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# Investigating STEM Awareness of University Teacher Educators

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**ABSTRACT**

The aim of this study is to determine the STEM awareness of academics working in education faculties and their STEM academic works affected by this awareness. The research was conducted according to a sequential explanatory design, which is one of the mixed research methods. In the quantitative part of the study, a relational type of screening model was used and in the qualitative part, a case study design was preferred. The sampling of the quantitative part was composed of 239 academics working in education faculties in Turkey within the scope of the appropriate sampling method, which was non-random. As a result of the analysis, a semi-structured interview form was prepared within the scope of 4 themes and the qualitative part was started. As a result of the research, it was determined that academics in education faculties had high mean scores for STEM awareness, and that there was no significant difference in terms of gender, professional area and department, but there was a significant difference in terms of age and title variables. In addition, the situations in which interviewed academics, whose awareness scores were high and low, were affected by STEM awareness were revealed and discussed.

**Keywords:** higher education, deviant case study, mixed method, STEM awareness

## INTRODUCTION

In today's world, information and technology are rapidly developing and changing. Therefore, countries should constantly revise and develop their education systems and curricula based on the needs of the age in order to get ahead in their competition with others. In many countries, students are expected to acquire the knowledge and adapt it for real life in order to solve problems. Along with these expectations, 21st century skills have recently gained importance. For example, in the Turkish curricula updated in 2011, the Ministry of National Education highlights that it is aimed to educate individuals who can generate information and use it in their daily life, solve problems and think critically, be entrepreneurial and decisive, and have communication skills (URL-1). However, it may not be possible for students to develop these skills if the outcomes of each lesson are given separately (Akgündüz et al., 2015). Therefore, a multi-disciplinary approach is needed to achieve these goals. Consequently, STEM (science, technology, engineering and mathematics), one of the multidisciplinary approaches, has emerged as an effective approach in recent years.

STEM is an interdisciplinary approach that includes all the disciplines of science, technology, engineering and mathematics. STEM education underscores that STEM is at the center of developing ideas about effective teaching and learning. In this approach, teaching and learning goes beyond just emphasis on memorizing the contents and information in a specific discipline.

In order for countries to be successful in competition with their counterparts, great importance should be given to STEM education (Lacey & Wright, 2009). STEM education may help countries develop in industrialization, competition in the world market and fostering qualified individuals in new emerging business fields. Therefore, it is important to foster individuals' STEM literacy. Employing STEM-literate people in the industrial fields should be included among the objectives of the country to increase industrial and economic development (Çevik, Şentürk, & Abdioğlu, 2019). This is because STEM-literate individuals can understand science, technology, engineering and math concepts in complex problems, solve these problems and generate new solutions (Meng, Idris, & Eu, 2014). STEM literacy involves being able to use scientific methods or engineering design principles in designing new tools, and being able to evaluate and explain the impact of any finding on the real world, rather than memorizing the content of a specific discipline (Stephan, Pugalee, Cline, & Cline, 2018).

Awareness is defined in different ways in the literature. According to Çatak and Ögel (2010), awareness is a mind and body practice that involves focusing the attention on immediate experiences and observing inner experiences. Keleş (2007) expresses awareness as conscious and sensitive behaviours towards different factors in the individual's and society's life areas. Kabat-Zinn (2005) defines awareness as concentration on the moment in an unbiased and attentive way in line with a specific aim. According to Hutton and Baumeister (1992), by increasing awareness towards a certain field, attitudes and behaviours towards that field are also seen to be strengthened.

STEM awareness can be expressed as awareness of the relationship between the areas of STEM and the ability to make logical deductions (Gürbüz & Karadeniz, 2020). Deveci (2018) expresses STEM awareness as fostering high-level thinking skills in individuals through STEM education, ability to use the disciplines of science, technology, engineering and mathematics together, understanding that a problem can be solved in different ways, being self-confident, and awareness of providing the ability to collaborate and establish effective communication. On the other hand, according to Kovarik et al. (2013), STEM awareness is regarded as a precondition for individuals to interact, possess self-efficacy and develop themselves. Accordingly, studies in the literature on the subject of awareness and STEM awareness reveal the importance of high awareness of STEM in individuals, besides their readiness for STEM.

Since STEM education constitutes the main technological foundations for the developed countries, the need for individuals specialized in the STEM area is constantly increasing (Meng, Idris, & Eu, 2014). Therefore, in order to increase the number of people specialized in thee STEM field, importance should be given to STEM education (Öner, Capraro, & Capraro, 2016). In order to achieve the desired outcomes, teachers from pre-school to university have a great responsibility. Among other educators, teacher educators have the biggest responsibility for fostering STEM awareness. Teacher educators, who educate pre-service teachers, should be aware of what STEM education is and why it is needed in socio-economic contexts. Because teacher educations greatly influence the perspectives of pre-service teachers who will educate the next generations, teachers educators' STEM awareness is worth examining.

## Importance of the Research

In order to educate students in the field of STEM education, teachers, who implement the curricula at schools, should have sufficient knowledge, skills and equipment in the field of STEM. Regardless of their specialization, teachers are expected to have attitudes, knowledge and skills related to at least one STEM discipline (Akgündüz et al., 2015). These attitudes, knowledge and skills depend not only on their own efforts but also on their undergraduate education. Thus, it is clear that teacher educators, who are responsible for training prospective teachers, play an important role.

In the literature, there have been many studies investigating the STEM awareness of teachers and teacher candidates. Studies have examined STEM awareness in preservice teachers' (Kızılay, 2016), chemistry and mathematics teachers (Aslan-Tutak, Akaygun & Tezsezen, 2017) and primary school, mathematics and science teachers (Bakırcı & Karışan, 2017).

This study was drawn on recent articles on STEM education by categorizing the research into seven inductively-developed purposes, including understanding STEM preservice teacher learning and development, understanding teacher educators and their practices, and five others. In this study, questions such as "Who is being studied, and who is doing the research?", "What are the methods that have been used?", etc., were included. Bell, Gitomer, Savage and McKenna (2019) reviewed a sample of 174 recent papers on STEM teacher preparation and identified fourteen studies focusing on teacher educators, but they concluded that none of these studies paid attention to teachers educators beliefs about STEM. This study elaborates on STEM teacher preparation and contributes especially to the knowledge on teacher educators' STEM awareness."

