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The Role of Astronomy in Early Stem Education: A Case Study of Preschool Teacher Training Programs

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Absract

Fostering cognitive development and promoting interest in scientific disciplines require integrating Science, Technology, Engineering, and Mathematics (STEM) into early childhood education. But preschool instructors sometimes lack the skills and self-assurance needed to teach esoteric STEM subjects, especially astronomy. This study assesses the efficacy of a preschool teachers' astronomy training program using a quantitative research methodology. Measuring improvements in teachers' astronomical knowledge, self-assurance, readiness, and capacity to incorporate astronomy into the preschool curriculum was the goal. Fifteen preschool instructors took part in a two-day training program using a pre-test/post-test approach. Structured questionnaires were used to gather data both before and after the training. According to the pre-survey results, just 20% of participants felt secure enough to teach astronomy, whereas 30% believed they knew enough about the subject. Results from the post-survey indicated a noteworthy improvement in these domains, with 70% indicating increased confidence in their ability to teach and 40% reporting better understanding of astronomy. Furthermore, from 25% to 60%, instructors were better equipped to teach astronomy, and from 13% to 40%, they were better able to incorporate astronomy into the curriculum. The findings imply that focused training initiatives might greatly improve preschool instructors' aptitude for teaching STEM subjects, especially astronomy. In order to close the gaps in instructional abilities and topic understanding and ultimately promote more successful STEM education in early childhood settings, our findings reinforce the necessity of ongoing professional development.

Keywords: Astronomy, Stem Education, Preschool, Teacher, Training

Introduction

Modern education systems across the world recognize the importance of implementing STEM instruction early on, particularly in preschool, as a result of the rapid advancement of technology. STEM education in early childhood is essential for developing critical thinking and problem-solving skills, with research indicating that integrating STEM concepts in preschool positively influences teachers' beliefs and practices (Jade and Poh, 2023). According to Ghazali et.al (2024), STEM education in early childhood is essential for cognitive development and involves 23 best practice themes for effective implementation, which help children gain meaningful experiences and prepare for the future. These fields are currently becoming more and more important for advancement in one's personal and professional life as well as for the innovations and competitiveness of the modern world. Given the substantial cognitive and social benefits of STEM education, there is a growing movement to introduce pre-schoolers to it at a young age. It has been shown that as kids get older up to the age of seven their lifelong learning foundations get stronger. Early childhood STEM education is critical and developmentally appropriate for building a foundation of concepts, knowledge, and skills related to STEM subjects. It emphasizes that concepts and skills learned from birth through 8 years of age are significant precursors to children's subsequent learning and school achievement (Park et.al., 2016). STEM integration at this age also helps kids appreciate items and how they work. STEM integration at this age improves children's appreciation of items and their uses. Research has shown that the more children learn by the time they reach the age of seven, the deeper the roots of learning they gain that will stay with them for life (Clements & Sarama, 2011). Nations are coming to understand the advantages of having a knowledge-based workforce, which is why there is a demand for STEM-savvy individuals. Thus, exposing kids to STEM topics early on fosters an interest in them that, in turn, may eventually affect their career trajectories and success in related disciplines (National Research Council, 2012).

Preschool STEM education provides an engaging way to foster kids' natural curiosity and spirit of exploration. Due to its fascinating and easily relevant character, astronomy appears to have the most potential of the four sciences in terms of catching the attention of young learners. Concepts like the solar system, the phases of the moon, and day and night provide fascinating chances for inquiry science evaluation. Astronomy, with its focus on the perceptible, also opens doors for pupils to receive a successful scientific education by empowering them to ask questions, gather data, and synthesize it. According to French (2004), astronomy is a multifaceted field that encompasses many facets of math, science, technology, and engineering, which makes it ideal for STEM education integration. In addition to learning about the cosmos, young children also study the fundamentals of science, which include making observations, formulating hypotheses, and carrying out experiments that provide the groundwork for future learning.

