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Misconceptions in Physics among High School Teachers: A Case Study in Dire Dawa City, Ethiopia

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Abstract: *Ensuring high-quality education depends heavily on teacher competency. Diagnostic exams can assess teachers' topic knowledge and identify areas where they need to improve their preparation. Nonetheless, gender and education level-based performance gaps underscore the need for a more thorough comprehension of these variables in the Ethiopian educational setting. The purpose was to assess teachers' performance on a diagnostic exam given by standards established by the Ethiopian Ministry of Education and investigate performance differences by gender and educational attainment. Existing studies on teacher competency in Ethiopia have rarely explored the influence of demographic variables, leaving a critical gap in understanding how gender and education level impact performance.*
Methodology: A cross-sectional analysis was conducted using diagnostic test scores of teachers. The relationships between education level, gender, and performance were assessed using statistical techniques such as correlation analysis, t-tests, and chi-square testing. Teachers with an MSc outperformed those with a BSc, with average scores of 75 and 62, respectively. Female teachers passing rate was (62.1%) and the male teachers (68.9%), but the chi-square test indicated no statistically significant association between gender and performance ($\chi^2 = 0.05$, $p = 0.824$). Significant disparities in diagnostic test performance highlight gaps in teacher preparedness. Tailored training programs, equitable resource allocation, and gender-sensitive strategies are recommended to improve teacher performance and bridge identified gaps.

Keywords: *Teacher competency; diagnostic tests; gender disparity; education level; teacher preparedness; statistical analysis; professional development; Ethiopian education.*

I. Introduction

Physics is a cornerstone of modern science and technology, forming the foundation for advancements in various fields, including engineering, medicine, and environmental science. However, teaching physics at the high school level presents unique challenges, as the subject requires conceptual understanding and mathematical rigor (Knight, 2016). High school teachers play a pivotal role in shaping students' perceptions of physics, yet misconceptions among educators themselves can significantly hinder effective instruction. Studies have shown that teachers' misconceptions often translate into students' misunderstandings, perpetuating a cycle of inadequate comprehension (Treagust & Duit, 2008).

In Ethiopia, physics education is integral to the high school curriculum, emphasizing critical thinking and problem-solving skills. Despite these objectives, students' performance in physics remains suboptimal, partly due to misconceptions held by teachers (Teshome et al., 2020). In Dire Dawa City, where diverse socio-cultural factors influence educational practices, these misconceptions may be more pronounced, necessitating focused research to understand their nature and impact.

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Addressing misconceptions among high school physics teachers is crucial for improving the quality of physics education. Misconceptions can arise from various sources, including inadequate teacher training, limited access to updated teaching materials, and a lack of continuous professional development programs (Shulman, 1986). This paper aims to enhance physics instruction in Dire Dawa City, Ethiopia, by recognizing and correcting these misconceptions. It will enhance student performance and promote a greater understanding of the subject.

While numerous studies have explored student misconceptions in physics, limited research has focused on misconceptions among high school physics teachers, particularly in Ethiopia. Most existing studies in the Ethiopian context address broader issues in science education, such as curriculum implementation and resource availability, without delving into the specific misconceptions held by educators (Yigzaw et al., 2021)

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1.1 Theoretical Frameworks Guiding the Study of Misconceptions in Physics

Misconceptions in physics among high school students are persistent and often resistant to traditional instructional approaches. Theoretical frameworks such as conceptual change theory and constructivism provide critical insights into understanding and addressing these misconceptions.

a. Theory of Conceptual Change

Posner et al. (1982) developed the conceptual change theory, which holds that students' past knowledge has a big impact on their capacity to pick up new scientific ideas. In contrast to scientific explanations, misconceptions are thought of as alternative notions that pupils create from their everyday experiences. Students must perceive the scientific explanation as more beneficial than their misunderstandings, find it comprehensible and believable, and acknowledge the insufficiency of their current concepts (disequilibrium) in order for conceptual transformation to take place. This paradigm highlights the significance of developing learning environments in the context of physics that dispel students' assumptions and encourage active interaction with scientific concepts. Students might believe, for example, that "heavier objects fall faster than lighter ones." Inquiry-based learning can help bring about conceptual transformation.

