE = Initial creation of safe learning environment; ICD = Initial class discipline; ITM = Initial time management; IO = Initial organisation; FPLE = Final positive learning environment; FCSLE = Final creation of safe learning environment; FCD = Final class discipline; FTM = Final time management; FO = Final organisation

Correlations were observed among class management and organisation competencies as shown in Table 5. For example, the 'Initial positive learning environment' strongly correlated with 'initial creation of safe learning environment' ($\rho = .78$, $p < .01$). There was also a correlation in their final counterparts. 'Final positive learning environment' strongly correlated with 'Final creation of safe learning environment' ($\rho = .92$, $p < .01$). There was also a correlation between initial and final competencies. For example, 'Initial positive learning environment' strongly correlated with 'Final positive learning environment' ($\rho = .70$, $p < .01$).

9.1.5 Correlation of competencies in assessment

Table 6 presents the Spearman correlations among four key assessment-related competencies assessed at both the initial and final lesson presentation. These involved monitoring for pupil understanding and the use of appropriate assessment strategies.

Table 6: Spearman correlations among assessment competencies (n = 25)

	IMPU	IAS	FMPU	FAS
IMPU	—			
IAS	.59**	—		
FMPU	.38	.40*	—	
FAS	.62**	.63**	.64**	—

Note.
* p < .05, ** p < .01 (two-tailed).
IMPU = Initial monitoring for pupil understanding; IAS = Initial assessment strategy; FMPU = Final monitoring for pupil understanding; FAS = Final assessment strategy

A **strong and statistically significant correlation** was observed between 'Initial monitoring for pupil understanding' **and 'Initial assessment strategy'** ($\rho = .59$, $p < .01$). This suggested that student teachers who were able to effectively monitor pupil understanding early on were also more likely to implement appropriate assessment strategies. Table 6 also shows that 'Final assessment strategy' was strongly correlations with 'Initial monitoring for pupil understanding' ($\rho = .62$, $p < .01$), 'Initial assessment strategy' ($\rho = .63$, $p < .01$) and 'Final monitoring for pupil understanding' ($\rho = .64$, $p < .01$).

9.1.6 Correlation of competencies in Language

Table 7 shows the correlations among four language-related competencies. This involves the initial and final use of verbal language.

Table 7: Spearman correlations among language competencies (n = 25)

	IL	INC	FL	FNC
IL	—			
INC	.50*	—		
FL	-.28	-.32	—	
FNC	-.10	.12	.70**	—

Note.
* p < .05, ** p < .01 (two-tailed).
IL = Initial language; INC = Initial non-verbal communication; FL = Final language; FNC = Final non-verbal communication

A moderate, statistically significant positive correlation was found between initial language and initial non-verbal communication ($\rho = .50$, $p < .05$), indicating that student teachers who demonstrated strong verbal skills early on also tended to use effective non-verbal cues, suggesting coordinated communication at the initial stage of lesson delivery. A stronger, statistically significant positive correlation was observed between final language and final non-verbal communication ($\rho = .70$, $p < .01$), showing that by the final lesson, articulate language use was closely associated with effective non-verbal engagement. In contrast, other correlations were weak and not statistically significant (e.g., initial language and final non-verbal communication, $\rho = –.10$), indicating no consistent relationship between initial and final communication competencies and suggesting variability in how student teachers responded to feedback and practice.

9.1.7 Correlation of competencies in Knowledge of Subject Matter

Table 8 presents the correlations among six competencies related to student teachers' **knowledge of subject matter. It takes into consideration the** initial and final phases of lesson presentations.

Table 8: Spearman correlations among knowledge of subject matter competencies (n = 25)

	IAI	ICRS	ICSM	FAI	FCRS	FCSM
IAI	—					
ICRS	.36	—				
ICSM	.53**	.21	—			
FAI	.50*	.23	.35	—		
FCRS	.54**	.38	.52**	.79**	—	
FCSM	.31	-.13	.36	.47*	.41*	—

Note.
* p < .05, ** p < .01 (two-tailed).
IAI = Initial accurate information; ICRS = Initial connect to real life situation; ICSM = Initial confidence with subject matter; FAI = Final accurate information; FCRS = Final connect to real life situation; FCSM = Final confidence with subject matter

Table 8 indicates that 'Initial accurate information' had a moderate to strong, statistically significant correlation with 'Initial confidence with subject matter' ($\rho = .53$, $p < .01$), 'Final accurate information' ($\rho = .50$, $p < .05$) and 'Final connect to real-life situations) ($\rho = .54$, $p < .01$). It suggests that student teachers who began with accurate content knowledge were likely to maintain accuracy and more likely to demonstrate ability to relate content to real-life applications at the second evaluation stage. 'Initial connect to real-life situations' shows no significant correlations with initial or final variables. Therefore, this could imply that student's ability to relate content to real-world applications may require specific support and scaffolding during teacher training.

