HJSTEM
Hellenic Journal of STEM Education, 3(1), 9-15, 2024

www.hellenicstem.com
ISSN: 2832-840X

RESEARCH ARTICLE

A systematic review of afterschool STEM literature in education

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Abstract

In this study, the literature on Afterschool STEM was reviewed from the ProQuest database. Within the scope of the research, 25 theses that met the criteria were examined. The year, type, a method used, data collection tools, study group and number, and keywords of the theses were systematically analyzed. The systematic review method, one of the qualitative research methods, was used to examine the graduate theses on Afterschool STEM. As a result of the findings obtained by examining the theses related to Afterschool STEM; it was found that the first thesis study was a doctoral thesis in 2003, there was a great increase in the number of theses published in 2015, and no thesis was published between 2004-2013, and most of the published theses were in the doctoral thesis type. In addition, in the distribution of theses according to the fields selected in the ProQuest database, it was determined that most theses were published in the field of Science Education, qualitative and mixed research methods were used equally and mostly as research methods, and survey, interviews, and observation were mostly used as data collection tools. In the analyzed theses, data were collected mostly from middle school students. When the number of participants in the theses was examined, the participants between 31-100 were mostly preferred in the studies. According to the keywords used in the theses, the words "education", "out of school time", "afterschool", "STEM" and "STEM education" were preferred.

Keywords

Afterschool STEM, out of school time STEM, systematic review

◆ Received 26 August 2022 ◆ Revised 21 November 2023 ◆ Accepted 24 November 2023

Introduction

Changes in the rapidly evolving technological age create different needs in the areas of knowledge, skills, and education. Twenty-first-century skills are crucial in preparing young people to be tomorrow's innovators, researchers, and leaders in science, technology, engineering, and mathematics (STEM) fields and in choosing future careers (Becker et al., 2011).

Education and training activities may not only take place within a certain time frame and in a certain place. Afterschool programs also play an important role in the development of educational activities (Afterschool Alliance, 2011). There is a need for opportunities to diversify the programs offered by afterschool programs and the ways in which students experience STEM learning. Afterschool programs differ from other informal science education settings in that they are often much more structured and are at the intersection of a freely chosen learning environment (Krishnamurthi, 2015).

Since school-age children spend less than 20% of their waking hours at school, afterschool programs play an important role in educational activities (Krishnamurthi, 2015). Adding an afterschool component to the science lessons taught in schools as part of the curriculum significantly affects students' active engagement in learning, their positive interest in science, technology, engineering, and mathematics, and STEM-based academic growth (Corbin, 2014).

Purpose of the Study

In this study, it was aimed to systematically examine the graduate theses on Afterschool STEM in the ProQuest database. By systematically reviewing the research questions in the research and the existing literature, it can help to identify existing knowledge gaps and enable the research to fill these gaps. In line with the purpose of the study, the following questions were sought: in the theses related to Afterschool STEM;

1. What is the distribution of the analyzed theses according to years, fields selected in ProQuest, and thesis type?
2. What is the distribution according to the research method?
3. What is the distribution according to data collection tools?
4. What is the distribution according to the level and number of participants?
5. What is the distribution according to the keywords used?

Methods

In this study, the systematic review method, one of the qualitative research methods, was used to examine graduate theses on Afterschool STEM. The systematic review is a methodology that identifies existing studies, selects and evaluates their content, analyzes and synthesizes data, and reports evidence in a way that allows meaningful and clear conclusions to be drawn about what is known and unknown (Denyer & Tranfield., 2009). In this study, the five-stage review design proposed by Denyer and Tranfield (2009) for conducting a systematic literature review was used. In the first stage, the research question was identified. In the second stage, studies were screened

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https://doi.org/10.51724/hjstemed.v3i1.28

from the ProQuest database according to words and criteria. In the third stage, the studies were manually screened and the studies that needed to be excluded were removed from the design. In the fourth stage, analysis and evaluation of the results were carried out in the last stage.

