Investigation of the relationship between teachers' self-efficacy in inquiry-based teaching for STEM+S and teaching 21st century skills*

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Abstract

This study examines the relationship between teachers' inquiry-based self-efficacy for STEM+S and 21st-Century skills teaching and whether these two scales change regarding various teacher variables. The study's sample, which is designed with relational design, consists of 407 teachers working in Gaziantep. The study includes teachers working in kindergarten, primary, secondary, and high school public and private schools. "Personal information form," "Inquiry-based teaching self-efficacy scale for STEM+S," and "21st-Century skills teaching scale" was used. The data obtained from the scales were analyzed using the SPSS program. As a result of the research, it is seen that the relationship between teacher 21st-Century skills teaching and inquiry-based teaching self-efficacy for STEM+S is moderate. The scores of the teachers' self-efficacy and sub-dimensions of inquiry-based teaching for STEM+S showed statistically significant differences according to their 21st-Century skills training. There is a significant difference in asking questions, research, discussion/reflection, and overall scale according to the status of receiving STEM education. A statistically significant difference is detected when the 21st-Century skills and sub-factor scores are analyzed according to 21st-Century skills and STEM education. Inquiry-based teaching for STEM+S has been found to have a statistically predictive effect on 21st-Century skills teaching. It can be said that approximately 46% of the variance explained for 21st-Century skills teaching consists of inquiry-based teaching for STEM+S. When this situation is examined, it is stated that self-efficacy based on inquiry for STEM+S has an essential effect on teachers' self-efficacy in explaining the teaching of 21st-Century skills.

Keywords: STEM, Inquiry, Self-efficacy, 21st-Century skills.

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INTRODUCTION

STEM consists of the initials of the English names of science, mathematics, technology, and engineering disciplines. "STEM" is an educational model that aims to find solutions to problems by revealing creativity in individuals that can affect all levels of education starting from preschool and, at the same time, activates a sense of curiosity (Ekbenli, 2017). To put it more comprehensively, according to Bybee (2010), STEM can be said as an educational model that is used in the solution of today's problems, that allows teachers to gain 21st-Century skills, and that emerges with the integration of science, mathematics, technology, and engineering disciplines. Thus, it is thought that students contribute to both STEM disciplines and career fields in STEM and increase interest in STEM fields (Başaran & Bay, 2022). In addition to the four disciplines, STEM education was tried to be integrated with other disciplines, such as Literature (STEM+L) and Art (STEAM) (Karahan, 2016), and integrative studies were seen as an effort to increase interest in the STEM field (Bolat, 2020). The rapid spread of STEM, an education model, into education systems worldwide (Bybee, 2010) has led to the acquisition of many stakeholders and has gained importance in terms of the qualifications it will bring to its stakeholders. These qualities are,

- Positive impact on predictive thinking
- Contribution to technology literacy
- Providing a bridge between the STEM education learned in school and real problems
- Be able to relate to their own culture and history
- Developing high-level thinking skills
- To be able to develop productive solutions to world problems
- It can be listed as raising self-confident individuals by developing self-confidence. (Corlu, Caprora & Caprora, 2014; Morrison, 2006; Yıldırım & Altun 2015).

However, it can be said that the STEM education model improves students' comprehension, assimilation, and information processing and increases the sense of working as a group (Güneş Varol, 2020). The STEM education model especially aims to solve students' real-life knowledge-based problems with technology, mathematics, science, and engineering approaches (Başaran, 2018) and emphasizes STEM literacy in school programs (Bybee, 2010). In order to increase competition between countries, the American National Research Council (NRC) (2011) aims to enable students at all levels of education to make original decisions, progress culturally, develop the awareness of being a citizen, and, most importantly, to develop STEM literacy that includes mathematical and scientific knowledge understanding of students. In line with these goals, it will be ensured that students gain appropriate skills and competencies (Akgündüz et al., 2015b). There are different ways of teaching STEM education. These disciplines of STEM education are included in the form of teaching by integrating all the disciplines expressed individually, in two groups, or in the most comprehensive way. In addition to all these approaches, the most used approaches are silo, embedded, and integrated approaches (Başaran, 2018). A silo approach is an information-based approach to memorization in which each discipline centers on the teacher with little or no connection to each other. The embedded approach ensures that knowledge is strengthened by being supported by other disciplines while learning in one discipline. The student can be more proficient in comprehension and application with the embedded approach. Finally, the integrated approach effectively allows students to integrate all disciplines in learning the subject and transform knowledge into practice. The integrated approach will allow students to find solutions to problems and simultaneously think critically and creatively. To better comprehend and make sense of STEM education, it is necessary to know the relationship and objectives of the disciplines within it. Natural science is a discipline that can create results by using generalizations about the relationship between the beings in nature and the events that occur (Yüksel, 2019). Skills have been essential from the existence of humanity to the present day and have always kept their place in the struggle for existence (Karataş, 2021). The rapid changes in science and technology have caused the skills to be transformed following the necessity of the new age. We live in the 21st century. It is necessary to acquire some skills to follow the developments in Turkey (Karataş, 2021). These qualities include critical thinking, gaining experience in accessing scientific information, solving problems, being open to new ideas, having leadership and productivity skills, being flexible and adaptable, and being able to cooperate (Eryılmaz & Uluyol, 2015). According to Kennedy and Odell (2014), 21st-Century skills: include collaboration and communication, problem-solving, technology and information literacy, global awareness, creativity and innovation, critical thinking, leadership, responsibility, and productivity. For an individual to acquire these skills and take part in their whole life, these skills must also take their place in education. The Ministry of National Education (2018) updates education programs of the 21st century so that students do not fall behind. skills and 21st century. makes their skills gain importance in education. For this, the role of teachers, one of the important stakeholders in education, also varies. Teachers need to have these skills to educate students in the 21st century. Should aim to gain skills (Çoban, Özdemir & Turan, 2021). 21st-Century skills can make learning interesting and meaningful for students (P21, 2009). The content and themes for acquiring these skills are grouped into three groups. Learning and Renewal Skills: To adapt to the rapid progress of the age, the individual needs to know how to obtain the learning he or she needs. The skills required for this are:

- Learning and renewal
- Innovation
- Creativity and originality
- Problem-solving
- Critical thinking
- Collaboration and communication

Life and Career Skills: Teachers must equip their students with skills to prepare them for rapidly changing conditions. With these skills, individuals are expected to be able to keep up with life changes, overcome some difficulties to their advantage, and simultaneously adapt to their environment and other individuals. These skills are:

- Entrepreneurship and self-direction
- Social and intercultural skills
- Leadership and responsibility
- Productivity and responsibility
- Flexibility and harmony

Information, Media, and Technology Skills: Today, we live in a media-oriented environment where information is plentiful, quickly accessible, and rapidly changing. Among all these, it is necessary to have some skills to reach the correct information and avoid information pollution. These skills are:

- Information literacy
- Information and communication technologies literacy
- Media literacy

According to Akyol (2020), it is the 21st century based on skills; to become an individual who can use technology, solve problems, manage himself and his environment, communicate, cooperate and, most importantly, produce. All these skills also serve the same purpose as the STEM education model (Akyol, 2020; Kavak, 2019). The STEM education model can enable students to learn by bringing the disciplines together, with skills such as creative thinking, problem solving, technology, and questioning parallel to their skills (Bolat, 2020). For this reason, in integrating the STEM education model and science, technology, mathematics, and engineering disciplines, 21st-Century skills play a huge role.