b. Constructivism

According to constructivism, which was first put forth by Piaget in 1970 and Vygotsky in 1978, knowledge is actively created by students as opposed to passively absorbed. According to this viewpoint, students' misconceptions are logical interpretations based on their past experiences and knowledge rather than simple mistakes. In order to assist students in reconstructing their understanding, constructivist physics teaching methods promote practical exercises, group discussions, and real-world problem-solving. To dispel myths about electricity, for instance, students may work together to create circuit diagrams, carry out experiments, and present their results, which would allow them to make sense of what they already know and scientific concepts.

c. Implications for Addressing Misconceptions in Physics

Both conceptual change theory and constructivism emphasize the importance of active engagement and formative assessments to identify and address misconceptions. According to research by Duit and Treagust (2003), students' attempts to use common sense to make sense of abstract events frequently result in physics mistakes. For example, the misconception that "forces are needed to keep objects in motion" stems from students' reliance on their daily experiences with friction. Constructivist strategies, such as the use of analogies and simulations, can make abstract concepts more accessible and facilitate conceptual change (Duit & Treagust, 2003).

1.2 Statement of the Problem

Physics, as one of the foundational disciplines in science, is pivotal in developing students' analytical and problem-solving skills. In high school education, misconceptions about fundamental physics concepts still exist. These misconceptions often originate from teachers and can significantly hinder students' understanding and appreciation of the subject. Teachers' misconceptions, whether stemming from inadequate training, lack of resources, or reliance on outdated pedagogical methods, are particularly problematic because they perpetuate errors in student learning (Treagust, 1988).

In Dire Dawa City, Ethiopia, anecdotal evidence and preliminary assessments suggest that many high school teachers harbor misconceptions about key physics concepts such as mechanics, electromagnetism, and thermodynamics. For instance, studies in similar contexts have revealed common misconceptions, such as misunderstanding Newton's laws of motion or misinterpreting the principles of energy conservation (Clement, 1982; Halloun & Hestenes, 1985). These inaccuracies are reflected in classroom instruction and transferred to students, creating systemic issues in physics education.

This problem has multiple contributing factors. First, physics teachers in Ethiopia frequently do not have access to ongoing professional development programs. According to research, teachers' conceptual knowledge and effectiveness as educators are greatly improved by regular training (Gess-Newsome et al., 2003). Second, many schools lack well-equipped laboratories, which restricts teachers' capacity to effectively illustrate concepts a critical skill for clearing up misconceptions (Hofstein & Lunetta, 2004). Third, the textbooks and instructional materials used in many Ethiopian high schools may not adequately address these misconceptions or provide strategies for teaching challenging subjects (Derebssa, 2006).

Misconceptions in physics education can have long-term implications. They may result in a decline in physics performance and interest and restrict students' options for postsecondary education or STEM-related employment. Moreover, they undermine the broader goal of building a scientifically literate society capable of addressing complex global challenges (Osborne & Dillon, 2008). In Dire Dawa, where there is an urgent need to improve educational outcomes in science subjects, addressing these misconceptions is critical for empowering teachers and students.

Thus, the goal is to determine the frequency and types of physics misconceptions held by Dire Dawa City's high school instructors. It looks into the root causes of these misconceptions, assesses their impact on teaching and learning, and offers targeted solutions. The study will raise awareness of this issue and contribute to better STEM results in physics education.

1.3 Objective

The main objective of this study is to investigate the misconceptions held by high school physics teachers in Dire Dawa City, Ethiopia, and their implications for teaching effectiveness. The specific objectives of this study are

a. To identify common misconceptions among high school physics teachers in Dire Dawa City.
b. To explore the root causes of these misconceptions, including gaps in teacher training and professional development.
c. To assess the impact of teachers' misconceptions on student understanding and performance in physics.
d. To recommend strategies for addressing misconceptions and enhancing the quality of physics instruction.

