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Enhancing Early Childhood Teacher Candidates' Perception of Teaching Science-Technology-Society (STS) through a Project-Based Interdisciplinary Approach

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Enhancing Early Childhood Teacher Candidates' Perception of Teaching Science-Technology-Society (STS) through a Project-Based Interdisciplinary Approach

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Abstract

This study aimed to investigate early childhood teacher candidates' perceptions of teaching Science and Technology in Society (STS) through a project-based interdisciplinary model. The model comprised activities like STS field trips, role-play contests, documentary movie projects, classroom tasks, and group discussions, to foster an understanding of the science and technology underpinning STS issues and promoting informed decision-making. Data were gathered from 30 candidates via reflective journals and short writing assignments. Results revealed candidates' recognition of the pivotal role of science and technology in societal progress and their intent to integrate interdisciplinary approaches learned into their future careers. They also acknowledged the necessity of employing diverse teaching strategies in teaching science and technology to children. Overall, the study underscores the efficacy of a project-based interdisciplinary approach in STS education for early childhood teacher candidates, highlighting the importance of nurturing critical thinking and decision-making skills among future educators.

Introduction

Over the past century, science and technology have increasingly shaped our daily lives. However, there has been limited effort to enhance children's perception of the impact of science and technology on our society (Jenkins, 2010). This lack of awareness has resulted in various adult environmental and social concerns at different levels of society, such as natural resource depletion, loss of biodiversity, environmental pollution, nuclear proliferation, social injustice, and global climate change (Brown et al., 2010). Developing science-related environmental literacy in early childhood is crucial (North American Association for Environmental Education [NAAEE], 2016). To address this issue, various organizations and governmental agencies, including the American Association for the Advancement of Science (1993), the U.S. Department of Commerce (2017), the National Assessment of Educational Progress (2020), and the National Science Teachers' Association (2016; 2020), have recommended incorporating science-technology-society (STS) into science education curricula. STS is an interdisciplinary subject that directly relates to real-world society and connects with other subject areas, promoting meaningful

learning experiences for children (NSTA, 1990). STS engages children in problem-solving activities connected to real-world issues and concerns, facilitating discussion, social negotiation, and cooperative learning (Tsai, 2001).

Purpose of the Study

This study aims to develop an interdisciplinary model for teaching science-technology-society (STS) to early childhood teacher candidates, enhancing their perception of the interconnection between science and technology and global society. The model utilizes project-based, hands-on/minds-on experiences, incorporating community resources to explore STS issues and their solutions for daily life. The study seeks to investigate the impact of the interdisciplinary model on teacher candidates' perceptions of teaching STS and their preparedness to educate future children in this field. Specifically, the study aims to answer the following research questions:

1) How does participation in the project-based interdisciplinary model impact teacher candidates' perceptions of STS teaching?
2) To what extent does the project-based interdisciplinary model prepare teacher candidates to teach STS to future children?

Literature Review

Interdisciplinary Approach

Interdisciplinary curricula and programs have revolutionized science education by integrating environmental education and promoting active learning strategies that enhance critical thinking and problem-solving skills (Pedretti & Nazir, 2011; Frodeman, Klein, & Pacheco, 2017). The interdisciplinary approach involves synthesizing knowledge from different disciplines to address complex problems, often focusing on deep themes that underlie central subjects (Martinello, 2000). By using this approach, children develop versatile skills to transfer knowledge from school to daily life, reinforcing their learning and research habits.

The National Research Council has emphasized the importance of considering science and technology in a social context in various documents, including the NSES (NRC, 1996), the Framework for K-6 Science Education (NRC, 2012), and the Next Generation Science Standards (NRC, 2013). Science and technology are often used to find solutions to practical problems, but this can result in complex social issues. Therefore, it is essential to prepare children for technological innovation, its impact on the quality of life, and the need for critical evaluation of societal matters, including the consequences of technology. The Science-Technology-Society (STS) interdisciplinary approach has been developed to promote scientific and technological literacy, enabling citizens to understand STS issues, make informed decisions, and take responsible actions (NSTA, 1990; Kumar & Chubin, 2000).