STEM has also been tasked with providing 21st-Century skills with the aims of science sciences, such as creating solutions to problems using scientific methods, making sense of the interaction of the individual, society, and environment with each other, and doing scientific work (Kutlu 2019). Science needs a STEM education model for students to gain different perspectives by benefiting from the feelings of inquiry and curiosity and finding solutions to real problems. The technology included in STEM, which we encounter in every field today, aims to provide a learning experience by establishing relations with other disciplines (Wang 2012). The importance of technology in the STEM education model is that students can collect data, visualize materials, and conduct experiments and research. Other disciplines other than technology in STEM can combine to produce technological products (Yıldırım & Türk, 2018). Another discipline involved in STEM is engineering.

For this reason, for individuals to understand and gain this discipline, it is necessary to place it at all levels of education, starting from kindergarten. In the engineering design process, some application steps include numerical thinking, model development, designing the solution path, analyzing the data, asking questions, and making interpretations. When these application steps are considered, it is thought that the engineering discipline can effectively teach subjects and rams in the STEM education model. Another discipline in STEM is mathematics. While mathematics's numbers, operations, patterns, and data constitute an essential part of engineering and science, they can contribute to technology. Mathematics is a discipline that allows students to think rationally and logically, teaches them to cope with real-life problems, and helps them make unbiased and consistent assessments (Yenilmez, 2011).

For this reason, mathematics becomes a sine qua non in the STEM education model. It allows students to create and develop scientific process skills, life skills, and, most importantly, products throughout their lives (Yüksel, 2019). The STEM education model integrates all these disciplines and includes various learning methods. Inquiry-based teaching is one of these methods (Yuliati et al., 2018). Inquiry-based teaching is also essential in STEM to allow students to think deeply (Crippen & Archambault, 2012). Inquiry-based STEM learning is reported to increase critical thinking skills in students (Onsee & Nuangchalerm, 2019). 21st-Century skills such as problem-solving, questioning, originality/creativity, and critical thinking aim at the same goal as STEM education (Akyol, 2020; Poplar, 2019). Considering the time lived, the rapidly changing and developing technology, and the skills needed in individuals, it is thought that there is a need for a study in which teachers' inquiry-based teaching self-efficacy and 21st-Century skills teaching for STEM+S are examined together. For this reason, the problem of the study was expressed as "What is the effect of these two variables on each other by examining the teaching self-efficacy of teachers based on STEM+S inquiry and 21st-Century skills teaching?" In line with this problem, three sub-problems have been identified

1) Are there any significant differences between the scores that teachers receive from the sub-dimensions of the "inquiry-based teaching self-efficacy for STEM+S" and "21st-Century skills teaching" scales according to various variables (gender, branch, year of service, level of employment, status of the institution they work for, education level, 21st-Century skills and whether they receive training related to the STEM education model)?
2) Is there a relationship between teachers' scores for questioning self-efficacy and 21st-Century skills teaching for STEM+S?
3) Is the inquiry-based teaching self-efficacy for teacher STEM+S equivalent to the 21st-Century skills teaching scores?

METHOD

Research Design

This research is designed as a relational (correlation) pattern. Relational design is a research method that tries to reveal the relationship between two variables (Büyüköztürk et al., 2018). This study reveals the relationship between teachers' STEM inquiry-based teaching self-efficacy and 21st-Century skills teaching with the relational pattern.

Participants and Procedure

The universe of the study consists of teachers working in public and private schools in Gaziantep in the 2021-2022 academic year. In the study, the random sampling method is used. The study sample consists of 407 teachers selected from all levels in public and private schools working in Gaziantep. The scales in the study were created on Google Forms and delivered to teachers online through the WhatsApp application on computers and smartphones. The demographic information of the teachers participating in the study was included in Table 1.

Table1. Frequency and Percentage Table of the Sample Group

Education Level	**f**	**%**
Undergraduate	336	82,6
Master	71	17,4
Doctor	0	0
Institution Status		
Private School	64	15,7
Public School	343	84,3
Gender		
Female	265	65,1
Male	142	34,9
Education Tier		
Kindergarten	17	4,2
Primary school	59	14,5
Secondary school	122	30
High School	209	51,4
Branch		
Kindergarten Teacher	16	3,9
Class Teacher	50	12,3
Math Teacher	36	8,8
Science Physics/Chemistry/Biology	29	7,1
Social Sciences/ Geography/History/Philosophy	35	8,6
Foreign Language	52	12,8
Vocational courses	54	13,3
English/Turkish Language and Literature	54	13,3
Other	81	19,9
Year of Service		
1-5 years	82	20,1
6-10 years	95	23,3
11-15 years	65	16
16-20 years	71	17,4
21 and over	94	23,1
21st-Century Skills Training		
Yes	76	18,7
No	331	81,3
Getting a STEM Education		
Yes	54	13,3
No	353	86,7

When Table 1 is examined, while 17.4% of the participants in the study are graduate graduates, 82.6% are undergraduate graduates. Although our research applies to doctoral studies, no doctoral teachers have been encountered. In addition, 84.3% of the participants in the study are in public schools, and 15.7% are in private schools. When examined in terms of gender, 65.1% are female, and 34.9% are male.

While 4.2% of the teachers participating in the study were in kindergarten, 14.5% were in primary school, 30% were in middle school, 51.4% were in high school level, 3.9% were in kindergarten, 12.3% were classroom teachers, 8.8% were mathematics, 7.1% were science/physics/chemistry/biology, 8.6% were social sciences/geography/history/philosophy, 12.8% were foreign languages, 13.3% were Turkish/Turkish language and literature, 13.3% were vocational course teachers and 19.9% were teachers of other courses. When the years of service of the teachers in the study are examined, 23.1% of them are teachers who have worked over 21 years, 17.4% are teachers who have worked for 16-20 years, 16% for 11-15 years, 23.3% for 6-10 years, and 20.1% for 1-5 years. In addition, when the educational status of the participants in the study is examined according to the table, 86.7% of the teachers participating in the study did not receive STEM, 81.3% did not receive 21st-Century skills training, while 13.3% received STEM, and 18.7% received 21st-Century skills training.

Data Collection Tools

The data collection tools applied to teachers in the study consist of three parts. The first part of the questions consists of the "Personal Information Form" prepared by the researcher. In this form, the personal information of the teachers participating in the research, such as the district where they work, education level, gender, branch, the level they work for, the status of the institution they work for, the year of service, 21st-Century skills and the status of receiving education related to STEM are included. The second part, "Inquiry-Based Teaching Self-Efficacy Scale for STEM+S," was applied by Yıldırım et al. (2018). DFA and AFA examinations of the scale were performed to determine the validity of the structure. The full scale consists of 4 dimensions and 17 items. The dimensions of the scale are "associating," "asking questions," "discussing and reflecting," and "researching and creating." Teachers' answers to the scale are arranged in a 5-point Likert. Expert academicians created the questions of the scale. For the scope and appearance validity of the scale, the opinions of five experts were taken from the 17 items formed in the fields of education, and it was determined that the items were related to the questioning steps and STEM education.

To determine the stability of the scale, a test-retest technique was applied by interviewing 34 teachers. For consistency, Cronbach's Alpha coefficient was calculated. In order to determine the compliance validity of the scale, it is stated that the correlation coefficient between the sub-dimensions of the total items is examined, and the scale shows harmony between the items and the dimensions. In the last part of the data collection tools, the "21st-Century Skills Teaching" scale was used. The scale was created by Jia and colleagues (2016) and adapted to Turkish by Özyurt (2020). The opinions of 3 faculty members from subject matter experts were taken to determine whether the scale was sufficient for 21st-Century skill measurement. For language validity, translation and backward translation techniques were used. DFA was examined for compliance validity, and Cronbach's Alpha coefficients were considered to determine the scale's reliability.