In order to achieve satisfactory outcomes in STEM education, STEM education in faculties at university and especially education faculties should be of good quality too. Teachers implement STEM programs at the schools. One way to increase their STEM awareness and to equip them with the necessary STEM skills is to ensure that teacher educators cooperate with some other faculties from different disciplines to both diversify and enrich teacher education (Akgündüz et al., 2015). For doing this, first of all, teacher educators should be familiar with the STEM approach and have the requirements for this approach. With the development of this awareness, how STEM awareness effects their teaching is another important issue. Kovarik et al. (2013) argued that individuals' ability to interact, their self-efficacy and their possession of content knowledge were prerequisites in the development of STEM awareness. Also Hutton and Baumeister (1992) emphasized that as the level of awareness increases, the relationship between attitude and behavior also becomes stronger. On the other hand, the advocates of theories of the cognitive-behavioral approach state that it is possible to increase the level of awareness about the feelings and thoughts that guide the behavior of the individual (Engin & Çam, 2005). In this context, it is thought that STEM awareness may influence teacher educators' readiness, interest, attitude, participation in activities and following current developments in the STEM field. Bybee (2010) emphasized that STEM awareness may relate to communication, decision-making, social and self-management skills. Therefore, teacher educators who have significant STEM awareness can train pre-service teachers who have self-efficacy for the scientific and technological needs of the age and are equipped with 21st century skills. These needs underscore that STEM awareness have a possible influence on other aspects of teacher education, which is a multi-dimensional phenomenon.

Examination of teacher educators' views on educational method has an important place in any phenomenon related to education. In the literature, studies have investigated teacher educators' views and emphasized the importance of examining their opinions. For example, Dağtekin and Zorluoğlu (2019) studied teacher educators' views on the updated science teacher education program and emphasized the importance of their views in revealing the advantages and disadvantages that the programs can provide to prospective teachers. Yılmaz (2010) emphasized that the views of teacher educators were one of the most efficient ways to unveil the problems encountered in the field of teacher education.

When the literature is examined, it is seen that individuals whose STEM awareness is investigated have also been examined as to whether this awareness varies according to variables such as age, gender, and department (field/area of expertise). For example, in their study examining STEM awareness in preschool, science and mathematics teacher candidates, Bakırcı and Karışan (2017) revealed that while there was no significant difference between genders, there was a significant difference between certain departments. In a study that examined the reasons why women were underrepresented in STEM professions, Xu (2015) revealed that there was a significant deviation in earning profiles between women and men in the first ten years of employment. Moreover, the findings showed that the incomes of women in STEM professions were lower in concurrence with their increasing family obligations (Xu, 2015). In another study, in which gender differences in science and mathematics achievement and competence were investigated, it was revealed that gender differences in science and mathematics may be indirectly related. On the other hand, there are no single or simple answers to the complex questions about gender differences in science and mathematics (Halpern et al., 2007). As can be seen from these studies in the literature, variables such as gender, age and department are examined in studies related to STEM. However, in the context of these studies, no study can be found in which STEM awareness of academics employed in education faculties is examined in depth according to variables like gender, age and department.

Therefore, it would be beneficial to examine the STEM awareness of teacher educators. With this purpose of the study, answers to the following questions were sought:

1. What level of STEM awareness do teacher educators have?
2. Does STEM awareness of teacher educators differ based on their gender, ages, titles and specialty areas?
3. What factors affect the STEM awareness of teacher educators?

## METHOD

### Research Model

A mixed methods research approach, in which quantitative and qualitative methods were used together, was utilized to examine the STEM awareness levels of teacher educators. Creswell (2012) defined a mixed methods research model as collecting and analyzing quantitative and qualitative data together. The research was carried out with sequential explanatory mixed methods. In this study, quantitative data were collected, and then qualitative data were collected to explain the quantitative data (Creswell & Plano Clark, 2014). This method was used to strengthen the results of the study by eliminating the weaknesses of a single quantitative data analysis, so that both research perspectives support each other to give strong evidence about the phenomenon under investigation (Suhonen, 2009). The research was carried out in two stages. In the first stage, quantitative data were collected. At this stage, a cross-sectional model was utilized. Cross-sectional models include selecting a sample that represents the population to reach a general conclusion (Karasar, 2007). In addition to this, a correlational research model was used to examine the relations between variables (Cohen, Manion & Morrison, 2000; Karasar, 2007). In the second stage of the research, participants who had lower and higher scores in the STEM awareness scale were

 

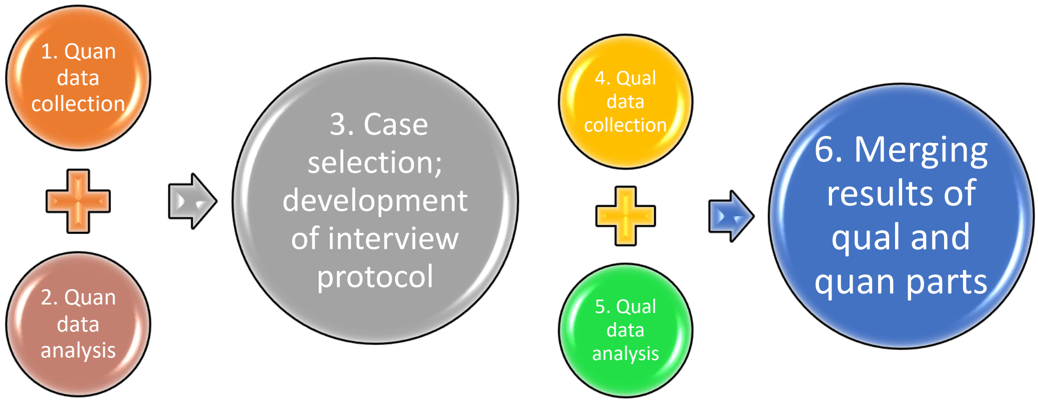


**Figure 1.** Sequential explanatory mixed methods research model diagram, (Creswell & Plano Clark, 2014)

**Table 1.** Descriptive characteristics of participants included in the quantitative part

| | | f | % |
|---|---|---|---|
| Gender | Female | 134 | 56.1 |
| | Male | 105 | 43.9 |
| Age | 20-30 | 35 | 14.6 |
| | 31-40 | 104 | 43.5 |
| | 41-50 | 72 | 30.1 |
| | 51-60 | 21 | 8.8 |
| | 61-70 | 7 | 2.9 |
| Department | Elementary science and mathematics | 86 | 36 0 |
| | Primary teaching | 63 | 26.4 |
| | Secondary science and mathematics | 39 | 16.3 |
| | Educational sciences | 32 | 13.4 |
| | Computer and educational technology | 14 | 5.9 |
| | Turkish and social education | 3 | 1.3 |
| | Art education | 2 | 0.8 |
| Title | Research assistant | 75 | 31.4 |
| | Lecturer | 5 | 2.1 |
| | Assistant professor | 80 | 33.5 |
| | Associate professor | 39 | 16.3 |
| | Professor | 40 | 16.7 |
| **Total** | | **239** | **100** |

included to examine the factors causing differences in STEM awareness. The data collection stages are shown in **Figure 1**.

In the quantitative methods coming before the qualitative methods, participants' scores on the quantitative part can be used as the sampling strategy (Sandelowski, 2000). Criterion sampling is a type of purposeful sampling used to select participants based on predetermined criteria, such as scores on the instrument. One type of sampling can also be called extreme or adverse case sampling (Sandelowski, 2000). In this method, successful or unsuccessful cases, extraordinary or unique examples are generally selected (Marshall & Rossman, 2014). The purpose of an extreme or deviant sampling strategy is to obtain different perspectives on the same phenomenon from dramatic or extraordinary cases (Liamputtong, 2013). It can be used to obtain extreme outputs to address the research questions based on contradictory situations (Charmaz, 2011). In the qualitative part of the research, data collection was carried out with the interview method. With the semi-structured interview form prepared according to the determined themes, questions were sent to participants via email due to COVID-19, and then interviews that could not be conducted face-to-face were carried out digitally by conducting them by video with the WhatsApp application. The obtained data were then analyzed.

