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SURVEY

State-of-the-Art Review on Current Approaches to Female Inclusiveness in Software Engineering and Computer Science in Higher Education

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ABSTRACT Software engineering (SE) and computer science (CS) programs in universities worldwide are marked by a gender gap, which subsequently translates into a gender gap at the industry level. However, there are positive activities that can help attract more women to these male-dominant professions. This study maps the literature related to the achievement of gender balance in SE and CS university-level education and identifies future research directions. More specifically, this article reports on a systematic mapping study of female-inclusive SE and CS tertiary education programs. The authors collected 882 publications between 2015 and 2022 from five databases (ACM, IEEE, Scopus, Web of Science, and Science Direct), selecting 143 peer-reviewed papers for further analysis. The results showed that the main academic contributors were researchers from the USA. The majority of the publications contained observations and explanations regarding the gender gap in computing education. However, an important part of the literature considered proposals and practical activities for achieving gender balance in SE and CS programs. Finally, the authors classified the literature related to female-inclusive SE and CS tertiary education programs, identified the main research focuses and regional distribution, and considered ideas for future research.

INDEX TERMS Computer science, diversity, education, engineering, gender gap, literature review, mapping study, software engineering.

I. INTRODUCTION

Modern societies continue to have female- or male-dominant industries and vocations [1], [2]. Historically, this division has occurred due to different requirements for physical strength and personal qualities, as well as cultural stereotypes regarding gender roles. For instance, firefighters and police officers needed to possess imposing figures, high strength, and endurance. In contrast, women tended to end up in care and support careers, working as nurses, secretaries, and assistants (if they were allowed to have a career at all). With most industries introducing new technologies, digitalization, and robotics, many physical tasks have been taken over by machines, and the previously male-dominant professions are beginning to accept women as equal members with realistic career prospects [3]. In other words, societies are undergoing digitalization with cross-industry collaboration [4] and are moving to new types of technology-assisted and automated jobs [5] that require knowledge competencies rather than typically male-related characteristics, such as physical strength. However, the gender gap persists in many areas that should be gender-neutral [6]. For example, fields such as computer science (CS), physics, and mechanical engineering remain male-dominated despite there being no reason for this [7], [8]; in fact, during the development of the first computers and programming languages, women were active, equal participants [9].

The gender gap in CS is highly noticeable in the science, technology, engineering, and mathematics (STEM) fields [8], [10]. According to Statista, a global developer

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survey showed that only 8% of software engineers are women [11]. At the same time, in global societies, men, women, and non-binary individuals are all software users. Therefore, the absence of an important portion of representatives from all user groups in software development jobs may lead to product deficiencies for some users and, consequently, to dissatisfaction. Moreover, diversity brings innovative ideas and stimulates knowledge sharing and innovative thinking [12], [13]. For example, studies have shown that companies with more women exhibit better innovative performance [14]. Furthermore, a good gender balance in the SE industry may lead to better software product quality because diverse teams have a better understanding of different users' needs and high innovational potential [6], [12], [14], [15]. However, although research has been conducted on how to transform specific courses, programs, and/or intensive software engineering (SE) educative events to improve gender balance, this topic requires further, deeper research. Gender imbalance in the technology industry begins in childhood and is present at each step of educational and career choices. Based on the norms accepted in society, boys and girls are raised differently and subsequently choose different career pathways [16]. Even in more equal countries, such as the Nordics, there are clear indications that boys are steered toward engineering, technology, and science tracks, whereas girls, who as a group generally have higher grade averages, are steered toward generalist electives, such as philosophy, psychology, and economics [17].

This study examined state-of-the-art academic research in major databases to map the status quo in the selected research area: gender research in SE and CS tertiary education. The paper is focused on studies addressing female inclusiveness in university-level SE education. The hypothesis was that there are multiple diverse ways to reduce the gender gap by fighting stereotypes, accommodating and considering female trades and needs, and rearranging the learning process and programs to make them more inviting and valuable for both men and women alike. The objective was to systematize the relevant literature about gender-inclusive CS educational programs and to establish the background for a deep literary analysis.