Data Analysis

In the study, the data were collected from the teachers via the WhatsApp application on the smartphone and computer and analyzed statistically in the SPSS 22.0 program. First, the Cronbach Alpha test was performed to determine the reliability of the scales between the sub-dimensions. Cronbach Alpha was applied to test the research's reliability of teachers' responses to the STEM+S inquiry-based teaching self-efficacy/sub-factor and 21st-Century skills teaching/sub-factor scales. The results for this are given in Table 2.

When Table 2 is examined, according to the Cronbach Alpha (internal consistency) results, the coefficients of innovation and problem-solving dimensions are 0.91, cooperation 0.85, the benefit of technology 0.83, 0.92 for discussion and reflection, 0.91 for research and creation, 0.82 for questioning, and association dimension 0.88 from the 0.93 sub-dimensions of the 21st-Century skill scale were determined. It was seen that the obtained results were quite reliable. In order to determine the analyzes that need to be done for the study, it is necessary to examine whether the data is distributed normally. Therefore, Kolmogorov-Smirnov and Skewness/Kurtosis coefficients are examined in Table 3.

Table 2. Inquiry-based Teaching Self-efficacy Scale for STEM+S Sub-dimension and 21st-Century Skills Teaching Scale/Reliability Analysis for the Sub-dimension

Scale and Sub-Dimensions		**Cronbach's Alpha**
STEM+S Sub-Dimensions	Discussion and reflection	0,92
	Research and creation	0,91
	Ask a question	0,82
	Attribution dimension	0,88
Inquiry-Based Instruction for STEM+S Self-efficacy Scale Total		**0,95**
21st-Century Skills	Collaboration sub-dimension	0,85
	The dimension of the usefulness of technology	0,83
	Innovation and problem-solving dimension	0,91
21st-Century Skills Teaching Scale Total		**0,93**

Table 3. Descriptive Statistics of the Scales and Findings on Their Suitability to the Given Normal Distribution

Scales	Descriptive Statistics				Kolmogorov-Smirnov			Skew.	Kurtosis
	Min	Max	Mean	S	Statistic	df	p		
Discussion/Reflection	10	30	23,81	3,99	0,11	407	0,01	-0,29	- 0,21
Research	7	20	15,39	2,91	0,13	407	0,01	-0,29	-0,36
Ask a question	7	20	14,97	2,72	0,09	407	0,01	-0,16	-0,07
Association	6	15	12,76	1,98	0,15	407	0,01	-0,67	-0,11
For STEM+S	34	85	66,94	10,1	0,07	407	0,01	-0,33	- 0,08
Collaboration	3	21	16,93	3,12	0,12	407	0,01	-0,87	0,83
Technology benefit	3	21	15,74	3,61	0,10	407	0,01	-0,53	-0,20
Innovation and problem	4	28	20,93	4,83	0,11	407	0,01	-0,52	-0,25
21st-Century Skills	10	70	53,60	10,59	0,08	407	0,01	-0,58	0,16

Although the Kolmogorov-Smirnov test was less than 0.05, it was accepted that it showed normal distribution, and parametric tests were applied because the skewness and flatness coefficient values were between ±2 (George & Mallery, 2010). Since the research shows a normal distribution, Oneway Analysis of Variance (Oneway ANOVA) was used to compare more than two unrelated variables, and a t-test (Independent sample t-test) was used to compare two unrelated groups. The Pearson correlation coefficient was used to determine the relationship between the variables. To express whether the results reached are meaningful or not, the level of significance of 0.05 was taken as a criterion.

Then, independent groups t-test is performed to determine whether the scores of the scales and their sub-dimensions have significant variability in terms of whether they have received STEM and 21st-Century skills training, the level of education they have completed, gender, and the status of the institution they have worked for; One-way analysis of variance (ANOVA) was used to express whether there was a significant difference in terms of the service year, education level, branch variables. Pearson correlation analysis was performed to determine whether the two scales used in the study were related. Finally, regression analysis was performed since there was a relationship between the two scales, and the normal distribution was shown. Thus, a simple linear regression analysis was performed to express the power of teachers' STEM+S inquiry-based self-efficacy to teach 21st-Century skills procedurally.

Ethical Considerations

This study meets the principles of research ethics. It is a part of a master thesis, and it is ensured that it addresses ethical principles and standards of scientific research. Ethical approval was obtained from Gaziantep University in October 2020 for "the ethics committee approval for research and publication in social sciences and humanities'' (Document date/number: E-87841438-050.03-162341).

FINDINGS

Findings Related to the First Sub-Problem

When the STEM+S and 21st-Century scales applied to teachers were examined according to gender, independent groups t-test was applied because there was a comparison of two unrelated groups.

Table 4. Findings on the Comparison of Inquiry-based Teaching Self-efficacy Scale/Sub-dimension Scores for STEM+S According to the Gender of Teachers

Scales	Gender	N	Mean ±Sd	t	df	p
Discussion/Reflection	Woman	265	23,86±3,95	0,32	405	0,75
	Male	142	23,73±4,07			
Research	Woman	265	15,37±2,98	-0,22	405	0,83
	Male	142	15,44±2,79			
Asking question	Woman	265	14,89±2,67	-0,83	405	0,40
	Male	142	15,13±2,81			
Association	Woman	265	12,82±1,92	0,71	405	0,48
	Male	142	12,67±2,1			
STEM+S Scale	Woman	265	66,93±10,42	-0,02	405	0,98
	Male	142	66,96±10,43			

When Table 4 is examined, while the average of female teachers is higher in the discussion/reflection and association sub-dimension of the STEM inquiry-based teaching self-efficacy scale, it is seen that the average of male teachers is higher in the sum of research, questioning, and scale. However, when the scores of the scales and their sub-dimensions are examined according to gender, they are not found to be at a significant level because the p> is 0.05.

Table 5. Findings on the Comparison of 21st-Century Skills Teaching Scale/Sub-dimension Scores by Gender of Teachers

Scales	Gender	N	$\bar{X}$±Sd	t	df	p
Collaboration	Woman	265	16,92±3,22	-0,13	405	0,90
	Male	142	16,96±2,95			
The benefit of technology	Woman	265	15,46±3,68	-2,16	405	0,03*
	Male	142	16,27±3,44			
Innovation and problem solving	Woman	265	20,56±4,87	-2,11	405	0,04*
	Male	142	21,61±4,69			
21st-Century Skills	Woman	265	52,94±10,82	-1,73	405	0,08
	Male	142	54,84±10,07			

When Table 5 is examined, it is determined that the scores of male teachers in the scale and sub-dimensions are higher than female teachers. However, this difference does not show a significant difference when compared with the whole scale and the cooperation sub-dimension score, but it shows the benefit of technology and innovation/problem-solving sub-dimensions because it is P<0.05 with its scores. When the STEM+S and 21st-Century scales applied to teachers were examined according to the education completed, independent groups t-test was applied because there was a comparison of two unrelated groups.