The incorporation of astronomy and other scientific subjects into early childhood education presents a number of challenges despite its promising future. The degree of preparation of a teacher is the biggest issue. Despite having had extensive training in general pedagogy, the majority of preschool instructors frequently lack background knowledge in scientific subjects like astronomy (Trundle & Sackes, 2015). When early childhood educators are discussing astronomy and space science topics to young children, they frequently encounter some abstract ideas, such as the motions of celestial bodies, the different phases of the moon, or

even the rationale behind the seasons. Many educators wish to and attempt to include astronomy more effectively at developmentally appropriate levels in their lessons, but they are either unable to do so or lack the necessary knowledge and/or training. This has also been made worse by the dearth of clear teaching strategies and easy-to-use exercises that simplify and enjoyably explain difficult scientific subjects. Teachers' lack of confidence and competence in early STEM education has led to the development of systematic teacher training programs, which are today considered a necessary evil. Preschool instructors who participate in training programs aimed at enhancing their sense of astronomy not only acquire the skills required to teach fundamental ideas, but also learn how to instruct younger students. Effective teacher preparation programs create fully qualified teachers by combining theory and practice. This allows the teacher to gain intimate knowledge of astronomy through hands-on activities like observation and testing, making most of the subjects seem easier to teach. In these respects, these activities also contribute to the improvement of the preschool curriculum.

This paper evaluates the efficacy of a teacher training program aimed at enhancing preschool teachers' astronomical knowledge while highlighting the need of teaching astronomy to young children within the framework of early STEM education. The purpose of the study is to determine whether or whether these kinds of training programs have an impact on instructors' knowledge, self-efficacy, and readiness to instruct young students in astronomy and other STEM subjects. Specifically, it evaluates the efficacy of a two-day teacher in service training that combined academic education in astronomy with practical approaches. The curriculum was developed in the fields of astronomy and early childhood education to bridge the previously noted gaps in instructors' readiness for their roles.

This specific study is significant because it might provide guidelines for astronomy teaching in early STEM programs. Through an assessment of preschool teachers' knowledge and confidence both before and after the training on the comprehension of the application of astronomy researched, this study aims to investigate the efficacy of professional development and support. The study's findings will also be discussed, with a focus on how astronomy might be included into early learning to enhance scientific instruction and the value of STEM education for young children. Additionally, the project's findings will influence the creation of educational policy and curricular changes by demonstrating that preschool STEM programs cannot succeed without proper support for teachers' professional development.

These results go to the idea that early STEM education particularly through astronomy is a fantastic way to engage kids and provide the foundation for future scientific endeavours. The preparedness and self-worth of preschool teachers, who play a critical role in creating the surroundings and learning experiences that shape the formative years of children, are what ultimately determine the success of these efforts. This paper will contribute to the understanding of how science education courses should be designed to bridge the professional gap in educators' STEM teaching knowledge, raising the bar for early childhood education and fostering a society of future generations with a strong foundation in science.

STEM Education in Early Childhood

Recent studies have demonstrated that early exposure to STEM domains can have long-lasting advantages on children's cognitive development and academic achievement. As a result, the

integration of STEM education at the preschool level has drawn more interest. Research has indicated that exposing young students to STEM ideas can greatly improve their capacity for creativity, critical thinking, and problem-solving (Clements & Sarama, 2011). Additionally, exposing kids to STEM-related subjects at a young age fosters the development of fundamental abilities that they will carry throughout their schooling and enhance their future competency in these areas.

Early STEM education also offers possibilities for experiential learning, in which kids participate in practical tasks that let them experiment and investigate their surroundings. Because young infants are inherently interested and ready to learn more about the world around them, these encounters are especially useful (Allen, 2016). Early childhood educators may provide learning settings that encourage inquiry, discovery, and a better comprehension of scientific and mathematical subjects by using this natural curiosity. According to Berkowitz (2013), children who are exposed to STEM in an engaging and age-appropriate way not only acquire new information but also grow to love studying and become interested in pursuing STEM-related careers in the future.

Nevertheless, there are obstacles in the way of introducing STEM education to young children. The inability of teachers to confidently and adequately explain difficult scientific and mathematical topics to young children is one of the main challenges. It can be challenging for early childhood educators to successfully include STEM concepts into their instruction since many of them have inadequate experience in these areas, especially in areas like technology and engineering (Sheridan et al., 2011). Additionally, instructors may face extra difficulties due to the abstract nature of some STEM topics, such as those found in astronomy, as they may not have the pedagogical skills or subject understanding necessary to clarify these ideas for toddlers.

Astronomy as a Gateway to STEM Learning

The visual stimulation and relatability that astronomy provides makes it an especially appealing subject for exposing young children to STEM concepts. Young students may participate in scientific inquiry and gain an awareness of the natural world via studying celestial bodies, the solar system, and fundamental astronomical phenomena including day and night cycles (French, 2004). Furthermore, astronomy may be a multidisciplinary field that incorporates parts of STEM education, which makes it a perfect fit for STEM education in its whole.