The following sections describe the background of the study, the research method, and the findings from the Systematic Mapping Study. The study presents literature sample quality analysis, regional research distribution, and the studies' focus area analysis. It also provides ideas and recommendations for future research directions and the most common practices for achieving gender balance in CS and SE tertiary education from the literature.

II. THEORETICAL BACKGROUND

Despite the steps already taken toward gender equality in many countries, the low persistence of women in the technology sector remains an issue to be solved [1]. The low female interest has been explained by researchers by reference to social factors, such as the pressure of stereotypes, dominant social norms, and habits [18]. For example, one sociocultural habit involves encouraging girls to develop creativity, while boys are encouraged to develop mathematical and technical skills from an early age [19]. At school, educators can influence students' career decisions based on social norms [20]. Young women who are not confident in their technical abilities, who were told to follow the norms, and who do not have any unorthodox role models will likely choose female-dominant fields in tertiary-level education [8], [18]. Even if girls decide to enter the STEM field by choosing an educational program in the technology field and later a technology-related career, there is still a considerable risk that they will feel discomfort and drop out of school or switch to another career path [21], [22]. In addition, although the dropout rates in the STEM fields are similar between the genders, women are far less likely than men to switch to STEM fields, even if they have prior education in other areas [17]. In this context, girls on the technology career track fall into the stereotype cycle illustrated in Figure 1. Thus, due to the pressure of social norms, girls tend to choose stereotypical educational tracks, favoring historically female-dominated fields. As a result, the existing ratio of men and women in engineering is maintained, which produces a constant lack of female role models. When there are no role models, it is harder to resist stereotypes, and there is even room for the emergence of new ones, which may further strengthen the social norms influencing girls' career decisions.

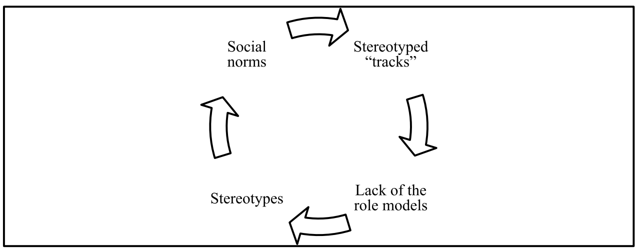

FIGURE 1. The cycle of stereotypes.

For a person to get out of the cycle, it is necessary to exclude at least one element, preferably several elements, from the cycle. The same goes for the entire society, which is a significantly greater problem than the personal-level situation. For example, at the personal level, one can change the company they work for and thus find an environment in which one or more elements of the cycle are absent. At the societal level, the activity of an increased number of role models may show that women are perfectly capable of coping with "male" positions, thus disproving stereotypes [23]. A large enough sample of proof will weaken the stereotypes that are currently accepted as de facto thinking lines in society, leading to positive changes [24] if there are no other barriers to preventing this development.

Some universities around the world are implementing different measures to attract more female students to male-dominant programs. For instance, Tsui recommends recruiting women into male-dominant programs by emphasizing and focusing on the value of such programs to society [25]. Cheryan and colleagues removed masculine-coded objects, such as Star Trek posters, from classroom interiors and reported positive female reactions [26]. Likewise, universities in Chile increased female admission from 19% to 32% by adding 40 places only for women [23]. Big-tech companies are also involved in attracting women to the field. For instance, Spotify [27] organized a female-inclusive hackathon, achieving an almost 50/50 gender balance. Although hackathons are generally project-oriented programming competitions [28], Spotify's strategy was to open the event for people without prior experience or knowledge and reduce the competitional aspect.

These examples of academic and industrial actions show that the gender gap in the technology sector is a global issue being addressed by various "players." However, although there are positive initiatives, knowledge of them is scarce, and the activities remain eclectic. Therefore, this study aimed to comprehensively map the literature on female-inclusive SE and CS tertiary-level study programs and to help overcome the fragmentation of existing female-inclusive activities in higher education. In the following sections, this systematic mapping study (SMS) will pinpoint the current studies, measures, and focus areas related to this phenomenon in higher education and identify directions for future research.

