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Preparing Tomorrow's Science Teachers: How Interdisciplinary Science Course Inspires STEM Teaching

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Abstract
The development of science teacher candidates' intentions to teach STEM is of great importance in terms of equipping teachers with an interdisciplinary approach required by contemporary education, enabling them to provide students with creativity, problem-solving and collaboration skills needed in the 21st century. In this context, the purpose of the current study is to investigate the impact of the 'Interdisciplinary Science Teaching' course on science teacher candidates' STEM teaching intentions. The study employed a single-group pre-test–post-test design. The sample consisted of 40 science teacher candidates enrolled in the "Interdisciplinary Science Teaching" course. The "Integrative STEM Teaching Intention Questionnaire" was utilized to collect the data. In data analysis, paired samples t-test was conducted. The findings revealed a statistically significant difference between the pre-test and post-test total and sub-factor scores of science teacher candidates' STEM teaching intentions, in favor of the post-test scores. Put differently, the 'Interdisciplinary Science Teaching' course is promising in improving science teacher candidates' integrative STEM teaching intentions. Future research is recommended to examine the robustness and generalizability of these findings by employing different samples and experimental designs incorporating control groups.

Keywords: STEM education, teacher education, interdisciplinary science teaching, integrative STEM teaching intentions, science teachers' candidates

INTRODUCTION

In today's world, interdisciplinary science teaching has been receiving much attention since it can provide opportunities to raise well-qualified individuals who are capable in different fields in the 21st century. Research revealed that there are many benefits of using interdisciplinary or integrated education (Stohlmann et al., 2012). For instance, interdisciplinary education is student centered, develops higher level thinking skills and problem solving, and retention (King & Wiseman, 2001). In addition, interdisciplinary curriculum presents less fragmented, more relevant, and more stimulating experiences (Frykholm & Glasson, 2005; Furner & Kumar, 2007; Koirala & Bowman, 2003).

STEM is one of the interdisciplinary science teaching approaches based on the integration of science, mathematics technology and engineering (Sheth & Pathak, 2023). As one of the interdisciplinary approaches, STEM has many benefits for students. Thanks to STEM approach, students can be problem solvers, self-reliant, inventors, innovators, technologically literate and logical thinkers (Morrison, 2006). Sanders (2012) emphasized that as an integrated teaching method, STEM education resolves the inapplicability of traditional, theory-based educational approaches. Since there are many advantages of interdisciplinary STEM approach, it is crucial to be preferred by teachers in their classrooms. Teachers can intend to use STEM approach in their classrooms if they feel prepared. Since teachers are central to the successful implementation of STEM education, attracting academically strong candidates with appropriate disciplinary expertise to teaching is of great importance (Kurup et al., 2019). Therefore, it is crucial to train pre-service teachers in interdisciplinary or integrated approaches like STEM approach. An integrated pre-service teacher education program is an effective way to help science teacher candidates recognize the STEM education teaching (Berlin & White, 2010; Shernoff et al.,2017).

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Purpose of the Research

The aim of the current study was to investigate the impact of interdisciplinary science teaching course integrative STEM teaching intentions of science teacher candidates.

RESEARCH BACKGROUND

Interdisciplinary Science Teaching

Interdisciplinary science teaching emphasizes the integration of an approach that aims to help students understand scientific concepts from a holistic perspective by integrating science with other disciplines such as mathematics, technology, engineering, arts, and social sciences. (Czerniak & Johnson, 2014; Holbrook, 2000; You, 2017). Within this course, students are encouraged to solve real-life problems by drawing on knowledge and skills acquired from multiple fields. Interdisciplinary science education supports the development of 21st-century skills like critical thinking, problem-solving, creativity and collaboration, while also helping learners connect classroom knowledge with everyday life. Through activities enriched with STEM (Science, Technology, Engineering, and Mathematics) practices, students gain a deeper and more meaningful understanding of scientific concepts, develop scientific process skills, and become inquisitive, analytical, and productive individuals. In this regard, interdisciplinary science education is considered an crucial component of contemporary educational approaches (Marcu, 2007).

STEM education is an innovative educational framework that integrates the fields of Science, Technology, Engineering, and Mathematics into a unified learning approach (Bybee, 2013). This approach aims not only to help students acquire theoretical knowledge but also to help them to apply what they learn to solve real-world problems. Thanks to STEM education, students have the chance to improve crucial 21st-century skills like critical thinking, creativity, problem-solving, collaboration, and communication. In today's digital transformation era, individuals are increasingly required to use knowledge and skills from multiple disciplines simultaneously. Therefore, STEM education plays a significant role in equipping students for the careers of the future.

