Chapter 7
Women Retention in STEM Higher Education: Systematic Mapping of Gender Issues

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Abstract Science, Technology, Engineering, and Mathematics (STEM) in Higher Education (HE) helps foster students' motivation to continue studying and cultivates students' regard for the role of science and technology in society. The gender gap in STEM HE can reduce through institutional efforts; however, the underrepresentation of women is prevalent. There have been efforts to research and implement strategies to increase the number of people attending STEM fields with a specific action to attract and retain women in these areas. Hence, the purpose of this research work is to carry out and show the results of a Systematic Mapping (SM) related to how HE institutions aim to address the gender gap in STEM education through research and educational innovation. The SM focused on published work from 2011 to 2021 indexed in Web of Science or Scopus. Findings show the state of knowledge for an essential topic: reducing the gender gap through guidance and retention strategies to attain completion. Furthermore, descriptive results give a general overview of the area, relevant trends, and other analytical evidence that provides an in-depth understanding of HE institutions' needs. We conclude that the retention of women studying STEM HE

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has become an essential issue worldwide universities have addressed increasingly during the last decade.

Keywords Retention · STEM education · Gender perspective · Guidance · Higher education · Educational innovation

7.1 Introduction

Science, Technology, Engineering, and Mathematics (STEM) in Higher Education (HE) has many objectives such as promoting learning, fostering students' motivation to continue studying, and cultivating students' regard for the role of science and technology in society. Research has proven that there is a gender gap in STEM HE due to several factors such as the traditional role of women in society and the lack of female role models and mentors in STEM areas, to name a few (Wang & Degol, 2013). Several international organizations have emphasized the importance of addressing the gender gap in STEM HE explicitly. Addressing the gender gap in HE is part of the UN's Sustainable Development Goal 4, specifically for target 4.3, which refers to ensuring equal access for women and men to tertiary education, including university. According to the Organization for Economic Co-operation and Development (OECD), the gender gap in STEM HE enrollment differs for different fields of study; the field of natural sciences, mathematics, and statistics has reached gender parity, while for engineering and information and communication technologies (ICT) the gender gap persists (Organisation for Economic Co-operation and Development, 2021). It is noteworthy that among the mentioned fields, there may exist differences between countries and areas of study, such as biology and physics within the natural sciences (García-Peñalvo, 2019). The OECD highlights the importance of removing stereotypes and implementing policies for reducing the gender gap in different fields of study.

HE institutions can implement several strategies to address the gender gap in STEM areas through different processes: attraction, access, and retention (García-Peñalvo et al., 2019). Within the retention process, some universities may identify guidance, completion, and other similar terms. Retention of engineering students is an important issue that academic institutions must address to avoid dropout by creating an inclusive and supportive environment (García-Holgado et al., 2020). We have identified review articles in the literature about the retention and guidance of women in STEM careers in HE. These review articles have provided some insights into the factors and obstacles that women in STEM face throughout their careers and their persistence in pursuing STEM majors. Eddy and Brownell (Eddy & Brownell, 2016) contributed to the literature with a framework that identifies performance and engagement as observable inequalities to explain gender gaps on persistence in STEM, a measure correlated with retention (Eddy & Brownell, 2016). Women in STEM face challenges in predominantly masculine environments, such as gendered organizational culture and stereotypes; their coping strategies center on conforming, impression management, and proactivity (Makarem & Wang, 2020). Within the STEM careers, some authors identify Physics, Engineering, Mathematics, and Computer science (PEMC) as more related to mathematical ability than the biological sciences fields. Within this distinction, a study reported that girls' mathematical ability beliefs under challenges may impact their chance of majoring in PEMC fields (Perez-Felkner et al., 2017). A study on the NSF ADVANCE program identified that systemic obstacles to recruitment, retention, and promotion impact women's underrepresentation in STEM areas (DeAro et al., 2019). In general, these articles confirm that the gender gap in STEM education is a systemic issue and that academic institutions can implement strategies in their guidance and retention process to avoid women's dropout from STEM careers.

Academic institutions and policymakers must inform each other about the strategies to guide women in STEM careers and avoid academic dropout (García-Peñalvo et al., 2019). We identify the need to conduct a literature review focused on the retention strategies that universities worldwide have adopted to guide and retain women in their STEM programs. This study aims to provide a systematic mapping of the literature related to how HE institutions aim to address the gender gap in STEM education through research and educational innovation. The main contribution of this work to society is to inform about best practices for women's retention in STEM careers. Authors analyze the state of knowledge in the last ten years concerning geographic information, relevant authors, and trending research topics with this aim in mind. In the methodology, we present the PRISMA method that we follow to develop the literature mapping. Then, the Results and Discussion section provides database analysis and the discussion of the emerging topics. The final section concludes with specific recommendations for HE institutions and policymakers to address the gender gap in STEM HE through the guidance and retention process.