9.1.8 Correlation of competencies in Professionalism

Table 9 presents correlations among eight professionalism-related competencies across initial and final teaching phases of student teachers.

Table 9: Spearman correlations among professionalism competencies (n = 25)

	IA	IE	IK	IC	FA	FE	FK	FC
IA	—							
IE	.34	—						
IK	.32	-.03	—					
IC	.76**	.26	.54**	—				
FA	.62**	.49*	.09	.34	—			
FE	.62**	.57**	.25	.38	.74**	—		
FK	.37	.16	.72**	.54**	.30	.37	—	
FC	.74**	.41*	.46*	.82**	.57**	.55**	.51*	—

Note.
* p < .05, ** p < .01 (two-tailed).
IA = Initial appearance; IE = Initial enthusiasm; IK = Knowledge of pupil; IC = Initial commitment; FA = Final appearance; FE = Final enthusiasm; FK = Final knowledge of pupil; FC = Final commitment

Initial Commitment demonstrated strong, positive, and statistically significant correlations with Initial Appearance (ρ = .76, p < .01), Initial Knowledge of Pupil (ρ = .54, p < .01), and especially Final Commitment (ρ = .82, p < .01), indicating that early commitment is closely associated with professionalism, pupil understanding, and sustained commitment over time. Similarly, Initial Appearance was significantly related to Final Appearance (ρ = .62, p < .01), and Initial Commitment also correlated with Final Knowledge of Pupil (ρ = .54, p < .01), suggesting that professionalism traits observed early tend to persist into the final lesson stage. Final Commitment showed positive and significant associations with all other competencies across both stages (ρ = .41 to .82, p < .05), underscoring its central role in overall professional development. However, some relationships, such as between Initial Enthusiasm and Initial Knowledge (ρ = −.03), were non-significant, indicating weak or negligible links among certain professionalism-related competencies.

9.2 Results from the analysis of lecturer-written feedback

This section focuses on the lecturer-written feedback for the initial and final student lesson presentations. It looks at feedback comments in relation to the quality of lesson delivery and the overall student school-based teaching experience.

9.2.1 Frequency of initial and final lecturer-written feedback

The written feedback provided by lecturers was categorised into groups based on the domains of teaching competencies to which each comment corresponded. The frequency of feedback comments decreased from the initial to the final evaluation across all domains as shown in Figure 2.

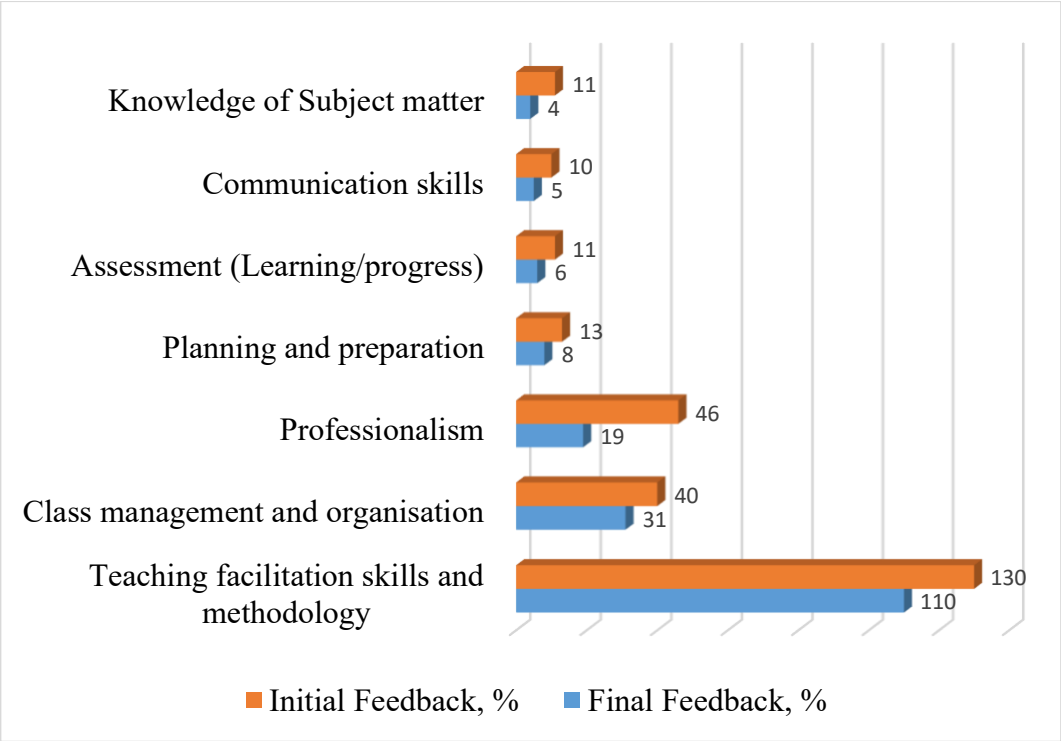


Figure 2: Frequency of initial and final feedback comments for each specified domain