Table 6. Findings on the Comparison of Inquiry-based Teaching Self-efficacy Scale/Sub-dimension Scores for STEM+S According to the Education Completed by Teachers

Scales	**T. Education**	**N**	$\bar{X}$ **±Sd**	**t**	**df**	**p**
Discussion/Reflection	Undergraduate	336	23,9±4,04	0,93	405	0,35
	Master	71	23,41±3,77			
Research	Undergraduate	336	15,48±2,96	1,30	405	0,19
	Master	71	14,99±2,63			
Asking question	Undergraduate	336	15,06±2,74	1,45	405	0,15
	Master	71	14,55±2,61			
Association	Undergraduate	336	12,83±1,98	1,53	405	0,13
	Master	71	12,44±1,96			
STEM+S Scale	Undergraduate	336	67,27±10,53	1,39	405	0,16
	Master	71	65,38±9,75			

When Table 6 is examined, in the scale and sub-dimensions, it is determined that the scores of the teachers who have completed their bachelor's degree are higher than the teachers who have completed a master's degree. However, this difference does not show a significant difference since it is p>0.05 compared with the whole scale and sub-dimension scores.

Table 7. Findings on the Comparison of 21st-Century Skills Teaching Scale/Subscores According to the Education Completed by Teachers

Scales	Education	N	$\bar{X}$ ±Sd	t	df	P
Collaboration	Undergraduate	336	16,94±3,24	0,13	405	0,90
	Master	71	16,89±2,5			
The benefit of technology	Undergraduate	336	15,83±3,64	1,04	405	0,30
	Master	71	15,34±3,5			
Innovation and problem solving	Undergraduate	336	20,91±5,01	-0,17	405	0,87
	Master	71	21,01±3,94			
21st-Century Skills	Undergraduate	336	53,68±10,97	0,31	405	0,75
	Master	71	53,24±8,65			

When Table 7 is examined, in the innovation/problem-solving sub-dimension of the 21st-Century skills teaching scale, it is seen that the scores of graduate teachers are high, while the scores of undergraduate teachers are higher in terms of cooperation, the use of technology, and the whole scale. However, according to the Independent Sample t-test, there is no significant difference since the scores of the whole scale and its sub-dimensions are p>0.005 when compared to the level of education completed by the teachers. When the STEM+S and 21st-Century scales applied to teachers were examined according to the status of the institution where they worked, independent groups t-test was applied because there was a comparison of two unrelated groups.

Table 8. Findings on the Comparison of Inquiry-based Teaching Self-efficacy Scale/Sub-dimension Scores for STEM+S According to the Status of the Institution where Teachers Work

Scales	**Institution**	**N**	**Mean ±Sd**	**T**	**df**	**P**
Discussion/Reflection	Public School	343	23,62±4,05	-2,23	405	0,03*
	Private School	64	24,83±3,52			
Research	Public School	343	15,29±2,94	-1,73	405	0,08
	Private School	64	15,97±2,72			
Asking question	Public School	343	14,78±2,74	-3,43	405	0,01*
	Private School	64	16,03±2,37			

Association	Public School	343	12,68±1,99	-2,00	405	0,04*
	Private School	64	13,22±1,92			
STEM+S Scale	Public School	343	66,36±10,54	-2,62	405	0,01*
	Private School	64	70,05±9,17			

When Table 8 is examined, it is determined that the scores of teachers working in private schools are higher than those of teachers working in public schools in the STEM+S inquiry-based teaching self-efficacy scale in discussion/reflection, association, question-asking, and throughout the scale. However, when the scores received by the teachers are compared with the research sub-dimension score> are seen as meaningless because the p.< is 0.05, a significant difference is seen because the scores of the discussion/reflection, association, questioning, and the whole scale are p.0.05 compared with the scores received by the teachers.

Table 9. Findings on the Comparison of 21st-Century Skills Teaching Scale/Subscores According to the Status of the Institution in which Teachers Work

Scales	Institutional Status	N	$\bar{X}$ ±Sd	t	df	P
Collaboration	Public School	343	16,81±3,13	-1,81	405	0,07
	Private School	64	17,58±3,04			
The benefit of technology	Public School	343	15,59±3,57	-2,02	405	0,04*
	Private School	64	16,58±3,78			
Innovation and problem solving	Public School	343	20,69±4,78	-2,34	405	0,02*
	Private School	64	22,22±4,93			
21st-Century Skills	Public School	343	53,08±10,42	-2,30	405	0,02*
	Private School	64	56,38±11,14			

When Table 9 is examined, in the lower dimensions of the scale, there are higher scores of teachers working in private schools than teachers working in public schools. However, according to the independent groups' t-test, when the Cooperation sub-dimension score is examined according to the status of the institution where the teachers work, it is not at a meaningful level because it is p>0.05, while the scores of innovation/problem solving, cooperation and the whole scale are at a significant level because they are p<0.05 according to the status of the institution where the teachers work. When the STEM+S and 21st-Century scales applied to teachers were examined according to the level of receiving STEM education, independent groups t-test was used because there was a comparison of two unrelated groups.

Table 10. Findings on the Comparison of Inquiry-based Teaching Self-efficacy Scale/Sub-dimension Scores for STEM+S According to Teachers' STEM+S Education Status

Scales	STEM+S Training	n	$\bar{X}$ ±Sd	t	df	P
Discussion/Reflection	Yes	54	24,98±3,36	2,33	405	0,02*
	No	353	23,63±4,05			
Research	Yes	54	16,43±2,46	2,82	405	0,01*
	No	353	15,24±2,95			
Asking question	Yes	54	15,74±2,5	2,24	405	0,03*
	No	353	14,86±2,74			
Association	Yes	54	13,04±1,79	1,09	405	0,28
	No	353	12,72±2,01			
STEM+S Scale	Yes	54	70,19±9,08	2,47	405	0,01*

	No	353	66,44±10,52			

When Table 10 is examined, it is determined that the scores of the entire STEM scale and its sub-dimensions are higher in teachers who receive STEM education than those who do not. According to the independent groups' t-test, the scores of the Attribution sub-dimension do not make a significant difference according to the status of teachers receiving STEM education, while the scores of research, discussion/reflection, asking questions and the full scale constitute a significant difference according to the status of receiving STEM education.

Table 11. Findings on the Comparison of 21st-Century Skills Teaching Scale/Subscores According to Teachers' STEM+S-Related Training Status

Scales	STEM+S Training	N	$\bar{X}$ ±Sd	t	df	p
Collaboration	Yes	54	17,83±2,44	2,29	405	0,02*
	No	353	16,79±3,19			
The benefit of technology	Yes	54	17,41±2,91	3,69	405	0,01*
	No	353	15,49±3,65			
Innovation and problem solving	Yes	54	23,06±3,97	3,53	405	0,01*
	No	353	20,6±4,87			
21st-Century Skills	Yes	54	58,3±8,33	3,55	405	0,01*
	No	353	52,88±10,72			

When Table 11 is examined, it is seen that the lower dimensions of the scale and the teachers who receive STEM education in all of them are higher than those who do not receive scores. According to the Independent Sample T-Test, this difference is significant. When the STEM+S and 21st-Century scales applied to teachers were examined according to the 21st-Century education status, an independent sample t-test was applied because there were two unrelated group comparisons.

Table 12. Findings on the Comparison of Inquiry-Based Teaching Self-Efficacy Scale/Sub-Dimension Scores For STEM+S According to The Status of Teachers Receiving Training Related to 21st-Century Skills

Scales	21st Century Training	N	$\bar{X}$ ±Sd	t	df	P
Discussion/Reflection	Yes	76	24,64±3,57	2,03	405	0,04*
	No	331	23,62±4,06			
Research	Yes	76	16,36±2,64	3,23	405	0,01*
	No	331	15,17±2,93			
Asking question	Yes	76	15,67±2,5	2,50	405	0,01*
	No	331	14,81±2,75			
Association	Yes	76	13,16±1,8	1,93	405	0,05*
	No	331	12,67±2,01			
STEM+S Scale	Yes	76	69,83±9,45	2,70	405	0,01*
	No	331	66,28±10,52			

When Table 12 is examined, it is seen that the lower dimensions of the scale and the teachers who received 21st-Century education in all of them were higher than those who did not receive scores. Since the independent groups were $p<0.05$ according to the t-test, this difference is significant.

