


Exploring attitudes towards STEM education: A global analysis of university, middle school, and elementary school perspectives

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Abstract

The goal of this study is to examine views regarding STEM education studies pertaining to a variety of disciplines inside an electronic database. In addition, the same keyword was used to search for articles published in the electronic database. 23 studies on STEM education context attitudes were assessed using criteria derived from the associated literature. As a result, Turkey provided the majority of the data, but Jordan, Indonesia, and China each contributed two sets. In research groups, instructors and middle school students mostly participated. University, elementary, and secondary school students participated sequentially. The most notable research explores whether participants' STEM attitudes alter in response to diverse conditions. Next are STEM-related studies. One research focuses on the development of scales. There are two types of STEM attitude factors. The first group consists of attitude-affecting elements. The second one is that factors are associated with attitudes (Personal and academic). Teachers' STEM attitudes were favorable, somewhat positive, and moderately positive. Studies of teachers reveal no gender differences. Also, it is indicated that a negative or no correlation between experience and attitudes. Private school science instructors were more supportive of STEM education than their public-school counterparts. The STEM perspectives of university students were favorable, whereas those of high school students were moderate. University and pre-university perspectives on STEM were not affected by gender. However, some pre-university studies demonstrate gender differences in STEM views. A traineeship or STEM education increased the STEM attitudes of university students. In pre-university STEM programs positively affect attitudes toward STEM.

Keywords: attitudes toward STEM, gender, STEM based activities

INTRODUCTION

The purpose of education is to help individuals in utilizing knowledge to improve their quality of life. The majority of individuals would neither apply school-learned information to their daily lives nor blend their daily experiences with school-learned information (Chen & Chen, 2021; Panferov et al., 2022). Science,

technology, engineering and mathematics (STEM) education attracts a lot of attention in many educational disciplines (Kareem et al., 2022; Lebedeva & Vilkovala, 2022).

STEM is a course that focuses on these four fields and is aimed to prepare students for employment following graduation (Rayner & Papakonstantinou, 2015). However, many students may find STEM education

Contribution to the literature

- This study sheds light on the studies on attitudes towards STEM in recent years.
- Study data provide support for the conceptualization of intervention studies to influence attitudes toward STEM.
- It provides a holistic perspective on whether the attitude towards STEM has changed according to which variables in the studies.

tough since it demands analytical thinking and complicated problem solving (McDonald & Waite, 2019). STEM fields are considered beneficial for students to focus on because they provide analytical thinking and useful skills that can be used in future career choices (Fajrina et al., 2020; Masalimova et al., 2022).

Each student responds to different teaching methods in their own way. Some people may respond well to hands-on activities, while others learn best when information is presented verbally (Mohammadi & Faskhodi, 2022). Still other students will appreciate visual examples of concepts rather than written explanations. No matter what your students' strengths and weaknesses are, there is a way to help them succeed in a STEM curriculum.

There is no doubt that attitudes towards STEM education have changed in recent years (Altakahyneh & Abumusa, 2020). With the advancement of technology and the need for a highly skilled workforce, many are now turning to STEM education to advance their skills (Widya et al., 2019). However, there are still many people who believe that STEM education is too difficult or unnecessary for their academic development (Culbertson et al., 2019). It examined how approaches to STEM education have changed over time and what factors have influenced these changes in the literature. All students have the opportunity to learn and succeed in STEM fields by accessing resources with a properly educated workforce (Tsybov, 2022). Thus, innovation and growing as a society can be possible.

METHOD

This study is mini literature review related to attitudes toward STEM in the electronic database.

The following data collection process was applied to find related publications:

1. "Attitudes" and "STEM education" were used as keywords through the electronic database (Scopus, ERIC and WOS). 141 articles were scanned at this stage.
2. Initial criteria are "full text availability" and "peer reviewed publication".
3. The titles and abstracts of 38 articles were examined, and 23 articles were included in the detailed review according to the result of this initial review.

Data Analysis

These articles were reviewed one by one in detail. A qualitative thematic review was used in this study. All articles were downloaded and read by the researchers. The groups with whom the studies were performed were first chosen. The instruments they employed to gauge their attitudes toward STEM, however, were identified. The studies were categorized in the following phases according to their goals. Which factors will be examined were decided at this point? The variables were classified during this step. The research' findings relating attitudes toward STEM were determined at the final step. At each stage, the authors came to an agreement before moving on to the next.