This suggests reduced areas of concern between the initial and final lesson evaluations. It is from these feedback comments that the frequency of persistent lecturer-written feedback per category were identified.

9.2.2 Persistent challenges identified from lecturer-written feedback

Analysis of lecturer-written feedback revealed recurring instructional challenges, indicating that observed changes in teaching practices were limited following the feedback. As summarised in Table 10, these persistent challenges were most prevalent in the domain of Teaching Facilitation Skills and Methodology (n = 31), followed by Class Management and Organisation (n = 11). Other domains such as Planning and Preparation, Assessment, Communication, Professionalism, and Subject Matter Knowledge registered lower frequencies but still indicated areas of instructional challenges.

Table 10. Analysis of persistent challenges from lecturer-written feedback (n = 25)

Domain	**Frequency of Persistent Feedback**	**Example Feedback Comment (Initial)**	**Example Feedback Comment (Final)**
Teaching Facilitation & Methodology	31	*"Demonstrate physics concepts."*	*"Make pupils understand the physics behind the observations."*
Class Management & Organisation	11	*"Be in charge of every process/step in your lesson."*	*"Ensure full control of lesson flow."*
Planning & Preparation	6	*"Use teaching aids strategically."*	*"Integrate charts and models into explanations."*
Assessment	3	*"Check pupil understanding consistently."*	*"Include oral questioning during lesson."*
Professionalism	3	*"Maintain rapport with learners."*	*"Show reflective practice in lesson delivery."*
Communication	2	*"Project your voice clearly."*	*"Improve clarity of explanations."*

Knowledge of Subject Matter	1	*"Clarify the principle behind the experiment."*	*"Provide stronger conceptual scaffolding."*

The high recurrence of feedback in teaching facilitation suggests that student teachers struggled to apply methods that translated physics concepts into clear and understandable experience. For example, repeated feedback comments to Student 12 for both Lesson 1 and Lesson 2 highlight persistent issues in student teacher's ability to demonstrate and communicate physics concepts to learners. In the initial feedback, the lecturer explicitly instructed the student to "DEMONSTRATE PHYSICS CONCEPTS," yet the final feedback indicates that the lecturer repeated feedback comment to help "Make pupils understand the physics behind the observations." This underlines the student teacher's ongoing difficulty in engaging learners through conceptual visualisation and hands-on strategies. This pattern reflects broader challenges among student teachers in executing teaching facilitation and instructional methodology.

Similarly, persistent feedback in Class Management and Organisation domain pointed to repeated issues related to student teachers' maintenance of class control and ensuring structured lesson flow. For example, repeated feedback to Student 10 to "be in charge of every process/step in your lesson" in both lessons reflects an ongoing challenge in classroom leadership which was observed after lecturer feedback.

In the Planning and Preparation domain, repeated feedback related to the use and integration of teaching aids was observed in six cases (n = 6). Though students like Student 8 prepared visual aids (e.g., charts), feedback suggested that these were not strategically employed during lesson delivery. This indicated a disconnection between planning and execution of the lesson.

While the frequency of persistent feedback was lower in domains such as Assessment (n = 3), Communication (n = 2), Professionalism (n = 3), and Knowledge of Subject Matter (n = 1), the recurrence of specific feedback such as inadequate voice projection or failure to build rapport with students reveals that even seemingly minor pedagogical elements can affect lesson quality and needs to be resolved.

Generally, these findings underscore that while feedback was given, its uptake was variable. Persistent challenges suggest a need for more scaffolding, longer practicum duration, and sustained mentoring to ensure that feedback translates into practice. The diagnostic value of feedback offers clear direction for refining both the practicum structure and the support mechanisms provided to student teachers.

10. Discussion

This study examined changes in teaching competencies among physics student teachers following lecturer feedback during the school-based practicum. Anchored in Hagger and McIntyre's (2006) model of teacher development and Vygotsky's (1978) social constructivist theory, the findings reveal a pattern of selective improvement, interconnected competency relationship, and persistent instructional challenges. This highlights the complexity of teacher learning in authentic classroom contexts. By integrating quantitative and qualitative data, the current study contributes contextual evidence from a resource-constrained setting to the growing body of research on teacher education feedback.