Science and Technology in Society

The STS approach strives to link traditional science content with social and technological contexts that are pertinent and meaningful to children (Woodhouse, 2014). By incorporating science content into a practical context

that is based on children' own experiences, the program's interdisciplinary nature is enhanced, and both teachers and children become more engaged (Cinar & Cepni, 2021). A study conducted with Iowa teachers revealed that children who participated in an STS program showed progress in process skills, the ability to apply science concepts and processes to new situations, and even an improved attitude toward science (Akcay & Akcay, 2014). Through the STS interdisciplinary approach, children gain a deeper understanding of scientific knowledge and process skills, which they can then apply to personal and social situations (Bybee, 2006).

Project-Based Learning

Project-based learning is a student-centered approach that empowers children to actively engage in the learning process, take charge of their own learning, and effectively organize information (Ergul & Kargin, 2013). In this approach, children have the autonomy to create and direct their learning, develop their creativity, and collaborate with others to solve real-life problems, bringing authentic experiences into the classroom. Children work independently or in small groups to create tangible projects that require them to find solutions to problems in a self-directed manner, which promotes the acquisition of practical skills and learning through hands-on activities (Chen, 2004). These features make project-based learning particularly advantageous for children, particularly in science and technology education, where it is increasingly popular due to its relevance to everyday life (Ayvacı & Çoruhlu, 2010).

Relationship between Teachers' Perception and Children's Performance

Teachers' perception is a cognitive process that allows the teachers to develop a mental model of their world, enabling them to anticipate future events and respond appropriately (Greve, 2015). While physical stimuli provide limited information, additional information from past experiences and memory is necessary for appropriate interpretation. Once stimuli are interpreted, they become understanding (Tyng et al., 2017).

There is a positive and significant relationship between teachers' perception and children's performance (Adu & Olatundun, 2007). This means that teachers' perception has an impact on children's performance, and the level of children's achievements can be aligned with teachers' perception of what they are teaching. Therefore, teachers must possess broad knowledge, subject matter expertise, attitudes, and behavior to ensure successful teaching. Strong understanding about what they teach can help teachers enhance children's learning and improve their performance.

Teachers' perception encompasses the cognition of environmental stimuli and their responses to those stimuli. Through the perceptual process, teachers acquire critical information about the properties and elements of the environment relevant to their teaching. Perception not only creates teachers' experiences of the world but also allows them to act within their environment (Maund, 2003). Therefore, teachers' perception affects all aspects related to teaching in their classrooms. Harris (2018) observed that teachers' perception influence various teaching skills, styles, models, and approaches that constitute a teaching repertoire within any subject area. This provides a clear framework for describing teaching.

Writing for Measuring Perception

Academic writing provides insight into the ways individuals think and use language (Wosley et al., 2012). As such, it is important for teachers to have well-defined perception of content knowledge and how to effectively convey it. However, this perception is often implicit and difficult to articulate without sustained discussion, as they reflect one's beliefs about linguistics, pedagogy, culture, and disciplinary knowledge and language (Leland et al., 2005). The perception is evident in a teacher's written and oral communication within the classroom (Shanahan & Shanahan, 2008). This study focuses on teachers' reflective writing journals to explore how their perception of teaching Science, Technology, and Society (STS) are shaped when using a project-based interdisciplinary model.

Methods

Research Site and Participants

This study utilized a qualitative approach to investigate the impact of a project-based interdisciplinary model on the comprehension of science and technology teaching among teacher candidates. The research involved 30 sophomore and junior teacher candidates at a Midwestern research university, all enrolled in the Science, Technology & Society course for a semester. These candidates expected to teach science to K-6 graders but lacked prior teaching experience as they were not yet enrolled in the teacher license program.