7.2 Methodology

The literature search should be designed to be robust and reproducible to ensure the minimization of biases. Although there are alternative approaches for both conducting literature searches and reporting systematic reviews or mappings, the authors have encountered difficulties with some of those methodologies due to the following reasons:

(i) the various methods are not comparable as they share few common reporting elements
(ii) there are numerous new checklists and tools that are not sufficiently described to be reliably replicated
(iii) there is a debate about what constitutes a reproducible search and how best to report the details of the search

The use of non-validated bibliographic search methods can raise doubts and reduce confidence in the final conclusions of the systematic review or mapping (Moher et al., 2015). The authors noted that if readers cannot understand or reproduce how the information was collected for this systematic mapping, they may suspect that the authors have introduced bias by not conducting a comprehensive or pre-specified literature search. These were the reasons why the authors chose the most commonly used reporting guide for systematic reviews and mappings, which covers the literature search component, which is the Preferred Reporting Items Statement for Systematic Reviews and Meta-Analyses, known as PRISMA Statement. The methodological approach consisted of a systematic mapping of the literature with a review process based on the PRISMA protocol (Xiao & Watson, 2019). The sequence of the PRISMA process consisted of 27 items (Page et al., 2021). The methodological stage of PRISMA is made up of items from 5 to 15, which are the following: Eligibility criteria; Information sources; Search strategy; Selection process; Data collection process; Data items; Study risk of bias assessment; Effect measures; Synthesis methods; Reporting bias assessment; Certainty assessment. In the present study, these items were appropriately included in the following steps:

1. Formulation of the problem and definition of the Research Questions (RQ).
2. Developing a review protocol.
3. Systematic search of literature, including the following steps: select databases and their descriptors; derive keywords from research questions; and adopt a sampling logic.
4. Screening for inclusion and exclusion criteria.
5. Extracting, analyzing, and synthesizing data.

The literature mapping carried out in the present study was guided by three research questions (RQ). From them, the methodology for data extraction was designed and the report of the findings was written. The RQs were narrowed from a general research topic until we chose a more defined subtopic from the original search using mapping (Campos et al., 2020). In this way, it was possible to identify the activities involving the refined RQs. The chapter structure and its representation of the data and findings are determined from the following RQs to bring out the information searching to achieve the main objective of this study: To carry out and show the results of a Systematic Mapping (SM) related to how HE institutions aim to address the gender gap in STEM education through research and educational innovation. Each RQ is defined to reach the specific Research Objectives (ROs) in this work as given below.

Descriptive research objectives and research questions are as follows:

- *RO1:* Identify the related research works disseminated between 2011 and 2021 and determine how they have been distributed in the defined databases.

  RQ1: How are publications distributed in the defined databases? What is the distribution of publications in the period between 2011 and 2021?

- *RO2*: Identify the grouping of the main research works in terms of the document type.

RQ2: What is the distribution by type of document?

- *RO3*: Identify the journals and conferences with distinguished publications related to this topic.

  RQ3: Which are the journals with the largest publications on this topic? Which conferences contribute the most to the literature on this topic?

- *RO4*: Determine the geographical distribution of the first authors and which are the specific countries that have been contributing to this research area.

  RQ4: What is the geographical distribution of the first authors? Which are the countries that carry out research on the research topic?-

  Analytical research objectives and research questions:

- *RO5*: Recognize the significant trending words stated in the obtained works and their accumulated frequency displayed in the keywords. Consequently, determine how these keywords can inform the trends in women retention in STEM HE.

  RQ5: What are the trending words (most common keywords) by the authors? What is the frequency of our keywords in the abstract, and how can these keywords inform the trends in publications on women retention in STEM HE?

- *RO6*: Characterize the most relevant articles by their citation metrics, showing the most significant impact on the research topic.

  RQ6: What are the most cited articles? Which publications have had the greatest impact in the area?

Due to the importance of selecting a review protocol, we decided to choose the PRISMA protocol which allowed us to reduce the possibility of research bias in data selection and subsequent extraction and analysis (Moher et al., 2015). In order to validate the protocol before executing the search, the work team was divided into two teams that worked independently to perform a peer review and validate the sequence of the protocol, as shown in Fig. 7.1.