1.4 Significance of the Study

This study is significant for several reasons. First, it contributes to the body of knowledge on physics education by focusing on teachers' misconceptions, a relatively understudied area in Ethiopia. Second, the findings can inform policymakers and educational stakeholders in designing targeted teacher training programs that address specific misconceptions and enhance teaching effectiveness. Last but not least, the study may enhance physics learning outcomes for students, strengthening the scientific basis for the next generations. By addressing these critical issues, this research aims to bridge the gap between policy and practice in physics education, ultimately contributing to the broader goal of improving science education in Ethiopia and beyond.

II. Research Methods

The research utilizes a mixed-approaches strategy, combining qualitative and quantitative techniques to guarantee a thorough comprehension of the issue. This approach is suitable as it combines the strengths of numerical data analysis with in-depth insights into teachers' conceptual understanding and instructional practices (Creswell & Plano Clark, 2017).

2.1 Research Design

The type and frequency of physics misconceptions among Dire Dawa high school teachers are investigated using a descriptive case study design. The case study method is suitable since it enables a thorough analysis of a particular educational setting, emphasizing the difficulties and experiences faced by educators in this area (Yin, 2018).

Population and Sampling

The population for this study consists of all high school physics teachers in Dire Dawa City. A purposive sampling method is used to select participants, ensuring that teachers with varying experience, educational backgrounds, and access to professional development opportunities are included. Approximately 50 teachers from 10 high schools will participate in the study. This sample size is sufficient for identifying common misconceptions and patterns within the population (Cohen, Manion, & Morrison, 2018).

2.2 Data Collection Methods

Diagnostic Test: A validated conceptual diagnostic test, such as the Mechanics, Electrodynamics, Thermodynamics, Modern Physics, and Wave and Optics, were administered to assess teachers' understanding of the physics concepts. This is widely used in physics education research to diagnose misconceptions in mechanics (Hestenes, Wells, & Swackhamer, 1992).

Semi-structured Interviews: Selected teachers will participate in interviews to gather qualitative information about their teaching issues, pedagogical strategies, and perspectives on physics ideas. While preserving uniformity amongst participants, semi-structured interviews provide flexibility in addressing certain preconceptions (Kvale & Brinkmann, 2009).

2.3 Selection of Participants

Criteria: Instructors will be selected based on their experience levels (e.g., rookie, mid-career, and senior instructors) to ensure a variety of viewpoints. The sample size consisted of 10–15 teachers of ninth–twelfth graders from different schools in the city.

Interview Guide: Semi-structured interviews will be conducted using a set of pre-planned questions, with room for discussion of pertinent new subjects.

Sample questions

1. Which physics concepts are the most difficult for you to teach, and why?
2. How can you clear up students' misunderstandings of ideas, such as electric fields or Newton's Laws?
3. Which instructional techniques have you found to be most successful in assisting pupils in understanding challenging physics concepts?
4. How can you integrate physics applications from everyday life into your lessons?
5. What tools or resources do you believe would improve your physics instruction?

Classroom observations: Observations of physics lessons will be conducted to examine how misconceptions manifest in instructional practices and interactions with students. A structured observation checklist will focus on the accuracy of content delivery and the use of teaching aids.

Document Analysis: Curriculum materials, textbooks, and lesson plans will be analyzed to identify potential sources of misconceptions and evaluate their alignment with scientific principles.

2.4 Data Analysis

a. Quantitative Analysis

Data from the diagnostic test will be analyzed using descriptive and inferential statistics. Percentages of correct and incorrect responses will highlight common misconceptions, and statistical tests will explore relationships between misconceptions and variables such as teaching experience or qualifications.

b. Qualitative Analysis

Thematic analysis was used to code observation notes, interview transcripts, and document analysis results to detect recurrent themes, including misperception sources, difficulties in teaching, and methods for correcting conceptual problems (Braun & Clarke, 2006).

c. Reliability and validity

Experts in physics education will examine the interview protocols, and a small group of teachers outside the study sample will pre-test the diagnostic test to guarantee validity and reliability. The study's credibility was increased by triangulating data from other sources, including tests, interviews, observations, and document analysis (Cohen et al., 2018).