Project-based Interdisciplinary Model

The project-based interdisciplinary model aimed to develop the candidates' perception of the interconnection of science, technology, and society (STS) through hands-on activities that addressed environmental issues drawn from real-world situations. The five activities included STS field trips, role-play, documentary movie projects, classroom projects, and group discussions: The STS field trips enabled the candidates to identify STS issues directly from their communities and to use local resources and materials to combine science and technology for critical thinking about the issues. However, the classroom faced challenges related to scheduling conflicts with professionals and the distance between community locations. Role-play activities allowed the candidates to apply the issues in a relevant, real-world context, understand different perspectives, and make better decisions. However, organizing these activities with ample time and access to resources was crucial. Documentary movie projects allowed candidates to research STS issues, understand them from various perspectives, and encourage creative and critical thinking by creating hands-on movie clips. However, these projects required time and advanced technology. Classroom projects that can be done within one class hour, such as poster exhibition, bridge building, and sustainable city design, enabled candidates to work together in groups, learn how to harmonize a project, gain others' perspectives, analyze issues, and make decisions. However, some group members may not engage in the project, and project evaluation rubrics indicated the level of involvement. Group discussions allowed candidates to explore specific STS issues together, critically think about the issues, share group decisions about the issues with the class. However, there was a need for more participation in the discussion.

Throughout the semester, the candidates were encouraged to critically evaluate STS issues and share their

experiences and thoughts in a mutually supportive group of practitioners. The course content was developed based on the Curriculum of Science-Technology-Society (COSTS), and hands-on activities were appropriately aligned with the course material (Yoon & Ko, 2013). The candidates met twice weekly for two hours to discuss issues and develop projects. Appendix A presents a work plan within the curriculum of the STS course.

Data Collection

Data for this study were collected using two methods: reflective journals (2-3 pages) and short-writing assignments (1-2 paragraphs). The participants submitted their reflective journals at the end of the semester, responding to three prompts that asked them to reflect on the STS course: Why teach STS, What to teach in STS, and How to teach STS. In-class short-writing assignments were given to participants, asking them to describe what they learned from the STS class that day. The journals and short-writing assignments provided insight into participants' perception of STS issues, as well as their ideas about how to teach STS to future generations of children.

Data Analysis

The participants' journals were reviewed by two researchers after all personal identifiers had been removed. During the initial review, each researcher conducted open coding to identify initial topics in the qualitative data. They then engaged in discussions with each other and used axial coding to identify the relationships between open codes (Corbin & Strauss, 2007). Once the two researchers had reviewed the entire journal for a single participant, they created an open-code table in a separate Word document. The table included their comments, open codes, and the participants' responses, allowing for comparison of each researcher's codes. To assess agreement and disagreement, the researchers compared their codes directly and tallied them for each participant. Rater agreement was calculated by dividing the number of agreed codes by the total number of codes in the document, resulting in a fractional percentage of codes that agreed. This approach made it easy to compare the level of agreement to the desired 80-90% range (Benson et al., 2016). Appendix B presents the open codes and axial codes, along with examples of three participants' responses.

Results

The data for this study were collected from teacher candidates' reflective journals and short-writing assignments. The analysis of this data yielded several compelling themes, which were categorized based on three key questions: Why Teach STS; What to Teach in STS; and How to Teach STS.

Why Teach STS

Almost all of the teacher candidates expressed that teaching science and technology is crucial to success in life and to addressing controversial issues in our society. They understood that STS education helps to equip children with the knowledge and skills necessary to succeed in a rapidly changing world. Through the Project-based

interdisciplinary model, the teacher candidates had gained an appreciation for the critical roles of science and technology in society, as well as an understanding of their potential for both success and failure. Ultimately, the teacher candidates recognized that STS education is essential for preparing future generations to thrive in a complex and interconnected world:

- *STS is to succeed in our lives in the future by understanding the critical roles of science and technology in society.*
- *Learning about Science, Technology, and society is crucial to the success of our lives and our world.*
- *Science and technology are fundamental in the development of new advances in the areas of military and medical research.*
- *STS has impacted me significantly because I now understand just how important it is to fully comprehend the use of science and technology in our world.*
- *We use it [science and technology] every day, often without even realizing that we are using things that fifty years ago people would have had no idea what we are doing.*
- *We learn from our mistakes. The airplane crash happened because something in the plans was not right, so we then fixed those plans to make plane trips safer for others in the future.*
- *Technology and science in our society can positively and negatively influence us.*
- *STS is critical because we as citizens need to know about what is happening in the world so that we can learn to protect ourselves and take certain precautions.*