In STEM-based learning environments, students actively participate in the educational process through project-based activities. For example, when students design a solution to reduce environmental pollution, they apply scientific concepts, utilize technological tools, perform mathematical calculations and follow engineering design processes. This interdisciplinary approach develops the permanence of learning while also fostering positive attitudes toward education. In addition, STEM education supports students to conduct research, create innovative ideas, and develop entrepreneurial skills that are highly valued in the modern workforce.

The widespread implementation of STEM education in schools is essential for improving a highly qualified workforce capable of meeting future societal needs. Students who are engaged in STEM activities from an early age tend to show greater interest in science and technology-related fields and are generally more motivated to pursue careers in these areas. Moreover, STEM education enables learners to become adaptable, lifelong learners who can respond effectively to the challenges of a rapidly changing world. As industries continue to depend on technological innovation and scientific advancement, the demand for individuals with STEM competencies is expected to increase. In conclusion, STEM education not only supports students' academic and professional development but also contributes to economic growth and social progress. Thus, STEM-based practices should be more widely integrated into educational systems to prepare future generations with the knowledge, skills, and confidence needed to succeed in the 21st century (Johnson & Czerniak, 2023).

Integrative STEM Teaching Intentions

Integrative STEM Teaching Intentions refer to teachers' willingness, motivation, and commitment to planning and implementing lessons that combine science, technology, engineering, and mathematics in an integrated manner (Hacıömeroğlu & Bulut, 2016; Lin & Williams, 2015; Wu et al., 2024). These intentions play a crucial role in the successful adoption of STEM practices in classrooms (Awad, 2023). Teachers with positive integrative STEM teaching intentions aim to promote students in solving real-world problems, making interdisciplinary connections, and developing higher-order thinking skills. Furthermore, this approach enhances students' creativity, collaboration, communication, and problem-solving skills while preparing them for future careers. Promoting teachers' STEM expertise, instructional skills, and confidence in their abilities can reinforce these intentions and facilitate the effective integration of STEM education practices. Research shows that several dimensions shape these intentions, including teachers' pedagogical beliefs, their willingness to integrate curricula, their attitudes against STEM, their self-efficacy in delivering lessons, and their need for professional development (Kurup et al., 2019; Wu et al., 2024). Such intentions matter since they promote student engagement, prepare learners with skills required in modern industries, and promote equity by making STEM accessible to diverse groups of students. Ultimately, integrative STEM teaching intentions represent a shift in mindset toward equipping students to solve complex, interconnected problems, requiring educators to embrace collaboration, ongoing training, and curriculum redesign (Madden et al., 2013).

The Interdisciplinary Science Education course plays a significant role in developing pre-service teachers' knowledge, skills, and attitudes toward STEM (Science, Technology, Engineering, and Mathematics) education. Through this course, science teacher candidates gain experience in connecting science with mathematics, technology, and engineering disciplines to generate solutions to real-world problems. In this way, they develop the ability to integrate 21st-century skills, such as problem-solving, critical thinking, creativity, and collaboration, which form the foundation of STEM education, into their teaching practices. Furthermore, the interdisciplinary approach enables pre-service teachers to move beyond traditional subject-centered instruction and learn how to create student-centered, inquiry-based, and design-oriented learning environments. By gaining experience in the planning, implementation, and assessment of STEM activities, they can develop instructional strategies that support students' scientific process skills and engineering design thinking abilities. In this respect, the Interdisciplinary Science Education course strengthens teacher candidates' STEM pedagogical content knowledge and contributes to their ability to implement effective STEM instruction in their future professional practice.

In this manner, the research question of the current research was as follows:

- Is there a significant difference between science teacher candidates' pre-test and post-test scores regarding integrative STEM teaching intentions after completing the Interdisciplinary Science Teaching course?

Moreover, the sub-research questions of the current research were like:

- ➢ Is there a significant difference between science teacher candidates' pre-test and post-test scores in the knowledge dimension of integrative STEM teaching intentions after completing the Interdisciplinary Science Teaching course?
- ➢ Is there a significant difference between science teacher candidates' pre-test and post-test scores in the value dimension of integrative STEM teaching intentions after completing the Interdisciplinary Science Teaching course?
- ➢ Is there a significant difference between science teacher candidates' pre-test and post-test scores in the attitude dimension of integrative STEM teaching intentions after completing the Interdisciplinary Science Teaching course?