The keywords for the search were derived from the RQs. For the first step in the literature search, the keywords "women in STEM", "STEM education" and "STEM learning" were used. Some concepts used as keywords included synonyms, alternative spellings, and related words, as in the case of gender gap, retention, guidance, dropout, completion, and attrition. The first search query for both databases was formed by the following general terms (linked by AND operators) and synonyms (linked by OR operators):

A. STEM Education

   A1. STEM learning

   A2. Women in STEM

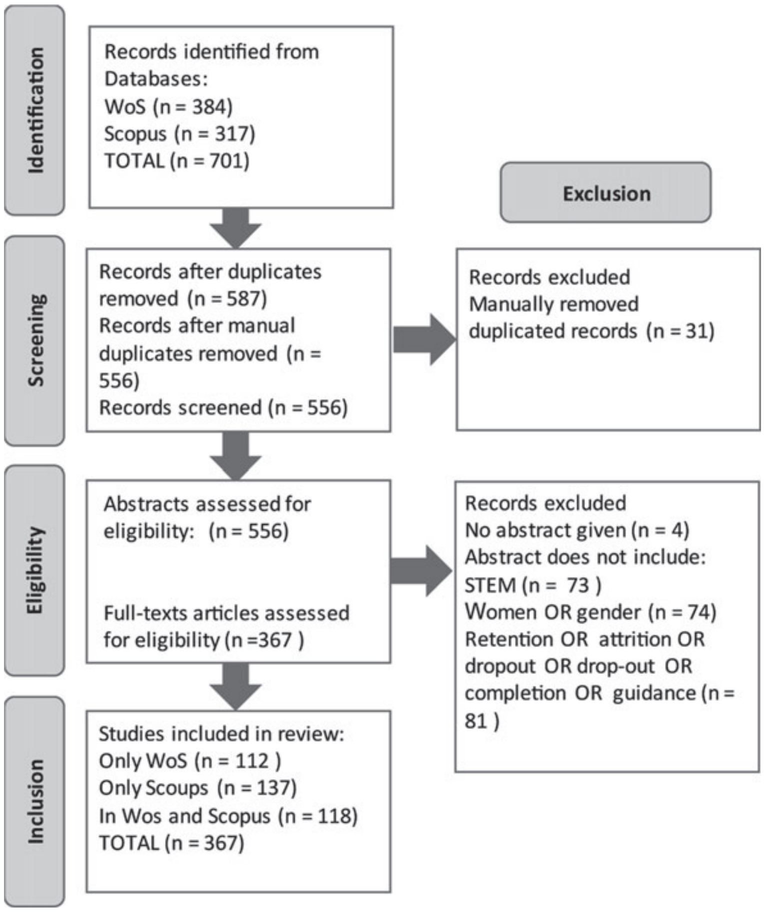

Fig. 7.1 PRISMA 2020 flow diagram for literature search

B. Gender Gap
   - B1. Women
   - B2. Gender

C. Higher Education
   - C1. University
   - C2. College

D. Retention
   - D1. Guidance
   - D2. Dropout

D3. Completion

D4. Attrition

Using these terms and synonyms, the query has the general form:

(A OR A1 OR A2) AND (B OR B1 OR B2) AND (C OR C1 OR C2) AND (D OR D1 OR D2 OR D3 OR D4).

To determine the relevance of each manuscript, the titles were analyzed and if the content discussed the topic of women in STEM or gender gap in STEM, we obtained their full reference, including author, year, title, and abstract, to then complete future evaluations. It is important to highlight that, in this first stage, all those manuscripts that were related to the botanical meanings "cell" of the word "stem" were detected and excluded. The search was limited to two databases: Web of Science and Scopus, as they are the two main databases frequented by researchers from the engineering and science disciplines (Pranckutė, 2021).

Due to the changes in the perception and revaluation of the role of women in STEM areas and the impulse that the issue of the gender gap has had in society in general, we limit the publication date to 2011 and 2021 (articles published in the last ten years), so that we can build our review on the recent literature that considers the influence of political, social, and cultural movements on the inclusion of women in STEM. The inclusion and exclusion criteria are defined in the PRISMA protocol in Fig. 7.1.