10.1 Student teacher's performance in lesson presentations

The observed improvements in procedural and observable competencies in areas such as teaching facilitation skills and methodology ($Z = -2.62$, $p = .009$, $r = .52$) and planning and preparation ($Z = -2.07$, $p = .038$, $r = .42$) can be explained by the structured and visible nature of these practices within classroom settings. These competencies are structured and more readily observable in classroom practice, which may explain their responsiveness to feedback (Toledo-Figueroa et al., 2017).

In contrast, no statistically significant improvements were found in class management and organisation, communication skills, or subject matter knowledge ($p > .05$), although effect sizes suggested small to moderate changes. These domains are more complex, context-dependent, and typically require longer periods for development. Classroom management, for instance, involves adaptive expertise (Li et al., 2024), while communication is linked to interpersonal teaching behaviours (Xie & Derakhshan, 2021). The study also found that subject matter knowledge remained mostly unchanged over the two observations. Therefore, the study suggests that structured lecturer feedback is associated with procedural teaching competencies. Therefore, these findings align with evidence from higher-resource contexts, where feedback may also be delivered digital (Chan, 2020; Murtagh, 2021). The study highlights the value of direct lecturer-student interaction in supporting foundational teaching practice in resource constrained contexts.

10.2 Interrelationship among Competencies

The correlation analyses revealed strong and consistent relationships among competencies. This suggested that growth in one area (e.g., teaching facilitation) correlated with improvement in others (e.g., questioning techniques or lesson introduction). These interrelationships mirror findings by Liu et al. (2017) and Brown et al. (2014), who conceptualise teacher learning as a holistic and interconnected process rather than a linear accumulation of discrete skills. The patterns of growth observed in this study align with Fischer and Kauertz's (2021) assertion that effective physics teaching requires the integration of pedagogical, cognitive, and interpersonal skills. Therefore, teaching during the student practicum is an integrative process in which various competencies interact.

This interdependence among competencies was likely reinforced by the lecturer's feedback, which acted as a form of scaffolding that helped student teachers progress through their zone of proximal development (Vygotsky, 1978). Such feedback aligns with Grossman et al.'s (2009) views on teacher practicum. Their study position feedback within iterative cycles of practice and reflection that promote the development of interrelated teaching competencies.

10.3 Ways in which persistent challenges manifest after lecturer feedback

Despite observable progress, challenges persisted in teaching facilitation, classroom management, and lesson planning. This highlights areas where feedback was not fully internalised by student teachers. For example, repeated comments such as *"demonstrate physics concepts"* and *"make pupils understand the physics behind the observations"* appeared in both the initial and final evaluations. This signifies that some student teachers struggled with teaching facilitation that could have helped translate feedback into improved conceptual demonstration to pupils. Similarly, recurring feedback such as *"be in charge of every process in your lesson"* reflected student teacher's continuing difficulties in class management.

The persistence of these challenges suggests that feedback, though provided, was not consistently enacted in practice. Asregid et al. (2023), highlighted the need for lecturer feedback to be structured in a way that would scaffold reflective practice in student teachers. Clark et al. (2023) found that novice teachers often feel underprepared to maintain effective learning environments despite instructional feedback. The feedback comments from lecturers were structured in line with university expectations, emphasising a dialogic approach that focused on how student teachers could improve their subsequent lessons.

However, the short two-week interval between lesson observations may have limited opportunities for full feedback internalisation, particularly for complex competencies such as classroom management and instructional methodology. From a theoretical standpoint, this indicates that the scaffolding provided by lecturers (Vygotsky, 1978) was only partially assimilated within the student teachers' *zone of proximal development.* Consequently, while lecturer feedback formed an important part of the student teacher practicum experience, the extent of the observed changes may also have been influenced by limited reflection time and the short duration of the practicum. As **Hagger and McIntyre (2006)** emphasised, internalisation of feedback requires iterative cycles of modelling, practice, and review. This is supported by Kakazu and Kobayashi (2023) in Japan and Mulenga and Bwalya (2022) in Zambia, who emphasised that feedback uptake depends on students' reflective capacity and practicum duration.

Mulenga and Bwalya went further and referred to this period as “adequate school experience period” (p.88). However, institutions of higher learning are yet to take advantage of this insight. The situation has been attributed to the fact that “administrators in institutions preparing teachers in Zambia seem to be concerned with the cost of conducting the teaching practicum at the expense of quality, which eventually makes supervisors rush through the supervision exercise so as to see as many students as possible within the provided time” (Mulenga & Bwalya, 2022, p. 22).

