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EFFECTIVENESS OF INSTRUCTIONAL MODULAR APPROACH ON ENHANCING SCIENCE TEACHING COMPETENCY AMONG PROSPECTIVE TEACHERS

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ABSTRACT

This research investigates the "Effectiveness of Instructional Modular Approach on Enhancing Science Teaching Competency among Prospective Teachers" through an experimental method employing a single-group pre-test treatment post-test design. The study focuses on 27 prospective teachers enrolled in the physical science teacher training program at Al-Ameen College of Education, Somasipadi, Tiruvannamalai, Tamil Nadu, India. The three-month experiment, centered on three units of Pedagogy of Physical Science – I, utilizes a Science Teaching Competency Scale as the research tool. The study's objectives encompass assessing baseline science teaching competency, implementing the instructional modular approach, comparing pre- and post-assessment scores, and analyzing specific indicators of the approach's effectiveness. The research applies both parametric and non-parametric statistical analyses. Major findings underscore a significant enhancement in science teaching competency following the Instructional Modular Approach, reflected in increased post-assessment mean scores. The approach positively influences content competency, pedagogical skills, practical laboratory skills, technology integration, and assessment and feedback competency. Notable improvements are observed in content and pedagogical skills, with nuanced variations in different competency dimensions. The findings reveal differential enhancements across competency aspects, emphasizing the varied impact of the Instructional Modular Approach. Proficiency improvements in laboratory skills and technology integration underscore the approach's effectiveness in fostering a comprehensive skill set among prospective teachers. Percentage score increases validate tangible growth in applied skills, particularly in practical laboratory skills and assessment/feedback competencies. Statistical analyses, including correlation coefficients and 't' values robustly support the findings, indicating a significant difference between pre- and post-assessment scores. The study provides comprehensive insights into nuanced enhancements across various dimensions, confirming the Instructional Modular

Approach's efficacy in shaping proficient and well-rounded science educators. The abstract concludes by highlighting the collective findings' validation of the approach's substantial impact on improving diverse teaching competencies, offering crucial insights for educational practices and teacher training programs.

KEYWORDS: Instructional Modular Approach, Science Teaching Competency, Prospective Teachers, Learning

INTRODUCTION

The pursuit of effective teaching methodologies is crucial for shaping competent and proficient educators, particularly in the realm of science education. This synopsis introduces a doctoral research study titled "Effectiveness of Instructional Modular Approach on Enhancing Science Teaching Competency among Prospective Teachers." The research adopts an experimental methodology, employing a single-group pre-test treatment post-test design to investigate the impact of the Instructional Modular Approach on the science teaching competency of prospective teachers.

Conducted at Al-Ameen College of Education in Somasipadi, Tiruvannamalai, Tamil Nadu, India, the study engages 27 actively enrolled prospective teachers from the physical science teacher training program. Over a three-month duration, the research focuses on three units of Pedagogy of Physical Science – I, aligning with the Tamil Nadu Teacher Education University syllabus. The research tool employed for assessment is the Science Teaching Competency Scale, a meticulously constructed and validated instrument.

The primary objectives of the study are multi-faceted. Firstly, the baseline science teaching competency of prospective teachers is assessed using pre-assessment measures. Subsequently, the Instructional Modular Approach is implemented, and its impact on science teaching competency is evaluated through post-assessment measures. The study also aims to compare pre- and post-assessment scores to determine the statistical significance of changes in teaching competency resulting from the instructional modular approach. Specific quantitative indicators, including content competency, pedagogical skills competency, practical laboratory skills competency, integration of technology competency, and assessment and feedback competency, are analyzed to gauge the effectiveness of the approach in diverse dimensions of science teaching.

The major findings of the study reveal a substantial enhancement in science teaching competency among prospective teachers due to the Instructional Modular Approach. Notably, improvements are observed across various dimensions, such as content competency, pedagogical skills, practical laboratory skills, technology integration, and assessment and feedback competency. Statistical analyses provide robust support for these findings, affirming the significant impact of the Instructional Modular Approach on shaping well-rounded and proficient science educators. This research, therefore, contributes valuable insights for informing educational practices, curriculum development, and teacher training programs aimed at advancing science education among prospective teachers.