In the systematic review type literature search, studies on Afterschool STEM from the past to 2022 were searched in the ProQuest database. The keywords "Afterschool and STEM", "After school and STEM", "Out of School Time and STEM", and "OST and STEM", related to Afterschool STEM were scanned according to their usage in the titles. As a result of the search, 306 results were obtained. From these search results, master's and doctoral theses that met the inclusion criteria in ProQuest between April 15 and July 31, 2022, were selected. Studies other than theses in the database were excluded. There were 26 registered theses in the database. Thesis titles were examined and 1 thesis that was not related to Afterschool STEM was excluded from the study. Thesis abstracts and full texts were examined in detail, and the 25 theses constituting the sample were systematically examined in terms of the year of the thesis, the type of thesis, the method used in the thesis, the data collection tools of the thesis, the study group and number of the thesis, and the keywords of the thesis. The thesis selection process is shown in the PRISMA flow diagram (**Figure 1**).

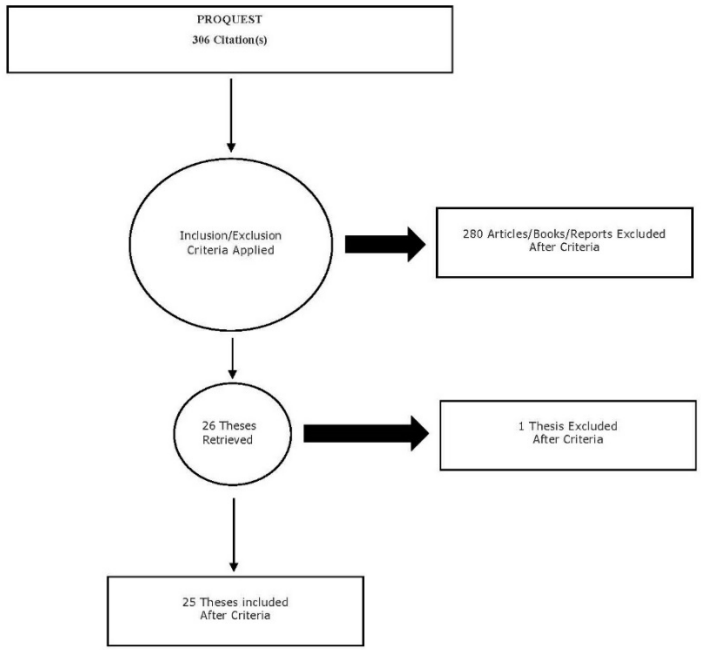

Figure 1. Thesis selection process - PRISMA flowchart

Findings

In this study, 25 theses related to Afterschool STEM, which are open to access in the ProQuest database, were examined (Abu-Rasool, 2015; Acosta, 2015; Ashford, 2016; Barnes, 2021; Basile, 2015; Calmer, 2015; Crawford-Ferre, 2017; Cupp, 2015; Eckels Anderson, 2016; Flowers, 2003; Grack Nelson, 2017; Hinds, 2014; Holba, 2015; Orduña, 2017; Pappas, 2021; Rains, 2018; Scipio, 2015; Sims, 2016; C. Smith, 2015; C. F. Smith, 2015; Swanson Hoyle, 2017; Talbot, 2014; Wang, 2020; Williams, 2021; Wortel, 2019). The findings of the analysis are presented under 5 sub-headings within the scope of the research questions.

Distribution of Theses Analyzed According to Years, Thesis Type, and Fields

Within the scope of the research, firstly, the distribution of theses according to year, research area, and type were analyzed.

