Junior High School Teachers' Self-Efficacy Levels for STEM Practices: A Sample of Aydin City

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Abstract: Today, it is of great importance to establish a workforce with knowledge and skills in fields such as science, technology, engineering, mathematics and education in order to reach the level of developed society. STEM, as an integrated educational approach, is known as one of the effective methods in teaching such knowledge and skills. However, the success of this method requires teachers to be competent in the field of STEM and it is important to investigate teachers' self-efficacy levels regarding to STEM approach. Therefore, the purpose of this study is to determine junior high school teachers' self-efficacy for STEM practices. It was designed as a survey research within the quantitative research methods. The sample was made up of 38 voluntary teachers working in junior high schools located in the city center of Aydin, Turkey. The data were collected through a questionnaire including questions asking for participants' demographic characteristics and Teachers' Self-Efficacy Scale for STEM Practices. According to the findings, participating teachers, on average, had a moderate level of self-efficacy for STEM practices. No significant difference was found in their self-efficacy scores according to gender, work experience and reason for choosing teaching experience.

Keywords: STEM, Self-efficacy, Junior high school, Teachers

Introduction

Developments in information and communication technologies affect the social activities of all countries. As a result of these interactions, countries are trying to restructure their education systems and try to harmonize teaching practices with the ever-increasing use of technology. The STEM education model is seen as one of the most convenient approaches to achieve this harmony. With STEM education, it is aimed to raise students as individuals with advanced 21st century skills and technology literacy and as citizens who can do research, make sense of the world, and solve problems in different structures (Thomas, 2014).

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STEM is adopted as one of the most important advances in the field of education that has occurred in order to train the people needed in the 21st century (Land, 2013). It is an interdisciplinary approach that aims to integrate science, technology, engineering and mathematical sciences rather than teaching them one by one (Bybee, 2010). The STEM education approach aims to support solving real-life problems, primarily to gain 21st century skills, to increase awareness and professional interest in STEM fields, to raise qualified individuals that the workforce will need in the future, and to support economic growth (Thomas, 2014). The most important factor in the emergence and adoption of the STEM education approach is the need for countries to adapt to scientific and technological developments and to keep up with the economic competitive environment triggered by these developments.

In order for the aims and objectives of STEM education to be realized, several important elements must be put to work in harmony. The first is the adoption of an integrated curriculum approach. This element is the cornerstone of STEM, and it is a requirement that real-life problems are multidimensional, requiring multiple disciplines, and that product and service development today depends on interdisciplinary teamwork (Johnson, Peters-Burton & Moore, 2016). The second element is the use of appropriate pedagogical approaches. STEM applications require student-centered, open-ended, inquiry-based and experiential-oriented instructional design with engineering design thinking that helps students develop and test solutions to problems (Baran, Canbazoğlu Bilici, Mesutoğlu & Ocak, 2016). Such desired pedagogical approaches can be effective when teachers accommodate their classrooms with active learning activities such as peer learning, group work activities and collaborative argumentation (see Latifi & Noroozi, 2021; Latifi et al., 2020, 2021; Noroozi 2018, 2022; Noroozi et al., 2018; 2020; Valero Haro et al., 2019; 2022). Another element is the provision of a motivating and engaging environment that includes laboratories, workshops and technological tools where students can develop and use models, plan and conduct research, analyze and interpret data, and design solutions (Stohlmann, Moore & Roehrig, 2012). The most important element is that there are qualified teachers who bring all these elements together, apply and manage them (Johnson et al., 2016).

In the STEM Education Workshop Report, in which STEM education in Turkey was comprehensively evaluated with the participation of academics, experts, administrators and teachers, teacher competencies were shown among the top priority issues to be developed in the use of STEM (Akgündüz, Ertepınar, Ger, Sayı &Türk, 2015). Literature reviews on the factors that influence successful STEM practices highlight the key role of teacher self-efficacy (Green & Sanderson, 2018). Dedicated and organized teachers are shown as an important requirement for the implementation of effective STEM education (Stohlmann et al., 2012).

Self-efficacy is generally known as individuals' judgments about their own abilities for a particular performance and is seen as a predictor of the relevant performance (Bandura, 1987). It is known that people with high self-efficacy are characteristically more interested in their work, can work longer and more, have better time control and task focus, are flexible and less anxious (Pajares & Miller, 1997). In this context, it is expected that teachers' self-efficacy beliefs towards STEM applications, which involve a complex and difficult process, will have a decisive role in their inclusion of STEM in their teaching processes. As a matter of fact, the limited number of studies conducted in this area show that teachers' perceived STEM self-efficacy levels are positively related to their attitudes towards STEM and their STEM practice (Lee, Hsu & Chang, 2019). These pioneering findings suggest that identifying teachers' self-efficacy beliefs towards STEM education practices is necessary both for the development of activities to support their self-efficacy levels and for a better understanding of STEM practice situations. In addition, it is important to determine the variables that may be related to teachers' STEM self-efficacy beliefs in this context. With these in mind, this study aimed to investigate junior high school teachers' self-efficacy level for STEM practices and its relationships with some demographics. In order to fulfill this purpose, the following research questions were formed:

- What is the level of teachers' self-efficacy for STEM practices?
- Do their self-efficacy levels for STEM practices differ across gender, work experience, and determining factors for choosing teaching career?

Method

Since this research explores the current state of junior high school teachers' self-efficacy levels regarding to use of STEM approach in education from a descriptive point of view, it was designed as a survey research model within the quantitative research methods.