STATEMENT OF THE PROBLEMS

The realm of science education faces a persistent challenge in preparing prospective teachers with comprehensive competencies essential for effective instruction. Despite the emphasis on pedagogical training, the efficacy of specific instructional approaches in enhancing science teaching competency remains inadequately understood. This research seeks to address this gap by focusing on the "Effectiveness of Instructional Modular Approach on Enhancing Science Teaching Competency among Prospective Teachers." The problem lies in the lack of empirical evidence

regarding the impact of instructional methodologies, particularly the Instructional Modular Approach, on the multifaceted competency requirements of science educators. The existing literature offers limited insights into how this approach influences various dimensions of teaching competency, including content knowledge, pedagogical skills, practical laboratory skills, technology integration, and assessment and feedback strategies.

The deficiency in understanding the instructional methods' efficacy hampers the development of tailored and effective teacher training programs. Without a comprehensive understanding of which approaches significantly enhance teaching competency, educators may lack the necessary tools to engage and empower students effectively in science education. Thus, this research aims to investigate, through rigorous empirical analysis, the specific impact of the Instructional Modular Approach on diverse facets of science teaching competency among prospective teachers. By addressing this problem, the study endeavors to provide actionable insights for enhancing teacher preparation programs and ultimately fostering more proficient and impactful science educators.

METHOD OF THE STUDY

The study employs an experimental method to evaluate the effectiveness of an instructional modular approach in enhancing the science teaching competency among prospective teachers specializing in physical science. This single-group design is conducted at Al-Ameen College of Education in Somasipadi, Tiruvannamalai, Tamil Nadu. The chosen method involves a controlled environment where all participants experience the same instructional intervention. The baseline science teaching competency of the prospective teachers is assessed using pre-assessment measures. Following this, the instructional modular approach is implemented, aiming to enhance their teaching skills in areas such as content application, pedagogical strategies, laboratory skills, technology integration, and assessment methods.

Post-assessment evaluations are then conducted to measure the impact of the instructional modules on the science teaching competency of the participants. Comparing pre- and post-assessment scores allows for the determination of any statistically significant changes in teaching competency due to the implemented approach.This methodology enables a direct analysis of the effectiveness of the instructional modular approach within the same group, offering insights into its potential to enhance science teaching competency among prospective teachers. The controlled design minimizes external influences, allowing a focused examination of the intervention's impact on the participants' teaching abilities.

DELIMITATION OF THE STUDY

The present study is delimited by the following factors:

1. The investigation focused exclusively on 27 prospective teachers(B.Ed.) who opted for Physical Science as their subject of specialization.
2. The experiment spanned a duration of three months.
3. The study was confined to three units of Pedagogy of Physical Science – I as outlined in the Tamil Nadu Teacher Education University syllabus.
4. The primary aim of this study was to enhance Science teaching competency in Physical Science. This was achieved through an Instructional modular approach, implemented via various classroom activities.

5. The research employed a single-group experimental design, without a designated control group for comparison.

OBJECTIVES OF THE STUDY

1. To assess the baseline science teaching competency of Physical Science prospective teachers at Al-Ameen College of Education, Somasipadi, Tiruvannamalai, Tamil Nadu, using pre-assessment measures.
2. To implement the instructional modular approach and measure its impact on the science teaching competency of the prospective teachers through post-assessment evaluations.
3. To compare the pre- and post-assessment scores to determine the statistical significance of changes in science teaching competency following the instructional modular approach.
4. To analyze specific quantitative indicators of the instructional modular approach's effectiveness, including improvements in content competency, pedagogical skills competency, practical laboratory skills competency, integration of technology competency and assessment and feedback competency.
5. To provide recommendations based on statistical findings to inform educational practices, curriculum development, and teacher training programs for enhancing science education among prospective teachers.

HYPOTHESES OF THE STUDY

1. There is no statistically significant difference in the mean science teaching competency scores of the prospective teachers before and after the implementation of the instructional modular approach.
2. The implementation of the instructional modular approach will result in a statistically significant improvement in the mean science teaching competency scores of the prospective teachers.
3. There is no significant difference in the mean scores for Content Competency application before and after the instructional modular approach.
4. There is no significant increase in the mean scores for Pedagogical Skills Competency following the implementation of the instructional modular approach.
5. There is no significant improvement in the mean scores for Practical Laboratory Skills Competency and Integration of Technology Competency after exposure to the instructional modules.
6. There is no significant increase in prospective teachers' mean scores for Assessment and Feedback Competency post-implementation of the instructional modular approach.

VARIABLES OF THE STUDY

Independent Variable

Instructional Modular Approach: This variable represents the intervention being studied. It is the teaching method implemented to enhance science teaching competency among prospective teachers.