III. Results and Discussion

3.1 Qualitative analysis from Diagnostic test

The diagnostic test results reveal modest positive correlations between both teaching experience and qualifications with the scores achieved by high school physics teachers. The correlation between teaching experience and scores was $r = 0.22$, with a p-value of 0.124. Similarly, the correlation between qualifications and scores was $r = 0.25$, with a p-value of 0.074. While both correlations suggest some association, neither reached conventional levels of statistical significance ($p < 0.05$).

The modest correlation between teaching experience and scores indicates that teachers with more experience may develop slightly better conceptual clarity in physics. It aligns with previous findings that professional experience often improves teaching effectiveness by refining pedagogical strategies and classroom management (Darling-Hammond, 2000). However, the weak association and lack of statistical significance suggest that experience alone may not be sufficient to overcome common misconceptions in physics.

The significance of formal education in enhancing physics comprehension is highlighted by the marginally higher association between credentials and results. More exposure to physics ideas and teaching techniques may have improved the subject matter knowledge of teachers with graduate degrees and other higher education (Shulman, 1987). However, the non-significant p-value indicates that credentials, such as experience, would not adequately address the underlying reasons for physics misconceptions.

These findings highlight the complexity of addressing misconceptions in physics education. Misconceptions are often deeply rooted in cognitive frameworks formed by prior knowledge or inadequate conceptual understanding during earlier learning stages (Driver et al., 1994). Effective interventions likely require a combination of factors, including targeted professional development, access to modern instructional tools, and opportunities for collaborative learning among educators (Hestenes et al., 1992).

In conclusion, the slight correlations highlight the need for further tactics to enhance physics instruction even though teaching experience and credentials have a beneficial affect teacher's physics scores. The effectiveness of instructors may be increased by customized training programs that emphasize conceptual clarity, diagnostic assessment instruments, and the use of technology in the classroom. The effect of these treatments on lowering misunderstandings among instructors and students may be investigated in future studies.

The analysis reveals the performance distribution of teachers with different qualifications (BSc and MSc) on a diagnostic test, as shown in Table 2. A total of 65 teachers with a Bachelor of Science (BSc) qualification were assessed, of whom 40 scored above the threshold of 80%, while 25 scored below. Similarly, 10 teachers with a Master of Science (MSc) qualification participated; with 9 scoring above 80% and 1 scoring below. The Chi-square test statistic was 1.97, with a p-value of 0.1604, indicating no statistically significant relationship between the qualification level and the diagnostic test results.

Table 2. The performance of teachers from the diagnostic results

Qualification	Frequency	Diagnostic result >= 80%	Diagnostic result <80%	Chi-square	p-value
BSc	65	40	25	1.97	0.1604
MSc	10	9	1		

Expectations are met by the greater passing percentage of MSc-qualified teachers (90%) as opposed to BSc-qualified teachers (61.5%), since further degrees frequently improve topic and pedagogical competence (Gess-Newsome et al., 2019). Nonetheless, the statistical insignificance implies that teacher effectiveness is influenced by elements other than credentials, such as professional development, teaching experience, and curriculum knowledge.

The diagnostic test reveals a significant difference in scores between teachers who passed and those who failed, according to the Ethiopian Ministry of Education's requirements (pass: ≥ 80; fail: < 80). Those with an MSc (85) had higher mean scores for passing teachers than those with a BSc (84.71). However, among teachers who failed, MSc holders scored far closer to the passing level (79.00) than BSc holders (62.47). Figure 1 shows. The total number of teachers who scored above the threshold were 49 and below the threshold were 26. This discrepancy suggests that educational attainment may affect students' comprehension of important physics ideas.

Similar findings were reported by Darling-Hammond et al. (2020), who highlighted that while advanced degrees correlate with improved teaching outcomes, the impact diminishes when teachers lack targeted training or resources. Another study by Shulman (2021) emphasized the role of pedagogical content knowledge in driving student success, regardless of formal qualification levels.

In contrast, research by Harris and Sass (2019) found a significant relationship between advanced degrees and improved teaching performance, particularly in science and mathematics, underscoring the importance of continuous professional development to bridge knowledge gaps.