The population includes teachers working in junior high schools located in the city center of Aydin, Turkey during the 2019-2020 academic years. Using a convenience sampling to overcome time and financial limitations, the sample comprised 38 volunteer and easily accessible teaches. The first author is a school manager of a junior high school in the city center. Therefore, the participants were those teachers working in either his school or nearby schools. Of the participants, 71% of them were male and 29% were female students. Regarding working experience, 15% have 1-10 years, 45% have 11-20 years and 40% have 21 or above years of teaching experience. The determinant of choosing teaching career was distributed as follow: centralized university entrance exam score (13%), the effects of social circle (37%), and personal factors (50%)

The data were collected through a paper-and-pencil type questionnaire including questions asking for participants' demographic characteristics and Teachers' Self-Efficacy Scale for STEM Practices developed by Yaman, Özdemir and Vural (2018). The scale was originally prepared to determine the self-efficacy beliefs of science teachers and prospective teachers towards the STEM approach. Yaman et al. (2018) started with an item pool containing 55 items, and as a result of expert examination and factor analysis, the scale reached its final form consisting of 18 items with a single factor.

The items in the scale were arranged according to a 5-point Likert-type rating scale and scored as "never=1, rarely=2, sometimes=3, often=4, and always=5". A composite score was made up of as the arithmetic mean of the scores obtained from the items. A high score means that the teacher has a high self-efficacy belief in applying STEM in their lessons. Yaman et al. (2018) calculated the Cronbach Alpha reliability coefficient as .98 as an indicator of the scale's internal consistency. In this study, the Cronbach Alpha coefficient was determined as .96.

Results

Table 1 presents the descriptive statistics for the scores that participants obtain from the STEM self-efficacy scale. As can been seen, self-efficacy scores ranged from 1.44 to 4.28 with a mean score of 2.88, just above the midpoint of its scaling range. The standard deviation value was .72, which shows moderately narrow dispersions of the data, suggesting that participants' scores were closely clustered around the mean.

Table 1. Descriptive Statistics for STEM Self-Efficacy

Variable	Minimum	Maximum	Mean	SD
STEM self-efficacy level	1.44	4.28	2.88	.72

An independent-samples t-test was conducted to compare participating teachers' self-efficacy scores across gender (Table 2). There was no significant gender difference [$t_{(36)}$=.36, p>.05] in STEM self-efficacy scores.

Table 2. Comparison of Teachers' Self-Efficacy Scores by Gender

Variable	Gender	N	Mean	SD	t	p
STEM self-efficacy level	Male	27	2.81	.73	.36	.72
	Female	11	2.91	.79		

A one-way between-groups analysis of variance (ANOVA) was conducted to explore work experience differences in teachers' self-efficacy scores (Table 3). There was no significant difference [$F_{(2, 35)}$=.47, p>.05] in STEM self-efficacy scores among teachers with different years of experience. Similarly, another ANOVA test was conducted to explore determinant of teaching career differences in teachers' self-efficacy scores (Table 4). There was no significant difference [$F_{(2, 35)}$=.47, p>.05] in STEM self-efficacy scores among teachers with different reasons for choosing teaching career.

Table 3. Comparison of Teachers' Self-Efficacy Scores by Work Experience

Work experience level	N	Mean	SD	F	p
1-10 years	6	3.02	1.06	.47	.63
11-20 years	17	2.75	.83		
21 years and above	15	2.98	.55		

Table 4. Comparison of Teachers' Self-Efficacy Scores by Determinant of Teaching Career

Determinant of teaching career	N	Mean	SD	F	p
University entrance exam score	5	3.10	1.05		.67
Personal factors	19	2.78	.86	.39	
The effect of social circle	14	2.94	.51		

Conclusion

The study shows that participating junior high school teachers, on average, had a moderate level of self-efficacy for STEM practices. In parallel with this finding, Dadacan (2021) reported in his study with science and preschool teachers that their self-efficacy, awareness and orientation towards STEM education are generally at a moderate level. Similarly, Yaman and Aşılıoğlu (2022), in their study examining awareness, attitude and in-class practice self-efficacy perceptions for STEM education, reported that their awareness, attitude and classroom practice self-efficacy for STEM education were moderate. This finding can be interpreted as the participant teachers see themselves as neither too ready nor too lacking in using STEM in their lessons. In other words, it can be said that teachers are undecided about their own potential at the point of applying STEM.

Another conclusion is that teachers' self-efficacy levels for STEM practices are independent of gender, work experiences and determinant of teaching career. Consistently, in the study conducted by Biçer, Uzoğlu and Bozdoğan (2019), there was no difference in teachers' self-efficacy perceptions in terms of working time. Ciğerci (2020), on the other hand, reported in his study that teachers with more than 16 years of seniority had significantly higher STEM awareness and self-efficacy compared to other years of seniority. Similarly, in Dadacan's (2021) study, it was seen that there was no significant difference in the self-efficacy, awareness and orientation of science and pre-class teachers towards STEM education in the variables of gender, university, and the faculty they studied. The lack of gender differences in this study is thought to be due to the similarity of their social and cultural structures. The fact that no significant difference was determined according to seniority and the reasons for choosing the profession is thought to be a result of the participants having a close/similar social environment.

Recommendations

The research offers several recommendations for future researchers and practitioners. STEM content and applications of teachers' in-service training programs can be expanded in a way to increase self-efficacy. Teachers can be encouraged to attend STEM-related activities to get early experiences which in turn trigger higher interest and further experiences. Future research may explore the effect of other demographic and occupational factors (age, branch, school type, academic career, etc.). Experimental or longitudinal studies can be conducted to find out what kinds of conditions/interventions are influential on self-efficacy.

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