III. METHOD

In this study, the SMS method to five large-scale academic publication indexes/databases (Association of Computing Machinery [ACM], Institute of Electrical and Electronics Engineers [IEEE], Scopus, Web of Science, and Science Direct) was applied to examine the current academic literature on female inclusiveness in SE at the tertiary education level. These databases were selected based on the following criteria: they represent the biggest academic metadata and index databases globally; they are well-known and reputed; their content aligns with the study scope; these databases are highly utilized in SMS, SLR, and similar studies in general.

SMS is a tool for structuring a specific research area [29]. The general SMS process consists of the following stages: source selection, exclusion, classification, and mapping [29], [30], [31], [32]. To determine the framework for the search criteria, the study goal was to map the state of research on female-inclusive SE and CS tertiary-education-level study programs. The process was initiated by generating a keyword list and dividing it into three logical groups: "gender keywords," "educational level," and "SE and CS." The terms suitable for each group were defined and tested in the search query. Each group was modified based on the search results. The educational group underwent the greatest changes in the keyword-testing process. First, the keywords "education," "course," and "program" were used. This query produced a broad and unsuitable dataset. To make the search more specific by limiting the results to higher education, several modifications were made, ending up with the "higher education" and "university" keywords. For the SE and CS keywords group, general terms such as "technology," "engineering," "STEM," and "information technology" were excluded, leaving "software engineering," "ICT," and "computer science." The final keyword set is presented in Figure 2.

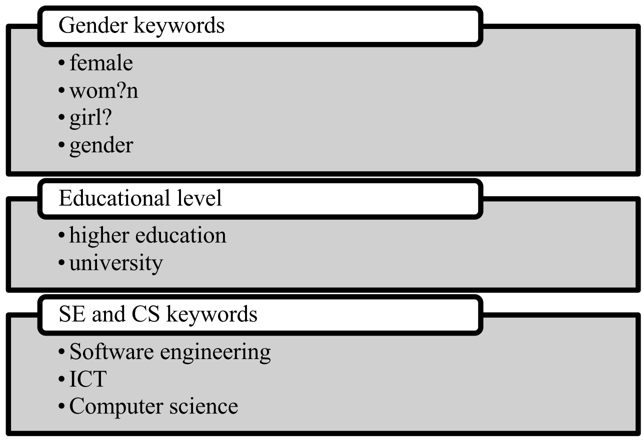

FIGURE 2. Keywords.

As the goal was to map the academic research on the topic area, one of the filtering rules was the exclusion of non-peer-reviewed literature. The publications were collected from the following major research indexes/databases: ACM, IEEE, Scopus, Web of Science, and Science Direct. An example of a search string from the Scopus database is presented in Figure 3. The search results and filtering steps for the collection process are presented in Figure 4.

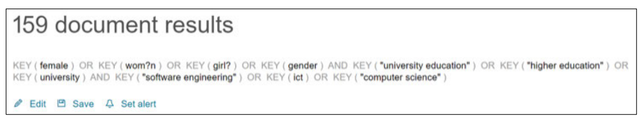

FIGURE 3. Keyword-based search string for the Scopus database.

Given that global societies are rapidly developing through digitalization, that CS and SE education is constantly changing, and that the recent pandemic has accelerated the transition from classrooms to distance and online teaching, the search was limited to the literature published between 2015 and 2022. In addition, only literature in English was selected. After the exclusion of duplicates, the total number of unique studies from the five databases was 882.

The selection and exclusion process for the 882 academic publications consisted of the following steps: identification of the inclusion criteria, the first round of evaluation based on publication titles, revision of exclusion/inclusion criteria, the second round of title evaluation, an evaluation based on abstracts, and finally full-text evaluation. The inclusion

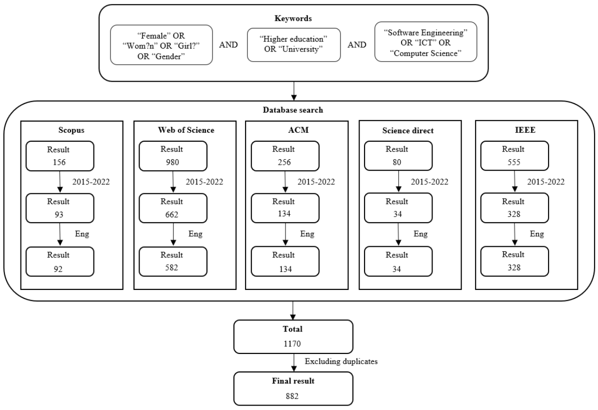

FIGURE 4. Database search.

criteria, along with the reasoning for the criteria, are presented in Table 1.

