Challenges in Teaching Practices in Science Education at the University Level

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Article

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Abstract: This study explores the challenges faced by science educators at the university level, with a focus on teaching practices and classroom management. A total of 100 faculty members, including Associate Professors, Professors, and Heads of Departments, were surveyed to gather insights. Data was collected using a two-point rating scale, examining three core areas: the future challenges in higher education, teaching methodologies, and effective classroom management. Key findings from the study highlight several pressing concerns. Financial burdens, including high tuition costs, continue to create barriers to access for students, while systemic issues hinder equitable opportunities in higher education. The study also identified the need for ongoing professional development for faculty to keep pace with evolving teaching methodologies, particularly in science education. Additionally, the increasing integration of AI tools into academic environments has raised concerns about maintaining academic integrity. Other challenges identified include the difficulties in transitioning to online or hybrid teaching formats, especially in the context of science education, and the growing reliance on adjunct faculty, which can impact the continuity and quality of instruction. The study concludes with recommendations aimed at addressing these challenges, emphasizing the importance of institutional support and faculty training to strengthen teaching practices, enhance classroom management, and adapt to the rapidly changing landscape of higher education.

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Introduction

The relationship between teachers' knowledge and their classroom practices has been a focal point of educational research for decades, especially in the context of science education. It is widely accepted that a teacher's understanding of subject matter directly influences their effectiveness in the classroom, as it shapes the way they present content and engage with students. However, research has increasingly revealed a more complex dynamic between teachers' knowledge and their practice. Initial assumptions that knowledge translates linearly into practice have been challenged by findings that highlight the nuanced and multifaceted nature of teaching, where tacit understanding, beliefs, and values play a significant role (Lakin & Wellington, 1994; Waters-Adams, 2000). Moreover, modern educational reforms, particularly in science education, stress the importance of shifting from traditional teaching methods to more inquiry-based and constructivist approaches to foster critical thinking, problem-solving, and independent learning in students (AAAS, 1994; NRC, 1996). Despite these reforms, change has been slow, and science education continues to face challenges, including the need for teachers to possess both deep subject matter knowledge and pedagogical expertise to facilitate higher-order thinking in students (Barak & Shakhman, 2008). Addressing these challenges requires not only innovative teaching strategies but also a deeper understanding of the factors that influence teacher practice, including reflective abilities and adaptability to new instructional methods (Leou, 2006; Zohar, 2006). Consequently, this paper explores the key challenges faced in teaching practices within science education at the university level, focusing on the complexities of translating educational reforms into effective classroom practices.

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Review of the Related Literature

The challenges in teaching practices within science education at the university level have been widely debated, particularly since the release of the National Science Education Standards (National Academy of Sciences, 1995). A central issue in this debate is how science should be taught, with many advocating for an inquiry-based approach that promotes science as a process of discovery. This model encourages students to engage with scientific principles through investigation. However, scholars like Chinn & Malhotra (2003) and Roth (1995) have raised concerns about this approach, arguing that it confuses the distinction between learning science and doing science. While scientific inquiry generates new knowledge, science education should help students understand established knowledge. Consequently, inquiry-based teaching often leads to misapplication, creating a "category error" that conflates acquiring scientific knowledge with the process of discovery.