## Research Group

Participants in the quantitative part of the study were selected using the convenience sampling method. A total of 455 teacher educators were contacted by email to voluntary participate in this study, and 239 teacher educators replied positively. This sampling method brought speed and practicality to the research (Yıldırım & Şimşek, 2006). Descriptive information about the participants is given in **Table 1**.

Of the participants, 134 (56.1%) were female and 105 (43.9%) were male. Most participants were in the age range between 31-40 (43.5%) while the fewest were in the age range between 61-70 (2.9%). The majority of the

 

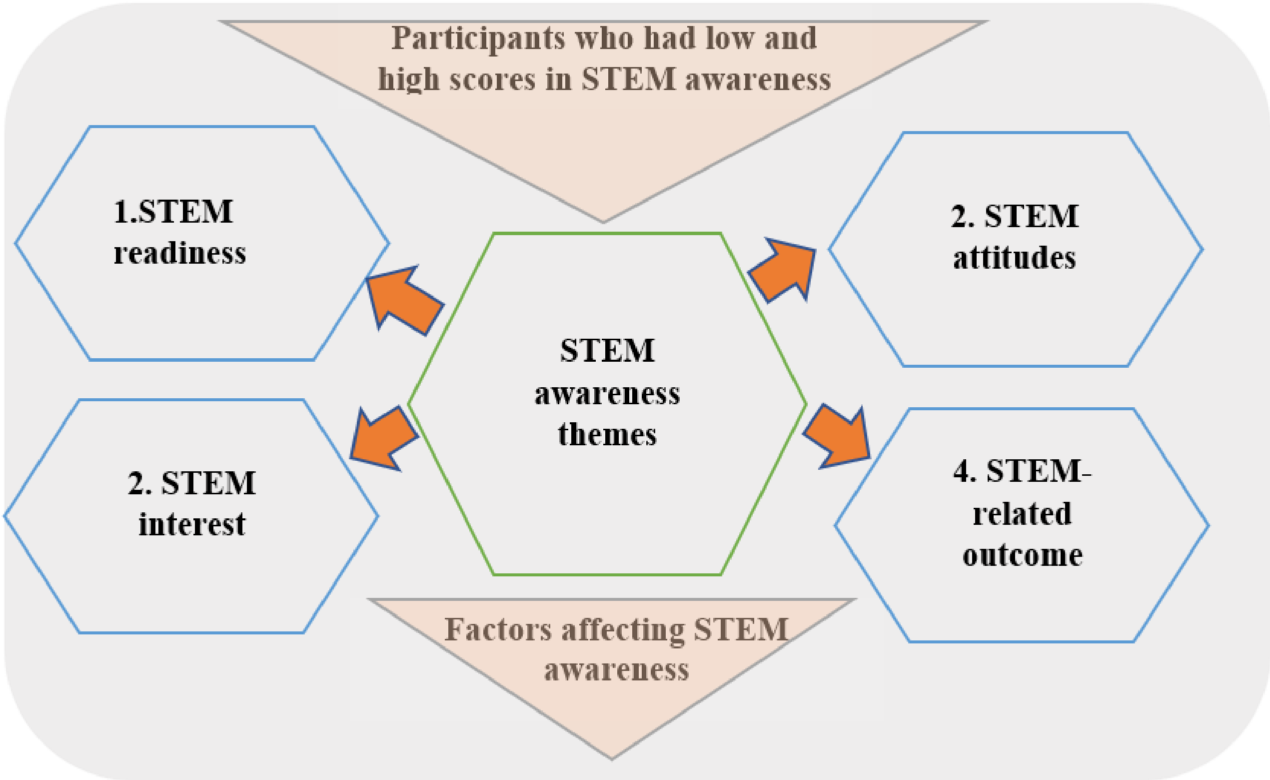


**Figure 2.** Diagram of the qualitative stage

participants were specialized in elementary science and mathematics (36.0%). Regarding the academic titles of the participants, assistant professors were in the majority (33.5%).

### Data Collection Tools

Detailed information on the qualitative and quantitative survey tools is given below.

*STEM awareness scale:* The STEM awareness scale was developed by Çevik (2017) to determine teachers' STEM awareness. It consists of 15 items in three sub-dimensions, named as *effects on students* (six items), *effects on the course* (five items) and *effects on teachers* (four items). (For scale items, see Appendix). Likert-type ratings are "Totally Agree," "Agree," "Not Sure," "Disagree," and "Totally Disagree." Scale items are scored from 5, which refers to "Totally Agree," to 1, which refers to "Totally Disagree." The overall Cronbach alpha coefficient of the scale was reported to be .86 (Çevik et al., 2017). Cronbach alpha coefficients for sub-dimensions were .89, .71, and .70, respectively. A Cronbach alpha coefficient higher than .70 is generally considered sufficiently reliable (Pallant, 2007). Goodness-of-fit indices of the scale revealed that the model was confirmed and that that this structure was valid for measuring STEM awareness ($\chi 2$= 156.87, d=247, $p < .01$, GFI= 0.92, AGFI=0.90, SRMR= 0.057, NFI= 0.94, NNFI= 0.96, CFI=0.97, IFI=0.96). The STEM awareness scale was administered to 89 participants in paper-and-pencil form and 145 participants in online form through Google Forms.

*STEM Awareness Interview Preparation Process*: In the light of the findings obtained from the analysis of the quantitative data, 4 themes were determined. Based on the previous studies, a semi-structured interview form was developed for in-depth examination in the four themes identified regarding STEM awareness. The interview protocol consisted of eleven questions. The first five questions were descriptive questions. There were two questions regarding STEM readiness, two questions on STEM attitude, one question on STEM interest and one question on STEM-related outcomes. In the preparation of the interview protocol, the focus was on clear, descriptive questions, refraining from directing, and developing alternative questions (Yıldırım & Şimşek, 2006). Once the interview protocol was developed, the opinions of one expert in science, one expert in mathematics and one science teacher were obtained and the form was finalized based on their feedback. The development of the interview protocol is shown in **Figure 2**.