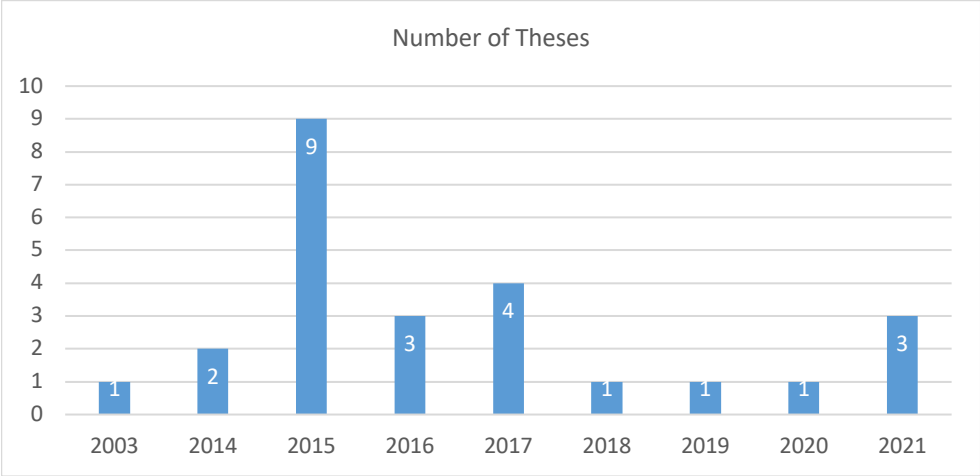

Figure 2. Distribution of theses by years

In the study, theses until July 2022 were analyzed. When the theses analyzed according to **Figure 2** are examined, it is seen that the first thesis in this context was published in 2003 and most theses were published in 2015 (n=9). It is noteworthy that the number of theses published in 2015 is higher than in the other years. It is also seen that no thesis was published between 2003 and 2014. As of July 2022, there is no thesis published 2022.

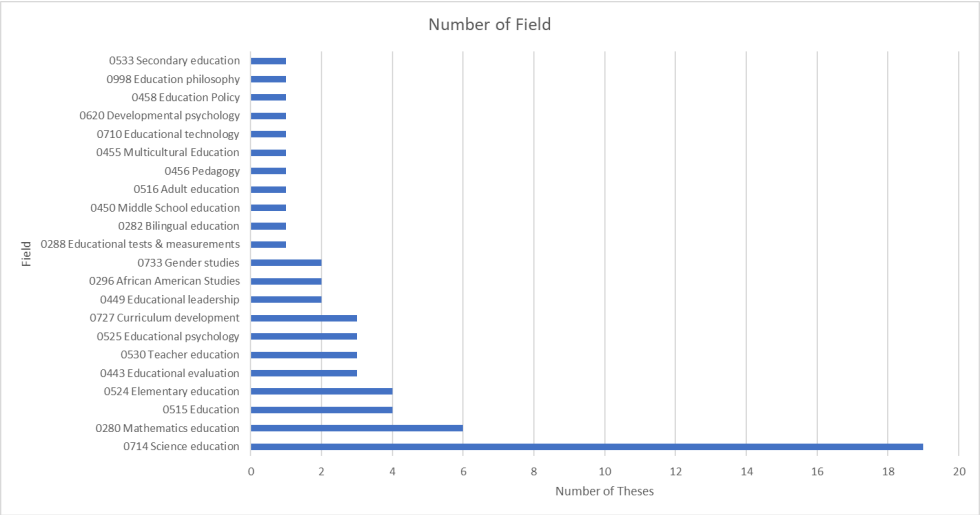

Figure 3. Distribution of theses according to number of fields in ProQuest

As seen in **Figure 3**, it is seen that the distribution of theses according to the fields selected in the ProQuest database is mostly in the field of Science Education (n=19). After Science Education, it is seen that most theses are in the field of Mathematics Education (n=6).

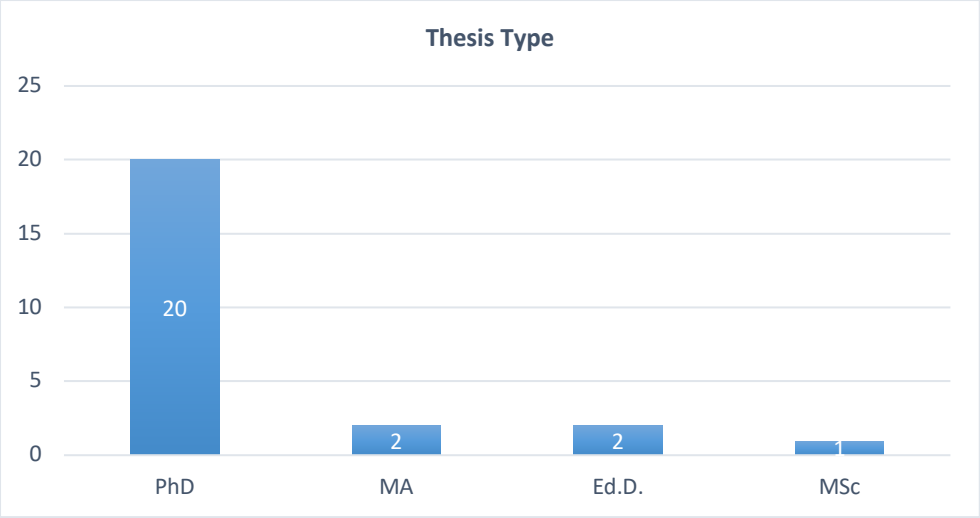

Figure 4. Distribution of theses according to type

As can be seen in **Figure 4**, it is seen that most of the thesis studies on Afterschool STEM are presented as Philosophie Doctor (Ph.D.) thesis (n=20). There are 2 Master of Arts (MA) theses, one Doctor of Education (Ed.D.) thesis, and one Master of Science (MSc) thesis.