A major issue in implementing inquiry-based science education is the lack of a universally accepted definition of teaching science through inquiry. Educators often reduce inquiry-based teaching to hands-on activities, which Osborne (2014) criticizes as "cookbook" laboratory exercises that emphasize following instructions rather than understanding scientific principles. This undermines the intended purpose of inquiry-based learning. Moreover, practical constraints such as limited time, inadequate resources, and insufficient professional development opportunities (Roth & Garnier, 2006) further hinder effective application. Addressing these challenges requires a shift from disconnected activities to an approach that promotes meaningful engagement with core scientific concepts. This aligns with the goals outlined in the Framework for K-12 Science Education and the Next Generation Science Standards, which emphasize deeper content understanding and scientific inquiry processes (Kloser, 2014). Kloser also argues for adaptable and contextual teaching practices, emphasizing the importance of professional development frameworks that integrate core teaching methods into real classroom settings. Teacher beliefs significantly shape how teaching practices are implemented. Calderhead (1996), Fang (1996), and Mansour (2009) note that teacher beliefs, influenced by ideologies and personal experiences, affect instructional methods and priorities. This becomes crucial when balancing inquiry-based learning with traditional science curricula. External pressures like standardized testing often push teachers to prioritize content coverage over innovative methods, limiting opportunities for student-centered inquiry (Haney, Czerniak, & Lumpe, 1996). Windschitl & Calabrese Barton (2016) call for a cultural shift in science education that emphasizes collaboration over individual teaching. By fostering partnerships between educators and researchers, universities can create infrastructures that support ambitious science teaching. These collaborations can help bridge the gap between inquiry-based and content-focused teaching, enabling educators to balance both effectively. An additional aspect of science education is the role of epistemic practices, which reflect the values and methods of scientific inquiry. Kelly & Licona (2018) emphasize that students should not only learn scientific content but also understand how scientific knowledge is constructed, communicated, and evaluated. This holistic approach can contribute to greater scientific literacy and equip students to engage with scientific issues meaningfully. Looking ahead, artificial intelligence (AI) presents both challenges and opportunities. On the one hand, AI poses risks such as potential misuse for academic dishonesty (Hernandez, 2021). On the other hand, it offers innovative possibilities, such as automating routine tasks, allowing educators to focus on higher-order instructional activities like mentoring and designing complex assessments (Jensen & Liu, 2021). AI's role in science education mirrors broader trends in higher education, where flexible, adaptable models—like hybrid learning—are becoming essential in an unpredictable educational landscape (Clark, 2022). These models not only enrich the student experience but also foster international collaborations, enabling global exchanges of knowledge and best practices (Emms, Laczik, & Dabbous, 2022). Early assumptions of a simple, linear connection between teaching practices and outcomes have been challenged by studies highlighting the dialectical nature of practice and the influence of tacit knowledge, beliefs, and values on teaching behavior (Lakin & Wellington, 1994; Laplante, 1997; Waters-Adams & Nias, 2003). This shift underscores the importance of both explicit and implicit knowledge in teacher practice.

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Today, fostering intellectual competencies like independent learning, problem-solving, and critical thinking is a key focus in science education. Educational reforms advocate for moving away from traditional methods toward constructivist-oriented instruction. Schraw, Crippen, and Hartley (2006) stress the need for promoting metacognition and self-regulation through inquiry-based learning, collaborative support, and problem-solving strategies. However, despite general agreement on these goals, implementation at the school level remains slow, with many classrooms still relying on traditional methods, such as content delivery and rote problem-solving. To promote higher-order thinking, teachers must possess both deep subject knowledge and pedagogical skills that foster cognitive processes in the classroom (Brickhouse, 1990; Bybee, 1993; Fullan, 1993).

Inquiry-based science education (IBSE) is widely promoted as a means of developing competencies such as decision-making, critical thinking, and adaptability. Hiang (2005) and Aksela et al. (2010) note that inquiry encourages active engagement with scientific concepts, fostering conceptual change through hands-on experiences. However, transitioning from traditional to inquiry-based methods requires careful measurement to ensure effective implementation and meaningful learning outcomes (Shamsudin et al., 2013). Research has shown that students often retain misconceptions despite being exposed to correct information, underscoring the need for strategies that actively engage learners in conceptual conflict and reflection (Driver et al., 1985; Osborne & Freyburg, 1985). Recent reforms stress the importance of understanding scientific concepts deeply rather than memorizing facts. Conceptual understanding involves knowing how scientific ideas interrelate and applying them to new phenomena (NRC, 1996). Engaging students with science requires teachers who understand student misconceptions and use this knowledge to guide instruction, helping students build scientifically accurate understandings of the world (Driver, Guesne, & Tiberghien, 1985). Effective strategies, such as the learning cycle, analogies, and language use, have proven successful in confronting and changing students' misconceptions (Karplus & Thier, 1967; Lawson et al., 1989; Fellows, 1994).