**Table 2.** Normality test results regarding the STEM awareness scale sub-dimensions

| Sub-Dimensions | Kolmogorov-Smirnov | | Skewness | | Kurtosis | |
|---|---|---|---|---|---|---|
| | Statistics | p | S | S. E. | K | S.E |
| Effects on students | .12 | .09 | -.67 | .15 | .70 | .31 |
| Effects on the course | .09 | .07 | -.20 | .15 | -.28 | .31 |
| Effects on teachers | .13 | 1.0 | .22 | .15 | -.02 | .31 |
| Total score | .05 | 2.0 | -.27 | .15 | .58 | .31 |

*p > .05, S. E.: Standard error*

**Table 3.** Arithmetic means of the scale used in the interpretation

| Score Range | Mean Score (P. range of items) | Scale | Evaluation |
|---|---|---|---|
| 1.00-1.79 | 15-26 | Totally disagree | Very low |
| 1.80-2.59 | 27-38 | Disagree | Low |
| 2.60-3.39 | 39-50 | Not sure | Middle |
| 3.40 -4.19 | 51-62 | Agree | High |
| 4.20 -5.00 | 63-75 | Totally agree | Very high |

**Table 4.** Mean scores related to STEM awareness

| Sub-Dimensions | N | Score range | | Min | Max | ss |
|---|---|---|---|---|---|---|
| Effects on students | 239 | 4.29 | 25.79 | 12 | 30 | 3.45 |
| Effects on the course | 239 | 3.78 | 18.94 | 10 | 25 | 2.99 |
| Effects on teachers | 239 | 3.89 | 15.56 | 10 | 20 | 2:06 |
| Total scale | 239 | 4.02 | 60.30 | 32 | 74 | 6.97 |

### Analysis of Data

First, the normality test was used to determine whether the collected data were normally distributed. The normality test was performed for the whole scale and for each sub-dimension. It is suggested that for data consisting of more than 50 cases, it is appropriate to use the Kolmogorov-Smirnov test to evaluate the normality (Büyüköztürk, Çokluk & Köklü, 2010). Kolmogorov-Smirnov test values for the scale are given in **Table 2**. All quantitative analyses were made with SPSS 24.0 software.

The Kolmogorov-Smirnov tests were statistically non-significant for the scores of each sub-dimension and the overall score of the STEM awareness scale. If the calculated p values are higher than .05, it is interpreted that the scores do not differ from normal distribution (Büyüköztürk, 2012). In addition to this, the skewness and kurtosis values for each sub-dimension were between +1 / -1. Skewness and kurtosis values within ± 1 limits are considered as evidence for normal distribution (Tabachnick & Fidell, 2013). Therefore, parametric tests were preferred in the data analysis. Frequency analysis, independent t-test and one-way ANOVA were used in the data analysis. In the determination of the levels, mean scores of 1.00-1.79 were considered as “totally disagree”, 1.80-2.59 as “disagree”, 2.60-3.39 as “not sure”, 3.40-4.19 as “agree”, and 4.20-5.00 as “totally agree” (See **Table 3**).

The scales given in **Table 3** guided the interpretation of participants’ STEM awareness. Content analysis was used in the analysis of qualitative data. Content analysis is used to summarize the qualitative data with smaller parts that have similar meanings (Büyüköztürk, Çokluk & Köklü, 2010). Content analysis requires the data collected to be quantized and analyzed in depth. It allows hidden themes and codes to be revealed. To provide evidence regarding the themes, direct quotations of the participants are presented and interpreted as illustrations.

Qualitative data analysis was checked by two different independent researchers. The number of codes on which agreement was reached was 35, while agreement was not reached on 5 codes. The coder reliability was computed by using the formula: Agreement = [Number of Agreements/(Number of Disagreements + Number of Agreements) X 100](Miles and Huberman, 1994). This was determined as ((35/35 + 5) * 100) = 87%. Later, the 5 disputed codes were discussed and re-evaluated, and the disagreements were solved after obtaining a third expert’s opinion. Codes were grouped in themes and data were presented with their frequencies and percentages.

## RESULTS

In this section, results regarding the research questions are presented.

### 1. Findings related to the research question of “What level of STEM awareness do teacher educators have?”

Teacher educators’ STEM awareness mean score for effects on students was found to be 25.79 with a range of 4.29 (See **Table 4**). It can be said that teacher educators’ STEM awareness towards effects on students was very

**Table 5.** Results of t-tests by gender

| | Gender | N | Mean | ss | t | p |
|---|---|---|---|---|---|---|
| Effects on students | Female | 134 | 25.73 | 3.46 | .26 | .79 |
| | Male | 105 | 25.85 | 3.47 | | |
| Effects on the course | Female | 134 | 19.04 | 2.94 | .57 | .56 |
| | Male | 105 | 18.81 | 3.06 | | |
| Effects on teachers | Female | 134 | 15.55 | 1.95 | -.07 | .93 |
| | Male | 105 | 15.58 | 2.21 | | |
| Total scale | Female | 134 | 60.34 | 6.68 | .09 | .92 |
| | Male | 105 | 60.25 | 7.36 | | |

**Table 6.** Results of ANOVA by age

| Sub-Dimensions of the Scale | Age range | N | Mean | ss | sd | F | p | Scheffe Test | Levene F Test |
|---|---|---|---|---|---|---|---|---|---|
| Effects on students | 20-30 | 35 | 24.82 | 3.93 | 234 | 2.06 | .08 | | $p > .05$, $F_{student} = .74$, sd = 234 p = .56 |
| | 31-40 | 104 | 26.23 | 3.39 | | | | | |
| | 41-50 | 72 | 25.81 | 3.35 | | | | | |
| | 51-60 | 21 | 24.61 | 3.00 | | | | | |
| | 61-70 | 7 | 27.28 | 3.09 | | | | | |
| Effects on the course | 20-30 | 35 | 25.79 | 3.45 | 234 | 4.27 | .00* | 20-30 / 31-40 20-30 / 61-70 | $p < .05$, $F_{course} = 5.89$, sd = 234, p = .07 |
| | 31-40 | 104 | 17.91 | 3.28 | | | | | |
| | 41-50 | 72 | 19.56 | 2.68 | | | | | |
| | 51-60 | 21 | 18.52 | 3.23 | | | | | |
| | 61-70 | 7 | 18.19 | 2.44 | | | | | |
| Effects on teachers | 20-30 | 35 | 21.42 | 1.39 | 234 | .57 | .68 | | $p > .05$, $F_{teacher} = 2.11$, sd = 234, p = .14 |
| | 31-40 | 104 | 18.94 | 2.99 | | | | | |
| | 41-50 | 72 | 15.34 | 2.33 | | | | | |
| | 51-60 | 21 | 15.75 | 2.02 | | | | | |
| | 61-70 | 7 | 15.40 | 2.04 | | | | | |
| Total scale | 20-30 | 35 | 15.42 | 1.50 | 234 | 3.14 | .01* | 20-30 / 31-40 20-30 / 61-70 | $p < .05$, $F_{overall} = 1.32$, sd = 234, p = .50 |
| | 31-40 | 104 | 16.14 | 3.13 | | | | | |
| | 41-50 | 72 | 15.56 | 2.06 | | | | | |
| | 51-60 | 21 | 58.08 | 7.95 | | | | | |
| | 61-70 | 7 | 61.54 | 6.57 | | | | | |

* *p <.05*

high. The STEM awareness mean score for effects on the course was 18.84 with a range of 3.78, indicating that the STEM awareness towards effects on the course was high. The mean score for STEM awareness for effects teachers was 15.56 with a range of 3.89, showing that teacher educators had a high level of STEM awareness for effects on teachers. It was found that the overall mean score of the STEM awareness that teacher educators had was 60.30 with a range of 4.02. This finding show that teacher educators had a high STEM awareness. While the highest mean score was for effects on students, the lowest mean score was for effects on the course.