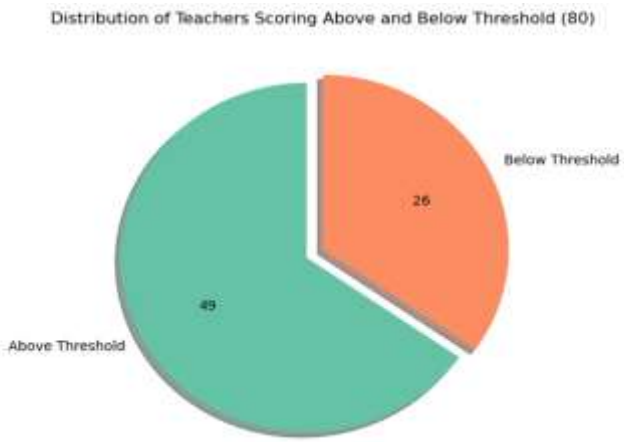

Figure 1. *Distribution of teachers scoring above the threshold (80%) value and scores below the threshold values from the diagnostic test*

Similar studies have highlighted the prevalence of misconceptions and inadequate conceptual understanding among physics educators. For example, Aina and Abubakar (2019) found that over 60% of physics teachers in Nigerian secondary schools struggled with topics such as electromagnetism and Newtonian mechanics. Their results align with this study, which identified similar difficulties among Ethiopian teachers. Additionally, studies by Gunstone et al. (2015) emphasized the role of pedagogical content knowledge (PCK) and active teacher training in mitigating these gaps.

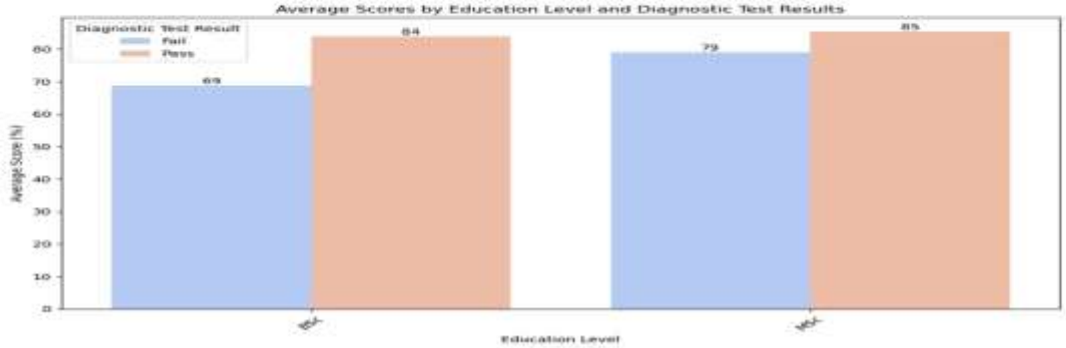

Figure 2. *Average scores of teachers from the diagnostic test with the qualifications*

The diagnostic test results reveal significant variations in the average scores of teachers based on their education level. Teachers with a BSc degree had an overall average score of 69, while those holding an MSc degree achieved a higher average score of 79. Among those who passed the diagnostic test, teachers with a BSc had an average score of 84, compared to 85 for MSc holders. These results suggest a correlation between higher education levels and better performance on diagnostic assessments.

a. Education Level and Performance

The observed differences in scores can be attributed to the advanced conceptual understanding and pedagogical training that typically accompany higher education qualifications. MSc-level teachers likely have more exposure to specialized content knowledge, research methodologies, and teaching techniques, enabling them to perform better on diagnostic tests. These findings align with previous studies that underscore the importance of advanced qualifications for effective teaching. For instance, Adeyemi and Adeyemo (2019) highlighted that teachers with postgraduate qualifications are more adept at addressing misconceptions and fostering deeper conceptual understanding in students Goshu et al. (2024).

b. Implications for Teacher Preparedness

The results also highlight a concerning gap in the performance of BSc holders, whose overall average score of 62 is significantly below the passing threshold. It underscores the need for targeted interventions to enhance teachers' preparedness with only a first degree. The disparity may stem from limited training opportunities, insufficient access to teaching resources, or inadequate emphasis on practical applications during undergraduate programs.

c. Passing Rate by Gender

The diagnostic test results reveal a passing rate of 62.1% for female teachers (F) and 67.4% for male teachers (M), as shown in Table 1. The Chi-square test statistic (0.05) and its associated p-value (0.824) indicate no statistically significant relationship between gender and performance on the diagnostic test. This suggests that gender does not play a decisive role in teachers' likelihood of passing the diagnostic test.