Given the significant influence of science and technology in our lives, the majority of teacher candidates expressed a strong desire to pass on their understanding and appreciation of these subjects to future generations of children. They recognized the importance of science and technology education in preparing children to navigate the complex and rapidly evolving world around them. As a result, the teacher candidates felt a sense of responsibility to inspire and engage their future children in these critical fields:

- *It is up to us to equip our children with the knowledge necessary to live in an ever-changing society.*
- *I plan to pass on this understanding and appreciation of STS to my future children so they can succeed in their careers by fully utilizing it.*
- *The influence of science and technology is excellent today, and it will only increase as we move forward, so with this growth of science and technology our discussion and education of it must also increase to keep our society and its members safe, healthy, and happy.*
- *Through scientific breakthroughs, our technologies are ever-changing, which is creating more of a need to educate our society about the technologies of the future.*
- *Using the classroom as my podium, I will be able to show my children what is going on in our world regarding science, technology, and specifically biology, which will help them understand our society and, more importantly, our world as a whole. Our children are our future, and because of this I want to teach them about these important aspects, science, technology and biology, so that they can use these tools to get ahead in life and hopeful one day help to make advances in our world using the educational ideas that I have given them.*

A significant number of teacher candidates expressed a strong commitment to teaching the importance of science

and technology in K-6 education. They were passionate about helping their future children learn and appreciate the power and potential of these subjects. The teacher candidates recognized that science and technology are critical for addressing some of the most pressing challenges facing our world, and they hoped to inspire their children to embrace these fields and make a positive impact in their communities and beyond.

- *STS is to provide solutions to controversial issues.*
- *I am deeply committed to instilling a love for STS in my future students.*
- *I believe that STS holds the key to addressing the complex challenges of our society.*
- *I am passionate about equipping children with the knowledge and skills they need to thrive in a rapidly evolving world.*
- *By fostering a sense of curiosity and wonder, I hope to inspire my students to explore the wonders of science and embrace the opportunities that technology offers in our society.*
- *I aspire to empower my students to become innovative problem-solvers and responsible global citizens, capable of making a positive difference in their communities and beyond.*

The project-based interdisciplinary model allowed teacher candidates to develop a deeper understanding of the interconnections between science, technology, and society. By engaging in hands-on projects and exploring real-world issues, the teacher candidates gained valuable insights into how science and technology can be used to address controversial and ethical dilemmas. They recognized that science and technology have the potential to both solve problems and create new challenges, and they felt empowered to guide society in a positive direction.

- *Science and technology play an instrumental role in our world, society, and daily lives, and it is essential to understand their positive and negative impact. Through what we have learned in this class, we must pass on our knowledge to others to create an educated and well-informed society that can overcome present and future problems and find solutions to these problems.*
- *Teaching STS to the children that I will one day have and other people, in general, is a critical task that needs to be handled correctly. Through scientific breakthroughs, our technologies are ever-changing, which is creating more of a need to educate our society about the technologies of the future.*
- *The ethical issues and controversies surrounding STS are prevalent in everyday life whether we notice it or not. We must educate each other on these topics because as helpful as science and technology can be, they can also be harmful. We need to ask ourselves where our science and technology are taking us and whether or not that is the direction that we want our great nation to take.*
- *I will also make sure to teach my children about the controversial ethical issues that are affecting the world of life science. Issues such as stem cell research and cloning are extremely hotbeds at this point with many people. Both of these tools could prove to be essential breakthroughs in the medical world, and by teaching my children about them, I believe I could help gain acceptance of their use.*
- *The "digital divide" refers to an invisible line separating some citizens from the benefits of science and technology. This is mainly because of economic issues but has also been found to be an indicator of ethnicity and location. This has become a major issue in America's society today because of the prevalence of computers and the internet. ……. The Government funds a low-cost computer line, making it affordable for low-income families to get their hands on the technology they need to keep up with society.*

What to Teach in STS

The teacher candidates recognized the importance of addressing STS issues in their future classrooms, as they understood the significant impact that science and technology have on our society. Throughout the semester, the teacher candidates explored a range of STS issues, including feminism, ethics, politics/economics, academia, art & music, minor groups, water conservation, global warming, and sustainability. As future science teachers, they felt a responsibility to share their knowledge and insights with their children to help create a more informed and responsible society. By incorporating STS issues into their teaching, the teacher candidates hoped to inspire their children to become engaged citizens and make a positive difference in the world.