FINDINGS

When it came to the countries where the data were obtained, the majority of the research was conducted in Turkey, although two data sets were collected in Jordan, Indonesia, and China. In the remaining nations of Saudi Arabia, Greece, Bosnia and Herzegovina, Liberia, Ghana, Malaysia, Korea, the United States, Thailand, and Taiwan, one data set was gathered for each country. When examining the research groups, studies were conducted with teachers and middle school students. It was then conducted with university students, primary school students, and high school students, in that order. According to the emphasis of the investigation, different measuring instruments were utilized. Most commonly employed were attitude measures for which validity and reliability research had already been conducted. In some investigations, attitudes were determined using a questionnaire.

The Aims of Studies

When the foci of the research are scrutinized, those studies that investigate whether or if the attitudes of the participants towards STEM shift in response to certain variables come to the forefront of the discussion. Then, at the top of the list, are studies examining the impact of STEM-based training or activities. Only scale development research was emphasized in one study (see in [Table 1](#)).

In the study by Alsmadi (2020), investigating whether the attitude of teachers is changing based on teachers' gender, specialty, and study stage is the aim. Another study by Altakahyneh and Abumusa (2020)

Table 1. Article authors, profile of the participants and data collection tools

ID	Article	Countries	Profile of the participants	Data Collection Tools
1	(Aldahmash et al., 2019)	Saudi Arabia	Teachers	Teachers' Attitudes Toward Teaching Integrated STEM
2	(Alsmadi, 2020)	Jordan	Teachers	Teachers' attitudes towards STEM
3	(Altakahyneh & Abumusa, 2020)	Jordan	University students	The attitudes towards the STEM approach
4	(Anastasiadis & Zirinoglou, 2022)	Greece	University students	The attitudes toward Readiness to implement STEM
5	(Baran et al., 2019)	Turkey	Middle schools' students	The STEM attitudes survey
6	(Benli Ozdemir, 2020)	Turkey	Middle schools' students	The Attitude Scale towards STEM
7	(Çengel et al., 2019)	Turkey	University students	The Attitude scale for STEM
8	(Çevik and Ata, 2019)	Turkey	University students	STEAM Attitude Scale
9	(Durakovic, 2022)	Bosnia and Herzegovina	Middle schools' students	STEM attitude scale
10	(Hackman et al., 2021)	Liberia	Teachers	The Attitude towards STEM Education
11	(Ibrahim & Şeker, 2022)	Turkey and Ghana	Middle schools' students	The STEM Attitude scale
12	(Kah Wei & Mistima Maat, 2020)	Malaysia	Teachers	The Teachers' attitude toward STEM
13	(Kartal & Taşdemir, 2021)	Turkey	University students	The Attitude towards STEM Scale
14	(Kim & Bolger, 2017)	Korea	University students	The teachers' attitudes about STEAM
15	(Michael & Alsup, 2016)	USA	Middle schools' students	The attitude toward STEM subjects
16	(Perdana et al., 2021)	Indonesia	Primary schools' students	The students' attitudes towards STEM
17	(Sachdev & Eamoraphan, 2020)	Thailand	Teachers	The Attitudes Toward STEM Education
18	(Sisman et al., 2021)	Turkey	Primary schools' students	The STEM attitude scale
19	(Tao, 2019)	China	Teachers	The Attitudes toward STEM Education
20	(Thibaut et al., 2019)	Taiwan	Teachers	Questionnaire
21	(Timur et al., 2020)	Turkey	Middle schools' students	The STEM Attitude Scale
22	(Zhao et al., 2022)	Indonesia	High schools' students	Questionnaire
23	(Zhou et al., 2019)	China	Primary and middle schools' students	The S-STEM questionnaire

examined whether university students' attitudes towards STEM changed according to their master's or bachelor's degrees. Another study by Anastasiadis and Zirinoglou (2022) evaluated if the gender of university pre-service teachers affected their STEM attitudes.