Following the process detailed below, we refined the search queries used in each database. To allow for replicability, we include the exact final search queries used in Scopus and Web of Science in the Appendix. In the Scopus database, the query yielded 255 results. In the WoS database, the final query yielded 230 results. The final query has the following general form, where the general terms are linked by AND operators and the synonyms are linked with OR operators:

Title, Abstract or keywords include:

A. STEM Education

A1. STEM learning

A2. Women in STEM

B. Gender Gap

B1. Women

B2. Gender

C. Higher Education

C1. University

C2. College

D. Retention

D1. Guidance

D2. Dropout

D3. Drop out

D4. Completion

D5. Attrition

Abstract includes:

E. STEM
F. Gender

F1. Women

G. Retention

G1. Attrition

G2. Guidance

G3. Dropout

G4. Drop out

G5. Completion

Time filter: 2011 to 2021.
Subject area filters.
Using these terms and synonyms, the final query has the general form:
Title, Abstract, Keywords ((A OR A1 OR A2) AND (B OR B1 OR B2) AND (C OR C1 OR C2) AND (D OR D1 OR D2 OR D3 OR D4 OR D5)).
AND Abstract (E AND (F OR F1) AND (G OR G1 OR G2 OR G3 OR G4 OR G5)).
AND Time (2011 to 2021).
AND Subject area filters.

7.3 Results and Discussion

Regarding the PRISMA stage corresponding to results, this study offers preliminary results corresponding to the study selection items (Tricco et al., 2018), which correspond, respectively, to:

16a. Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.

16b. Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.

For reasons concerning the length of this chapter, items 17 to 22 (from the Results Section of the PRISMA Checklist) were excluded from this report. The items not considered were: Study characteristics; Risk of bias in studies; Results of individual studies; Results of syntheses; Reporting biases; and, Certainty of evidence.

We present the results of our analysis of the 367 records based on the databases, the type of documents with an overview of the journals and conferences that publish the most about this topic, the countries of the first authors that publish research on this topic, and the emerging keywords to find interesting trends.

7.3.1 Database Analysis and Timeline

We analyzed the articles that emerged in the Scopus database, in the Web of Science, and in both. We found that 118 records were in both databases, so 112 records were exclusively in WoS and 137 records were exclusively in Scopus, coherent with Fig. 7.1. We found an increasing trend in the number of records published between 2011 and 2021. From 2011 to 2013, there were less than 20 records published each year. From 2014 to 2017, there was a turning point in the number of records, having between 20 and 35 each year. After 2018, the number of records increased to more than 50 each year until 2020. In 2021, we found 32 records up until the middle of the year when we created this database, so the trend is confirmed. In each database, we see similar trends. In the Scopus database, the years with most records were 2017 with 28, 2018 with 41, and 2020 with 45 records. In Web of Science, the most relevant years were 2018 with 29, 2020 with 31, and 2019 with 41 records. These results are promising because they show that the research about guidance and retention of women in STEM HE is increasing each year. This implies that universities are more interested in implementing strategies for reducing the gender gap in STEM HE completion than 10 years ago.

7.3.2 Type of Documents

We analyzed the types of documents published about this topic in Scopus and WoS between 2011 and 2021. We identified 196 articles (53%), 159 conference papers (43%), 10 book chapters (3%), and 2 books (1%). We present an analysis of the publishing trends for articles and conference papers based on the years and the most relevant journals and conferences on the topic.

We can see an increasing trend in the number of articles in Fig. 7.2; from 2011 to 2014 and 2016, there were less than 10 articles per year. In 2015 and 2017, there were more than 15 articles, in 2018, there were more than 20, and from 2019 to 2021 (ongoing), there were more than 30 articles each year. The journals that have published more on this topic were PLOS ONE (9 articles), the International Journal of STEM Education (7 articles), Equality, Diversity and Inclusion, Frontiers in Psychology, Journal of Chemical Education, Journal of Women and Minorities in Science and Engineering, Sex Roles, and Teachers College Record (5 articles, each).