Dependent Variables

Science Teaching Competency: This is the primary dependent variable, reflecting the level of competency in science teaching among the prospective teachers. It encompasses various

dimensions such as content knowledge application, pedagogical skills, and practical laboratory skills, integration of technology, and assessment and feedback competency.

These variables collectively constitute the framework for understanding the relationship between the instructional modular approach and the enhancement of science teaching competency among prospective teachers.

NEED AND SIGNIFICANCE OF THE STUDY

This study holds immense significance in addressing the critical need for elevating the quality of science education by focusing on the efficacy of an instructional modular approach. Within Al-Ameen College of Education, where physical science prospective teachers are participating, there exists a pressing need to enhance the teaching competency in science education. Despite possessing sound content knowledge, many educators face challenges in effectively translating this knowledge into engaging and impactful classroom experiences.

The need for this study stems from the dearth of tailored methodologies that effectively bridge the gap between theoretical understanding and practical application in science pedagogy. The instructional modular approach presents a promising solution by offering a structured framework to bolster teaching competencies. Evaluating its effectiveness in this specific context of physical science education is crucial to better equip prospective teachers with the requisite tools and strategies to navigate the complexities of science instruction. Insights garnered from this study can inform curriculum development, instructional practices, and teacher training programs, thereby potentially revolutionizing how science education is imparted. Ultimately, by addressing the need for innovative and effective teaching methodologies, this study endeavors to enhance the quality of science education, empowering future educators to inspire and educate the next generation of scientific minds.

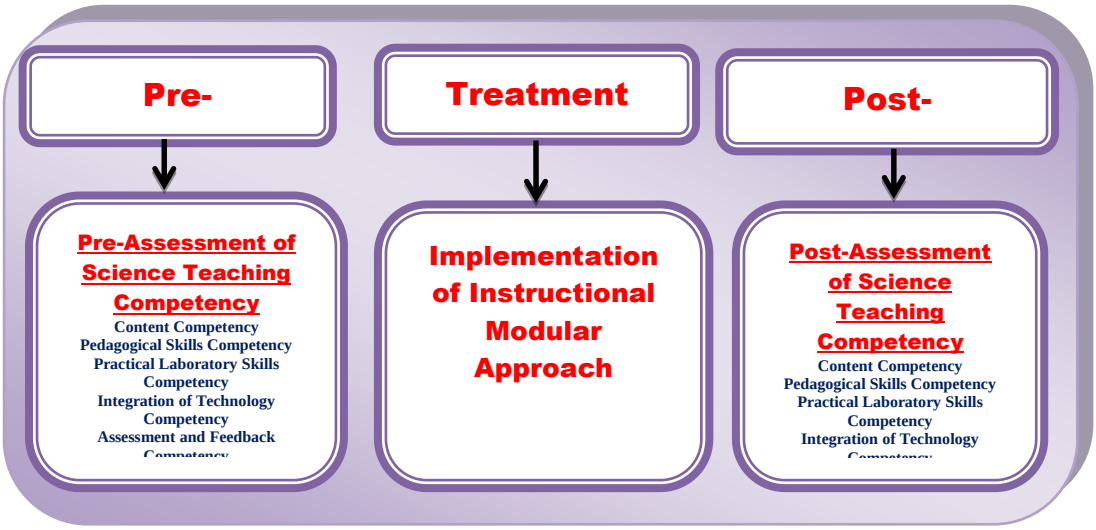
POPULATION OF THE STUDY

The study's population comprises undergraduate students enrolled in the Bachelor of Education (B.Ed.) physical science teacher training program. These individuals are dedicated to advancing their expertise in physical science education within this educational institution. Actively engaged in academic pursuits, they acquire fundamental knowledge and skills essential for teaching science. This diverse cohort, with varied educational backgrounds and aspirations in physical science pedagogy, forms the foundation of this research. Representing a broader group of prospective teachers aiming to enhance their competency in science education, this population is committed to professional development and acquiring effective teaching methodologies. Their participation is crucial to assess the impact of the instructional modular approach on enhancing science teaching competency, shaping the quality of science education for future educators.

SAMPLE OF THE STUDY

The study's sample comprises 27 actively enrolled prospective teachers from Al-Ameen College of Education in Somasipadi, Tiruvannamalai, Tamil Nadu, India. Specifically selected from the physical science teacher training program, this subset forms the participants for the research study. The investigation centers on assessing the impact of instructional modular approaches on the enhancement of science teaching competency among this group of prospective educators.