Astronomy has the ability to improve early childhood education by encouraging critical thinking, observational skills, and curiosity, as demonstrated by several studies. For example, Plummer and Krajcik (2010) discovered that when given in an interactive and developmentally appropriate way, even young toddlers may understand basic astronomical ideas. Children may investigate the motions of celestial bodies, such as the Earth, sun, and moon, in ways that are interesting and approachable by using models, visual aids, and hands-on activities. Children are also encouraged to evaluate their theories, formulate predictions, and ask questions all essential steps in the scientific method by studying astronomy.

Despite its promise, a lack of astronomy teacher experience frequently prevents astronomy from being fully included into early childhood education. According to research by Trundle

and Sackes (2015), many early childhood educators find it difficult to teach astronomy topics to young children because of their abstract character and lack the subject understanding required. The necessity for specialized training programs that emphasize boosting educators' confidence and comprehension of fundamental astronomy ideas is highlighted by this gap in teacher preparation.

Teacher Training in STEM Education

Programs for teacher training and professional development are essential for raising the standard of STEM instruction in early childhood settings. Several studies have shown that the efficacy of STEM education is significantly influenced by the expertise and confidence of the teachers (Pinto et al., 2013). Teachers are more likely to incorporate STEM topics into their lessons in relevant and interesting ways when they have access to the right materials and training. This is especially true for courses like astronomy, where instructors would require more help to acquire the pedagogical techniques and subject matter expertise needed to teach abstract scientific ideas.

A blend of theoretical and practical components is often included in effective STEM teacher training programs, enabling educators to obtain actual teaching experience in addition to deepening their subject area knowledge. According to Van Driel and Berry (2012), teacher preparation programs that include inquiry-based learning strategies, group discussions, and practical applications are more likely to improve instructors' subject-matter expertise and methods of instruction. Moreover, age-appropriate teaching techniques and the use of visual aids are two training programs that are likely to have a long-lasting effect on teacher performance since they are specifically designed to meet the needs of early childhood educators.

According to Crane et al. (2016), teacher confidence in teaching astronomy can be increased by participating in training programs that give them the chance to use solar system models, observe celestial phenomena, and experiment with interactive learning resources. These programs can help simplify difficult concepts and demystify them. Giving educators access to materials like lesson plans, activity guides, and visual aids can also help them be more successful in getting young students interested in astronomy-related activities.

There are still a lot of unanswered questions about astronomy education in the classroom, despite a rising corpus of research on STEM education in early childhood and its promise as a teaching tool. More research is specifically required to examine the long-term effects of early STEM education on kids' academic performance and interest in STEM professions. More study is also required to determine the best ways to prepare early childhood educators to teach astronomy and other STEM disciplines. Above all, it is critical to create teacher training programs that are scalable and adaptable to a variety of educational environments in order to guarantee that all students, regardless of background, have access to excellent STEM instruction.

Astronomy-based STEM education has a lot of promise to support young children's cognitive growth and scientific curiosity when included into early childhood settings. However, for these programs to be implemented successfully, it is imperative that the issues of teacher preparation and topic understanding be addressed. Early childhood educators may be

equipped to provide STEM education that is both interesting and successful, laying the groundwork for lifetime learning, by means of focused professional development and the provision of relevant materials.

Early childhood education is a vital time for brain development, where introducing basic concepts in STEM can improve children's problem-solving skills, critical thinking, and curiosity. Despite understanding the importance of early STEM education, many preschool teachers struggle to include STEM topics, especially astronomy, in their teaching. Research indicates that early STEM exposure can boost academic success and interest in STEM careers. However, many preschool teachers feel unprepared due to a lack of knowledge and confidence, as well as limited teaching resources. This makes it difficult for them to explain abstract concepts like astronomy to young children. This study examines the challenges in early STEM education, particularly focusing on improving preschool teacher training in astronomy. It highlights the need for specialized training programs to enhance teachers' knowledge and teaching methods, enabling them to effectively teach astronomy. Ultimately, the goal is to provide a stronger STEM foundation for pre-schoolers.