Distribution of Theses According to Research Method

Secondly, the theses were analyzed according to the distribution of their methods. The theses were analyzed under quantitative, qualitative, mixed, and literature review headings according to their methods.

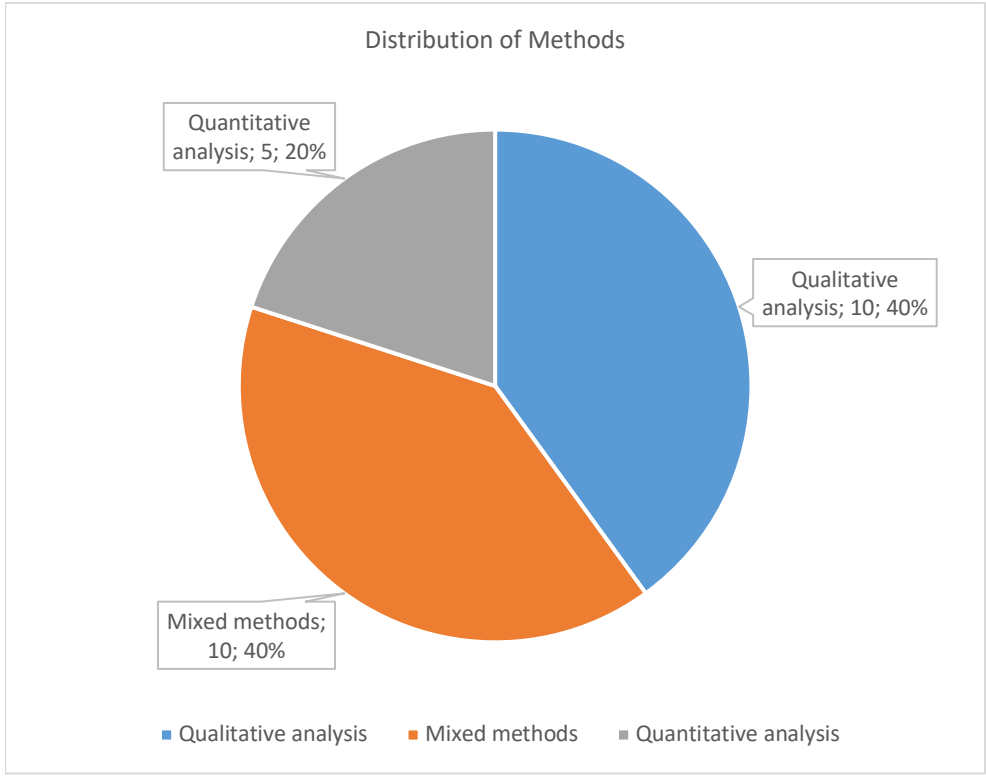

Figure 5. Distribution according to the methods of theses

It was determined that the qualitative research method (n=10) was used in 10 (40%) of the 25 theses examined within the scope of the research (**Figure 5**). The mixed research method was used in 40% (n=10). The quantitative research method was used in 20% (n=15). No literature review method was found in the theses analyzed.

Distribution of the Theses Analyzed According to Data Collection Tools

Thirdly, the distribution according to the data collection tools used in the theses was analyzed. **Figure 6** shows the distribution according to the data collection tools used. In some theses, more than one data collection tool was used.