SINGLE GROUP PRETEST TREATMENT POST TEST DESIGN



The selection of a single-group research design for this study, titled "Effectiveness of Instructional Modular Approach on Enhancing Science Teaching Competency among Prospective Teachers," is grounded in a careful consideration of practical constraints, ethical considerations, and the specific objectives of the research. The practical constraints of the study setting at Al-Ameen College of Education, Somasipadi, Tiruvannamalai, Tamil Nadu, India, play a significant role in the choice of a single-group design. Limited resources, time constraints, and the logistical challenges associated with conducting experiments in an educational context often make it challenging to implement a more complex research design, such as a randomized controlled trial with multiple groups. The single-group design allows for a focused investigation within the available resources and time frame, providing a more realistic and feasible approach to assessing the effectiveness of the instructional modular approach.

FRAMEWORK FOR INSTRUCTIONAL MODULAR APPROACH AND SCIENCE TEACHING COMPETENCY

This study focuses on advancing the proficiency of prospective science teachers through the meticulous exploration of an instructional framework titled "Effectiveness of Instructional Modular Approach on Enhancing Science Teaching Competency among Prospective Teachers." Central to this framework are five key components of Instructional Modular Approaches aimed at refining teaching methodologies. Modular Teaching Techniques, Integration of Learning Modules, Adaptability and Flexibility, Technology Integration within Modular Teaching, and Assessment and Feedback in Modular Teaching serve as pillars in restructuring pedagogical strategies for aspiring educators.

The structured framework delineates essential components for the instructional module. Beginning with a comprehensive Introduction and Overview, it provides clear Instructions and a Pre-test to gauge existing knowledge, followed by delineated Objectives, diverse Learning Activities, Summary and Recap sessions, and a Post-Assessment to evaluate outcomes. These

components are tailored to foster a structured and comprehensive learning experience for prospective teachers.

The experimental study, a critical aspect of this framework, concentrates on three pivotal units in physical science pedagogy: Teaching Skills, Approaches of Teaching, and Methods of Teaching. Within these units, prospective teachers delve into micro-teaching, lesson planning approaches, and a spectrum of instructional methods from teacher-centered approaches like lectures and demonstrations to learner-centered strategies involving self-learning and technology integration. These units aim to equip future teachers with a diverse toolkit for effective science instruction.

Central to this framework is the development of Science Teaching Competency across five crucial domains: Content Competency, Pedagogical Skills Competency, Practical Laboratory Skills Competency, Integration of Technology Competency, and Assessment and Feedback Competency. These competencies serve as the cornerstone for fostering a well-rounded and adept science teaching cadre, ensuring a comprehensive grasp of subject matter, versatile teaching methodologies, hands-on practical skills, adeptness in technology integration, and refined assessment strategies.

This comprehensive framework amalgamates instructional modular approaches, structured components, focused experimental study units, and targeted competency development to elevate the proficiency and preparedness of prospective science educators. It presents a structured pathway towards not only enhancing their teaching capabilities but also ensuring a more robust and effective science education landscape.

TOOLS USED FOR THE STUDY

The Science Teaching Competency Tool is a comprehensive instrument crafted to empower educators in the continually evolving landscape of science education. Integrated with insights from esteemed researchers and scholars, this tool encompasses vital dimensions: Content Competency, Pedagogical Skills, Practical Laboratory Skills, Integration of Technology, and Assessment and Feedback Competency. Educators are encouraged to engage in reflective practices, refine teaching strategies, and adopt innovative approaches to elevate student learning. This tool serves as a guiding compass for educators, fostering a community of adaptable professionals.

Drawing upon consultations with educational experts, the investigator developed the "Science Teaching Competency Scale" comprising 37 components across five dimensions, as presented in below table.

Dimension of Competence in Teaching Science and Number of Items

	ons	**ms**
	ompetency	
	Laboratory Skills Competency	
	cal Skills Competency	
	n of Technology Competency	
	ent and Feedback Competency	

PREPARATION AND SCORING OF ITEMS IN SCIENCE TEACHING COMPETENCY SCALE

The Science Teaching Competency scale, developed based on consultations with experts, comprises 40 statements graded on a four-point scale. Scores range from zero (Not at all) to three (To the maximum extent).

	ion	
	extent	
	lerate extent	
	aximum extent	

4VALIDATION OF TOOLS

The investigator conducted a literature review and consulted experts in teacher education to evaluate science teaching competency among trainees. Considering the diverse nature of existing tools, the researcher developed this tool after gathering relevant information and expert suggestions. The scale was administered, reviewed by experts, and validated based on content and face validity established through dimension-wise analysis.