Objectives

This research aims to investigate the relevance of Astronomy in early STEM education, through the case of specialization teacher training for pre-school teachers. The objective of this study is to:

a. To evaluate the effectiveness of an astronomy-focused training program in enhancing preschool teachers' knowledge and confidence in teaching STEM-related concepts.
b. To identify the most successful teaching strategies used by preschool teachers for introducing astronomy in early childhood education.
c. To improve the understanding of basic concepts in astronomy among teachers.

Methodology

The influence of a specific astronomy training program on preschool teachers' knowledge, confidence, and readiness to teach STEM topics was assessed in this study using a quantitative research approach. With organized, quantitative data gathered both before and after the training session, the aim of this study was to evaluate changes in the topic knowledge, attitudes for integrating astronomy into early childhood education, and self-efficacy of teachers.

The study used quantitative data gathering techniques to assess the training program's efficacy using a quasi-experimental pre-test/post-test approach. To determine whether there had been any changes in the participants' knowledge, attitudes, and confidence about astronomy and its place in early STEM education, surveys were given to them both before and after the training. The post-test allowed for an assessment of how well the training had improved the astronomy teaching abilities of the instructors, while the pre-test provided a baseline. This study design's structure and objectivity made it possible to gather data that could be statistically examined. With this method, the training program's impact on the participants' knowledge and confidence levels could be measured and documented.

Participants

Fifteen preschool instructors from various preschools in a metro region participated in the study. The instructors were willing to engage in the training program and were easily accessible, thus a convenience sample approach was employed to choose the participants. Participants had to meet the following requirements in order to be considered for inclusion:

1. Have at least three years of expertise instructing young children.
2. Engage in active teaching in a preschool environment.
3. Be prepared to participate completely in the two-day training course and the pre- and post-training evaluations.

The participants' gender distribution was typical of early childhood education, with 87% of them being female (n = 13) and just 13% being male (n = 2). The instructors' experiences varied widely in terms of length of time spent teaching, ranging from one to more than eleven years.

The Training Program

The two-day teacher training course was created especially to improve teachers' comprehension of fundamental astronomical ideas and to provide them ideas for incorporating these ideas into preschool curricula. The curriculum was designed with theoretical classes covering fundamental astronomy subjects including the moon, solar system, and day-night cycle in addition to practical classes where professors conducted practical exercises with students utilizing models, visual aids, and other teaching aids.

The training's objectives were to increase participants' pedagogical understanding and topic knowledge for teaching astronomy through interactive talks, group projects, and lectures. The purpose of the practical component was to provide instructors the chance to put their newly acquired knowledge into practice by having them create lesson plans and teach demonstrations, which the trainers would then assess.

Data Acquisition

Quantitative data was gathered using structured surveys before (pre-test) and after (post-test) the workshop to evaluate the training program's impact. Likert scale and multiple-choice questions were used in the surveys to gauge the following important factors:

a. Content Knowledge: Ten multiple-choice questions covering basic astronomical topics, including the solar system's composition, the moon's phases, and Earth's rotation, were included in the survey. The quantity of right answers provided both before and after the training was used to gauge the participants' level of knowledge.
b. Confidence in Teaching Astronomy: Using a Likert scale, teachers scored their level of confidence in teaching astronomy from 1 (not at all confident) to 10 (extremely confident). This made it possible to monitor changes in self-efficacy, especially with regard to their capacity to impart abstract astronomical notions to young children.
c. Attitudes Toward STEM and Astronomy: Teachers' opinions on the significance of STEM education and the benefit of including astronomy into curriculum for young children were evaluated using Likert-scale questions, with 1 denoting strongly disagree and 5 denoting strongly agree. Teachers' opinions on the applicability of astronomy to young students and their readiness to integrate these ideas into their lesson plans were investigated through a series of questions.

Data Processing

Both descriptive and inferential statistics were used to examine the information gathered from the pre- and post-surveys. Calculations of means, frequencies, and standard deviations were made in order to compile the data and give a general idea of the participants' answers. The average change in knowledge scores, confidence ratings, and attitudes toward astronomy education were the main goals of this investigation.

In order to better understand and be able to teach astronomy as part of early STEM education, a total of 15 preschool teachers took part in a two-day astronomy training session as part of the project. In order to guarantee a varied representation of teaching experience, educational background, and demographic factors, these individuals were chosen through the use of deliberate sampling. The gender distribution of the participants was primarily female, which is indicative of the general gender distribution in the early childhood education field. In particular, 13% (n=2) of the participants were men and 87% (n=13) were women. The gender gap draws attention to a prevalent pattern in early childhood education, where the majority of teachers are women. The requirement for professional development programs to accommodate a female-dominated field while still welcoming male educators is highlighted by this gender representation.