- *In our STS class this semester, we explored many issues and topics related to the relationship between science and technology and how they help develop and change our lives. In our future careers as teachers, this class will help us identify what STS issues to teach to our children.*
- *Through STS, we learned a lot about how science and technology shaped and changed our society. We now know many issues that we need to be aware of and help educate others so they can be aware of them too. As a teacher, it will be my job to educate my children about STS, and I look forward to that task.*
- *All the topics covered this past semester are imperative to everyone's life and should be communicated and taught to everyone.*
- *I have also analyzed the various categories of STS and have come up with what needs to be taught the most to those who are yet to be informed.*

How to Teach STS

The teacher candidates shared their plans for teaching science and technology to future children in their reflective journals and writing assignments. A significant number of them expressed their intention to apply the pedagogical techniques learned through the Project-based interdisciplinary model and integrate multiple approaches when teaching.

Student Engagement. The teacher candidates recognized the importance of keeping children engaged in class and viewed it as an essential aspect of their teaching practice. They emphasized the need to understand children's needs and provide age-appropriate learning materials. For instance, one teacher candidate suggested:

- *Make sure the material is appropriate for the intended age. For instance, if you are teaching first graders, you shouldn't look at stem cell research but maybe look at general medical advances throughout the 20th century.*

Many teacher candidates highlighted the importance of selecting relevant and interesting topics to enhance student engagement. Some teacher candidates suggested that introducing new and exciting topics can grab children's attention and create a sense of curiosity. This approach helps children learn new and fascinating information, increasing their knowledge, and perception of science and technology:

- *Look past the obvious and overused topics. Science and technology can be found everywhere, so try to*

find new topics to engage children and teach them new material they did not know before.

- *Instead of focusing solely on traditional topics like the solar system or basic computer skills, I can explore cutting-edge topics such as biotechnology or artificial intelligence.*

Several candidates reported that bringing materials related to and applicable to their children' lives was another effective strategy to keep children engaged in STS learning. By relating the materials to the children' everyday lives, the teacher candidates believe that they can help children understand how science and technology impact their world, thus making the subject more relevant and interesting:

- *Teach topics that the children can relate to and apply to their lives. Children are always more interested in the material they can understand and apply to their life.*
- *Having the children come up with topics they would like to study might help them get ideas.*
- *Encouraging children to come up with topics they are curious about can further enhance their engagement by allowing them to take ownership of their learning. For instance, discussing topics like renewable energy sources or the impact of technology on their communication can resonate with children and help them understand the real-world implications of scientific and technological concepts.*

Other respondents suggested that this could be achieved by creating a supportive and positive learning environment where all children can participate equally:

- *As mentioned above, many STS issues have ethical debates associated with them. Be sure as an educator to equally explain both sides of the argument so the children get an objective view of the issue.*
- *By creating an environment where every voice is valued and respected, I can empower children to engage in meaningful discussions and explore STS issues with empathy and understanding.*

Use of Technology. Many teacher candidates expressed their intention to incorporate technology into their teaching methods to teach the importance of science and technology to their future children. The World Wide Web was identified as an essential resource for finding teaching ideas, subject-related information, and expert opinions. Some candidates mentioned specific websites that they would use, such as a platform for environmental issues and solutions to teach sustainability. Additionally, many candidates planned to use YouTube videos to present engaging content and enhance their children' learning experience:

- *Finding videos of people's personal experiences with a topic is extremely valuable because many children have not dealt with the real-world lifestyle yet as we are still in school.*
- *Utilizing online resources provides a wealth of information and teaching ideas that can make learning more dynamic and engaging.*
- *Use of YouTube videos offers firsthand accounts and personal experiences related to various topics.*