- Is there a significant difference between science teacher candidates' pre-test and post-test scores in the subjective norm dimension of integrative STEM teaching intentions after completing the Interdisciplinary Science Teaching course?
- Is there a significant difference between science teacher candidates' pre-test and post-test scores in the perceived behavioral control and behavioral intention dimension of integrative STEM teaching intentions after completing the Interdisciplinary Science Teaching course?

METHOD

This study followed a single-group pre- and post-test design as its quantitative research method. Such a design measures the impact of an intervention by assessing the same group of participants before and after the program. In practice, a baseline test (pre-test) is administered to capture participants' initial knowledge, skills, or attitudes, followed by a second test (post-test) after the intervention to identify changes. Comparing these scores provides evidence of the intervention's effectiveness (Cohen et al., 2007; Fraenkel et al., 2012). In the current study, the focus was on pre-service science teachers' intentions toward integrative STEM instruction. Over the course of ten weeks, participants completed the "Interdisciplinary Science Teaching" course, after which their STEM teaching intentions were reassessed to evaluate changes from the pre-test results.

Sample

The study sample consisted of 40 pre-service science teachers enrolled in the Interdisciplinary Science Teaching course at a public university in Istanbul, Türkiye. Criterion sampling, one of the purposive sampling methods, was employed in the study. The participants were selected because they met the criteria considered essential for the research purpose: being senior-level pre-service science teachers, having completed most of their pedagogical and content-related coursework, and having no prior knowledge or experience related to STEM education and STEM lesson design. This group was considered particularly suitable for examining the development of STEM teaching competencies and instructional design skills throughout the course, as they were encountering STEM education for the first time in a structured learning environment. Furthermore, the accessibility of the participants and their direct involvement in the course under investigation enabled an in-depth examination of the instructional process and its outcomes.

Implementation

At the beginning of the *Interdisciplinary Science Teaching* course, the '*Integrative STEM Teaching Intention Questionnaire'* was administered as a pre-test to determine pre-service science teachers' intentions toward integrative STEM teaching. The course lasted ten weeks and was structured in two phases: a theoretical phase and a practical phase.

Theoretical Phase

The theoretical phase was conducted during the first five weeks of the course. Each week consisted of two hours of instruction. During this phase, pre-service science teachers were introduced to the fundamental concepts and principles of STEM education. The topics covered the definition and development of STEM education, the historical background of the STEM movement, the educational and societal benefits of STEM literacy, and the role of STEM education in preparing students for 21st-century skills. Participants were also introduced to instructional strategies and pedagogical approaches commonly used in STEM education. In addition, different STEM integration models, including STEAM (Science, Technology, Engineering, Arts, and Mathematics), E-STEM (Environmental STEM), and C-STEM (Computational STEM), were discussed through presentations, classroom discussions, and examples of STEM lesson implementation.

Practical Phase

The practical phase was carried out during the following four weeks and focused on designing and implementing STEM activities. Participants worked collaboratively in small groups and completed four engineering design-based STEM tasks entitled *"I'm Designing a Spacecraft," "I'm Designing My Race Car," "I'm Designing a Freighter,"* and *"I'm Designing a Roller Coaster."* Each activity was grounded in the engineering design process and required participants to identify a problem, generate possible solutions, design and construct a prototype, test their product, evaluate the results, and redesign when necessary. Throughout these activities, participants were encouraged to integrate science, technology, engineering, and mathematics concepts while solving authentic and real-world problems.

In the final week of the course, participants were asked to develop their own STEM lesson plans based on middle school science curriculum objectives. After preparing the lesson plans, each group conducted a microteaching session in which they implemented their STEM lessons in the classroom environment. Following the teaching practices, feedback was provided through peer discussions and instructor evaluations regarding STEM integration, instructional design, and classroom implementation.

At the completion of the ten-week course, the '*Integrative STEM Teaching Intention Questionnaire'* was administered again as a post-test to determine whether participants' intentions toward integrative STEM teaching had changed following the intervention.