The variability in the participants' preschool teaching backgrounds contributed to the data's richness when assessing the program's efficacy at various skill levels. Three different ranges were identified from their teaching experience:

a. A one to five-year tenure: Sixty-seven percent of the participants (n = 10) had been teachers for one to five years. This group probably consisted of educators who were still in the early stages of their employment but had enough expertise to deal with the difficulties of instructing difficult courses like astronomy.
b. Six to ten years of experience: Of the participants, 27% (n=4) had six to ten years of experience as teachers, which is a lower number. These educators may have been more exposed to a wider range of instructional techniques and pedagogical approaches, which might provide insightful information on how seasoned educators adjust to new subjects like astronomy.
c. 11+ years of experience: Of the participants, only 6% (n=1) had more than 11 years of experience as teachers. This participant most likely represented a very seasoned educator who had seen how early childhood teaching techniques have changed over time. This person may have offered perceptions on how seasoned educators see the incorporation of fresh material, such as astronomy, into already-existing courses.

It is plausible to assume that the teachers came from a variety of educational backgrounds, which is normal in early childhood education settings, even if the study did not specifically offer data on the participants' official educational degrees. While some participants may have more broad teaching degrees, others may have specialized in early childhood education. Their earlier confidence in teaching STEM related subjects and their foundational understanding of astronomy may have been impacted by the variety of their educational background. Every participant showed a dedication to professional growth by signing up for and finishing the two-day session on astronomy training. Their readiness to participate in this training indicates that they both want to enhance their methods of

instruction, especially with regard to STEM education. The participants' commitment to expanding their knowledge and abilities is essential because it demonstrates how proactive they are in addressing the difficulties involved in teaching difficult and abstract subjects like astronomy to young students.

The participants' self-reported baseline knowledge of astronomy varied prior to the instruction, with many claiming a lack of acquaintance. According to the pre-survey findings, 66% of the participants thought their knowledge of astronomy was insufficient. This finding probably reflects the fact that astronomy is not often given much attention in teacher training programs or early childhood education curriculum. On the other hand, 34% of the participants said they understood fundamental astronomy concepts better, indicating that some members of the group may have been exposed to astronomy earlier due to personal interest or past professional development opportunities.

Diverse perspectives were expressed by the participants on STEM education, specifically with the incorporation of astronomy. Pre-survey results showed that although 60% of participants thought it was necessary to teach astronomy to preschool-aged children, 40% disagreed or were unsure about this. This gap demonstrates the different viewpoints that educators bring to the classroom; some are more open to the notion of integrating STEM, while others are unsure of its suitability for younger students.

The pre-survey findings also showed that many participants had no idea how to teach astronomy to young children. Of those surveyed, 53% said they were ignorant of the many approaches and techniques that may be used to teach astronomy to young children. Furthermore highlighting the need for focused professional development in this area, 61% of respondents said they were unsure of how to utilize astronomy in a learning context.

The study's participants included a collection of early childhood educators with a range of experiences in the classroom and degrees of confidence in STEM subjects, especially astronomy. The teachers' involvement in the training program yielded significant insights into the efficacy of professional development activities, specifically with regard to augmenting their knowledge and self-assurance in instructing STEM subjects. A thorough grasp of how various educators interact with and profit from specialized training programs such as the one under evaluation in this study has been made possible by the distribution of genders, the variety of teaching experiences, and the variance in baseline knowledge.

Result and Discussion

To evaluate the effect of the astronomy training program on preschool teachers' knowledge, confidence, and readiness to integrate astronomy into early STEM education, a quantitative technique was employed to examine the pre- and post-survey data of the study. The pre- and post-survey results for the instructors who took part in the astronomy training program are shown in Figure 1 in comparison.