The purpose of this study (Çengel et al., 2019) was to assess preschool teachers' attitudes toward STEM. The objective of the article (Durakovic, 2022) is to study how characteristics such as gender, grade level, math achievement, and grade point average influence attitudes toward the STEM of middle school students. Hackman et al. (2021) seeks to examine the attitudes of teachers depending on gender, school type, grade level, education level, age, and years of teaching experience. The goal of the study by Ibrahim and Şeker (2022) is to look at the attitudes of 7th and 8th grade students in Turkey and Ghana toward STEM education. The aim of the study by Kartal and Taşdemir (2021) is to examine pre-service teachers' attitudes of STEM in terms of a number of factors (gender, department, class level, having a traineeship about STEM, level of information about STEM). The purpose of the study by Michael and Alsup (2016) was to determine whether boys and females in a Protestant Christian middle school setting had different attitudes about STEM courses. This study (Perdana et al., 2021) aims to evaluate the attitudes of students in primary school in relation to 21st-century abilities, gender, and grade level. The goal of research by

Sachdev and Eamoraphan (2020) was to see if there were any gender-related differences in teachers' attitudes toward STEM education. The aim of Tao (2019)'s research was Chinese kindergarten teachers' attitudes about STEM education and any teaching experience and potential geographical differences in these teachers' attitudes toward STEM education. The major objectives of the study by Kah Wei and Mistima Maat (2020) were to evaluate teachers' attitudes toward STEM education and the difference in attitudes between male and female students.

Some studies (Aldahmash et al., 2019; Kim & Bolger, 2017; Thibaut et al., 2019) aimed to investigate whether professional development training was effective in affecting the attitudes of teachers or pre-service teachers. In some studies in which students participated, the effect of the STEM program (Baran et al., 2019; Zhou et al., 2019), STEM-based Science activities (Benli Ozdemir, 2020; Sisman et al., 2021), and STEM workshops (Timur et al., 2020) on students' attitudes towards STEM was investigated. The study (Zhao et al., 2022) aimed to investigate the effect of students' attitudes in high schools on acceptance and satisfaction. The goal of the study by Çevik and Ata (2019) was to adapt the STEAM Attitude Scale in order to define the STEAM attitudes of preservice teachers and to test a structural equation model comprised of the attitude toward art and STEM awareness, in addition to other variables.

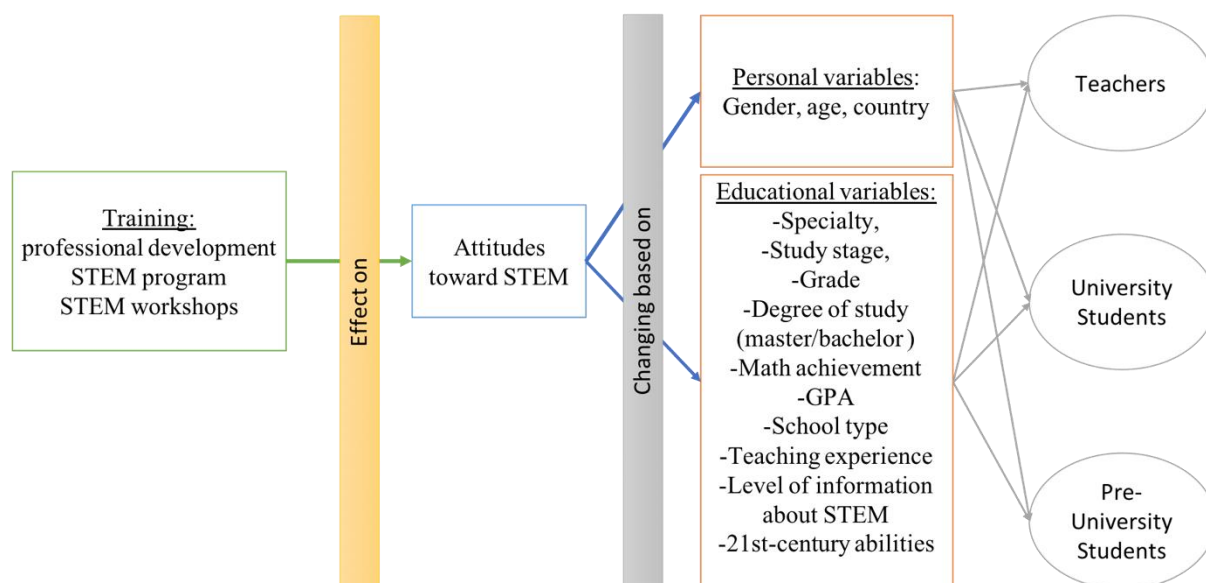


Figure 1. The relation variables attitudes toward STEM (Source: Authors' own elaboration)

Relations among Attitudes toward STEM and Variables

Variables related to attitude towards STEM are divided into two main groups as indicated in **Figure 1**. In the first group, there are variables that have a direct effect on attitude. In the second group, it is in question whether the existing attitude changes according to some variables (Personal and educational). In presenting the findings, first of all, the findings about the teachers will be shared, and then the findings related to the results of the variables in which the students are participants will be shared.