Another candidate described creating videos in class as one of the most enjoyable teaching methods:

- *I would assign a multimedia group project that involved making a 15-minute video about one of the subjects we talked about in class. I enjoyed making the video. It was one of the most fun I have done as a student, and I am sure school kids would enjoy it too.*

Several candidates emphasized their intention to fully utilize computers in and out of the classroom. For example, one candidate reported planning to use computer-based assignments and tests as a way to enhance their teaching:

- *Quizzes and tests could be done online in the school computer labs, and papers and homework can also be submitted online through email to save more paper…. It is an excellent thing to teach kids the importance of recycling early so that they can continue good eco-friendly habits for the rest of their lives.*

Diversifying Teaching Methods. The teacher candidates recognized the importance of using various teaching methods in addition to technology. They reported that they plan to incorporate methods such as PowerPoint presentations, debates and group discussions, graphic diagrams, field trips, role-play activities, and research projects to make classes more informative and engaging. While PowerPoint presentations were viewed as a useful tool to deliver information effectively, the candidates acknowledged that using only this method would make the class boring. Therefore, most teacher candidates reported incorporating other activities to make classes more exciting. Many candidates believed that debates and group discussions would enhance children's learning outcomes by providing opportunities for them to practice and learn from each other. For example, one candidate planned to engage children in class discussions after presenting PowerPoint slides:

- *It [group discussion] helps children hear more points of view which help them make a more educated opinion.*

Several candidates highlighted the importance of project-based, hands-on activities such as creating graphic diagrams, participating in field trips, and conducting research projects with specific topics. These candidates reported having had positive experiences with the Project-based interdisciplinary model and expressed a willingness to incorporate similar strategies in their future teaching. In contrast to solely relying on PowerPoint presentations or lectures, project-based activities allow children to actively participate in their learning and apply their knowledge in practical situations. One candidate specifically recommended the use of role-play activities as a fun and effective way to engage children in class:

- *Using role-play gets the children to look into a specific topic and make a small skit about what they learned. This is a great way for children to learn a topic in-depth without the feeling that they have spent time researching rather than having fun with it…. This makes for a very fun learning environment and gets children out of their seats and gives them a chance to use their imagination to learn rather than just taking notes in the classroom.*

Limitations

While this study provided valuable insights into the perspectives of certain teacher candidates on teaching science and technology in society and their intended use of technology in the classroom, it is important to acknowledge its limitations. The study was conducted on a single U.S. campus and may not be representative of teacher candidates in other regions or educational contexts. As a result, the findings cannot be generalized beyond the sample population. Therefore, it is crucial to exercise caution when interpreting the study's results.

Discussion

The findings of this study underscore the significance of project-based interdisciplinary models in shaping teacher candidates' perceptions of Science, Technology, and Society (STS). The candidates reported enhanced engagement and a deeper understanding of STS issues through hands-on activities, aligning with the literature that emphasizes the effectiveness of experiential learning in teacher education (Margot & Kettler, 2019). This approach not only fosters critical thinking but also encourages collaboration among candidates, which is essential for developing the skills necessary for future educators (Kumar & Chubin, 2000).

The positive experiences reported by candidates regarding project-based activities, such as role-play and field trips, resonate with recent studies that advocate for active learning strategies in STEM education. For instance, a systematic review by Margot and Kettler (2019) highlights that integrating STEM with real-world applications significantly enhances students' motivation and understanding. This aligns with our findings that candidates felt more prepared to teach STS concepts when they engaged in practical, real-world contexts.

Moreover, the candidates' reflections indicated a shift from traditional lecture-based learning to more interactive and participatory methods. This shift is supported by the National Research Council (2012), which emphasizes the importance of engaging students in scientific practices and crosscutting concepts to foster a deeper understanding of science and technology in societal contexts. The candidates' desire to incorporate similar strategies in their future teaching reflects a growing recognition of the need for innovative pedagogical approaches in early childhood education.