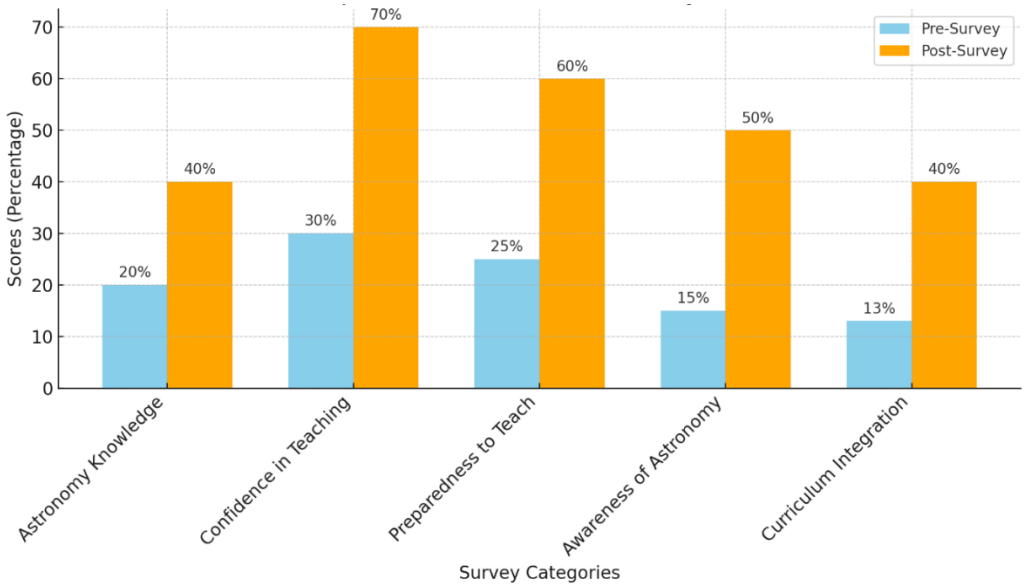

Figure 1. Comparison of Pre and Post Survey

Based on Figure 1, the quantitative data displays the percentage improvement in five important areas: curriculum integration, awareness of astronomy, preparedness to teach astronomy, confidence in teaching astronomy, and astronomy knowledge.

Knowledge of Astronomy

• Pre-survey: Only 34% of participants showed a firm grasp of fundamental astronomical concepts, while 66% of participants judged their knowledge of astronomy to be insufficient before to the training. This show that an average of 20% of participants rated their knowledge as adequate before the training. The general lack of familiarity that early childhood educators have with STEM-related disciplines is reflected in this lack of content understanding.
• Post-survey: Forty percent (40%) of participants gave their knowledge of astronomy a score of 10, which represents a significant gain in comprehension, after the training. This enhancement demonstrates how well the training bridges the knowledge gap.

Pre-survey results indicated that many instructors lacked familiarity with basic astronomical topics including the solar system and moon phases. However, following the training, teachers' knowledge significantly increased, indicating a major positive change.

Confidence in Teaching Astronomy

• Pre-survey: Only 30% of teachers rated their self-efficacy at the highest level (Score 10), indicating a lack of confidence in their ability to teach astronomy. Because they lacked the necessary background knowledge and teaching techniques, many teachers experienced uneasiness when it came to teaching abstract scientific concepts.
• Post-survey: After the training, this percentage rose to 70%, with the majority of participants expressing more assurance in their capacity to instruct astronomy. The post-survey findings showed that instructors' comfort levels with teaching astronomy topics had clearly improved. Figure 1 unequivocally demonstrates that teachers' self-efficacy was raised by the training, with post-survey confidence levels being much higher than pre-survey levels.

Preparedness to Teach Astronomy

• Pre-survey: Prior to the training, just 25% of instructors said they were sufficiently equipped to teach astronomy. This finding indicates a widespread lack of knowledge about how to teach astronomy to pre-schoolers in a way that is both fascinating and age-appropriate.
• Post-survey: 60% of instructors reported feeling more prepared following the training, with many saying they felt considerably more ready to include astronomy in their lessons. This growth indicates that the program was successful in providing instructors with the useful resources they required to instruct the topic.

The session offered useful tactics and approaches that instructors could implement in their classrooms, as evidenced by the preparation scores before and after the training.

Awareness of Astronomy

Pre-survey: Prior to the program, only 15% of participants were aware of the possible uses of astronomy in everyday life and early childhood education.

Post-survey: Following the program, 50% of participants rated their level of awareness between 6 and 10, with 50% concurring that astronomy education should begin in preschool. This suggests that awareness of the value of astronomy in STEM education has significantly improved.

The post-survey data indicates a significant change in teachers' beliefs about how important it is to introduce astronomy to young students, indicating that the training was successful in increasing teachers' knowledge of the subject's relevance.

Curriculum Integration

Pre-survey: Just 13% of participants were able to apply astronomical principles in a preschool learning setting, and 61% were unaware about how to incorporate astronomy across the curriculum.