Additionally, studies explore the effectiveness of various teaching strategies, such as inquiry-based learning, teacher-directed instruction, and adaptive teaching, on student outcomes. While inquiry-based learning yields mixed results depending on the discipline, teacher-directed instruction consistently correlates with improved science outcomes. Adaptive teaching and feedback are also recognized for fostering personalized learning and enhancing student engagement in science (Waldrop, 2015). In the broader context of higher education, research underscores its growing significance in economic development, social equity, and knowledge creation. Universities are increasingly seen as key drivers of societal progress. Despite this attention, research in higher education can sometimes be fragmented, lacking integration with broader comparative frameworks. Topics like access, equity, governance, and market-driven education dominate the research agenda, yet greater cohesion is needed to address these challenges within higher education systems.

In conclusion, the challenges in science education teaching practices at the university level are complex, involving the misapplication of inquiry-based learning, the impact of teacher beliefs, and systemic constraints within educational systems. Moving forward, refining teaching practices, providing robust professional development opportunities, and fostering collaborative environments will be essential to support innovative science education. Emerging technologies, such as AI, offer new possibilities for flexible, student-centered learning models that could reshape the future of science education.

Statement of the Problem

The study aimed to explore the challenges in teaching practices in science education at the university level.

Objectives of the Study

1. To identify the challenges facing the future of higher education.
2. To explore the challenges in teaching practices at the university level.
3. To identify the challenges of classroom teaching management at the university level.

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Research Questions

1. What are the challenges facing the future of higher education?
2. What are the challenges in teaching practices at the university level?
3. What are the challenges of classroom teaching management at the university level?

Methodology

Population:

University teachers, including Associate Professors, Professors, and Heads of Departments, were selected based on the informed consent of the Deans of all schools.

Sampling:

The entire sample consisted of 100 university teachers, including Associate Professors, Professors, and Heads of Departments from various departments.

Research Tool:

A two-point rating scale was developed for university teachers, Associate Professors, Professors, and Heads of Departments.

Methods and Procedure:

Relevant literature was reviewed to explore the future of higher education, focusing on the challenges in teaching practices at the university level. Based on this review, a two-point rating scale was constructed with the following main categories:

- University teachers, Associate Professors, Professors, and Heads of Departments.
- Challenges Facing the Future of Higher Education.
- Challenges in Teaching Practices at the University Level.
- Challenges in Classroom Teaching Management at the University Level.

Data was collected, tabulated, interpreted, and analyzed in terms of percentages. Conclusions were drawn accordingly, and recommendations were provided in line with the findings.

Data Collection:

The rating scale was personally administered by the researchers to all respondents in the sample. Almost all head teachers were cooperative.

Data Analysis:

The collected data was tabulated and statistically analyzed using percentages and standard deviations, and the results are presented below.

Section 1: Challenges Facing the Future of Higher Education

S.no	Questionnaire	Agree	% Agree	Disagree	% Disagree
1	The increasing use of technology in higher education poses significant challenges to traditional teaching methods.	77	77%	13	13%
2	Universities need to adapt to meet the demands of a globalized educational environment.	89	89%	11	11%
3	The financial burden of tuition is a major barrier for students seeking higher education.	95	95%	5	5%
4	Systemic barriers, such as those faced by underrepresented groups, hinder access to higher education.	98	98%	2	2%

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Section 2: Challenges in Teaching Practices at the University Level

S.no	Questionnaire	Agree	% Agree	Disagree	% Disagree
1	Faculty members struggle with the time demands of transitioning courses to online or hybrid formats.	80	80%	20	20%
2	There is a need for ongoing professional development for faculty to keep pace with educational technologies.	95	95%	5	5%
3	AI tools in education can undermine academic integrity and student assessment quality.	91	91%	9	9%
4	Faculty should be trained to effectively use learning management systems (LMS) and other digital tools.	92	92%	8	8%
5	Mental health resources should be integrated into course designs to support student success.	93	93%	7	7%