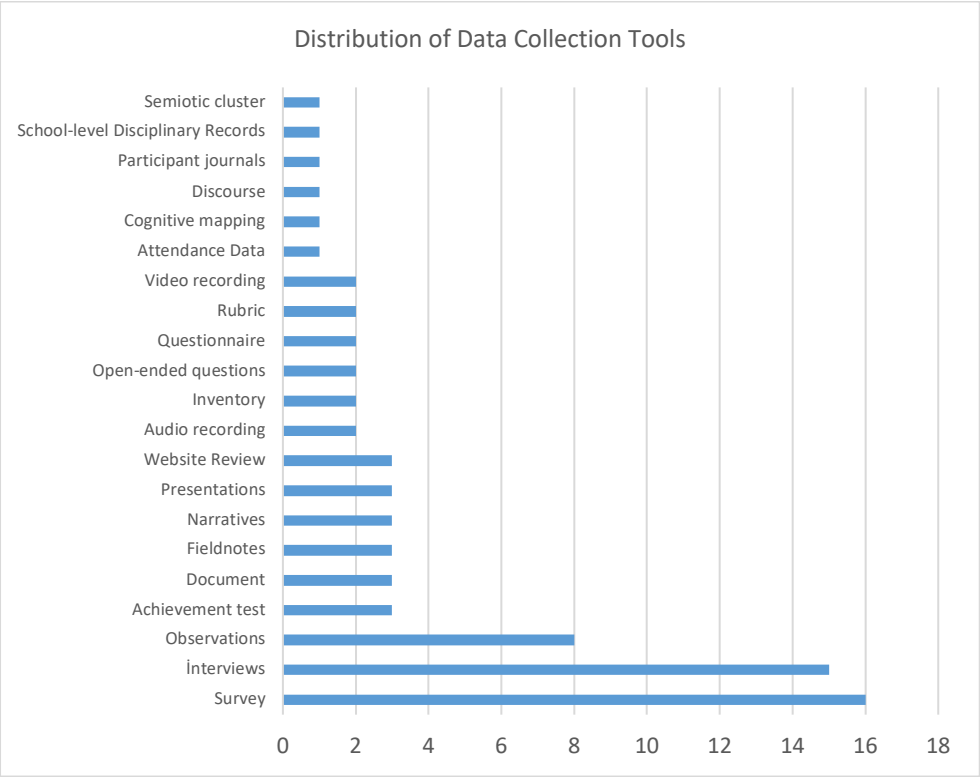

Figure 6. Distribution by data collection tools used in theses

According to **Figure 6**, surveys were used as data collection tools in 16, interviews in 15, and observation in 8 of the theses on Afterschool STEM. In addition, website review, presentations, narratives, fieldnotes, documents, and achievement test data collection tools were used 3 times each, video recording, rubric, questionnaire, inventory, and audio recording data collection tools were used 2 times each, and semiotic duster, school level disciplinary records, participants journal, discourse, cognitive mapping, and attendance data were used 1 time each.

Distribution According to the Level and Number of Participants in the Theses Analyzed

Fifthly, the level and number of participants in the theses and the distribution according to the sample selection method were analyzed. Some of the analyzed theses had more than one sample group. The results of the analysis according to the specific sample groups in the studies are shown in **Table 1**.

Table 1. Types of subjects of theses / participants

Participants	Number/percentage of studies	Sample study
Elementary school students	5/20%	Eckels Anderson (2016)
Elementary school students+educator/site leads/tutors/coaches/mentor	3/12%	Basile (2015)
Middle school students	6/24%	Barnes (2021)
Middle school students+educator/site leads/tutors/coaches/mentor	1/4%	Flowers (2003)
Middle and High school students	2/8%	Grack Nelson (2017)
High school students	1/4%	Rains (2018)
Graduated from high school/aged out/dropped the program persons	1/4%	Williams (2020)
Undergraduate students+educator/site leads/tutors/coaches/mentor	1/4%	Scipio (2015)
Educator/site leads/tutors/coaches/mentor	3/12%	Abu-Rasool (2015)
After-school programs/networks/websites	2/8%	Crawford-Ferre (2017)
Total	25/100%	

According to **Table 1**, as a result of the analysis of the analyzed theses, middle school students (n=6) were mostly preferred as participants in the theses. Then, elementary school students (n=5), elementary school students+educator/site (n=3), educator/site leads/tutors/coaches/mentor (n=3), Middle and High school students (n=2) and After-school programs/networks/websites (n=2) were the participants/study group. Middle school students+educator/site, high school students, graduated from high school/aged out/dropped the program persons, and undergraduate students+educator/site leads/tutors/coaches/mentor groupings have one study each.