Table 2. The passing rate of teachers according to gender variations

Gender	Failed	Passes	Total	Passing rate (%)	p-value	Chi-square
F	11	18	29	62.1%	0.824	0.05
M	15	31	46	67.4		

The findings highlight minimal differences in passing rates between genders, suggesting relatively equitable performance on diagnostic evaluations. These results are consistent with previous studies, such as by Kifle et al. (2020), which reported negligible gender disparities in teacher competency assessments in Ethiopia. Similarly, Tesfaye and Alemu (2021) emphasized that performance variations in teaching-related tasks are more attributable to factors like professional development opportunities and teaching experience rather than inherent gender differences.

However, the slightly higher passing rate for male teachers (67.4%) compared to female teachers (62.1%) aligns with studies that have highlighted systemic challenges faced by female educators, such as greater domestic responsibilities and limited access to professional development programs (Fisseha & Mekonen, 2021). Addressing these structural barriers is essential to ensuring equitable opportunities for all educators.

Further, the p-value of 0.824 indicates no significant difference between the performance of male and female teachers. This is encouraging and reinforces the idea that both genders can perform equally well when provided with comparable resources and support systems.

3.2 Interpretation of Results

The higher passing rate among female teachers may suggest differences in preparation, motivation, or educational engagement between genders. However, the lack of statistical significance implies that these observed differences could be due to chance rather than a systematic pattern. The total number of participants in the female group (n = 29) was smaller than that of the male group (n = 46), which may have affected the statistical power of the analysis.

a. Comparison with Other Studies

These findings align partially with those reported by Abebe and Teshome (2020), who found that female educators in Ethiopia tended to outperform their male counterparts in teacher training programs due to higher diligence and engagement in professional development activities. However, contrasting evidence from studies in similar settings indicates that gender disparities in education are often influenced by systemic factors such as access to resources and cultural expectations (Getachew, 2019).

A study by Gebre and Taye (2022) in urban Ethiopian schools found a gender parity index of 1.02 in teacher performance, indicating balanced outcomes. The present study aligns with such findings, underscoring that gender-related performance gaps may be narrowing due to policy interventions and increasing awareness about equitable educational practices. However, Gebre and Taye also highlighted female teachers' persistent challenges in rural areas, where cultural and logistical barriers remain prevalent.