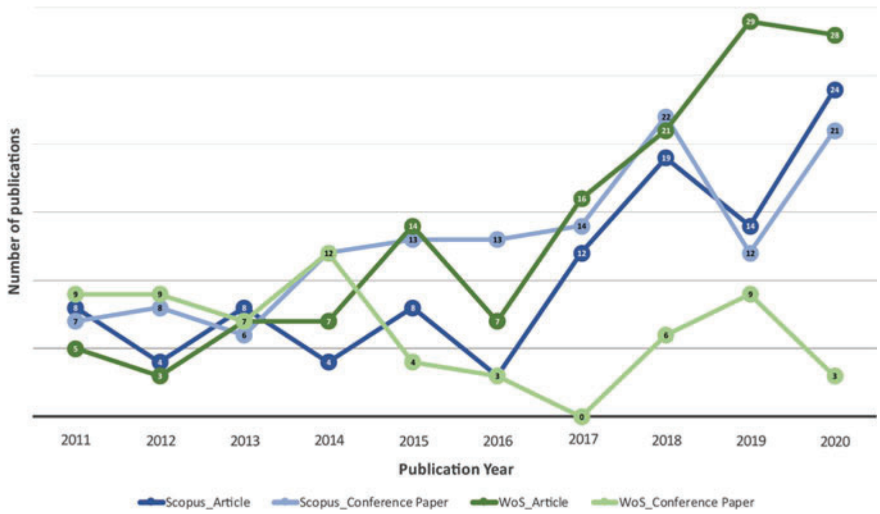

Fig. 7.2 Publication trends from 2011 to 2020 per type of document (journal article or conference paper) and source (Scopus or WoS). *Note* The graph only includes full years (2011 to 2020). That is, 2021 is excluded because the information is not completed yet.

The conference papers have a steadier trend, remaining between 10 and 20 conference papers every year, except for 2018 and 2020, where we found 26 and 22, respectively. The conference that contributes the most to this area is the American Society for Engineering Education (ASEE) Annual Conference and Exposition with 99 conference papers (27% of all records), followed by the Frontiers in Education (FIE) Conference, with 13 papers (3.5% of all records). Other relevant conferences were the International Conference on Education and New Learning Technologies (EDULEARN), the International Conference of Education, Research and Innovation (ICERI), and the International Technology Education and Development (INTED) Conference, contributing 4 conference papers each.

7.3.3 Geographic Data

We analyzed the country of the first author for each article based on their affiliation. We found that the vast majority of studies about retention of women in STEM programs are performed in the United States of America (295 articles, 80.7%). We found other 6 countries that contribute to the literature on this topic: Australia (9 articles, 2.5%), Canada (8 articles, 2.2%), Germany (7 articles, 1.9%), Mexico (5 articles, 1.4%), Spain (4 articles, 1.1%), and the United Kingdom (4 articles, 1.1%). We identified 24 more countries that have contributed to the literature with less than 3 articles each, representing less than 1% of the total. As the data suggests, most of the research on this topic is done in North America, specifically in the US, Canada, and Mexico, followed by Europe with Germany, Spain, and the UK. Most of these countries are English or Spanish speaking.

7.3.4 Trending Keywords

In an effort to capture the authors' most common keywords as an indicator of a trend, we analyzed the keywords given by the authors of the 367 documents. We present them in Fig. 7.3. STEM (99 times) and gender (80 times) are the words that appear most frequently (8.2% and 6.6%, respectively). Then, there is a step down to 3.6% (44 times) for the word education and 3.3% (40 times) for women. The next group of most common keywords is science (25 times, 2.1%), diversity (24 times, 2.0%), and engineering (23 times, 1.9%). Then comes faculty, students' retention, academic, and

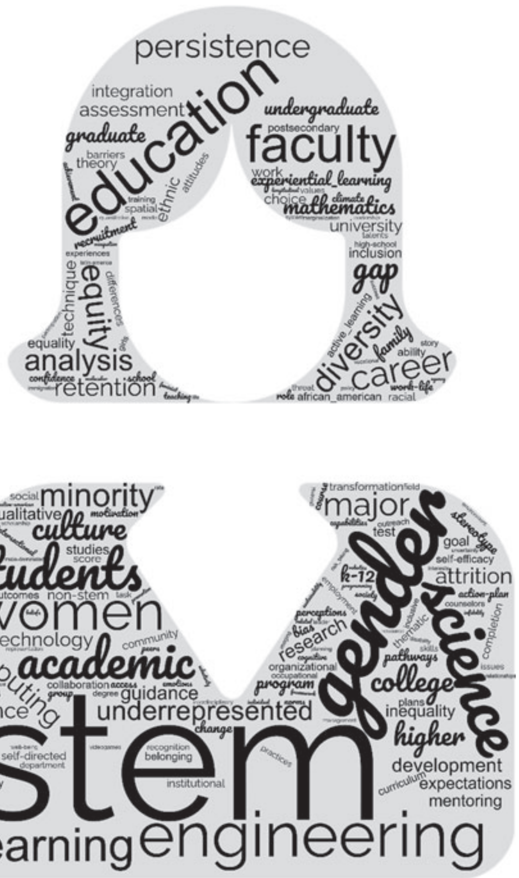

Fig. 7.3 Analysis of the authors' most common keywords

learning with about 1.8% each (around 18 mentions each of these keywords). The last group consists of the keywords career, culture, equity, gap, persistence, minority, major appearing 12 times (corresponding to 1.0% for each one).