TABLE 1. Inclusion criteria.

	Criteria	Reasoning
1	The study should be focused on female experience or gender differences	Fulfilling the long-term goal of understanding how to improve **female inclusivity** in SE/CS education.
2	Relation to higher education	Gender equality in SE/CS should be achieved by implementing measures in different educational and social institutions. However, the study focuses on what can be done at the **university level.**
3	Not STEM but CS, SE, or ICT	Although the situation in STEM is similar to SE and CS, SE and CS have unique characteristics.

At each evaluation step, the publications were labeled as "include," "uncertain," or "exclude." The results of each step are presented in Table 2. During the evaluation, 163 publications were selected for the final list. However, when the full texts were evaluated, 20 further publications were either unavailable as full text or were unsuitable to be considered peer-reviewed academic work. Therefore, the final selection contained 143 studies.

TABLE 2. Literature selection process.

Evaluation	Step 1A: Title	Step 1B: Title	Step 2: Abstract	Step 3: Text	Full-text availability
Include	165	107	169	163	143
Uncertain	316	160	10	0	0
Exclude	401	615	703	718	738

With the 143 publications selected, the classification and mapping phase were processed. According to Petersen, SMS may include a "snowballing" phase [29]. However, due to the high number of publications, the number of duplicates reached hundreds by the end of the analysis steps.

To map the studies, the following main literature characteristics and descriptive statistics were collected: publication year, citations, research region, and research methods. The publication year may indicate the development of the study direction, the citations help identify the most widely read papers, research regions reveal the global distribution of the research, and research methods may show the most popular approaches when researching this topic. All studies were classified using the codification scheme defined in Table 3.

TABLE 3. Literature classification.

Classification	Options	Description
Focus area	Course or initiative	The study was performed in a course, summer camp, hackathon, or another narrow context.
	Higher education	The study investigated an educational institution, considering various aspects of its performance.
	Broader perspective	The study considered university-level education and the educational system, work life, and society in general.
Subarea	Interest and motivation	The researchers focused on female interest and motivation to study CS and SE at different life stages.
	Enrollment	The study specifically focused on evaluating/modifying the enrollment process.
	Learning process	The study evaluated women's experiences of studying SE and CS
	Persistence	The researchers focused on female persistence at the university/field.
Category	Evaluating gender differences	The study compared female and male experiences in CS/SE education.
	Understanding female motivation	The study was mainly focused on women and their desire to be in the CS/SE field.
	How to attract more women	The researchers focused on how to attract more women to the field.
Result	Observations and explanations	The study observed the patterns or looked for the reasons for low female presence in SE and CS.
	Proposals	Based on their findings, the researchers made proposals for what could be done.
	Practical implementations	The researchers evaluated their experiences of practical implementations of tools or strategies for achieving gender balance in SE/CS.

IV. MAPPING STUDY RESULTS AND CLASSIFICATION

The included academic publications comprised 105 conference papers, 34 journal articles, and two books, with the annual distribution illustrated in Figure 5.

Analyzing the annual number of publications, one can notice a decline from 2020 onwards. It is not clear how to

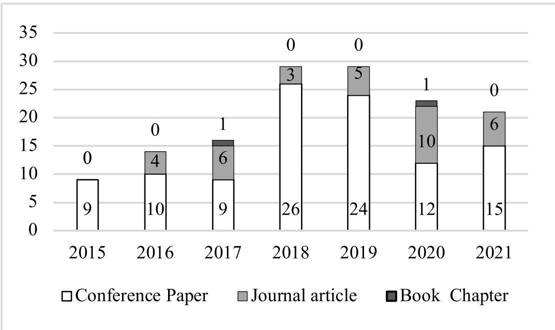

FIGURE 5. Database search.