However, the study also revealed challenges, such as varying levels of participation in group projects. This finding is consistent with the literature that discusses the complexities of group dynamics in educational settings (Shanahan & Shanahan, 2008). To address these challenges, future research could explore strategies for enhancing individual accountability within group projects, ensuring that all members contribute meaningfully to the learning experience.The project-based interdisciplinary model proved effective in enhancing teacher candidates' perceptions of STS, aligning with contemporary educational frameworks that advocate for integrated and experiential learning. As the field of education continues to evolve, it is crucial for teacher preparation programs to adopt such innovative approaches, preparing future educators to navigate and teach the complexities of science and technology in society.

Conclusion

The study focused on early childhood teacher candidates' perception of teaching science and technology in society and how the project-based interdisciplinary model can help improve their perception. However, it is important to note that the study had limitations, as it only involved teacher candidates from a single U.S. campus enrolled in an STS course. Thus, caution should be exercised when generalizing the findings beyond this sample.

Nevertheless, the study found that the project-based interdisciplinary model helped teacher candidates develop a

deeper appreciation for the significance of science and technology in our lives and the solutions they offer to social issues. Through reflective journals and writing assignments, teacher candidates demonstrated an understanding of the roles that science and technology play in society. Many expressed a desire to teach their future children STS issues they had experienced through the project-based interdisciplinary model, utilizing multiple instructional methods learned in the course.

The study suggests that the project-based interdisciplinary model has a positive impact on early childhood teacher candidates' perception of teaching STS. By examining STS issues and understanding science and technology's roles in society, teacher candidates develop research skills, synthesis of perspectives, and problem-solving strategies. This preparation is essential for teaching scientific and technological innovation, productivity, and the critical evaluation of societal matters. Additionally, the study found that teacher candidates' strong perception of what they teach are linked to their children' successful learning outcomes. The project-based interdisciplinary model stimulates teacher candidates' perception of why, how, and what they teach STS, leading to improved knowledge, attitudes, and behavior that benefit their future teaching. The model also helps teacher candidates develop models of teaching STS that prepare them for future societal changes. Therefore, incorporating the project-based interdisciplinary model into science teacher education programs is crucial for teacher candidates to gain the necessary knowledge, skills, feelings, and values of STS. It has the potential to positively impact their perception of teaching STS in the future society.

Recommendations

Based on the findings of this study, several recommendations can be made to enhance the preparation of early childhood teacher candidates in teaching Science, Technology, and Society (STS):

Teacher education programs should incorporate project-based learning as a core component of their curriculum. This approach not only engages candidates but also helps them develop practical skills in teaching STS concepts. Programs should design interdisciplinary projects that connect science and technology to real-world societal issues, allowing candidates to experience firsthand the relevance of STS in everyday life.

Educators should create opportunities for collaborative learning among teacher candidates. Group projects, peer teaching, and collaborative problem-solving activities can enhance communication skills and foster a sense of community. Implementing structured group dynamics and accountability measures can ensure that all participants contribute meaningfully to the learning process.

Continuous professional development should be offered to current educators to familiarize them with project-based and interdisciplinary teaching methods. Workshops and training sessions can equip teachers with the necessary tools and strategies to effectively implement STS education in their classrooms, thereby enhancing their teaching practices and student engagement.Teacher candidates should be trained to utilize technology and digital resources in their teaching of STS. Integrating tools such as simulations, online collaborative platforms, and multimedia resources can enrich the learning experience and help candidates engage students in innovative ways.

Future research should include longitudinal studies to assess the long-term impact of project-based interdisciplinary models on teacher candidates' teaching practices and their students' learning outcomes. This will provide valuable insights into the effectiveness of these approaches over time and inform continuous improvement in teacher education programs.Teacher education programs should actively seek partnerships with local organizations, businesses, and community members to provide real-world contexts for STS education. Field trips, guest speakers, and community projects can enhance candidates' understanding of the societal implications of science and technology, making their learning experiences more relevant and impactful.By implementing these recommendations, teacher education programs can better prepare early childhood educators to teach STS effectively, fostering a generation of informed and engaged learners who are equipped to navigate the complexities of science and technology in society.