The diversity and science keywords are of particular interest since they could come from papers with different perspectives. From the 24 papers, eight of them (33%) study women with a race perspective; they are studies in which they focus on minorities (e.g., Black American, Hispanics) and gender. Three manuscripts study the women's perspective on a broader diverse standpoint about race and GLBT or disabilities. The rest of them (54%) regard women from only the gender perspective. In the case of the science keyword, three (12%) of them focus on biology, four focus on computer science, and five focus on natural and exact sciences. The rest (52%) focus on STEM disciplines without specifying a precise science of emphasis.

7.3.5 Most Cited Articles

There are six documents that are cited by more than 100 publications. Ong et al. (Ong et al., 2011), a paper from the Harvard Educational Review in 2011 has 401 citations averaging more than 36 citations per year in Scopus and 292 citations in WoS with an average of more than 26 citations per year. They produced a nice review of research in the previous 40 years regarding the African American females' experiences in the STEM fields in their undergraduate and graduate education. They made a strong discussion of policy implications of their work and they emphasized what were the topics where research was needed. The number of citations has to do with that discussion.

Cech et al. (2011), from the American Sociological Review, has 287 citations averaging more than 28 citations per year in Scopus and 243 with an average of more than 24 citations per year in WoS. They made a critical contribution regarding the retention of women in STEM fields at the undergraduate level. In their data, instead of having family plans or math self-assessment as key factors, they introduced a new factor at that time, professional role confidence. They found that women's lack of this role confidence compared to men is a major factor for women attrition.

Sadler et al. (2012) from Science Education has 282 citations and an average of more than 28 per year in Scopus and 206 citations and an average of more than 18 in WoS. They studied 6000 students in 34 colleges around the USA to see the relationship of interests in STEM fields according to how that interest shifted during their high school years. The key factor they found was that females' interest at the end of high school was strongly related to their interest at the beginning of their high school. However, they compared females' and males' decline in interest in STEM fields and resulted that females' interest declined significantly more than males' interest.

Hernandez et al. (2013) from the Journal of Educational Psychology has 153 citations and 17 per year in Scopus and 125 with an average of more than 13 citations per year in WoS. They did a three-year study following university high academic achievers from the minority groups in the STEM fields. They found that students' engagement in undergraduate research was a key factor for success. Related to this, they found that the growth in scientific self-identity and task goals capabilities has a strong effect on students' retention and that performance-avoidance goals were related to students' attrition.

Morgan et al. (2013) from Social Science Research has 126 citations with an average of 14 per year in Scopus and a total of 114 with an average of more than 12 citations per year in WoS. They did a longitudinal study for four years focusing on students' pathways through college. They found gender differences across the STEM fields including health science disciplines. They also found that one of the main factors for students' college selection was students' occupational plans as seniors in high school.

Dennehy and Dasgupta (2017) is the most recent document in the list of the most cited with 121 citations averaging more than 24 per year in Scopus and 92 with an average of more than 18 citations per year in WoS. They did a longitudinal intervention study for two years in which, in the first year, entering female students participated in a mentor program. Some of the students had a female mentor, some of them a male mentor, and the rest had no mentor at all. They found that retention was more successful with a same-sex mentor and that result was modulated by an increase of belonging and self-efficacy.

Interestingly, from the six documents that had more citations, four of them were studies in which the authors were interested in finding factors in which retention depends on minority groups, in particular women. Two of them even took data of students when they were in high school. Another document, the one with more citations is a review analyzing more than 110 previous studies. We highlight that those five studies had no intervention. The last document, the most recent one is the only study with an intervention with significant results.

The descriptive and analytical trends presented in this results section have provided an overview of the state of knowledge regarding institutional efforts to guide and retain women in STEM fields. From our results, we can envision that women retention in STEM HE is an important issue that universities are beginning to address in different parts of the world. The analysis has shown the countries that have contributed the most, and the keywords that greatly define this area of research. The last part of the results has focused on an in-depth analysis of the most cited articles, finding interesting trends there, such as the focus on studies about women retention, but fewer articles about actual implementations.

7.4 Conclusion

Retention of women studying HE in the STEM areas has become an important issue addressed by many universities in different countries. Especially since 2016, there is a clear increasing trend in journal articles and conference papers dedicated to women or the gender gap within STEM education with a focus on retention, attrition, dropout, guidance or completion. This systematic literature mapping reveals how HE institutions show concern and awareness by documenting their good practices and institutional policies. This study analyzes the dropout issues in HE from a gender perspective within 2011 and half of 2021. It could be used as a reference source for further investigations or to expand the current one, since this revision focused on the publications reported in the two main indexing systems Web of Science and Scopus.