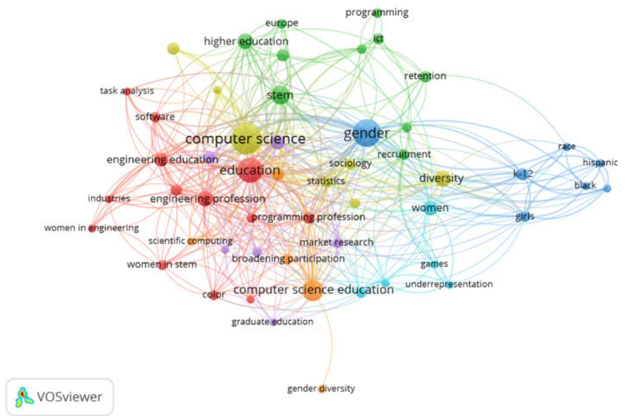

FIGURE 6. Literature keyword analysis.

interpret this change, but a few hypotheses can be made based on widely known facts. First, in 2015 the United Nations Sustainability Development Goals (SDGs) could have boosted academic research on inclusiveness and gender neutrality at different educational levels. The publication of studies takes time, which could explain the spike around 2018 and 2019. Most likely, however, the decline is related to the COVID-19 pandemic and its effect on academic work and research. First, many research units and universities had to close in 2020 [33]. Second, staff resources had to be diverted toward pedagogical issues and other urgent tasks, such as transferring education to the online mode and modifying face-to-face intensive courses to an online format [34], [35]. All of these changes, along with sick leave impacting available resources, could influence the postponement of gender-related studies. At the same time, these hypotheses require further research to establish a clear correlation between the suggested factors. It is also possible that the amount of research remained at the 2018 and 2019 levels while the count of unique publications dropped because the amount of data and depth of the work per publication increased, and the output in total was quite stable. In other words, the latest studies have become more extended and deeper.

With the quantitative and descriptive data about the collected sample, the process of establishing an understanding of the publications' quality and general relevance for the research goals was initiated. More specifically, in this mapping study, the tools to analyze the selected literature were used. One of the most common tools is VOSviewer, which helps with keyword- and terminology-based analysis. Using VOSviewer, the keywords of the entire set of publications were analyzed and visualized. The results of the analysis-based visualization are presented in Figure 6. Based on the analysis, the major keyword groups were computer science, education, and gender. A comparison of the results with the search criteria indicated good correspondence between the selected literature and the study goals, which provided an initial validation of the quality of the selected keyword in the SMS process [36].

Next, based on citation numbers, the perceived academic quality/contribution value of the selected studies was analyzed. The total citation count was collected from the Google Scholar citation index [37]. Then, the count was converted to citation per year values to fairly compare publications with different amounts of publicity time (see Figure 7).

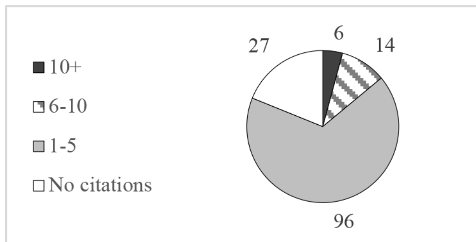

FIGURE 7. Citations per year.

More than half of the papers (116) had at least one citation, and six were cited more than ten times yearly. Only 27 papers were not cited. To evaluate the quality of the citation rates, the Google Scholar citation rates of the most-cited publications were compared with the rates on Scopus and the Web of Science (WOS) databases. Table 4 presents 19 papers with the highest citation (HC) rates yearly. The number of citations in Scopus exceeded half of the Google Scholar results, while the Web of Science rate was lower. This finding corresponds to the study of Happonen and Ghoreishi [38]. These results indicated that the sample had the necessary quality for the research.

After the citation count analysis, the regions of the studies were analyzed. Figure 8 shows that the main contributors to this research area (49% of papers) came from the USA.