The number of participants in the analyzed theses were categorized as 1-10, 11-30, 31-100, 101-300, 301-1000, and 1000 and above. The distribution according to the number of participants in the theses is shared in **Figure 7**.

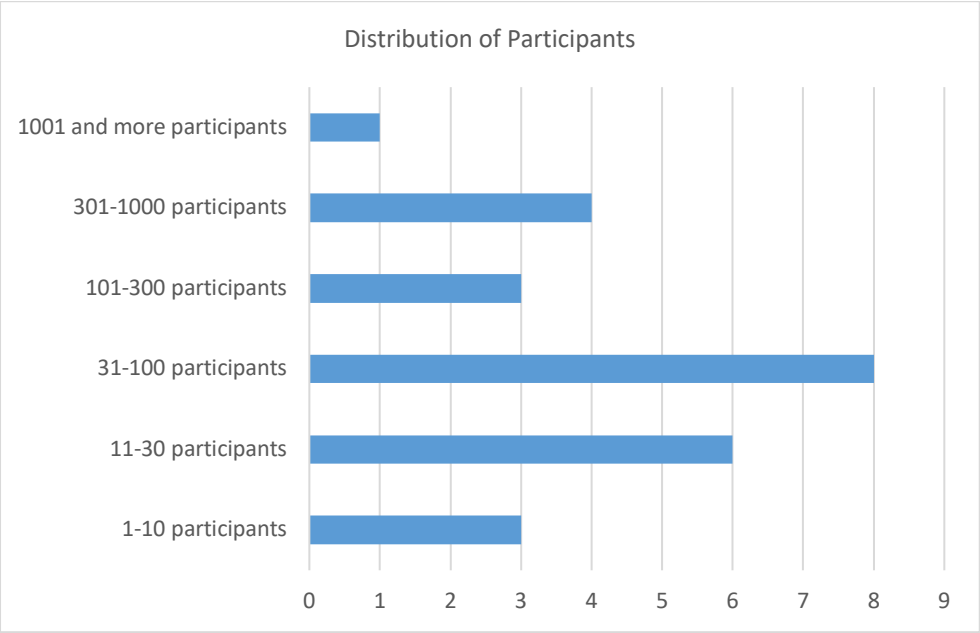

Figure 7. Distribution by number of participants in theses

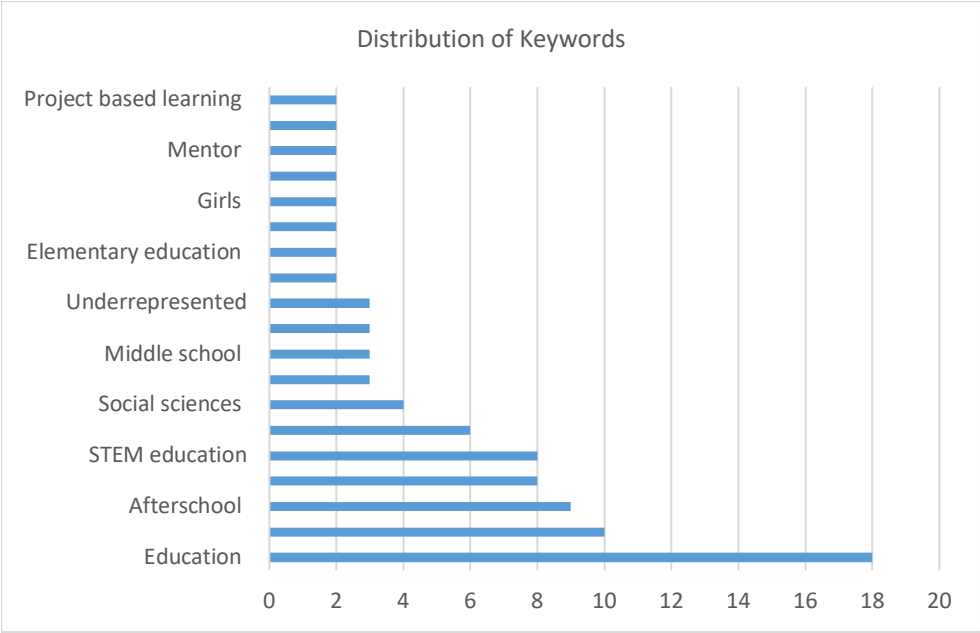

Figure 8. Distribution of keywords in theses

It is seen that 8 of the analyzed theses were conducted with 31-100 participants, 6 with 11-30 participants, 4 with 301-1000 participants, 3 with 101-300 participants, 3 with 1-10 participants, and 1 with 1001 or more participants. The results of the number of participants in a total of 25 studies are given in **Figure 7**.