We conclude there is an increasing interest in promoting retention of women studying HE in the STEM areas by the number of articles each year. However, the interest of institutions and researchers in the field is a small number compared to the total number of universities that offer those programs. We recommend institutions adopt new policies addressing this problem from the action perspective; that is, getting to know the research results and implementing attraction, access, and retention actions to increase the number of women involved. In attraction, we recommend implementing a campaign directed to young women with seminars and talks by professional women in STEM areas. In access, we recommend giving close follow-ups to young women for college/university applications. In retention, we recommend offering guidance programs such as mentoring and academic consultation, fostering identity by creating women's networks, and offering seminars and workshops by women in the industry or outside the academic system.

This research provides a perspective on women retention studies in HE institutions within the STEM fields and their approaches to support their students to complete their academic programs. This chapter may be of interest to researchers, students, teachers, and decision makers interested in improving the academic environment and culture to promote equity for all.

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Appendix

Final query for Scopus Database:

((ABS(retention) OR ABS(attrition) OR ABS(guidance) OR ABS(dropout) OR ABS(drop out) OR ABS(completion)) AND (ABS(gender) OR ABS(women)) AND (ABS(STEM))) AND (TITLE-ABS-KEY((stem OR "STEM Education" OR "STEM learning" OR "Women in STEM" AND NOT cell) AND ("gender gap" OR women OR gender) AND ("higher education" OR university OR college) AND (retention OR guidance OR dropout OR "drop out" OR completion OR attrition)) AND (LIMIT-TO(PUBYEAR, 2021) OR LIMIT-TO(PUBYEAR, 2020) OR LIMIT-TO(PUBYEAR, 2019) OR LIMIT-TO(PUBYEAR, 2018) OR LIMIT-TO(PUBYEAR, 2017) OR LIMIT-TO(PUBYEAR, 2016) OR LIMIT-TO(PUBYEAR, 2015) OR LIMIT-TO(PUBYEAR, 2014) OR LIMIT-TO(PUBYEAR, 2013) OR LIMIT-TO(PUBYEAR, 2012) OR LIMIT-TO(PUBYEAR, 2011)))

Final query for Web of Science Database:

(AB=(stem) AND (AB=(retention) OR AB=(attrition) OR AB=(guidance) OR AB=(dropout) OR AB=(drop out) OR AB=(completion)) AND (AB=(women) OR AB=(gender))) AND (((((ALL=("stem education") OR ALL=("stem learning") OR ALL=(women in stem)) AND (ALL=("gender gap") OR ALL=(women) OR ALL=(gender))) NOT ALL=(CELL)) AND (ALL=("HIGHER EDUCATION") OR ALL=(UNIVERSITY) OR ALL=(COLLEGE)) AND (ALL=(RETENTION) OR ALL=(GUIDANCE) OR ALL=(DROPOUT) OR ALL=("DROP OUT") OR ALL=(COMPLETION) OR ALL=(ATTRITION))) AND ((PY==("2021" OR "2020" OR "2019" OR "2018" OR "2017" OR "2016" OR "2015" OR "2014" OR "2013" OR "2012" OR "2011")) NOT (DT==("CORRECTION" OR "MEETING ABSTRACT") OR TASCA==("ORTHOPEDICS" OR "OBSTETRICS GYNECOLOGY" OR "MEDICINE GENERAL INTERNAL" OR "CLINICAL NEUROLOGY" OR "PSYCHIATRY" OR "REHABILITATION" OR "HEALTH CARE SCIENCES SERVICES" OR "SPORT SCIENCES" OR "EVOLUTIONARY BIOLOGY" OR "SURGERY" OR "GERIATRICS GERONTOLOGY" OR "PUBLIC ENVIRONMENTAL OCCUPATIONAL HEALTH" OR "ONCOLOGY" OR "ENDOCRINOLOGY METABOLISM" OR "PLANT SCIENCES" OR "LANGUAGE LINGUISTICS" OR "LINGUISTICS" OR "RADIOLOGY NUCLEAR MEDICINE MEDICAL IMAGING" OR "NURSING" OR "SOCIAL WORK" OR "SUBSTANCE ABUSE" OR "GERONTOLOGY" OR "LITERATURE" OR "HOSPITALITY LEISURE SPORT TOURISM" OR "UROLOGY NEPHROLOGY" OR "TROPICAL MEDICINE" OR "CRIMINOLOGY PENOLOGY" OR "HEALTH POLICY SERVICES" OR "INTEGRATIVE COMPLEMENTARY MEDICINE"))))

References

Campos, E., Armenta, I. H., Barniol, P., & Ruiz, B. (2020). Physics education: Systematic mapping of educational innovation articles. *Journal of Turkish Science Education, 17*(3), 315–331.