RELIABILITY OF THE TOOLS

The reliability of the Science Teaching Competency tool was established using Cronbach's Alpha method, resulting in a reliability coefficient of 0.83. This coefficient signifies the tool's reliability in measuring science teaching competency. This high reliability indicates the consistency and dependability of the tool in measuring science teaching competency.

DIFFERENTIAL ANALYSIS

Mean, S.D and 't' values between Pre and Post Assessment Scores on Science Teaching Competency

	eaching Competency			
	sment			
	ssment			

***Significantat0.05level**.

The calculated 't' value of 215.64 between the mean scores of Pre-Assessment and Post-Assessment is significantly greater than the theoretical 't' value of 2.056. This indicates a highly significant difference between the Pre-Assessment and Post-Assessment mean scores in terms of Science Teaching Competency.

The 't' test is a statistical measure that helps determine whether the mean scores between two groups (in this case, Pre-Assessment and Post-Assessment) are significantly different. In this scenario, the extremely high 't' value suggests an immense and statistically significant improvement in Science Teaching Competency from the pre-assessment phase to the post-assessment phase.

Therefore, based on the 't' test results, it is concluded that the Post-Assessment mean score is significantly greater than the Pre-Assessment mean score, providing strong evidence that the instructional approach has led to a substantial enhancement in Science Teaching Competency.

EFFECT SIZE

Although the difference between means is a useful concept to understand power, we need statistics that will allow us to compare different experiments. Specifically we need one that will allow us to compare directly the results of different experiments using the same scale. Cohen decides such statistics and calls it Effect Size (ES). This statistics is represented by the index 'd' which is defined as the degree of departure from Ho of the alternate Hypotheses or the effect size we wish to detect for the directional (one tailed) case.

Effect Size (d) between Pre-assessment and Post-assessment Scores on Science Teaching Competency

	ent				
	sment				
	ssment				

Upon analysis of the above table, the effect size (d) value between pre-assessment and post-assessment scores on teaching competency is 29.02. It indicates a significant difference between pre-assessment and post-assessment scores as a dependent variable in science teaching competency.

GAIN RATIO

McGrin and Peters (1965) suggested that the best criterion for program effectiveness is the gain between the amount learned and the amount that could be learned. The gain ratio is calculated using the formula:

Gain ratio = Science Teaching competency

$$\frac{\text{Mean of (Post Assessment Scores–Pre Assessment Scores)}}{\text{Mean (Full Scores–Pre Assessment Scores)}}$$

Gain Ratio on Science Teaching Competency

	ents	**io**
	eaching Competency (TC)	

Upon analysis of the above table, it is evident that there is a gain of 92.96% in science teaching competency due to the Instructional Modular Approach.

FINDINGS OF THE STUDY

1. The level of Science teaching competency in physical science among prospective teachers is enhanced by the Instructional Modular Approach, as indicated by the improvement in post-assessment mean scores.
2. The calculated 't' value of 215.64 between the mean scores of Pre-Assessment and Post-Assessment is significantly greater than the theoretical 't' value of 2.056. This indicates a highly significant difference between the Pre-Assessment and Post-Assessment mean scores in terms of Science Teaching Competency.
3. The effect size (d) value between pre-assessment and post-assessment scores on teaching competency is 29.02. It indicates a significant difference between pre-assessment and post-assessment scores as a dependent variable in science teaching competency.
4. The evident that there is a gain of 92.96% in science teaching competency due to the Instructional Modular Approach.

EDUCATIONAL IMPLICATIONS

- The study underscores the need for educational institutions to integrate instructional modular approaches into teacher education curricula. This would enhance the development of science teaching competencies among prospective teachers, ensuring a more comprehensive and effective training program.
- Designing continuous professional development programs is crucial. These programs should expose educators to effective instructional modular approaches through workshops, seminars, and training sessions. Ongoing training will equip teachers with the necessary skills for successfully implementing modular techniques in their day-to-day teaching practices.
- Given the significant impact on Integration of Technology Competency, teacher education programs should prioritize seamlessly integrating technology into their training modules. This involves developing educators' skills in utilizing technology for effective teaching and learning, aligning with the demands of modern education.
- Institutions should focus on refining content competency and pedagogical skills among prospective teachers. A targeted approach towards these areas, combined with the instructional modular method, can result in substantial improvement, ensuring educators are well-prepared in both subject matter expertise and effective teaching strategies.