Researcher's Role

The researcher served as the instructor of the '*Interdisciplinary Science Teaching'* course and was responsible for planning and conducting both the theoretical and practical components of the intervention. During the theoretical phase, the researcher presented the course content, facilitated classroom discussions, and provided examples of STEM integration practices. During the practical phase, the researcher guided participants through the engineering design activities, monitored group work, provided feedback when needed, and supported participants in developing STEM lesson plans. To minimize potential researcher bias, the same instructional procedures, materials, and learning opportunities were provided to all participants throughout the study. The researcher's role was limited to facilitating the learning process and collecting research data through the pre-test and post-test administrations.

Table 1. Implementation of 'Interdisciplinary Science Teaching' Course

Weeks (Hours)	**Subjects**
1.week (2 lesson hours)	STEM education and its history
2.week (2 lesson hours)	The long-term benefits of STEM training
3.week (2 lesson hours)	The strategies of STEM teaching
4.week (2 lesson hours)	Different STEM integrations: STEAM, E-STEM, C-STEM approaches
5.week (2 lesson hours)	Different STEM integrations: STEAM, E-STEM, C-STEM approaches
6.week (2 lesson hours)	STEM practice: 'I'm designing a spacecraft'
7.week (2 lesson hours)	STEM practice: I'm designing my race car'
8.week (2 lesson hours)	STEM practice: 'I'm designing a freighter',
9.week (2 lesson hours)	STEM practice: I'm designing a roller coaster'
10.week (2 lesson hours)	STEM lesson plan and teaching practice

Data Collection and Analysis

The data was collected with 'Integrative STEM Teaching Intention Questionnaire' developed by Lin and Williams (2015) and Hacıömeroğlu and Bulut (2016) adapted to Turkish. The questionnaire includes 31 items and is a 7-point likert type scale (from 1-very strongly disagre to 7- very strongly agree). The adapted instrument involves 5 sub-factors: knowledge, value, attitude, subjective norm, perceived behavioral control and behavioral intention. The Cronbach's alpha coefficient of the questionnaire was found to be 0.94 by researchers who conducted the adaptation study (Hacıömeroğlu and Bulut, 2016). In the current research, Cronbach's alpha coefficient was calculated as 0.92. A paired-samples t-test was performed to analyze the data, as the difference scores between the two related measurements were normally distributed.

Ethical Concerns

The current research was carried out with the agreement of the Yıldız Technical University, Social and Human Sciences Scientific Research and Publication Ethics Board (Report No: 20260309196), granted at the meeting dated March 2, 2026 (Decision No: 2026/03). Informed consent was obtained from all pre-service science teachers before participation. Participants were thoroughly briefed about the study procedures, including the implementation, data collection, and course content. They were clearly informed that the activity was part of the research, that their participation was optional, and that they could withdraw at any stage. To protect privacy, no personal information or names were recorded or shared, ensuring anonymity. Additionally, strict measures were taken to safeguard pre-service science teachers, and the researcher ensured that no harm, risk, or disadvantage arose during the study.

RESULTS

In this study, the impact of 'Interdisciplinary Science Teaching' course on science teacher candidates' integrative STEM teaching intentions were examined. The pre- and post-test results about PSTs' integrative STEM teaching intentions were presented in Table 2 and 3. According to the findings, there were statistically significant differences between pre- and post-test scores in favour of both PSTs' post total test scores (t (39) = -24.48, p<.05). Furthermore, Cohen's d value (effect size) was calculated according to the formula (Cohen's d =Mean/Standard Deviation) and found as 3.86 along with its 95% confidence intervals. That is, there was a significantly large difference between the scores of PSTs' pre- and post-scores of integrative STEM teaching intentions.

Table 2. PSTs' Integrative STEM Teaching Intentions

Integrative STEM Teaching Intentions		**Mean**	**N**	**Std. Deviation**
Total	Pre-test	150.93	40	8.04
	Post-test	190.20	40	6.89

Table 3. Results of Paired Samples t- test for PSTs' Total Scores in Integrative STEM Teaching Intentions

					95% Confidence Interval of the Difference					
Integrative STEM Teaching Intentions		**Mean**	**Std. Deviation**	**Std. Error Mean**	**Lower**	**Upper**	**t**	**df**	***p***	***Cohen's d***
Total	Pre-test-Post-test	-39.28	10.15	1.60	-42.52	-36.03	-24.48	39	p < .001	3.86

*p<0.05

Results about 'Knowledge' Factor of Integrative STEM Teaching Intentions

Firstly, the effect of 'Interdisciplinary Science Teaching' course on science teachers candidates' scores in the knowledge dimension of integrative STEM teaching intentions were examined in the current study. The pre- and post-test results about PSTs' scores in the knowledge dimension of integrative STEM teaching intentions were presented in Table 4 and 5.