Table 13. Findings on The Comparison 0f 21st-Century Skills Teaching Scale/Subscores According to the Status of Teachers Receiving Training Related to 21st-Century Skills

Scales	21st training	n	$\bar{X}$±Sd	t	df	P
Collaboration	Yes	76	17,91±2,56	3,06	405	0,01*
	No	331	16,71±3,2			
The benefit of technology	Yes	76	17,28±2,91	4,19	405	0,01*
	No	331	15,39±3,67			
Innovation and problem solving	Yes	76	23,04±3,5	4,32	405	0,01*
	No	331	20,44±4,97			
21st-Century Skills	Yes	76	58,22±8,12	4,31	405	0,01*
	No	331	52,54±10,81			

When Table 13 is examined, it is seen that the lower dimensions of the scale and the teachers who received 21st-Century education in all of them were higher than those who did not receive scores. This difference is significant because the independent groups were $p<0.05$, according to the t-test. When the STEM+S and 21st-Century scales applied to teachers were examined according to their education levels, One-Way Variance (ANOVA) was applied because there were more than two unrelated comparison groups.

Table 14. Findings on the Comparison of Inquiry-based Teaching Self-efficacy Scale/Sub-dimension Scores for STEM+S According to Teachers' Education Levels

Scale/Size	**Education Tier**	**N**	$\bar{X}$**±Sd**	**Sources of Variance**	**Sum of Squares**	**df**	**Mean Squares**	**F**	**P**
Discussion and Reflection	Kindergarten	17	24,293,6	B.G.	10,29	3	3,3	0,21	0,89
	Primary school	59	24,07±4,09	W.G.	6.456,14	403	16,02		
	Secondary school	122	23,8±3,82	Total	6.466,43	406			
	High School	209	23,7±4,11						
Research	Kindergarten	17	15,71±3,24	B.G.	21,59	3	7,20	0,85	0,47
	Primary school	59	15,85±2,89	W.G.	3.419,51	403	8,49		
	Secondary school	122	15,45±2,88	Total	3.441,10	406			
	High School	209	15,21±2,91						
Asking question	Kindergarten	17	15±2,5	B.G.	40,25	3	13,42	1,82	0,14
	Primary school	59	15,66±2,96	W.G.	2.966,46	403	7,36		
	Secondary school	122	14,66±2,68	Total	3.006,70	406			
	High School	209	14,96±2,68						
Association	Kindergarten	17	12,76±1,86	B.G.	10,68	3	3,56	0,90	0,44
	Primary school	59	13,14±1,96	W.G.	1.586,68	403	3,94		
	Secondary school	122	12,62±2	Total	1.597,36	406			
	High School	209	12,74±1,99						
STEM+S Scale	Kindergarten	17	67,76±9,69	B.G.	239,45	3	79,82	0,73	0,53
	Primary school	59	68,71±10,89	W.G.	43.767,14	403	108,60		
	Secondary school	122	66,53±10,21	Total	44.006,58	406			
	High School	209	66,61±10,46						

Note: B.G.: Between Groups, W.G.: Within Groups

When Table 14 is examined, while the scores of the primary school teachers were high in the discussion/reflection sub-dimension, the scores of primary school teachers were high in the association, questioning, research sub-dimension, and the whole scale. According to the ANOVA analysis, there is no significant difference since the scale and sub-dimensions are compared to the teacher levels and p>0.05.

Table 15. Findings on the Comparison of 21st-Century Skills Teaching Scale/Subscores According to Teachers' Educational Levels

Scale/Size	Education Tier	N	$\bar{X}$±Sd	Sources of Variance	Sum of Squares	df	Mean Squares	F	P
Collaboration	Kindergarten	17	17±2,42	B.G.	20,04	3	6,68	0,68	0,56
	Primary school	59	17,17±3,1	W.G.	3.936,03	403	9,77		
	Secondary school	122	17,17±2,9	Total	3.956,07	406			
	High School	209	16,72±3,3						
The benefit of technology	Kindergarten	17	15,71±3,26	B.G.	36,41	3	12,14	0,93	0,43
	Primary school	59	16,07±3,65	W.G.	5.267,50	403	13,07		
	Secondary school	122	16,07±3,47	Total	5.303,91	406			
	High School	209	15,46±3,71						
Innovation and problem solving	Kindergarten	17	20,76±5,06	B.G.	63,23	3	21,08	0,90	0,44
	Primary school	59	21,49±4,52	W.G.	9.418,56	403	23,37		
	Secondary school	122	21,3±4,88	Total	9.481,79	406			
	High School	209	20,56±4,87						
21st-Century Skills	Kindergarten	17	53,47±10,11	B.G.	337,48	3	112,49	1,00	0,39
	Primary school	59	54,73±10,63	W.G.	45.194,24	403	112,14		
	Secondary school	122	54,54±10,08	Total	45.531,72	406			
	High School	209	52,74±10,9						

Note: B.G.: Between Groups, W.G.: Within Groups

When Table 15 is examined, the scores of primary school teachers were high in innovation/problem solving and all of the scales, the scores of kindergarten teachers were high in the sub-dimension of cooperation and the benefit of technology. According to the ANOVA analysis, there is no significant difference since the scale and sub-dimensions are compared to the teacher levels and p>0.05. When the STEM+S and 21st-Century scales applied to teachers were examined according to their years of service, One-Way Variance (ANOVA) was applied because there were more than two unrelated comparison groups.

Table 16. Findings on the Comparison of Inquiry-based Teaching Self-efficacy Scale/Sub-dimension Scores for STEM+S According to Teachers' Years of Service

Scale/Size	Year of Service	N	$\bar{X}$±Sd	Sources of Variance	Sum of Squares	df	Mean Squares	F	p
Discussion and Reflection	1-5 years	82	23,99±3,46	B.G.	96,92	4	24,23	1,53	0,19
	6-10 years	95	23,25±3,72	W.G.	6.369,51	402	15,84		
	11-15 years	65	23,45±4,42	Total	6.466,43	406			
	16-20 years	71	23,68±4,54						
	21 -+	94	24,57±3,89						
Research	1-5 years	82	15,79±2,84	B.G.	28,31	4	7,08	0,83	0,50

	6-10 years	95	15,05±2,83	W.G.	3.412,79	402	8,49		
	11-15 years	65	15,26±2,99	Total	3.441,10	406			
	16-20 years	71	15,3±2,97						
	21 -+	94	15,55±2,96						
Asking question	1-5 years	82	15,1±2,39	B.G.	25,20	4	6,30		
	6-10 years	95	14,84±2,73	W.G.	2.981,50	402	7,42		
	11-15 years	65	14,49±3,11	Total	3.006,70	406		0,85	0,49
	16-20 years	71	15,11±2,65						
	21 -+	94	15,22±2,76						
Association	1-5 years	82	12,93±1,92	B.G.	17,74	4	4,43		
	6-10 years	95	12,58±1,85	W.G.	1.579,62	402	3,93		
	11-15 years	65	12,43±2,21	Total	1.597,36	406		1,13	0,34
	16-20 years	71	12,83±2,1						
	21 -+	94	12,99±1,9						
STEM+S Scale	1-5 years	82	67,8±9,26	B.G.	497,08	4	124,27		
	6-10 years	95	65,73±9,89	W.G.	43.509,50	402	108,23		
	11-15 years	65	65,63±11,76	Total	44.006,58	406		1,15	0,33
	16-20 years	71	66,92±11,14						
	21 -+	94	68,34±10,28						

Note: B.G.: Between Groups, W.G.: Within Groups

When Table 16 is examined, in the research sub-dimension of the scale, the scores of teachers working for 1-5 years are high, while the scores of teachers who have worked over 21 years in questioning, association, discussion/reflection, and the whole scale are high. However, when the scores of the entire scale and its sub-scores are compared with the teachers' years of service, there is no significant difference since it is $p>0.05$, according to the ANOVA analysis.