Distribution of Theses According to Keywords Used

Within the scope of the research, the distribution of the most frequently repeated keywords (n≥2) in the theses were analyzed.

According to **Figure 8**, "education" (n=18) was used as the most common keyword in the analyzed theses, followed by "out of school time" (n=10), "afterschool" (n=9), "STEM" (n=8), and "STEM education" (n=8). Finally, "science" (n=6), "social science" (n=4), "mathematics" (n=3), "middle school" (n=3), "teacher" (n=3), "enderrepresented" (n=3) and "African American" (n=2), the keywords "elementary education" (n=2), "engineering" (n=2), "girls" (n=2), "identity" (n=2), "mentor" (n=2), "minority" (n=2) and "project based learning" (n=2) are repeated.

Discussion and Conclusion

In this study, it was aimed to systematically analyze 25 theses on Afterschool STEM in the ProQuest database. The theses were analyzed in terms of the year, type, research method, data collection tool, field selection in ProQuest, participant level, number of participants, and keywords. The results are discussed based on the findings obtained from the study.

When the findings were examined, it was seen that the first thesis study under the title of Afterschool STEM was a doctoral thesis in 2003. In addition, according to the first research question in 2015 (n=9), it was seen that there was a great increase in theses related to afterschool STEM. All of the theses published in 2015 (n=9) were doctoral dissertations. It is noteworthy that no thesis studies on Afterschool STEM were published between 2004-2013. In addition, in the theses examined, it was determined that there were the highest number of doctoral theses related to Afterschool STEM (n=22), while there were 3 studies at the master's level.

In the distribution of theses according to the fields selected in the ProQuest database, it is seen that most theses are published in the field of Science Education. After the field of Science Education, it was determined that most theses were in the field of Mathematics Education.

According to the information obtained from the research method analysis of the analyzed theses, the qualitative research method was used in 40% of the theses. Qualitative research seeks to understand how people interpret their experiences, how they construct their world, and how they attribute meaning to their experiences (Merriam, 2015, p.5). In addition, the mixed research method was used in 40% of the theses. Creswell (2014) states that both qualitative and quantitative data have limitations, but by combining two data sources, researchers can understand a problem better than using a single method. It was determined that a small number of the analyzed theses preferred the quantitative research method.

While collecting data in theses related to Afterschool STEM, surveys were used the most, followed by interviews. In 8 of the analyzed theses observation was used as data collection tools. In addition, website review, presentations, narratives, fieldnotes, documents, and achievement test data collection tools were used 3 times each, video recording, rubric, questionnaire, inventory, and audio recording data collection tools were used 2 times each, and semiotic duster, school level disciplinary records, participants journal, discourse, cognitive mapping, and attendance data were used 1 time each.

In the analyzed theses, it was found that the most data were collected from "Middle school students" participants. It can be said that "Middle school students+educator/site", "High school students", "graduated from high school/aged out/dropped the program persons" and "Undergraduate students+educator/site leads/tutors/coaches/mentors" are the groups with the least data collected with one study each. However, due to the diversity of the participant groups, it can be thought that richer data can be provided in terms of data diversity in these groups.

When the number of participants in the theses was analyzed, the participants between 31-100 were preferred the most. In terms of the methods in the theses examined, the data on the preference of qualitative and mixed research methods were higher. Considering that more comprehensive data will be obtained in qualitative and mixed research methods, it can be said that the number of participants in these studies is kept narrower than in quantitative studies. The least preferred group according to the number of participants is the group with 1001 or more participants.

In the analyzed theses, it is seen that the keyword "education" is mostly used as a keyword, followed by "out of school time", "afterschool", "STEM" and "STEM education". This is a result that can be expected in line with the purpose of the study.

As a result, this study reveals some important information about the theses related to Afterschool STEM. It is thought that future studies on Afterschool STEM, it will contribute to the originality of the research if researchers plan their studies by considering these points.

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