Table 4. Results about 'Knowledge' Factor

Factor of Integrative STEM Teaching Intentions		**Mean**	**N**	**Std. Deviation**
Knowledge	Pre-test	18.58	40	2.02
	Post-test	24.15	40	1.83

Table 5. Results of Paired Samples t- test for PSTs' Scores in the 'Knowledge' Dimension of Integrative STEM Teaching Intentions

Factor of *Integrative STEM Teaching Intentions*		**Mean**	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**		**t**	**df**	***p***	***Cohen's d***
					Lower	**Upper**				
Knowledge	Pre-test-Post-test	-5.56	2.43	.384	-6.351	-4.798	-14.53	39	p < .001	2.28

*p<0.05

Results showed that PSTs' scores in the knowledge dimension of integrative STEM teaching intentions were medium level at the beginning of the 'Interdisciplinary Science Teaching' course. After the course, PSTs' scores in the knowledge dimension of integrative STEM teaching intentions developed and reached higher level (Knowledge (t (39) = -14.53, p<.05) (Table 4-5). Moreover, Cohen's d value (effect size) was was calculated according to the formula (Cohen's d =Mean/Standard Deviation) and found as 2.28 along with its 95% confidence intervals. That is, there was a significantly large difference between the scores of PSTs' pre- and post scores in the knowledge dimension of integrative STEM teaching intentions.

Results about 'Value' Factor of Integrative STEM Teaching Intentions

Secondly, the effect of 'Interdisciplinary Science Teaching' course on science teachers candidates' scores in the value dimension of integrative STEM teaching intentions were examined in the current study. The pre- and post-test results about PSTs' scores in the value dimension of integrative STEM teaching intentions were presented in Table 6 and 7.

Table 6. Results about 'Value' Factor

Factor of Integrative STEM Teaching Intentions		**Mean**	**N**	**Std. Deviation**
Value	Pre-test	28.88	40	3.05
	Post-test	35.15	40	2.23

Table 7. Results of Paired Samples t- test for PSTs' Scores in the 'Value' Dimension of Integrative STEM Teaching Intentions

Factor of *Integrative STEM Teaching Intentions*		**Mean**	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**		**t**	**df**	***p***	***Cohen's d***
					Lower	**Upper**				
Value	Pre-test-Post-test	-6.28	3,99	.632	-7.55	-4.99	-9,92	39	p < .001	1.57

*p<0.05

Results showed that PSTs' scores in the value dimension of integrative STEM teaching intentions were medium level at the beginning of the 'Interdisciplinary Science Teaching' course. After the course, PSTs' scores in the value dimension of integrative STEM teaching intentions developed and reached higher level (Value (t (39) = -9,92 p<.05) (Table 6-7). In addition, Cohen's d value (effect size) was was calculated according to the formula (Cohen's d =Mean/Standard Deviation) and found as 1.57 along with its 95% confidence intervals. That is, there was a significantly large difference between the scores of PSTs' pre- and post scores in the value dimension of integrative STEM teaching intentions.

Results about 'Attitude' Factor of Integrative STEM Teaching Intentions

Thirdly, the effect of 'Interdisciplinary Science Teaching' course on science teachers candidates' scores in the attitude dimension of integrative STEM teaching intentions were examined in the current study. The pre- and post-test results about PSTs' scores in the attitude dimension of integrative STEM teaching intentions were presented in Table 8 and 9.

Table 8. Results about 'Attitude' Factor

Factor of Integrative STEM Teaching Intentions		**Mean**	**N**	**Std. Deviation**
Attitude	Pre-test	30.05	40	3.48
	Post-test	36.65	40	1.70

Table 9. Results of Paired Samples t- test for PSTs' Scores in the 'Attitude' Dimension of Integrative STEM Teaching Intentions

Factor of *Integrative STEM Teaching Intentions*		**Mean**	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**		**t**	**df**	***p***	***Cohen's d***
					Lower	**Upper**				
Attitude	Pre-test-Post-test	-6.60	3.41	.539	-7.69	-5.51	-12.24	39	p < .001	1.94

*p<0.05

Results showed that PSTs' scores in the attitude dimension of integrative STEM teaching intentions were medium level at the beginning of the 'Interdisciplinary Science Teaching' course.