**2.a) Findings related to the research question of "Does the STEM awareness of teacher educators differ in terms of gender?"**

Findings regarding the STEM awareness mean score of teacher educators in terms of gender are given in **Table 5**. As seen in **Table 5**, there was no significant difference between female and male teacher educators' STEM awareness scale mean scores for the three sub-dimensions or the whole scale.

**2.b) Findings related to the research question of "Does the STEM awareness of teacher educators differ in terms of age?"**

Findings regarding the STEM awareness mean score of teacher educators in terms of age are given in **Table 6**. The mean values show that teacher educators' STEM awareness varied in one sub-dimension and the total score based on their age. ANOVA was run to test whether this difference was statistically significant. As a post-hoc test, the Scheffe test was used to determine the direction of the difference. The Scheffe test was developed to compare all possible linear combinations between groups. This method is generally considered as a flexible post-hoc type of test that can keep the α margin of error under control (conservative) when there are many groups to be compared, and does not take into account the assumption that the number of observations in the groups are equal (Scheffe, 1959). In the sub-dimension of effects on the course, the test resulted in a statistically significant difference between the 20-30 and 31-40 age groups in favor of the 31-40 age group, and between the 20-30 and 61-70 age groups in favor of the 61-70 age group [ $F_{course} = 5.89$, sd = 234, p = .07]. In the sub-dimensions of

**Table 7.** Results of ANOVA by academic title

| Sub-Dimensions of the Scale | Titles | N | Mean | ss | sd | F | p | Scheffe Test | Levene F Test |
|---|---|---|---|---|---|---|---|---|---|
| Effects on students | Res. Asst. | 75 | 25.41 | 3.93 | 234 | 1.08 | .36 | | p > .05, $F_{student}$ = 2.26, sd = 234 p = .06 |
| | Lecturer | 5 | 25.60 | 2.88 | | | | | |
| | Asst. Prof. | 80 | 26.43 | 2.81 | | | | | |
| | Assoc. Prof. | 39 | 25.38 | 3.97 | | | | | |
| | Professor | 40 | 25.62 | 3.15 | | | | | |
| Effects on the course | Res. Asst. | 75 | 18.64 | 3.15 | 234 | 2.33 | .04* | Res. Asst.- Asst. Prof. Asst. Prof.- Assoc. Prof. | p < .05, $F_{course}$ = 1.77, sd = 234, p = .13 |
| | Lecturer | 5 | 19.60 | 3.78 | | | | | |
| | Asst. Prof. | 80 | 19.71 | 2.57 | | | | | |
| | Assoc. Prof. | 39 | 18.20 | 3.04 | | | | | |
| | Professor | 40 | 18.62 | 3.11 | | | | | |
| Effects on teachers | Res. Asst. | 75 | 15.37 | 2.23 | 234 | 1.32 | .26 | | p > .05, $F_{teacher}$ = .95, sd = 234, p = .43 |
| | Lecturer | 5 | 16.00 | 2.44 | | | | | |
| | Asst. Prof. | 80 | 15.97 | 1.88 | | | | | |
| | Assoc. Prof. | 39 | 15.23 | 2.15 | | | | | |
| | Professor | 40 | 15.40 | 1.93 | | | | | |
| Total scale | Res. Asst. | 75 | 59.42 | 7.72 | 234 | 2.25 | .06 | 20-30 / 31-40 20-30 / 61-70 | p > .05, $F_{overall}$ = 2.11, sd = 234, p = .08 |
| | Lecturer | 5 | 61.20 | 8.16 | | | | | |
| | Asst. Prof. | 80 | 62.12 | 5.90 | | | | | |
| | Assoc. Prof. | 39 | 58.82 | 7.56 | | | | | |
| | Professor | 40 | 59.65 | 6.28 | | | | | |

* $p < .05$

**Table 8.** Results of ANOVA by specialty area

| Sub-Dimensions of the Scale | Source of Variance | Total Squares | sd | Mean Squares | F | p |
|---|---|---|---|---|---|---|
| Effects on students | Between | 265.50 | 22 | 12.06 | 1.01 | .45 |
| | Within | 2582.03 | 216 | 11.95 | | |
| | Total | 2847.54 | 238 | | | |
| Effects on the course | Between | 92.78 | 22 | 4.21 | .44 | .98 |
| | Within | 2037.50 | 216 | 9.43 | | |
| | Total | 2130.29 | 238 | | | |
| Effects on teachers | Between | 61.87 | 22 | 2.81 | .63 | .89 |
| | Within | 956.73 | 216 | 4.42 | | |
| | Total | 1018.61 | 238 | | | |
| Total scale | Between | 646.73 | 22 | 29.39 | .58 | .93 |
| | Within | 10935.97 | 216 | 50.62 | | |
| | Total | 11582.70 | 238 | 12.06 | | |

effects teachers and effects on students, no significant difference was found [($F_{student}$ = .74, sd = 234, p = .56) and ($F_{teacher}$ = 2.11, sd = 234, p = .14)]. Regarding the overall scale, a statistically significant difference was found between the 20-30 and 31-40 age groups in favor of the 31-40 group, and between the 20-30 and the 61-70 age groups in favor of the 61-70 age group [ $F_{overall}$ = 1.32, sd = 234, p = .50].

**2.c) Findings related to the research question of "Does the STEM awareness of teacher educators differ in terms of their academic title?"**

ANOVA results are given in Table 7. The Scheffe test was chosen as the post-hoc test. Analysis showed that in the effects on the course sub-dimension, there were statistically significant differences between research assistants and assistant professors in favor of assistant professors, and assistant professors and associate professors in favor of assistant professors p<0,[ Fcourse = 1.77, sd = 234, p = .13]. No statistical difference was found between groups in the effects on teachers and effects on students sub-dimensions, or total scale scores p>0, [($F_{student}$ = 2.26, df = 234 p = .0 6), ($F_{teacher}$ = .95, df = 234, p = .43) and ($F_{total}$ = 2.11, sd = 234, p = .08)].

**2.d) Findings related to the research question of "Does the STEM awareness of teacher educators differ significantly based on their specialty area?"**

ANOVA results are presented in Table 8. As seen, no statistical significance was found between groups in all sub-dimensions ([ ($F_{student}$ (1.01) =. 45, p> .05, $F_{course}$ (.44) =. 98; p> .05, ($F_{teacher}$ (.63) =. 89; p> .05 and ($F_{overall}$ (.58) =. 93; p> .05)].