Teachers' attitudes toward STEM were determined as positive (Sachdev & Eamoraphan, 2020; Thibaut et al., 2019), high (Alsmadi, 2020), fairly positive (Hackman et al., 2021), and moderate level (Kah Wei & Mistima Maat, 2020). It is stated that there is no differentiation according to gender in studies where teachers are participants (Alsmadi, 2020; Hackman et al., 2021; Kah Wei & Mistima Maat, 2020; Sachdev & Eamoraphan, 2020). There are statistically significant differences in their estimates according to the study stage variable and in favor of the elementary stage (Alsmadi, 2020; Kah Wei & Mistima Maat, 2020) but in the study senior high school teachers felt more confident about their STEM (Hackman et al., 2021). According to Tao (2019), there was little correlation between teachers' years of teaching experience and their attitudes. However, Thibaut et al. (2019) report a negative correlation between experience in mathematics and total years of teaching and several aspects of teachers' attitudes toward teaching STEM. According to Hackman et al. (2021), science instructors at private schools had a more favorable attitude toward STEM education than their colleagues in public schools.

According to the results of the study in which university-level students participated, students' attitudes toward STEM were positive (Altakahyneh &

Abumusa, 2020; Kartal & Taşdemir, 2021), and at moderate level among pre-university students (Perdana et al., 2021). It has been demonstrated that while they faced doubt in the other aspects (Science and Technology), they had more favorable opinions concerning mathematics and engineering (Anastasiadis & Zirinoglou, 2022). However, compared to other pre-service teachers, pre-service science instructors exhibit higher favorable opinions about STEM (Kartal & Taşdemir, 2021). Additionally, there was no statistically significant difference between the two degree types (master's vs. bachelor's) (Altakahyneh & Abumusa, 2020). Participants' attitudes toward STEM did not differ based on gender at university level (Kartal & Taşdemir, 2021), also at pre-university level (Ibrahim & Şeker, 2022; Timur et al., 2020). However, pre-university level, in some studies indicate that significant differences in students' attitude toward STEM based on gender (Durakovic, 2022; Perdana et al., 2021). The attitudes of university students toward STEM were more favorable after participating in a traineeship or learning about the field (Kartal & Taşdemir, 2021; Kim & Bolger, 2017). In pre-university level, STEM Program, students had a positive change on their attitudes towards STEM (Baran et al., 2019; Benli Ozdemir, 2020; Sisman et al., 2021; Timur et al., 2020; Zhou et al., 2019).

CONCLUSION AND RECOMMENDATIONS

In this study, research studies on attitudes toward STEM between 2016 and 2022 were examined. Consequently, Turkey provided most of the data, although two sets were acquired in Jordan, Indonesia, and China. Research groups included instructors and middle school students. University, primary, and high school students participated in order. Validity and reliability-tested attitude measures were most widely

used. Some surveys measured sentiments. The research that examines whether participants' STEM attitudes change in response to various variables is most prominent. STEM-related studies come next. One study focused on scale development. Two categories of STEM attitude variables exist. Attitude-affecting factors are in the first group. In the second group, is the attitude affected by variables? (Personal and educational). Teachers had favorable, high, moderately positive, and moderate STEM attitudes. Teacher studies show no gender difference. a negative correlation or no relation between experience and attitudes. Private school science teachers favored STEM education more than public school teachers. University students' STEM views were good, whereas pre-university students were moderate. Gender didn't affect STEM views at university or pre-university. But some pre-university researches show gender variations in STEM attitudes. A traineeship or STEM education improved university students' STEM attitudes. STEM attitudes improved in pre-university STEM programs.

According to the results of the study, the effect of the gender variable varies according to the age groups. Detailed studies on the reasons for this can be carried out. Meta-analysis studies can be conducted on the effect of STEM-based education. The study is limited to the articles indexed by the databases. There may be researches that are not indexed in these databases and that contribute to the study subject.

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