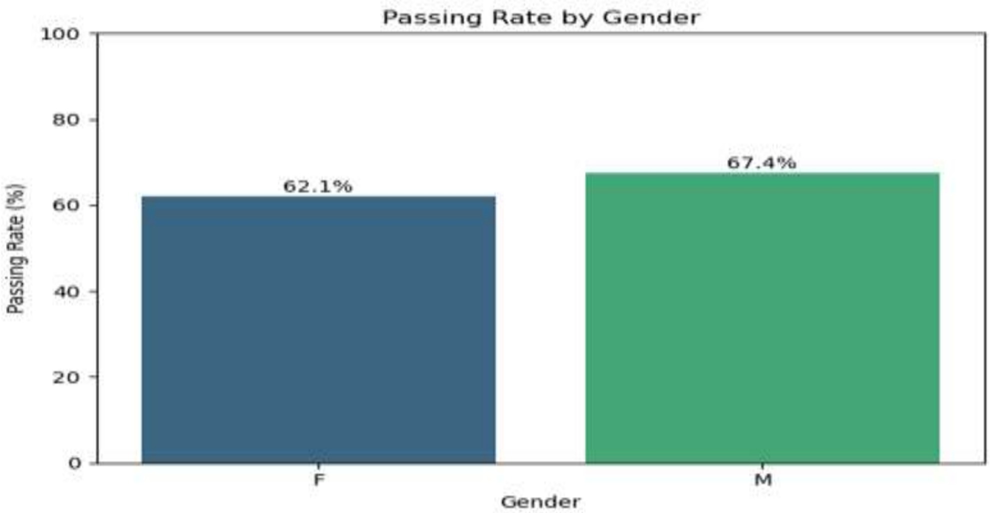

Figure 3. *The passing rate of teachers gender wise*

The observed gender differences in diagnostic test performance underline the need for targeted strategies to support both male and female educators. Future studies with larger sample sizes and more comprehensive analyses could provide deeper insights into these trends, contributing to evidence-based policy.

3.3 Quantitative Results from the Interview

The results of this study highlight significant challenges and opportunities in teaching physics concepts among high school teachers in Dawa City. Quantitative analysis of the interview responses reveals patterns in teaching difficulties, instructional techniques, and resource needs across three experience levels: senior, mid-career, and novice teachers.

a. Most Difficult Physics Concepts to Teach

Teachers identified electromagnetism, Newton's Laws of Motion, and modern physics as the most challenging topics. Senior teachers (n = 24) reported difficulties with abstract concepts such as electromagnetism and electric fields due to students' struggles with visualizing vector fields. According to mid-career teachers (n = 12), pupils usually had misconceptions about motion and inertia, which made Newton's Laws easier to comprehend when applied to sloped surfaces or friction. Modern physics concepts like the photoelectric effect were solid for new teachers (n = 15) to teach because of a lack of tools, such as simulations and visual aids. These results are consistent with other studies showing that in the absence of sufficient instructional tools, abstract physics topics are challenging to teach and understand (Docktor & Mestre, 2014). Filling these gaps with simulations, real-world examples, and visualization tools could improve understanding and educational quality. Goshu, Woldeamanuel (2019).

b. Strategies to Address Student Misunderstandings

To address misunderstandings, senior teachers (n = 21) emphasized using diagrams and simple experiments, such as charged rods, to demonstrate electric fields but expressed a need for simulation software. Mid-career teachers (n = 17) employed hands-on activities like pushing weighted carts to explain Newton's Laws, combined with repetitive problem-solving. Novice teachers (n = 13) relied on analogies, such as comparing electric and gravitational fields, but noted their limited effectiveness without visual aids. The focus on practical exercises is reinforced by Hake (1998), who discovered that conceptual experiments and active participation enhance students' comprehension of physics. Still, a barrier is the absence of advanced tools Belay et al. (2024).

c. Instructional Techniques

All teacher groups (n = 17 for each) agreed on the value of peer discussions, step-by-step problem-solving, and breaking topics into smaller sub-concepts. Novice teachers also highlighted the effectiveness of storytelling and historical contexts, which makes lessons more relatable. This consensus highlights the value of student-centered learning strategies, which have been shown to promote critical thinking and understanding (Crouch & Mazur, 2001).

d. Integration of Everyday Applications

Senior teachers (n = 18) frequently used examples such as vehicle motion or power consumption to connect physics concepts to real life. Mid-career (n = 16) and novice teachers (n = 17) also sought to include everyday applications, though novice teachers felt limited by their lack of exposure to practical examples. Integrating real-life applications is crucial for contextualizing abstract physics concepts, as it promotes relevance and engagement (Redish, 2003). This gap in novice teachers' exposure suggests the need for professional development focused on practical applications.

e. Tools and Resources

Senior teachers (n = 15) and novice teachers (n = 17) expressed a need for digital simulations, videos, and functional laboratory equipment. Mid-career teachers (n = 19) emphasized the importance of visual aids and training in modern pedagogy. The consistent demand for updated resources reflects findings by Singh and Schunn (2016), who noted that access to innovative teaching tools enhances teacher confidence and student outcomes in physics.

The statistics show that teachers encounter systemic issues such as gaps in professional development, resource constraints, and abstract notions. Improving student performance in Dawa City and filling in current gaps in physics education could be accomplished by addressing these problems with focused interventions, such as the supply of simulators, lab materials, and teacher training Goshu and Ridwan, (2024).