RECOMMENDATIONS

- Educational institutions need to comprehensively integrate modular teaching approaches into their official policies and regulations for teacher training programs. This formal integration ensures consistency and a structured approach to adopting effective teaching methodologies across the educational institution.
- Emphasize and encourage further research initiatives to explore and innovate within modular teaching methodologies. This entails investing resources and academic efforts into studying the diverse impacts of modular approaches across various subjects, ensuring a well-rounded understanding of effective teaching methods.

- Foster collaborations between educational institutions and experts in educational technology. By establishing these partnerships, institutions can benefit from the expertise of specialists, thereby infusing the latest technological advancements seamlessly into teacher training programs.
- Create and sustain communities of practice among educators specializing in science. These communities serve as platforms for sharing experiences, resources, and best practices related to implementing modular approaches effectively in science education.

SUGGESTIONS FOR FURTHER RESEARCH

- Conduct longitudinal studies to analyze the sustained impact of the instructional modular approach on science teaching competencies over an extended period, providing insights into the long-term effectiveness of the approach.
- Perform comparative analyses between different instructional methodologies to ascertain their relative effectiveness and applicability in diverse educational settings, aiding in the identification of the most suitable approaches for specific contexts.
- Explore the adaptability of instructional modules across various science disciplines to cater to the specific needs of diverse subject areas, ensuring the broader applicability of the modular approach in different branches of science.
- Investigate the influence of cultural and contextual factors on the implementation and effectiveness of instructional modules in different regions or countries, recognizing the importance of context-specific considerations in enhancing science education.
- Focus research on the correlation between educators' proficiency gained through instructional modules and subsequent student learning outcomes, shedding light on the direct impact of teacher training on student achievements.
- Research innovative designs and delivery methods for instructional modules, incorporating advancements in technology and pedagogical research to continually enhance and modernize teaching practices.

CONCLUSION

This research ultimately offers profound insights into the effects of the Instructional Modular Approach on the science teaching competency of prospective teachers. The findings illuminate substantial improvements across various dimensions, encompassing content competency, pedagogical skills, practical laboratory techniques, integration of technology, and assessment and feedback proficiency. These enhancements underscore the Instructional Modular Approach's significant role in the professional development of aspiring educators, preparing them for the complexities of contemporary science education.

The research underscores the critical role of tailored interventions in specific competency areas such as content knowledge, pedagogical skills, and technology integration. Notably, the substantial improvements in these domains emphasize the necessity for diversified and targeted approaches within teacher education programs. Moreover, the strong correlation between pre-assessment and post-assessment scores fortifies the consistency and reliability of the findings, showcasing a substantial 92.96% gain in science teaching competency due to the Instructional Modular Approach.

The implications of this research extend far beyond its immediate context, offering invaluable recommendations for curriculum design, professional development initiatives, and technology integration within teacher education. Emphasizing practical laboratory skills alongside fostering effective assessment and feedback practices contributes significantly to the holistic development of educators. This study advocates for the continued exploration and integration of innovative pedagogical approaches within teacher education. As educational landscapes evolve, the adoption of effective teaching methods becomes increasingly imperative. The Instructional Modular Approach stands out as a promising avenue for nurturing proficient and adaptable science educators, primed to inspire and engage the next generation of learners.

The culmination of the research, titled "Effectiveness of Instructional Modular Approach on Enhancing Science Teaching Competency among Prospective Teachers," represents a substantial contribution to the realm of science education. Situated within Al-Ameen College of Education, the study tackles the critical need for refined teaching methodologies and effective pedagogical practices. Employing a single-group experimental design, the research validates the instructional modules' efficacy in enhancing knowledge acquisition, pedagogical skills, and confidence levels among prospective teachers.

Noteworthy improvements in Content Competency, Pedagogical Skills Competency, Practical Laboratory Skills Competency, and Integration of Technology Competency underscore the multifaceted impact of the instructional modular approach. Educational implications advocate tailored methodologies in teacher training, emphasizing the necessity to bridge theoretical understanding with practical application in science pedagogy. Statistical findings yield recommendations to enhance science education among prospective teachers. Looking ahead, avenues for further research, such as longitudinal studies and analyses of cultural influences on module effectiveness, present crucial areas for exploration. Ultimately, this research leaves an indelible mark on teacher training and science education, paving the way for a more impactful and transformative approach to shaping the educators of tomorrow.

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DISCLOSURE OF INTEREST

I don’t have any competing interest

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