After the course, PSTs' scores in the attitude dimension of integrative STEM teaching intentions developed and reached higher level (Attitude (t (39) = -12.24, p<.05) (Table 8-9). In addition, Cohen's d value (effect size) was was calculated according to the formula (Cohen's d =Mean/Standard Deviation) and found as 1.94 along with its 95% confidence intervals. That is, there was a significantly large difference between the scores of PSTs' pre- and post scores in the attitude dimension of integrative STEM teaching intentions.

Results about 'Subjective Norm' Factor of Integrative STEM Teaching Intentions

Fourthly, the effect of 'Interdisciplinary Science Teaching' course on science teachers candidates' scores in the subjective norm dimension of integrative STEM teaching intentions were examined in the current study. The pre- and post-test results about PSTs' scores in the subjective norm dimension of integrative STEM teaching intentions were presented in Table 10 and 11.

Table 10. Results about 'Subjective Norm' Factor

Factor of Integrative STEM Teaching Intentions		**Mean**	**N**	**Std. Deviation**
Subjective Norm	Pre-test	20.95	40	3.98
	Post-test	29.05	40	2.71

Table 11. Results of Paired Samples t- test for PSTs' Scores in the 'Subjective Norm' Dimension of Integrative STEM Teaching Intentions

Factor of *Integrative STEM Teaching Intentions*		**Mean**	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**		**t**	**df**	***p***	***Cohen's d***
					Lower	**Upper**				
Subjective Norm	Pre-test-Post-test	-8.10	4.40	.696	-9.51	-6.69	-11.639	39	p < .001	1.84

*$p<0.05$

Results showed that PSTs' scores in the subjective norm dimension of integrative STEM teaching intentions were medium level at the beginning of the 'Interdisciplinary Science Teaching' course. After the course, PSTs' scores in the subjective norm dimension of integrative STEM teaching intentions developed and reached higher level (Subjective norm (t (39) = -11.639, p<.05) (Table 10-11). In addition, Cohen's d value (effect size) was was calculated according to the formula (Cohen's d =Mean/Standard Deviation) and found as 1.84 along with its 95% confidence intervals. That is, there was a significantly large difference between the scores of PSTs' pre- and post scores in the Subjective Norm dimension of integrative STEM teaching intentions.

Results about 'Perceived Behavioral Control and Behavioral Intention' Factor of Integrative STEM Teaching Intentions

Fifthly, the effect of 'Interdisciplinary Science Teaching' course on science teachers candidates' scores in the perceived behavioral control and behavioral intention dimension of integrative STEM teaching intentions were examined in the current study. The pre- and post-test results about PSTs' scores in the perceived behavioral control and behavioral intention dimension of integrative STEM teaching intentions were presented in Table 12 and 13.

Table 12. Results about ‘Perceived Behavioral Control and Behavioral Intention’ Factor

Factor of Integrative STEM Teaching Intentions		**Mean**	**N**	**Std. Deviation**
Perceived Behavioral Control and Behavioral Intention	Pre-test	52.48	40	5.32
	Post-test	65.20	40	5.01

Table 13. Results of Paired Samples t- test for PSTs’ Scores in the ‘Perceived Behavioral Control and Behavioral Intention’ Dimension of Integrative STEM Teaching Intentions

Factor of *Integrative STEM Teaching Intentions*		**Mean**	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**		**t**	**df**	***p***	***Cohen’s d***
					Lower	**Upper**				
Perceived Behavioral Control and Behavioral Intention	Pre-test-Post-test	-12.73	7.58	1.20	-15.15	-10.30	-10.619	39	p < .001	1.68

*p<0.05

Results showed that PSTs’ scores in the perceived behavioral control and behavioral intention dimension of integrative STEM teaching intentions were medium level at the beginning of the ‘Interdisciplinary Science Teaching’ course. After the course, PSTs’ scores in the perceived behavioral control and behavioral intention dimension of integrative STEM teaching intentions developed and reached higher level (Perceived Behavioral Control and Behavioral Intention’ (t (39) = -10.619, p<.05) (Table 12-13). In addition, Cohen’s d value (effect size) was was calculated according to the formula (Cohen’s d =Mean/Standard Deviation) and found as 1.68 along with its 95% confidence intervals. That is, there was a significantly large difference between the scores of PSTs’ pre- and post scores in the Perceived Behavioral Control and Behavioral Intention dimension of integrative STEM teaching intentions.