Table 17. Findings on the Comparison of 21st-Century Skills Teaching Scales/Subscores According to Teachers' Educational Levels

Scale/Size	Year of Service	N	$\bar{X}$±Sd	Sources of Variance	Sum of Squares	df	Mean Squares	F	p
Cooperation	1-5 years	82	16,89±3,19	B.G.	13,71	4	3,43		
	6-10 years	95	17,08±3,01	W.G.	3.942,36	402	9,81		
	11-15 years	65	16,97±2,76	Total	3.956,07	406		0,35	0,84
	16-20 years	71	16,56±3,52						
	21 -+	94	17,06±3,13						
The benefit of technology	1-5 years	82	16,26±3,5	B.G.	76,58	4	19,14		
	6-10 years	95	15,79±3,62	W.G.	5.227,33	402	13,00		
	11-15 years	65	16,17±3,55	Total	5.303,91	406		1,47	0,21
	16-20 years	71	15,56±3,92						
	21 -+	94	15,09±3,47						
Innovation and problem solving	1-5 years	82	21,16±4,56	B.G.	49,43	4	12,36		
	6-10 years	95	20,75±5,1	W.G.	9.432,36	402	23,46		
	11-15 years	65	21,34±4,64	Total	9.481,79	406		0,53	0,72
	16-20 years	71	20,3±5,2						
	21 -+	94	21,1±4,68						
21st-Century Skills	1-5 years	82	54,3±10,23	B.G.	201,07	4	50,27		
	6-10 years	95	53,62±10,77	W.G.	45.330,65	402	112,76	0,45	0,78
	11-15 years	65	54,48±9,93	Total	45.531,72	406			

	16-20 years	71	52,42±11,77
	21 -+	94	53,24±10,33

B.G.: Between Groups, W.G.: Within Groups

When Table 17 is examined, in the full scale and each sub-dimension, the scores of teachers working in different years of service are high. In addition, this difference is not significant since it is p>0.05 according to ANOVA analysis. When the STEM+S and 21st-Century scales applied to teachers were examined according to the district where they worked, One-Way Variance (ANOVA) was applied because there were more than two unrelated comparison groups.

Table 18. Findings on the Comparison of the Dimension Scores of the Sub-Dimensions of the Inquiry-based Teaching Self-efficacy Scale for STEM+S According to the Branches of the Teachers

Scale/Size	Branch	N	$\bar{X}$±Sd	Sources of Variance	Sum of Squares	df	Mean Squares	F	p
Discussion and Reflection	Mathematics	36	24,31±4,04	B.G.	71,40	8	8,92	0,56	0,81
	Turkish/TLL	54	24,22±4,32	W.G.	6.395,03	398	16,07		
	Kindergarten	16	24,69±3,32	Total	6.466,43	406			
	Science	29	23,72±3,39						
	Foreign L.	52	23,25±3,57						
	Vocational C.	54	23,22±4,15						
	Social S.	35	23,77±3,77						
	Class Primary	50	24,14±4,13						
	Other	81	23,74±4,28						
Research	Mathematics	36	15,61±3,12	B.G.	57,65	8	7,21	0,85	0,56
	Turkish/TL	54	15,54±2,91	W.G.	3.383,45	398	8,50		
	Kindergarten	16	16,19±2,64	Total	3.441,10	406			
	Science	29	15,55±2,91						
	Foreign L.	52	15,04±2,59						
	Vocational C.	54	14,96±3,05						
	Social S.	35	15,17±2,49						
	Class Primary	50	16,06±2,79						
	Other	81	15,19±3,21						
Asking Question	Mathematics	36	15,47±2,85	B.G.	74,27	8	9,28	1,26	0,26
	Turkish/TL	54	14,39±2,84	W.G.	2.932,43	398	7,37		
	Kindergarten	16	15,31±2,15	Total	3.006,70	406			
	Science	29	14,97±2,1						
	Foreign L.	52	14,69±2,39						
	Vocational C.	54	14,7±2,95						
	Social S.	35	15,17±2,6						
	Class Primary	50	15,8±2,93						
	Other	81	14,84±2,79						
Association	Mathematics	36	12,92±1,89	B.G.	36,75	8	4,59	1,17	0,32
	Turkish/TL	54	13,07±2,15	W.G.	1.560,61	398	3,92		
	Kindergarten	16	12,81±1,91	Total	1.597,36	406			
	Science	29	12,69±1,83						
	Foreign L.	52	12,56±1,92						
	Vocational C.	54	12,57±1,97						
	Social S.	35	12,97±1,81						
	Class Primary	50	13,26±1,78						

	Other	81	12,37±2,18						
STEM+S Scale	Mathematics	36	68,31±10,96	B.G.	681,53	8	85,19	0,78	0,62
	Turkish/TL	54	67,22±11,32	W.G.	43.325,05	398	108,86		
	Kindergarten	16	65,46±10,9	Total	44.006,58	406			
	Science	29	66,93±8,99						
	Foreign L.	52	65,54±8,98						
	Vocational C.	54	66,14±11,15						
	Social S.	35	67,09±9,2						
	Class Primary	50	69,26±10,82						
	Other	81	69±8,52						

B.G.: Between Groups, W.G.: Within Groups

When Table 18 is examined, in the discussion/reflection and research sub-dimension of the scale, the scores of the kindergarten teachers are high. In contrast, the scores of primary school teachers are high in the whole questioning, association, and scale. However, when the scores of the entire scale and its sub-scores are compared according to the teachers' branch, there is no significant difference since it is $p>0.05$ according to the ANOVA analysis.

When Table 19 is examined, the scores of teachers working in different branches are high on the whole scale and in each sub-dimension. In addition, this difference is not significant since it is $p>0.05$ according to ANOVA analysis. For the second problem of the study, STEM+S, the Pearson correlation coefficient was examined to examine the relationship between the questioning-based teaching self-efficacy scale/sub-dimension and the 21st-Century skills teaching scale/sub-scores.