Section 3: Challenges of Classroom Teaching Management at the University Level

S.no	Questionnaire	Agree	% Agree	Disagree	% Disagree
1	The increasing reliance on adjunct faculty can compromise the quality of classroom instruction.	89	89%	11	11%
2	Faculty members find it challenging to balance their roles as instructors and content creators in online learning environments.	82	82%	18	18%
3	Institutional support for instructional design is essential for effective teaching practices.	95	95%	5	5%
4	The lack of collaboration among universities limits the sharing of best practices in teaching.	94	94%	6	6%
5	Flexibility in teaching models is necessary to address the diverse needs of students in higher education.	87	87%	13	13%

Interpretation of the Data: Challenges in Higher Education

The data gathered from the questionnaire provides insights into various challenges in higher education, categorized into three sections: (1) challenges facing the future of higher education, (2) challenges in teaching practices at the university level, and (3) challenges in classroom teaching management. The responses indicate a high level of concern across these areas, with specific trends emerging in terms of agreement and disagreement.

The increasing use of technology in higher education poses significant challenges to traditional teaching methods, with 77% agreeing and 13% disagreeing. Universities need to adapt to meet the demands of a globalized educational environment, as 89% agree and 11% disagree. The financial burden of tuition is a major barrier for students seeking higher education, with 95% agreeing and 5% disagreeing. Systemic barriers, such as those faced by underrepresented groups, hinder access to higher education, with 98% agreeing and 2% disagreeing. Faculty members face challenges with the time demands of transitioning courses to online or hybrid formats, with 80% agreeing and 20% disagreeing. There is a strong need for ongoing professional development to help faculty keep pace with educational technologies, with 95% in agreement and 5% disagreeing. AI tools in education are seen as potentially undermining academic integrity and the quality of student assessments, with 91% agreeing and 9% disagreeing. Faculty should receive training to effectively use learning management systems (LMS) and other digital tools, with 92% in agreement and 8% disagreeing. Additionally, mental health resources should be integrated into course designs to support student success, with 93% agreeing and 7% disagreeing. The increasing reliance on adjunct faculty can compromise the quality of classroom instruction, with 89% agreeing and 11% disagreeing. Faculty members find it challenging to balance their roles as instructors and content creators in online learning environments, with 82% agreeing and 8% disagreeing. Institutional support for instructional design is essential for

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effective teaching practices, with 95% agreeing and 5% disagreeing. The lack of collaboration among universities limits the sharing of best practices in teaching, with 94% agreeing and 6% disagreeing. Flexibility in teaching models is necessary to address the diverse needs of students in higher education, with 87% agreeing and 13% disagreeing.

Findings

These were the main findings:

- The majority of the respondents indicated that universities need to adapt to meet the demands of a globalized educational environment.
- The majority of the respondents identified the financial burden of tuition as a major barrier for students seeking higher education.
- The majority of the respondents noted that systemic barriers, such as those faced by underrepresented groups, hinder access to higher education.
- The majority of the respondents emphasized the strong need for ongoing professional development to help faculty keep pace with educational technologies.
- The majority of the respondents expressed concerns that AI tools in education could potentially undermine academic integrity and the quality of student assessments.
- The majority of the respondents believed that faculty should receive training to effectively use learning management systems (LMS) and other digital tools.
- The majority of the respondents suggested that mental health resources should be integrated into course designs to support student success.
- The majority of the respondents highlighted that institutional support for instructional design is essential for effective teaching practices.
- The majority of the respondents observed that the lack of collaboration among universities limits the sharing of best practices in teaching.

Conclusions

In light of the data analysis and study findings, several key conclusions can be drawn. One of the main challenges facing the future of higher education is the difficulty faculty members encounter in managing the time demands of transitioning courses to online or hybrid formats. This shift highlights the need for universities to adapt to the growing demands of a globalized educational environment. Additionally, faculty members face similar time constraints in their teaching practices at the university level, particularly when implementing online or hybrid learning. Another significant challenge is classroom teaching management, where the increasing reliance on adjunct faculty can negatively impact the quality of instruction. Addressing these issues is crucial for ensuring the continued effectiveness and quality of higher education.

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