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Appendix A. The Project-based Interdisciplinary Model Work Plan

Week	Contents	Student Activities
1	Epistemology and social context of science	Group discussion/Short writing
2	The nature of technology and its relationship with science, technology, and society, including ethical and value considerations between.	Group discussion/Short writing
3	Characteristics of scientists/technologists	Group Discussion/Short writing
	Social constructions of scientific technological knowledge.	Group Discussion/Short writing
4	The role of Feminism in STS	Group Discussion/Short writing
5	Ethical issues that arise in STS	Drawing a poster
6	Political/economic issues in STS	Writing a letter
7	Academic issues in STS	Drawing a poster
8	Issues surrounding arts and music	Role-play
9	Perspectives of Minority groups	STS field trips
10	Water conservation & its importance	Role-play
11	Effects of Global warming	STS field trips
12	Sustainability & Its implications	Sustainable City design
13	STS movie day to explore STS themes	Group Discussion/Short writing
14	Role-play contest	
15	Our future and roles of STS in shaping it	Documentary movie project
16	Summary	Reflective Journal

Appendix B. Open Codes, Examples of Participants' Responses, & Axial Codes for the Question Why Teach STS

Open Code	Examples of Participants' Responses	Axial Code
STS is for the success of our lives.	Participant 1. Learning about Science, Technology, and society is crucial to the success of our lives and our world. Participant 2. Science and technology are immensely important in the development of new advances in the areas of military and medical research. Participant 3. Using the classroom as my podium I will be able to show my children what is going on in our world regarding science, technology, and specifically biology which will help them understand our society, and more importantly our world as a whole. Our children are our future, and because of this, I want to teach them about these important aspects, science, technology, and biology, so that they can use these tools to get ahead in life and hopefully one day help to make advances in our world using the educational ideas that I have given them.	STS is to succeed in our lives in the future by understanding the important roles of science and technology in society.
STS is to learn about the failures.	Participant 1. Another important aspect of learning about STS is learning about the failures that our world has dealt with. The failures that we have made in the past are how we make the world better in the future. Basically, we learn from our mistakes. Airplane crashed happen because something in the plans wasn't right, so we then fix those plans to make plane trips safer for others in the future. Participant 2. STS is important because we as citizens need to know about what is going on in the world so that we can learn to protect ourselves and to take certain precautions. Participant 2. The nuclear disaster in 1986 Chermobyl shows that while many of the technological and scientific advances that have been seen in our society and have indeed been beneficial, to us as well as to things such as the environment, there are also many aspects of these advances that have had a negative effect on our society.	STS is to understand past failures and their implications for the future, raising awareness of critical environmental issues.

Open Code	Examples of Participants' Responses	Axial Code
	Participant 3. People need to know that with everything they do it has an effect on either us or our world. One example is global warming. People do not realize how terrible the effects are. I am sad to say until I took this course I did not know either.	
STS is for resolving Social Conflicts	Participant 3. The "digital divide" refers to an invisible line separating some citizens from the benefits of science and technology. This is mainly because of economic issues, but has also been found to be an indicator of ethnicity and location. This has become a major issue in America's society today because of the prevalence of computers and internet. ……. The Government funds a low-cost computer line, making it affordable for low-income families to get their hands on the technology they need to keep up with society.	STS is to provide solutions to controversial issues.
STS is helpful to settle Ethical Dilemmas	Participant 1. The ethical issues and controversies surrounding STS are prevalent in everyday life whether we notice it or not. It is so very important that we as a nation educate each other on these topics, because as helpful as science and technology can be, it can also be harmful. We need to ask ourselves where our science and technology are taking us and whether or not that is the direction we want our great nation to take. Participant 3. I will also make sure to teach my children about the controversial ethical issues that are affecting the biology world. Issues such as stem cell research and cloning are extreme hot beds at this point in time with many people. Both of these tools could prove to be important breakthroughs in the medical world, and by teaching my children about them I believe I could help in gaining acceptance of their use.	The ethical complexity of STS is crucial for informed decision-making and a responsible future.