The authors investigated female experiences at different stages of the education process. Different initiatives can be implemented in the enrollment procedure and the learning process in general to increase female interest, motivation, and persistence in the field. Figure 9 shows that the majority (64) of the publications considered the learning process to be the main study focus area. Perhaps such popularity is related to the fact that in the learning process, both major and minor changes can be made, and the result can be tested quickly enough, for example, during a specific course. A little

TABLE 4. Citation rates comparison: Google Scholar, Scopus, and WOS.

ID	Google Scholar (total)	Scopus (total)	WoS (total)
HC2	85	NA	36
HC3	85	51	32
HC5	65	26	22
HC4	61	35	22
HC1	60	33	26
HC8	41	19	12
HC9	40	21	7
HC13	34	26	13
HC15	32	22	7
HC11	31	19	12
HC7	28	19	11
HC12	28	17	6
HC14	27	22	11
HC6	21	15	11
HC16	19	11	8
HC10	16	8	4
HC19	16	7	7
HC17	6	4	NA
HC18	6	4	NA

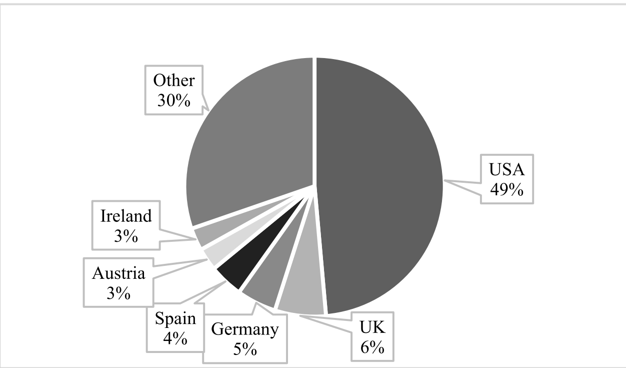

FIGURE 8. Country distribution.

less common (47) were studies of women's motivation and interest in general. However, persistence in the field was weakly studied, although the core task of higher education is to prepare specialists for the industry. Therefore, additional research is needed on female persistence in SE and CS education as well as in the industry.

The publications considered different perspectives, from in-class activities to society in general. The focus area analysis showed that the majority (81) of the papers focused on higher education in general, 46 considered a particular course or initiative, and only 16 adopted a broader perspective. Figure 10 shows that the smaller the focus area, the more practical tests researchers make. It is easier to check whether a measure works in the classroom context than in the university or society.

For the literature analysis, different publication groups may be analyzed separately. Table 5 shows the reference list for each group. For instance, publications in the Practical

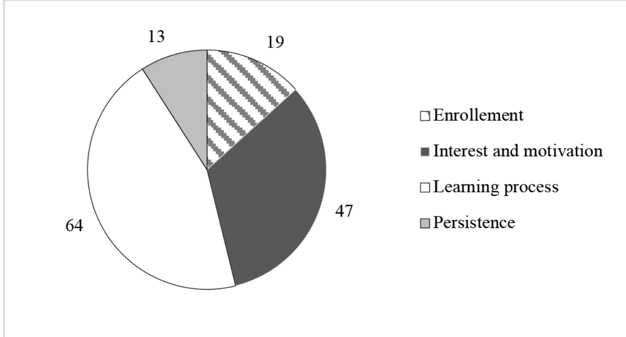

FIGURE 9. Women's inclusiveness subarea distribution.

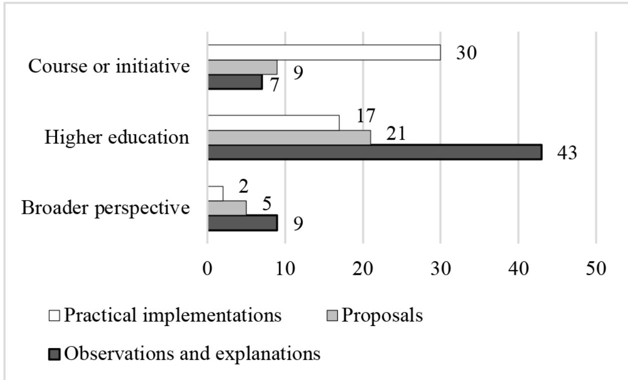

FIGURE 10. Focus area distribution by the results.