 

**Table 9.** Results of ANOVA by department

| Sub-Dimensions of the Scale | Source of Variance | Sum of Squares | sd | Mean Squares | F | p |
|---|---|---|---|---|---|---|
| Effects on students | Between | 116.23 | 6 | 19. 37 | 1.64 | .13 |
| | Within | 2731.30 | 232 | 11. 77 | | |
| | Total | 2847.54 | 238 | | | |
| Effects on the course | Between | 51.94 | 6 | 8. 65 | .96 | .44 |
| | Within | 2078.34 | 232 | 8. 95 | | |
| | Total | 2130.29 | 238 | | | |
| Effects on teachers | Between | 21.11 | 6 | 3. 51 | .81 | .55 |
| | Within | 997.50 | 232 | 4. 30 | | |
| | Total | 1018.61 | 238 | | | |
| Total scale | Between | 453.27 | 6 | 75. 54 | 1.57 | .15 |
| | Within | 11129.42 | 232 | 47. 97 | | |
| | Total | 116.23 | 238 | | | |

**2e) Findings related to the research question of "Does the STEM awareness of teacher educators differ significantly based on their department?"**

In **Table 9**, ANOVA results are given. As seen, no statistical significance was found between groups in all sub-dimensions ([ ($F_{student}$ (1.01) =. 45, p> .05, $F_{course}$ (.44) =. 98; p> .05, ($F_{teacher}$ (.63) =. 89; p> .05 and ($F_{overall}$(.58) =. 93; p> .05)].

**3. Findings related to the research question of "What factors affect the STEM awareness of teacher educators?"**

In the quantitative stage, the STEM awareness mean score of the participants was 60.30. This result shows that teacher educators had high STEM awareness. However, some participants scored very low and some scored high. To examine in-depth why they had different STEM awareness scores, interviews were conducted with the participants, who were selected through the extreme or deviant sampling strategy, which included cases with high scores and low scores. A semi-structured interview form was developed by the researchers. The form consisted of five themes, namely STEM readiness, STEM attitudes, importance of STEM, STEM interest and STEM-related activity. The themes were determined to guide revealing of the factors in the development of STEM awareness. Once the opinions of an expert in STEM were obtained, and one of the themes, "importance of STEM", was removed. The final version of the interview protocol included four themes. Some of the questions in the interview form were:

1. Could you give information about STEM education?
2. Do you think that STEM education should be included in Turkey?
If yes, how should it be? If no, why not?
3. Have you been involved in any STEM projects / activities?
If yes, what was your job description in the project / activity?
4. Do you read about STEM?
If yes, what kind of texts do you read? If no, can you briefly explain why?
5. On what sub-dimension of education, student, course or teacher, do you think the STEM approach has the most influence? Please list these from most to least important.

14 participants who had a STEM awareness score higher than 70.0 and 13 participants who had a STEM awareness score less than 26 were identified. Because of the Covid-19 pandemic, face-to-face interviews were not able to be conducted. Instead, the interview form was sent to the 27 participants though Google Forms, and 5 participants in the low group and six in the high group responded to the form. Regarding the responses given by the 11 participants, video interviews were conducted separately by means of the WhatsApp program, making it possible for in-depth discussion of some questions (for example, discussions were made in relation to the question, "Do you think that STEM education should be included in Turkey?"). The duration of the meetings ranged between 15-20 minutes. The final form of the data obtained through the interviews was recompiled and analyzed by the researchers. Participants with high scores were assigned to group H and those with lower scores to group L. Demographic information about the participants included in the qualitative stage is given in **Table 10**.

**Table 10.** Demographic information about interviewed participants

| **Gender** | **f** | **%** |
|---|---|---|
| Female | 5 | 45.5 |
| Male | 6 | 54.5 |
| **Academic title** | | |
| Professor | 3 | 27.3 |
| Assoc. Prof. | 2 | 18.2 |
| Asst. Prof. | 2 | 18.2 |
| Res. Asst. | 4 | 36.3 |
| **Department** | | |
| Elementary Mathematics and Science Education | 3 | 27.3 |
| Secondary Science and Mathematics Education | 4 | 36.3 |
| Primary Education | 3 | 27.3 |
| Educational Sciences | 1 | 9.1 |
| TOTAL | 11 | 100 |

**Table 11.** Codes related to teacher educators' views on the "STEM" approach

| | **Themes** | **Codes** | **f** |
|---|---|---|---|
| High awareness group | STEM Readiness | Up-to-date | 6 |
| | | Daily life | 3 |
| | | Educational Value | 1 |
| | | Contribution to teaching | 1 |
| | | Other | 1 |
| Low awareness group | STEM Readiness | Up-to-date | 4 |
| | | Daily life | 3 |
| | | Educational Value | 2 |
| | | Contribution to teaching | 1 |
| | | Other | 2 |

**Table 12.** Frequency of views on necessity of STEM in Turkish Curriculum

| | **Themes** | **Codes** | **f** |
|---|---|---|---|
| High awareness group | STEM Requirement | Yes | 5 |
| | | No | 0 |
| | | Both yes and no | 0 |
| | | Conditional | 1 |
| Low awareness group | STEM Requirement | Yes | 3 |
| | | No | 0 |
| | | Both yes and no | 1 |
| | | Conditional | 1 |

5 interviewees were female and 6 were male. Of these, three were full professors, four were research assistants, two were assistant professors and one was an associate professor. Four participants were working at secondary mathematics and science departments, three were at elementary mathematics and science departments, and three were at primary teaching departments.

The first question on the interview protocol designed to explore participants' views on STEM was "Could you give information about STEM education?". The frequency distribution of the responses they gave is displayed in **Table 11**.

These findings show that participants with high scores had high STEM readiness while participants with low STEM awareness had little prior knowledge about STEM. The following quotes from the participants can be given as examples of this interpretation:

*H1: "STEM, by forming education with an interdisciplinary approach, helps students acquire the 21st century skills. With STEM education, students can further internalize knowledge."*
*H4: "… it is a teaching approach that aims to train STEM staff that will be needed in the future."*
*H5: "It is an approach that integrates science education with technology, engineering and mathematics to learn by doing."*

*L1: "A teaching approach that I think is exaggerated and that spreads like fashion, and is used for advertising and commercial purposes, rather than its scientific aspect ..."*
*L4: "I do not have much information about STEM. Although it may seem like something new, I think it is the approach that we have been talking about for years as interdisciplinary work and project production and that we want to foster in students."*

The distribution of the participants' responses to the question of whether STEM education should be a part of the Turkish national curriculum is given in **Table 12**.