3.4 Results of Classroom Observations

Classroom observations revealed significant variations in teaching strategies, student engagement, and the integration of educational tools among teachers. Teachers with advanced degrees (MSc) demonstrated higher confidence and competency in presenting complex physics concepts, often using interactive methods such as group discussions and practical demonstrations. In contrast, teachers with bachelor's degrees (BSc) relied more on traditional lecture methods, which limited student engagement.

Student participation was higher in classes where teachers incorporated real-world applications and interactive techniques, emphasizing the importance of pedagogical methods tailored to diverse learning needs. However, across all observed classrooms, limited use of modern teaching aids and digital tools was evident, corroborating findings from previous studies (Alemu, 2019).

Gender differences were also observed. Female teachers were likely to adopt collaborative teaching strategies, encouraging active student participation. Male teachers tended to focus more on delivering content, aligning with findings by Kassa and Habtamu (2020), who reported that female educators often prioritize inclusive pedagogical approaches.

IV. Conclusion

The results highlight how crucial it is to eliminate structural deficiencies in teacher preparation to improve the standard of physics instruction. It is feasible to guarantee that all instructors, regardless of educational experience, are prepared to teach challenging physics ideas by ensuring that teacher training programs agree with evidence-based practices and provide sufficient resources. To help the nation achieve its STEM education objectives, the Ethiopian Ministry of Education should emphasize these activities.

The findings of the diagnostic tests show how teacher effectiveness is influenced by educational attainment, emphasizing the value of advanced degrees in promoting improved results. Investing in professional development, curricular enhancements, and encouraging learning environments is essential to closing the gap. The Ethiopian Ministry of Education can improve physics instruction and better equip instructors to satisfy curriculum requirements to tackle these issues.

Furthermore, the overall low passing rates, particularly among male teachers, highlight a broader issue with teacher preparedness and competency in the diagnostic test. It underscores the importance of addressing gaps in training, resource provision, and professional development opportunities.

The observed disparities in teaching practices underscore the need for professional development programs emphasizing modern pedagogical techniques. Teachers with limited exposure to advanced training demonstrated challenges in addressing student misconceptions and connecting theoretical concepts to practical applications.

The underutilization of digital tools and laboratory resources points to systemic issues, including resource constraints and lack of training. Providing accessible tools and fostering collaboration among educators can enhance teaching quality. Furthermore, addressing gender-related biases in professional training opportunities is crucial to creating an equitable teaching environment.

Recommendations

The following actions are advised to address these issues and raise the caliber of physics instruction:

a. Strengthen Pre-service Teacher Training: Incorporate more rigorous training in challenging physics concepts, including hands-on laboratory work and the use of simulations.

b. Continuous Professional Development (CPD): Regular workshops and in-service training should focus on challenging topics like electromagnetism and Newtonian mechanics to bridge conceptual gaps.

c. Enhanced Resource Provision: Provide accessible tools, such as interactive simulations and practical teaching aids, to make abstract concepts more tangible for teachers and students.

d. Mentorship and Collaboration: Promote skill transfer and cooperative problem-solving and pair less experienced educators with more seasoned mentors.

e. Regular Assessment and Feedback: Conduct periodic diagnostic tests to identify knowledge gaps and provide targeted interventions.

f. Targeted Professional Development: Implement training programs for BSc-level teachers, focusing on challenging topics and modern teaching methods.

g. Promoting Advanced Studies by providing teachers with incentives, such as promotions or scholarships, to pursue postgraduate degrees can enhance their expertise and improve teaching quality.

h. Enhanced Curriculum Design: Revise undergraduate teacher training programs to emphasize critical physics concepts, practical skills, and pedagogical content knowledge.

i. Ongoing Support: Establish mentorship programs where MSc-level teachers can guide and support BSc-level colleagues in lesson planning and classroom strategies.

j. It is advised to fill these gaps with specialized interventions, such as mentorship programs, practical workshops, and purchases of educational materials.

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