Table 19. Findings on the Comparison of 21st-Century Skills Teaching Scale/Subscores According to Teachers' Branch

Scale Dimension	Branch	N	$\bar{X}$±Sd	Sources of Variance	Sum of Squares	df	Mean Squares	F	P
Collaboration	Mathematics	36	17,14±3,16	B.G	36,12	8	4,52	0,46	0,88
	Turkish/TL	54	17,5±3,15	W.G	3.919,95	398	9,85		
	Kindergarten	16	17,06±2,49	Total	3.956,07	406			
	Science	29	16,86±3,19						
	Foreign Language	52	16,71±2,4						
	Vocational Course	54	16,61±3,28						
	Social S.	35	16,83±2,85						
	Class Primary	50	17,2±3,23						
	Other	81	16,69±3,56						
The benefit of technology	Mathematics	36	16,14±3,29	B.G	67,51	8	8,44	0,64	0,74
	Turkish/TL	54	15,83±3,99	W.G	5.236,40	398	13,16		
	Kindergarten	16	15,63±3,34	Total	5.303,91	406			
	Science	29	15,76±3,6						
	Foreign Language	52	15,92±3						
	Vocational Course	54	15,94±3,93						
	Social S.	35	15,6±3,7						
	Class Primary	50	16,26±3,45						
	Other	81	15,01±3,81						
Innovation and problem solving	Mathematics	36	21,94±4,36	B.G	155,85	8	19,48	0,83	0,58
	Turkish/TL	54	21,35±4,7	W.G	9.325,94	398	23,43		

	Kindergarten	16	21,13±4,99	Total	9.481,79	406			
	Science	29	21,03±5,14						
	Foreign Language	52	20,46±4,47						
	Vocational Course	54	20,5±4,95						
	Social S.	35	20,71±4,59						
	Class Primary	50	21,86±4,45						
	Other	81	20,21±5,45						
21st-Century Skills	Mathematics	36	55,22±9,23	B.G	573,95	8	71,74	0,64	0,75
	Turkish/TLL	54	54,69±10,61	W.G	44.957,77	398	112,96		
	Kindergarten	16	53,81±10,34	Total	45.531,72	406			
	Science	29	53,66±11,32						
	Foreign Language	52	53,1±8,57						
	Vocational Course	54	53,06±11,13						
	Social S.	35	53,14±10,12						
	Class Primary	50	55,32±10,69						
	Other	81	51,91±11,95						

Note: B.G.: Between Groups, W.G.: Within Groups

Findings Regarding the Second Sub-Problem

Table 20. Investigation of the Relationship Between Inquiry-based Teaching Self-efficacy Scale/Sub-dimension and 21st-Century Skills Teaching Scale/Subscores for STEM+S

		Mirror a discussion	Create a probe	Asking question	Association	STEM+S	Cooperation	Technology benefit	Innovation and problem solving
Create a probe	r	**0,79**							
	p	0,01*							
	n	407							
Asking question	r	**0,72**	**0,75**						
	p	0,01*	0,01*						
	n	407	407						
Association	r	**0,79**	**0,66**	**0,61**					
	p	0,01*	0,01*	0,01*					
	n	407	407	407					
STEM+S	r	**0,94**	**0,90**	**0,87**	**0,84**				
	p	0,01*	0,01*	0,01*	0,01*				
	n	407	407	407	407				
Cooperation	r	**0,66**	**0,65**	**0,55**	**0,60**	**0,70**			
	p	0,01*	0,01*	0,01*	0,01*	0,01*			
	n	407	407	407	407	407			
Technology benefit	r	**0,53**	**0,58**	**0,51**	**0,45**	**0,59**	**0,70**		
	p	0,01*	0,01*	0,01*	0,01*	0,01*	0,01*		
	n	407	407	407	407	407	407		
	r	**0,58**	**0,60**	**0,51**	**0,49**	**0,61**	**0,77**	**0,77**	
	p	0,01*	0,01*	0,01*	0,01*	0,01*	0,01*	0,01*	

Innovation and problem solving	n	407	407	407	407	407	407	407	
21st-Century Skills	r	**0,64**	**0,66**	**0,57**	**0,55**	**0,69**	**0,89**	**0,90**	**0,95**
	p	0,01*	0,01*	0,01*	0,01*	0,01*	0,01*	0,01*	0,01*
	n	407	407	407	407	407	407	407	407

When Table 20 is examined, there is a high and positive relationship between the STEM scale and its sub-factors (0.84<r <0.94) and between the 21st-Century scale and its sub-factors (0.89<r<0.95). There is a moderate and positive relationship between the 21st-Century skills teaching scale and the inquiry-based teaching self-efficacy scale for STEM+S (r: 0.69, p<0.05). The results for this are given in table 20.

Findings Related to the Third Sub-problem
For the last problem of the study, STEM+S, regression analysis was performed to determine that inquiry-based teaching was in the process of self-efficacy and 21st-Century skills teaching scores.

Simple linear regression analysis was performed for STEM+S since inquiry-based teaching self-efficacy and 21st-Century skills teaching scales fulfilled these two conditions.

Table 21: Regression Analysis of Inquiry-based Teaching Self-efficacy Scores for STEM+S Predicting 21st-Century Skills Teaching Scores

Dependent Variable: 21st-Century Skills Teaching score					
Independent	**B**	**S.E.**	**B**	**t**	**p**
Constant	6,974	2,495		2,795	0,01
Inquiry-Based Teaching Self-Efficacy Score for STEM+S	0,697	0,037	0,685	18,909	0,01
R: 0,685	**F (1,405) =357,550**				
R^2: 0,469	**p: 0,01**				

When Table 21 is examined, the inquiry-based teaching self-efficacy score for STEM+S appears to be a statistically significant predictor (explainer) of the 21st-Century skills teaching score (R= 0.685, R2 = 0.469, F (1.405) = 357.550 p<0.01). 46% of the total variance (change) for 21st-Century skills teaching scores can be explained by the inquiry-based teaching self-proficiency score for STEM+S.

In simple linear regression, the predictive (inquiry-based teaching for STEM+S) variable can be expressed with an equation to predict the predictive (21st-Century teaching) variable according to the variable's values.

y= a+bx

21st-Century skills teaching score = constant of equation + (constant of argument x inquiry-based teaching self-efficacy score for STEM+S)

21st-Century skills teaching score = 6.974 +(0.697 x inquiry-based teaching self-efficacy score for STEM+S) the equation is obtained. According to this equation, 1 point from inquiry-based teaching self-efficacy for STEM+S may lead to an increase of 7,671 points in 21st-Century skills teaching.

DISCUSSION, CONCLUSION, AND RECOMMENDATIONS

In the study conducted to examine the relationship between teachers' self-efficacy based on STEM inquiry and 21st-Century skills teaching, first, the status of the scales such as the branch, gender, district where they work, the status of the institution they work for, years of service, level of work, STEM and 21st-Century education were examined.