CONCLUSION AND DISCUSSION

This study explored how the Interdisciplinary Science Teaching course influences pre-service science teachers’ intentions to adopt integrative STEM practices. The findings indicated a statistically significant increase in participants’ integrative STEM teaching intention scores from pre-test to post-test. Similarly, Adams et al. (2014) reported that STEM teaching through integrated, place-based activities positively influenced pre-service teachers’ perceived competence, and their intentions to design and implement place-based STEM learning activities. Additionally, Karisan et al. (2019) revaled that pre-service teachers’ intentions and awarenness to teach STEM-related subjects increased after participating in a STEM methods course. In addition, Aydogan Yenmez et al. (2021) showed that teachers who embrace STEM education, incorporate activities into their lessons, and value interdisciplinary knowledge can contribute meaningfully to the Turkish education system. Deniş Çeliker (2020) reported that scenario-based STEM projects improved teachers’ teaching intentions, their conceptions of 21st-century skills, and attitudes toward STEM. Likewise, Kurup et al. (2019) revealed that pre-service teachers possess strong intentions toward teaching STEM in their future professional careers. Hiğde (2022) also demonstrated that STEM teaching intentions rose significantly after implementation, with notable differences between pre- and post-test scores across knowledge, values, attitudes, perceived control, and behavioral intentions. Şenyiğit and Serin (2022) found that pre-service teachers at primary school who used technology regularly or consistently demonstrated significantly higher levels of integrated STEM teaching intentions compared to those who used technology rarely or never. Uğraş and Genç (2018) revealed that preschool teachers viewed STEM positively, believing it helps students think critically, apply theory in practice, and create tangible products. They emphasized the need for undergraduate programs to include STEM courses, encourage collaboration across disciplines, and provide STEM training. These findings underscore the importance of STEM approaches, which benefit students by fostering innovation and practical skill development. In addition, the results suggest that STEM-based activities can effectively enhance teachers' intentions and attitudes toward integrative STEM teaching. As Abell (2007) noted, teachers must be well-prepared in both subject matter and pedagogy to successfully implement STEM. The Interdisciplinary Science Teaching course equips future science educators with the professional knowledge needed to teach effectively through STEM.

In conclusion, interdisciplinary science courses are vital in preparing future teachers by integrating concepts across science, technology, engineering and mathematics. This holistic approach helps educators design lessons that mirror real-world complexity, deepens their content knowledge, and inspires innovative, inquiry-based teaching. By experiencing the interconnectedness of scientific ideas, pre-service teachers gain confidence to nurture curiosity, problem-solving and critical thinking—skills necessary for cultivating the next generation of STEM learners.

Limitations and Recommendations for Future Research

This study has several limitations that should be considered when interpreting the findings. First, the study employed a single-group pre-test and post-test design without a control group. Therefore, although changes in participants' intentions toward integrative STEM instruction were observed after the intervention, it is not possible to attribute these changes solely to the course with complete certainty, as other external factors may have influenced the results. Future research should employ experimental or quasi-experimental designs that include control or comparison groups to provide stronger evidence regarding the effectiveness of STEM-related interventions.

Second, the study was conducted with a relatively small sample consisting of 40 pre-service science teachers from a single public university in Istanbul, Türkiye. Consequently, the findings may not be generalizable to all pre-service teachers in different educational contexts, institutions, or regions. Future studies should involve larger and more diverse samples drawn from multiple universities and geographical regions to enhance the generalizability of the findings.

Third, the participants were selected using purposive criterion sampling and all were enrolled in the same course. While this approach was appropriate for addressing the research objectives, it may limit the representativeness of the sample. Future research could employ probability-based sampling methods or include participants from different teacher education programs and academic backgrounds to obtain a more representative sample.

Finally, the study focused on participants' self-reported intentions toward integrative STEM instruction rather than their actual classroom practices. Although teaching intention is an important predictor of future behavior, the findings do not provide direct evidence regarding participants' implementation of STEM instruction in real classroom settings. Future studies should incorporate classroom observations, teaching performance assessments, interviews, and longitudinal research designs to investigate whether and how these intentions translate into actual STEM teaching practices over time. Such studies may also explore the factors that facilitate or hinder the transition from intention to practice.

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