Cech, E., Rubineau, B., Silbey, S., & Seron, C. (2011). Professional role confidence and gendered persistence in engineering. *American Sociological Review, 76*(5), 641–666. https://doi.org/10.1177/0003122411420815.

DeAro, J., Bird, S., & Ryan, S. M. (2019). NSF ADVANCE and gender equity: Past, present and future of systemic institutional transformation strategies. *Equality, Diversity and Inclusion: An International Journal, 38*(2), 131–139.

Dennehy, T. C., & Dasgupta, N. (2017). Female peer mentors early in college increase women's positive academic experiences and retention in engineering. In *Proceedings of the National Academy of Sciences of the United States of America,* vol. 114(23), 5964–5969. https://doi.org/10.1073/pnas.1613117114.

Eddy, S. L., & Brownell, S. E. (2016). Beneath the numbers: A review of gender disparities in undergraduate education across science, technology, engineering, and math disciplines. *Physical Review Physics Education Research, 12*(2), 020106.

García-Holgado, A., González-González, C. S., & Peixoto, A. (2020). A comparative study on the support in engineering courses: A case study in Brazil and Spain. *IEEE Access, 8*, 125179–125190.

García-Peñalvo, F. J., Bello, A., Dominguez, A., & Romero Chacón, R. M. (2019). Gender balance actions, policies and strategies for STEM: Results from a world café conversation. *Education in the Knowledge Society, 20*, 31–41.

García-Peñalvo, F. J. (2019). Women and STEM disciplines in Latin America: The W-STEM European Project. *Journal of Information Technology Research, 12*(4), v–viii.

Hernandez, P. R., Schultz, P. W., & Estrada, M. et al. (2013). Sustaining optimal motivation: A longitudinal analysis of interventions to broaden participation of underrepresented students in STEM. *Journal of Educational Psychology, 105*(1), 89–107. https://doi.org/10.1037/a0029691.
Makarem, Y., & Wang, J. (2020). Career experiences of women in science, technology, engineering, and mathematics fields: A systematic literature review. *Human Resource Development Quarterly, 31*(1), 91–111.
Moher, D., Shamseer, L., & Clarke, M. et al. (2015). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. https://doi.org/10.1186/2046-4053-4-1.
Morgan, S. L., Gelbgiser, D., & Weeden, K. A. (2013). Feeding the pipeline: Gender, occupational plans, and college major selection. *Social Science Research, 42*(4), 989–1005. https://doi.org/10.1016/j.ssresearch.2013.03.008.
Ong, M., Wright, C., Espinosa, L. L., & Orfield, G. (2011). Inside the double bind: A Synthesis of empirical research on undergraduate and graduate women of color in science, technology, engineering, and mathematics. *Harvard Educational Review, 81*(2), 172–208. https://doi.org/10.17763/haer.81.2.t022245n7x4752v2
Organisation for Economic Co-operation and Development. (2021). Education at a Glance 2021: OECD Indicators. *OECD Publishing, Paris,*. https://doi.org/10.1787/b35a14e5-en
Page, M. J., McKenzie, J. E., & Bossuyt, P. M. et al. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, 372.
Perez-Felkner, L., Nix, S., & Thomas, K. (2017). Gendered pathways: How mathematics ability beliefs shape secondary and postsecondary course and degree field choices. *Frontiers in Psychology, 8*, 386.
Pranckutė, R. (2021). Web of science (Wos) and scopus: The titans of bibliographic information in today's academic world. In Publications (Vol. 9, Issue 1). MDPI AG. https://doi.org/10.3390/publications9010012.
Sadler, P. M., Sonnert, G., Hazari, Z., & Tai, R. (2012). Stability and volatility of STEM career interest in high school: A gender study. *Science Education, 96*(3), 411–427. https://doi.org/10.1002/sce.21007.
Tricco, A. C., Lillie, E., Zarin, W., et al. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine, 169*(7), 467–473.
Wang, M. T., & Degol, J. (2013). Motivational pathways to STEM career choices: Using expectancy–value perspective to understand individual and gender differences in STEM fields. *Developmental Review, 33*(4), 304–340.
Xiao, Y., & Watson, M. (2019). Guidance on conducting a systematic literature review. *Journal of Planning Education and Research, 39*(1), 93–112. https://doi.org/10.1177/0739456X17723971