Post-survey: According to post-workshop data, 33% of respondents reported gains in classroom implementation, and 40% of respondents now had a strong knowledge of how to integrate astronomy into their teaching. This modification shows how well the curriculum has worked to teach educators how to include astronomy into a variety of lesson plans.

The data demonstrates a considerable improvement in curricular integration scores following the training, suggesting that instructors were more adept at integrating astronomy into more comprehensive STEM instruction strategies.

Conclusion

The pre- and post-survey results collectively demonstrate that the training program improved instructors' knowledge, self-assurance, readiness, and attitudes toward astronomy instruction. All categories saw a considerable rise in the percentage of participants who gave their abilities and comprehension the highest ratings. This shows that the training was successful in addressing the main difficulties preschool instructors encounter when attempting to teach STEM subjects, especially those involving abstract ideas like astronomy. In addition to increasing instructors' subject-matter expertise, the training gave them useful tools and techniques they could use in the classroom right away. This is an important result because it guarantees that the knowledge acquired during the workshop is applied to practical teaching strategies that assist young students. To sum up, the results show how important focused professional development initiatives are for improving STEM instruction in the early

grades. These programs may greatly enhance instructors' capacity to present difficult subjects like astronomy to young children by emphasizing both content knowledge and pedagogical abilities, thereby encouraging a deeper interest in STEM areas from an early age.

The results of this study highlight how important professional development is in enabling preschool instructors to successfully include astronomy into early STEM teaching. The findings of the pre- and post-survey showed notable gains in instructors' understanding, self-assurance, readiness, and awareness of astronomy as a worthwhile topic for young students. Many of the participants were ignorant of the significance of teaching STEM ideas to preschoolers, and the majority lacked the topic expertise and confidence to teach astronomy prior to the training. Nonetheless, following the two-day training session, participants reported significant improvements in their knowledge of astronomy, their comfort level while instructing it, and their readiness to include it in their curricula. This study emphasizes how astronomy may be an interesting way to introduce young students to STEM fields. With its visually appealing and accessible phenomena, astronomy provides youngsters with exceptional chances to investigate the natural world, hone their scientific inquiry abilities, and cultivate a sense of curiosity. This training program shows how astronomy can be effectively integrated into early childhood education, building a solid basis for future STEM learning, by providing teachers with the essential information and teaching tools. The findings also show that focused professional development can help teachers overcome a lot of the difficulties they have while instructing students in abstract scientific ideas. The program's ability to improve teachers' readiness to teach astronomy and increase their knowledge of its significance demonstrates the transformational power of well-designed training initiatives for early childhood educators.

Recommendation

Several suggestions may be made to enhance the incorporation of STEM education, especially astronomy, into early childhood education in light of the study's findings:

a. Ongoing Professional Development: Although a single two-day session proved to be successful in this study, instructors' knowledge and abilities must be continuously improved via ongoing professional development. It is advised that preschool instructors take advantage of frequent chances for professional development in STEM fields to make sure they stay knowledgeable and equipped to instruct students in these areas. Refresher courses, access to new teaching resources, and follow-up workshops may all assist sustain the momentum from the first training.
b. Incorporation of Hands-On Learning Resources: A major focus of the training program was the use of practical tools and hands-on activities. Teachers gained valuable knowledge on how to utilize models, visual aids, and interactive activities to help children understand astronomy. In order to enhance the teaching of astronomy and other STEM topics, schools and educational officials should make sure that instructors have access to a broad variety of interactive learning resources. Purchasing solar system models, age-appropriate science kits, and other interactive resources that promote hands-on learning are examples of this.
c. Integration Across the Curriculum: According to the survey, many educators first found it difficult to envision how astronomy might be included into the more comprehensive preschool curriculum. More materials and lesson plans that show how astronomy and other STEM topics may be integrated into other learning domains, such math, reading,

and art, are advised for curriculum creators. Through the integration of STEM education into regular classroom activities, kids can get a more comprehensive and interesting understanding of science.

d. Extension of STEM Content in Teacher Education Programs: The study reveals a notable deficiency in the content understanding of astronomy and other STEM disciplines among early childhood educators. It is advised that more thorough STEM curriculum be incorporated into university and college teacher preparation programs to guarantee that aspiring preschool instructors have a strong foundation in science, technology, engineering, and math when they join the industry. As a result, there will be less need for prolonged professional development after instructors start their careers.

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