 

**Table 13.** Responses related to involvement in STEM projects

| | Themes | Codes | f |
|---|---|---|---|
| High awareness group | STEM Activity | I am involved | 4 |
| | | I'm not involved | 1 |
| Low awareness group | STEM Activity | Not at our university | 1 |
| | | I am involved | 1 |
| | | I'm not involved | 4 |

In **Table 12**, while all of the participants with high STEM awareness stated that STEM was a need for the current curriculum, some of the participants with low awareness answered in the same way. Quotes from the participants are as follows:

*H1: "Yes, it should definitely be. STEM is important and efforts to find its value and spread it in the national curriculum should be made. However, it is seen that all the necessary steps for STEM have not been taken yet. The priority of the Council of Higher Education in Turkey should be to ensure all STEM academics receive the necessary education to sustain the STEM approach (coding, Arduino, design, etc.), apply STEM activities and know how to act with the disciplines required for STEM, and to be able to prepare a lesson plan. But unfortunately, our academics were not prepared in this field and sufficient training was not given."*

*H3: "Yes, it should be taught as a 2-hour course at middle schools and high schools."*

*L3: "Both the Ministry of National Education and teacher education curricula should be reviewed. A spiral program should be adopted. STEM can be taught as a separate course in order to demonstrate the relationship between the disciplines. STEM should be started from primary school."*

*L5: "I think we are at the very beginning of STEM education right now. There is a tendency towards robotics fields in particular, but I don't think STEM logic is fully understood."*

The participants' views on how STEM should be conditionally implemented in schools are as follows:

*H5: "Although I think this approach is applicable in our education system, I do not think it is suitable for all age groups. Although learning by doing-living is an indispensable part of preschool education, which is my area of expertise, I believe that the basic field of engineering poses a problem in the application process in this approach. Considering the roles of families in the process, especially in the performance assignments applied in primary school, it can be said that this approach causes problems with expectation for the target audience."*

*L1: "I do not think it should be exaggerated, but rather it should or should not take place. If it is used correctly and nicely and it will work, of course it should be used."*

Views of the participant who said both yes and no about the necessity of STEM are given below:

*L2: "Yes, because I think it will contribute to students' knowledge of the engineering profession and to their scientific creativity, and it will be useful in schools as it will show all disciplines together as in daily life.*

*No, because I think both the readiness levels of the students and the teachers' knowledge of designing the necessary activities are not sufficient. There are a lot of misconceptions in the literature, and unfortunately, teachers' opinions are not clear on this subject."*

The distribution of participants' responses to the question of whether they participated in any STEM project or activity at their university, and if they did, what their job descriptions were, is shown in **Table 13**.

According to **Table 13**, it is seen that the participants with high awareness participated in activities related to STEM while the participants with low STEM awareness mostly said they were not involved in STEM-related activities.

Some of responses of the participants were follow:

*H2: "We worked on TUBITAK projects and postgraduate studies related to STEM."*

*H5: "TUBİTAK 4004 Project Instructor."*

*H6: "TUBİTAK 4004 Project Coordinator."*

*L2: "During my graduate education, I managed STEM workshops and worked as an educator in STEM teacher trainings supported by National Education Directorates."*

One participants stated that no STEM project was carried out at the university where she worked, so he participated in STEM projects that different organizations carried out. Her quote is as follows:

*H1: "Unfortunately, no STEM project has been carried out at our university. However, I was involved in STEM projects organized by the Ministry of National Education."*

**Table 14.** Responses of the academics regarding the status of reading about STEM

| | Themes | Codes | f |
|---|---|---|---|
| High awareness group | STEM Interest | Yes | 5 |
| | | No | 1 |
| Low awareness group | STEM Interest | Yes | 5 |
| | | No | 0 |

**Table 15.** Participants' responses about having a STEM-related publication

| | Themes | Codes | f |
|---|---|---|---|
| High awareness group | STEM Product | Yes | 4 |
| | | No | 2 |
| Low awareness group | STEM Product | Yes | 0 |
| | | No | 5 |

**Table 16.** Answers about which of the training sub-dimensions the STEM approach contributed most to

| | Student | Teacher | Course / Teaching | f |
|---|---|---|---|---|
| High awareness group | 1st | 3rd | 2nd | 4 |
| | 2nd | 3rd | 1st | 2 |
| Low awareness group | 2nd | 3rd | 1st | 2 |
| | 1st | 3rd | 2nd | 2 |
| | 2nd | 1st | 3rd | 1 |

* 1 = maximum, 2 = medium, 3 = minimum

In order to determine the interest of teacher educators in STEM, they were asked if they read any materials in the STEM field. The frequency distribution of the responses is shown in **Table 14**.

As seen in **Table 14**, five participants (83 %) with high awareness stated they read various sources related to STEM, while one participant said he did not read about STEM. Also, all of the participants with low awareness (100%) reported that they read about STEM. Some of their responses are presented below:

*H1: "I follow articles for STEM. I also read the books on the market and use them for my classes. As a participant, I also follow videos to improve myself, articles on which activities are developed, and trainings organized by the National Ministry of Education for teachers."*
*H4: "… I follow the publications in academic journals. I also follow the books about the new STEM."*
*H6: "I still do STEM+ reading in curriculums developed for the STEM approach."*
*L1: "I follow the news about articles and STEM events. It doesn't interest me much."*
*L3: "I am trying to follow the relevant literature. I care about STEM. I read articles. I read activity books."*
*L5: "I read articles about application examples and projects abroad."*

The response of the participant who stated that he did not read about STEM is as follows:

*H3: "I did not feel the need to be too interested in STEM, a concept that emerged in the last years of my professional life."*

Teacher educators were asked whether they had any publications on the STEM approach, and the frequency distribution is shown in **Table 15**.

In **Table 15**, findings indicated that participants with high STEM awareness had work related to STEM published, whereas those with low awareness were not involved in any STEM-related publication. Some of the responses of the participants are given below:

*H1, H2: "Yes, I have one publication on STEM."*
*L4: "Yes, I have four STEM publications."*
*L6: "Yes, I have ten STEM-related publications."*

The frequency distribution of responses about ranking the benefits of the STEM approach in the student, teacher and course / teaching sub-dimensions from most to least important are given in **Table 16**.

Four participants with high STEM awareness stated that STEM education would positively influence students, the course and teaching, and teachers, in that order. Two participants with high STEM awareness ranked the positive effects as the course and teaching, students and teachers, respectively. Two participants with low STEM awareness stated that STEM education contributed first to the course and teaching, then to the student, and lastly, to the teacher. Two teacher educators in the low group ranked the contributions as the student, the course and teaching, and the teacher, in that order. One participant with low STEM awareness stated that STEM education contributed mostly the teacher, then the student, and lastly, the course and teaching. These findings show that teacher educators with high STEM awareness believed that STEM education contributes more to students and the course and teaching, whereas teacher educators with low STEM awareness did not have any agreement on this issue.

## CONCLUSION AND DISCUSSION

As a result of this research, it was determined that the participants of this study all had high levels of STEM awareness. This result is consistent with the results of Çolakoğlu and Günay-Gökben's (2017) study, in which they identified the STEM work of teacher educators with the deans of education faculties. Çolakoğlu and Günay-Gökben (2017) underlined that although the teacher educators' STEM awareness was high, their work on STEM was not sufficient. In this study, parallel with this finding, despite their high STEM awareness, teacher educators' STEM-related publications, projects and seminars were not at a satisfactory level. Studies that found teachers' STEM awareness to be high reported that the reason for the high STEM awareness was that in the content teaching course in the teacher education program, new teaching methods in the literature were emphasized (Çevik, Danıştay & Yağcı, 2017; Karakaya, Ünal, Çimen & Yılmaz, 2018). Because these courses were taught by teacher educators that were the subject of this study, it can be said that the results of this study were indirectly parallel with the findings of previous studies. By supporting the quantitative findings, the qualitative findings of this study underscored that teacher educators with high STEM awareness believed that STEM education was up-to-date and valued its educational importance rather than its popularity.