There is no significant difference when teachers' STEM+S scale and sub-dimensions are compared according to gender. It is observed that the average score of male and female teachers from the whole scale and its sub-factors is very close. This shows that teacher genders are similar in questioning STEM self-efficacy. While the study of Aksoy and Şenler (2019), Değirmenci (2020), İmir (2019), and Yüksel (2020) supported the finding that STEM self-efficacy was not at a significant level according to gender, the Er and Başeğmez (2020) study found a discernible difference in favor of women according to gender. In the 21st-Century skill scale, there is a significant difference in favor of men in all other sub-factors except the cooperation sub-factor and the whole scale. Göksün (2016) and Murat (2018) support the research in their study. However, the difference is in favor of women, not men. In the study of Kıyasoğlu (2019) and Gürültü and colleagues (2020), they did not find a significant difference in comparing 21st-Century skills teaching according to gender. This discrepancy arises from the diversity of samples. When the questioning-based teaching self-efficacy and sub-dimensions of STEM+S are examined according to the level of education completed by the teachers, it is seen that although the scores of undergraduate teachers are higher than the teachers who have a master's degree, this difference is not statistically significant. However, according to the study of Biçer (2018) and Yüksel (2020), a differentiation is observed between the level of education completed by teachers and self-efficacy in STEM applications. According to Biçer and Yüksel's study, the average score of the doctoral student is higher than the master's and bachelor's education level. It is thought that the reason for the different results obtained from other studies is that 12% of the STEM education recipients work with a sample group of master's degrees, and 88% have a bachelor's degree. In addition, Değirmenci's (2020) work supported the work of Biçer (2018) and Yüksel (2020). Açıkgöz and Uluçınar Sağır (2020) did not detect any differentiation in the comparison of teachers according to the level of education they completed based on the research inquiry. Within the scope of 21st-Century skills, teachers should have some skills. Clark (2008), Garba, Byabazaire, and Butshami (2015) also emphasized that 21st-Century teachers should be at a sufficient level in using technological tools and equipment. When the teaching of 21st-Century skills and its sub-dimensions are examined according to the level of education completed by the teachers, it is seen that although the scores of the teachers with a bachelor's degree are higher than the teachers who have a master's degree, this difference is not statistically significant. When the 21st-Century literature is examined, Kıyasoğlu (2019) examines the relationship between the 21st-Century skills of the education levels of the teachers and the other sub-dimension except for one sub-dimension, and no significant difference is observed in terms of 21st-Century skills. In the lower dimension, where there is differentiation, it was found that the average score of the teachers who did not have a master's degree was higher than those who did not. It is thought that the reason for obtaining different results from other studies in the study is that 24% of those who received education related to 21st-Century skills worked with a sample group of master's degree graduates, and 76% of them graduated as undergraduates. There is a statistically significant difference between the scores that teachers receive in discussion and reflection, asking questions and association, excluding research, from the inquiry scale and sub-dimensions for STEM+S according to the variable of the status of the institution in which they work. This differentiation takes place in favor of teachers working in private schools. In Şahin's (2019) study, which is similar to the study, a differentiation was observed in the sub-dimension of STEM education self-efficacy regarding the status of the institution where teachers worked, while no differentiation was detected in the self-efficacy of STEM applications. There is also a significant difference between the status of the institution where teachers work and the scores they receive in teaching 21st-Century skills and in the benefit of technology, innovation, and problem-solving, except for cooperation from sub-dimensions. It is seen that this difference is in favor of teachers working in private institutions. There is a statistically significant difference between the scores of teachers in discussion and reflection, asking questions and research, excluding association, from the questioning scale and sub-dimensions for STEM+S according to the variable of receiving STEM education. Out of a sample of 407, 54 teachers received STEM education. 88% of 54 teachers were teachers who completed a bachelor's degree, while 87% worked in public schools. It can be said that bringing teachers together with STEM education through in-service training and projects will allow the development of their questioning-based self-efficacy for STEM+S. Biçer's (2018) finding that there will be a differentiation in terms of self-efficacy in STEM according to the status of receiving STEM education supports the research. Similarly, because of the studies conducted by Değirmenci (2019) and Şahin (2019), it was seen that there was variability in terms of STEM self-efficacy when teachers received training. In their study, Yaman and colleagues (2008) also found a significant difference between the self-efficacy of teachers who received STEM education and those who did not. All these findings support that the teachers who received training differed in questioning-based self-efficacy for STEM+S compared to those who did not. However, Aksoy and Şenler (2019) did not find a significant difference between the inquiry-based education given to classroom teachers and inquiry-based teaching. However, according to the status of teachers receiving STEM education, there is a significant difference in teaching 21st-Century skills and the scores they receive from the sub-dimensions. Especially in this difference, it is seen that those who receive education are higher than those who do not. This may indicate that STEM education has a huge impact on teachers. The fact that there is a significant relationship between STEM education and 21st-Century skills teaching may indicate that with STEM education, teachers can reach a level where they can use 21st-Century skills in their lessons. In addition, no studies have examined the relationship between 21st-Century skills according the status of receiving STEM education. Whether teachers are trained in 21st-Century skills, a statistical differentiation is observed between the self-efficacy and sub-dimensions of inquiry for STEM+S. Out of 407 samples, 76 teachers received training in 21st-Century skills. 76% of the teachers trained work in public schools. In addition, 76% of the trainees are teachers who have completed their undergraduate education. Especially in the scale and sub-dimensions, it is seen that the average score of the teachers who receive 21st-Century skills training in the inquiry for STEM+S is higher than those who do not. As it is understood from these findings, it can be said that 21st-Century skills education and STEM+S questioning skills and all sub-dimensions are parallel. No studies have compared 21st-Century skills education with STEM or inquiry-based teaching self-efficacy. It turned out that the teachers' years of service did not affect their questioning-based self-efficacy for STEM+S. Similarly, in the Kocagül (2013) study, the inquiry-based teaching of science teachers did not detect any differentiation according to the seniority year studied. There is no statistical difference between 21st-Century skills teaching and sub-dimensions of cooperation, the use of technology, innovation and problem solving, and the teachers' years of service. Similarly, in the Kıyasoğlu (2019) study, no significant awareness was found between the year of service and 21st-Century skills. There is no differentiation between the teachers' district and the questioning-based self-efficacy for STEM+S. There is no statistical difference between 21st-Century skills teaching and sub-dimensions of cooperation, the use of technology, innovation, and problem-solving, and the district where teachers work. For STEM+S, the questioning-based teaching self-efficacy scale/sub-dimension scores do not show a statistically significant difference according to the teachers' branch. However, Değirmenci (2019) found in his study that there is a significant relationship between teachers' branches and self-efficacy scores. In the study of Açıkgöz and Uluçınar Sağır (2020), the researchers concluded that there was no significant difference in inquiry-based teaching compared to the branch of teachers, and these findings supported the study. There is no statistical difference between teaching 21st-Century skills and its sub-dimensions and cooperation, the usefulness of technology, innovation, and problem-solving, and the branch of teachers. In Gürültü, Aslan, and Alcı (2020) study, when the relationship between the 21st-Century scale and sub-dimensions of the teachers' branch is examined, differentiation is seen between some sub-dimensions, and no differentiation is seen between some sub-dimensions. It was found that there was a significantly higher relationship between 21st-Century skills and their sub-dimensions and that there was also a significantly higher relationship between inquiry-based teaching self-efficacy and sub-dimensions for STEM+S. There is a moderately significant relationship between questioning-based teaching self-efficacy and sub-dimensions of 21st-Century skills and sub-dimensions for STEM+S. For STEM+S, inquiry-based teaching appears to have a statistically significant impact on regression analysis between self-efficacy and 21st-Century skills teaching. The inquiry-based teaching self-efficacy score can explain 46% of the total variance in 21st-

Century skills teaching scores for STEM+S. When this situation is examined, it can be stated that questioning 21st-Century skills teaching for STEM+S has a significant impact.

Depending on the branch in which teachers work and their level, weekly lesson plans can be prepared with achievements emphasizing inquiry-based teaching for 21st-Century skills and STEM+S. Similar studies with different sample groups on 21st-Century skills education and inquiry-based teaching self-efficacy for STEM + S can be obtained that can be compared more axially. Since the research can be explained by questioning teaching self-efficacy for 46% of the education of teachers 21st-Century skills STEM+S, studies can be conducted to identify variables that affect 54% of 21st-Century skills teaching.

Statement of Researchers

Researchers' contribution rate statement: This Study, the master thesis titled "Investigation of the Relationship Between Teachers' Self-Efficacy in Inquiry-Based Teaching for STEM+S and Teaching 21st-Century Skills)" conducted by the first author under the supervision of the second author was utilized.
Conflict statement: There was no conflict between the researchers.
Support and thanks: None.

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