Implementations group considered already working recommendations that may be implemented at the university. The Proposals group addressed ideas of what could be tested in an educational context, while Observations and Explanations provided grounds for reflection and additional insights and designed portraits of potential CS female students to facilitate the design of approach for attracting them.

TABLE 5. Literature groups division.

Research result	Quantity	Papers
Observations and explanations	59	[22], [39]–[52], [52]–[95]
Proposals	35	[96]–[130]
Practical implementations	49	[114], [131]–[179]

Five papers with the highest citation rates from each group were reviewed to test whether these groups' expectations were correct. Based on the observations, a portrait of a female CS student could be drawn. The study by Lehman et al. [64] shows that CS female students rate their abilities lower than male students do. The main concern is related to their computing skills: 56.9% of the women assessed their skills as higher than average compared to 82.3% of the men. Moreover, women majoring in CS are more undecided about their future careers than men. Another study highlighted higher computer identity among male students than female ones [67]. Lewis et al. [22] interviewed CS students to study their sense of belonging. They found that the students who could provide examples of non-stereotypical computer scientists easily rejected stereotypes. This proves the importance of having different role models and a diverse media picture. One aspect of external involvement (e.g., of parents and teachers) was covered in the work of Wang and Moghadam [93]. They found that 39% and 47% of the boys were encouraged to major in CS by teachers and parents, respectively, compared to 26% and 27% of the girls.

As expected, the proposals suggested ideas for improving CS and SE programs. For example, the study by Michell et al. [121] suggested providing networking opportunities for women by organizing meetings in libraries, excluding stereotypes from marketing campaigns, and implementing gender studies in the university program. Acknowledging male and female differences may help educators show their intentions of supporting every student and maintaining a healthy climate in the classroom [98]. University visits from women working in CS to the school and discussing CS opportunities may increase female interest in this study field [97]. Babes-Vroman and colleagues recommended dividing CS classes based on students' prior experiences to make everyone feel comfortable and have the same opportunities in the classroom [100].

Practical implementations presented the results of actions implemented in practice. For instance, studies by Ying et al. [179] and Kuttal et al. [154] both investigated the effect of pair programming on different genders. They found that pair programming increased the confidence of both female and male students and helped them understand the topic. However, they noticed that same-gender pairs had higher work satisfaction and a fairer work division. The authors recommended considering individuals' characteristics when creating pairs and implementing an automatic role-transfer system. Brady et al. [134] introduced physical computing practices in short-term introduction courses for women to help female students explore the vast opportunities that CS can provide and raise their awareness of their career perspectives. Burnette et al. [135] implemented growth mindset interventions in CS classes to convince students that they are capable of computing and that computing abilities can be improved.

V. DISCUSSION AND IMPLICATIONS

Although modern societies are actively implementing actions to achieve gender equality, gender imbalances remain in certain fields, such as CS and SE. Although specific physical requirements justify the gender imbalance in some professions, the CS and SE fields are not subject to such requirements because these professions are skill- and knowledge-based. This leads to the assumption that "something is going wrong".

Researchers have associated the gender gap in the technology sector with outdated social norms, stereotypes, and a lack of role models. These factors lead to girls and women feeling negatively about belonging to the technical field and preferring female-dominated professions. In other words, there are still real factual barriers for women to pursue careers in technical fields [180]. However, studies have shown that well-chosen measures for attracting women to the technology sector can reduce insecurity among the female audience along with the gender gap. For this reason, this study aimed to map the state of research investigating gender-equality changes in CS and SE higher education.

Based on the studied literature, interest in this research area has steadily grown since 2015. However, the number of papers declined slightly in 2020 and 2021. This phenomenon may be explained by the COVID-19 pandemic and such factors as social distancing and the refocusing of education and research-related resources, particularly in 2020. The unexpected transfer from classes to online lectures and educational activities shifted the focus of educational institutions toward short-term tasks, such as re-editing teaching materials, repurposing personnel resources, and balancing limited resources due to excess sick leave situations. These changes may have impacted the research focus. Moreover, many conferences were postponed, which could have affected the number of publications. To confirm these assumptions, further investigation is needed: there is a lack of research on changes in academic focus during the pandemic.