11. Conclusion

This study investigated how physics student teachers’ teaching competencies changed after lecturer feedback during school-based practicum in Zambia. The findings indicate that lecturer feedback supports improvement in specific, observable teaching practices (use of teaching aids, use of technology, and assessment strategy), but has limited impact on more complex competencies within the practicum period. Although most competencies did not show statistically significant changes, effect size analysis and qualitative findings suggest that meaningful association occurred.

The correlational analysis indicated that improvements in certain competencies were associated with improvements of other competencies within a given domain. For example growth in facilitation skills, positively correlated with growth in others areas, including lesson planning, assessment, and classroom management. This confirms the interconnected nature of student competencies in teacher training. These patterns emphasise the importance of adopting holistic training strategies that recognise the synergies between various domains.

However, the qualitative findings from lecturer-written feedback showed persistent challenges in areas such as teaching facilitation, classroom management and lesson planning. Despite repeated feedback, student teachers struggled to effectively use feedback provided by the lecturer. Challenges were especially in areas such as demonstrating of scientific concepts and class control. The repeated feedback comments across evaluation cycles reveal that student teachers often require prolonged engagement to internalise and operationalise complex pedagogical concepts. These limitations suggest that while feedback may play an important role in the practicum process, observed improvements are also likely to depend on student teachers’ ability to reflect on and act upon the feedback they receive. These findings imply the need to extend practicum duration and reinforce feedback mechanisms through ongoing mentorship, peer collaboration, and structured reflection sessions.

Overall, this study reinforces the indispensable role of constructive, contextualised and sustained feedback during practicum phase of teacher education. It calls for enhanced mentoring practices, deliberate integration of reflective dialogue, and ongoing support structures that enable student teachers to translate theoretical input into professional competence. Additionally, strengthening the school-based practicum through more frequent supervision, reflective dialogue, and sustained mentoring can bridge the gap between theoretical preparation and classroom realities. For teacher education institutions in Zambia and similar contexts, this study underscores the importance of institutionalising feedback-rich, reflective, and context-sensitive practicum models that foster holistic teacher development and improved instructional quality.

12. Limitations

1. The interval of less than two weeks between the two lesson observations may have been insufficient for student teachers to fully internalise and implement the feedback that was provided by the lecturer. Pedagogical growth, particularly in complex areas such as classroom management may require more time of practicum.
2. Student teacher feedback and performance was determined exclusively by the university lecturer after each lesson observation. This approach overlooks the insights and evaluations by school-based mentor who had interacted with student teachers and observed their lessons more consistently during practicum.
3. The study involved student teachers from one public university in Zambia. Therefore, results may have limited generalisability to other education institutions across Zambia or other countries. This is because

variations in institutional culture, resources and curriculum across different universities may lead to varied experiences of student teachers.

4. These findings should be interpreted with caution because a one-group pre–post design was utilised to demonstrate changes. This does not allow for causal attribution of these changes solely based on feedback. Other factors such as normal practicum progression and increased familiarity with the assessment rubric may also have contributed to the observed changes.
5. The sample size comprised only 25 student teachers. Such a small number of participants limits the statistical power of the study. Therefore, these findings provide useful initial insights that can inform future research.

13. Recommendations

Future studies should consider the following:

1. Lengthening the interval between lesson observations (e.g., 4-6 weeks) and extend the duration of the teaching practicum. Pedagogical skills, especially in complex areas like classroom management, require sustained practice. Therefore, lecturers' participation in the practicum should not be treated as a two-stage event involving only initial and final evaluations. The implementation of an extended practicum period should be expedited by allowing student teachers to at least undertake the exercise twice during their training. For example, once in the third year and again in the fourth year of the four-year teacher education programme.
2. Expanding the study to include multiple higher education institutions (both public and private) across different provinces of Zambia. A multi-site study would help determine whether findings are consistent across varying institutional cultures, resource availability, and curriculum structures. Different universities may have distinct teaching philosophies, mentorship approaches, and practicum structures, which can influence student teachers' experiences.
3. Increasing the sample size so that the future study will have improved statistical reliability. At least the sample size must be increased to not less than 100 student teachers.

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Ethical Approval: Ethical approval for this study was obtained from the Directorate of Research and Innovation at the university were the study was conducted.

Informed Consent: Student teachers were informed about the purpose and procedures of the study prior to departing for their school-based teaching practice. Participation was voluntary with no consequences for non-participation.

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