Additionally, in the study we examined whether teacher educators' STEM awareness differed according to their gender. However, parallel to the findings of studies with teachers (Bakırcı & Karışan, 2017; Çevik, Danıştay & Yağcı, 2017) and teacher candidates (Demir Başaran & Temircan, 2018; Karakaya & Avgın, 2016; Kırılmazkaya, 2017; Lin & Williams, 2016), no difference was found between female and male teacher educators' STEM awareness. However, there was a significant difference in teacher educators' awareness based on their age. Analysis showed that this difference was between teacher educators in the 20-30 and the 31-40 age groups, in favor of the 31-40 age group, in the sub-dimension related to the effects on the course. Also, it was found that teacher educators aged 61-70 had a higher awareness than those aged 20-30. These results are consistent with studies conducted with school principals and teachers (Ciğerci, 2020; Nadelson & Seifert, 2013). The results indicated that participants who had high STEM awareness had more work experience in the field of their study. As Margot and Kettler (2019) stated, age, gender and teachers' STEM experiences are the factors affecting their expectations from STEM education. In the qualitative part of the study, it was determined that the majority of the teacher educators with high awareness were more experienced ones. This case also supports the result of the quantitative part. It was also determined that the STEM awareness of the teacher educators was significantly different according to their academic titles. Further analysis revealed that assistant professors had higher awareness than research assistants and associate professors. The reason for this can be that the assistant professors may closely follow new approaches, teaching methods and techniques in the literature during their doctoral studies and their tenure track. Gökgöz and Ünsar (2009) reported that the habit for hard work that they gained during their doctoral studies, and their requirements to be appointed as assistant professors and to keep up with their colleagues caused assistant professors to engage in intensive work in their desire to advance their careers. In the literature it was reported that because research assistants do not have a course workload and are less experienced than faculty members, they will have different professional development needs (Moeini, 2003). Also, since research assistants are still at the beginning of their academic life and their interests are newly formed, they may not be willing to devote extra time to new approaches including STEM, as they are more likely to focus on master's or doctoral studies, and therefore, their awareness may be less than that of faculty members. As for associate professors, they may have a decrease in their awareness compared to assistant professors because they are no longer in the tenure tracking and read more on a specific field. It was also found that STEM awareness of teacher educators did not significantly differ based on their departments.

Bers and Postmore (2005) underscore that teacher candidates should be trained in using new methods and techniques effectively during their studies in undergraduate education. In this regard, it is necessary for teacher candidates to be taught the engineering process in teacher education programs, especially in science and technology teacher programs (Marulcu & Sungur, 2012). In this context, we found that participants with high STEM awareness stressed that STEM education needed to be included in the curriculum, whereas those with low STEM awareness did not. In the STEM Research Report published by the Ministry of National Education (2016), it is highlighted that STEM course activities should be integrated into the curriculum. Interdisciplinary integration is essential because of the 21st century requirements and problems requiring a multiple perspective. Therefore, it is important to develop educational programs by integrating the right disciplines (Bahar, Yener, Yılmaz, Emen &

Gürer 2018). At this point, it is a vital requirement that in the curriculum of STEM education, qualified teachers who implement a multi-disciplinary approach should be involved (Ramaley, 2007; Wang, 2012). In this study, it was found that STEM awareness was influenced by participation in STEM-related projects or activities and publishing scientific work on STEM. STEM awareness is a prerequisite for self-efficacy, interaction and self-improvement (Kovarik et al., 2013). This will influence the training of qualified preservice teachers who have 21st-century skills in teacher education programs. The National Institute of Education (2009) emphasized the characteristics of being innovative and entrepreneurial among the teacher competencies needed for the 21st century. It can be inferred from the results of this study that STEM awareness indirectly affects the entrepreneurship characteristics of pre-service teachers (Deveci, 2018).

On the contrary, preservice teachers' disinclination to use information in an integrated way causes disconnection between theory and practice (Gürsoy & Çinici, 2019). This disconnection may be rectified with STEM education, which allows them to use math and science concepts in engineering design and technology (Chamberlin & Pereira 2017). To make this happen, teacher educators who are responsible for the training of teacher candidates play a bridge role in the context of STEM.

One finding of this study indicated that teacher educators with high STEM awareness believed that the STEM approach contributed more to students and the course / teaching. As a matter of fact, Eroğlu and Bektaş (2016) stated that science teachers who have received STEM education are effective in improving student creativity with STEM-based lesson activities. On the other hand, participants with low STEM awareness did not clearly have any consensus about the effect of STEM education. Their low STEM awareness can be a reason for this disagreement.

## LIMITATIONS

This study was carried out with 239 teacher educators working at 54 state universities in seven different regions of Turkey. Further studies can be carried out with more participants. Also, studies can investigate the STEM awareness of faculty members who work at different colleges, such as colleges of science or engineering, since STEM is a multi-disciplinary approach. It was left to the participants selected by the convenience sampling method to be included in the study. This may be one of the weak points of the study. It is because those who are interested in STEM research wanted to participate and this may have affected the result. However, there are also those with very low STEM awareness among those included in the study. In a different study a different method may be used to select the participants. In this way, the scientific quality of the study can be further strengthened. The objective of this study was to determine STEM awareness, and further studies can be extended to STEM attitudes, interest and skills. One limitation of this study was that in-depth face-to-face interviews could not be done due to the COVID-19 pandemic. Instead, answers were received with digital forms and discussions were made on these answers via WhatsApp.

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## APPENDIX

### STEM AWARENESS SCALE FOR TEACHERS

| | Totally Agree | Agree | Not Sure | Disagree | Totally Disagree |
|---|---|---|---|---|---|
| **Effects on Students** | | | | | |
| 1. STEM education contributes to the increase of hand skills of students. | | | | | |
| 2. STEM education improves students' analytical thinking skills. | | | | | |
| 3. STEM education motivates students for the lesson. | | | | | |
| 4. STEM education increases students' problem-solving skills. | | | | | |
| 5. STEM education practices increase students' self-confidence. | | | | | |
| 6. STEM education supports students for gaining a critical perspective. | | | | | |
| **Effects on The Course** | | | | | |
| 7. It is inevitable that STEM education will cause the lesson to be reflected on daily life. | | | | | |
| 8. STEM training requires high-level materials. | | | | | |
| 9. STEM education practices negatively affect class dominance. | | | | | |
| 10. STEM education activities waste a lot of time in the lesson. | | | | | |
| 11. STEM education activities should be included in the curriculum. | | | | | |
| **Effects on Teachers** | | | | | |
| 12. STEM education makes it necessary for teachers to use technology in the lesson. | | | | | |
| 13. STEM educational practices are an opportunity for teachers to improve themselves. | | | | | |
| 14. Teachers should take an active role in STEM education activities. | | | | | |
| 15. Teachers can easily plan STEM education for in-class / out-of-class activities. | | | | | |

* The scale was developed by Çevik (2017).