It was found that there was a geographic imbalance among the studies. The main contributors (49%) to research on female-inclusive CS and SE tertiary education came from the USA. There are several socio-cultural explanations for this phenomenon. First, the USA may have a highly developed SE industry, but it also experiences high workforce demand, enhancing talented programmers' availability. Second, the USA may have higher motivation to perform gender equality-related research as gender equality is one of the Sustainable Development Goals. Third, the USA may also face the developed country paradox, whereby women with freedom of choice do not choose to study technology [17]. Therefore, they feel a need to initiate this type of research. More studies in other cultural contexts are needed to develop female-inclusive measures for particular countries.

Another research gap was the low interest in female persistence in the field. Only 13 papers focused on this issue. However, universities should strive to attract more women to their programs, supporting them through graduation and entering the field. Therefore, this study direction requires more research.

One positive finding was that a significant part of the literature provides recommendations to educators for achieving gender balance. Studies both explain why this disparity exists and suggest practices for gender-inclusive education. Such practices can be implemented at different administrative levels. Gender talks [138], [162], [171] and community-building [153], [163], [175] activities help make the entire university environment more gender friendly.

Meanwhile, departments can organize mentoring or tutoring for students who need support [152], [177] and preliminary training that ensures all students have an equal knowledge base to start their studies [133], [138], [163] as well as provide opportunities to attain practical experience through internships, industry visits, and case studies [146], [150], [172], [177]. These initiatives help women feel confident and increase their sense of belonging, and educators may improve their learning materials to increase female interest in the subjects. For instance, modern technologies, such as 3D visualization and robotics, received special attention from female students [132], [150], [166], [175]. In addition, it is important to emphasize the social aspect of computing [131], [142] and introduce collaborative exercises, such as pair programming [154], [178]. Moreover, some changes could be made in the promotion of the programs. For example, in recent years, a shift in social media marketing and personal branding has revolutionized companies' approach to promoting themselves [181]. This has also resulted in greater visibility for historical minorities and a positive impact on diversifying target audiences [182], [183]. To summarize, there are studies that provide gender-related knowledge on efficient gender-inclusive practices; a combination of such practices in the program design can close the gender gap in SE and CS tertiary education.

VI. CONCLUSION

In recent decades, society has been actively moving toward gender equality. However, the gender gap in SE and CS remains and needs to be closed. The literature shows that the main reason may be the fact that women face stereotypes and discrimination related to their career perspectives at different ages. As university members, the authors were particularly interested in how the experience of female students can be improved and how the gender balance in SE and CS faculties can be achieved.

Drawing on state-of-the-art studies on female-inclusive SE and CS university programs, this SMS study was made. The goal was to map existing studies and identify directions for a systematic literature review. For this purpose, different keyword sets were developed and tested to gather the most relevant sample. Then, these keywords were used in five databases: ACM, IEEE, Scopus, Web of Science, and Science Direct. The final sample of 143 publications was selected by reading the titles, abstracts, and full texts before classifying the publications for further analysis.

Based on the context of the publications, the studies could be divided into those focused on courses or initiatives (46), university-level activities (81), and the broader context (16). The results of the analyzed studies indicate that minor changes can be made at the course level and that such measures are easier to test in practice. Most publications (64) focused on changes to the learning process. A large portion of the sample (49) considered practical tests of measures for implementation in university education. There are already tested interventions that universities can use to create a female-inclusive environment. Still, given the size of the challenge, authors see this to be just a positive-spirited starting point, in great need of extensive addition to receive researched, tested, and practically confirmed models, distributed openly and globally to more efficiently start to tackle this wicked problem. In the found literature, 35 publications proposed female-inclusive activities, and 59 examined and explained the existing gender gap in SE and CS education.

For future research, the authors recommend seeking new insights into the issue by extending participation and motivation in the context of females and STEM/ICT careers, job selections, and technology knowledge positions to translate the findings into study program development goals. Also, this study's findings suggest a need to continue performing deep literature analysis and testing the findings in different social and cultural contexts to combine all the knowledge and design a gender-inclusive SE or CS program.

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