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Review article

Understanding STEM career choices: A systematic mapping

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ABSTRACT

STEM disciplines are considered essential for human development, and they are associated with low unemployment rates and good economic prospects. However, many countries are faced with the problem of too few STEM graduates, which raises the question of why more students do not choose STEM majors. This study presents a systematic mapping of studies published prior to 2021 in Web of Science or Scopus in order to examine the research trends on the factors that cause students to choose a career in Computer Science, or more generically, in the STEM fields. These factors have been identified and classified in 3 categories: Environmental factors, Social influencers and Personal factors. The categories are made up of 4 levels of subcategories. We analyzed (1) the countries in which the study was conducted, (2) the characteristics of the study and (3) the frameworks used. The results show that the bulk of the studies were conducted in developed countries, mainly in North America and Europe. The frameworks most commonly used in the studies are Expectancy-Value Theory and Social Cognitive Career Theory, and consequently, the most commonly studied factors for STEM degrees are those related to personal psychological factors. For Computer Science degrees, the most frequently studied factor is career prospects. On the other hand, a small number of studies on the impact of social media on the choice of studies in the technology field were detected. Among the studies analyzed, there is great interest in determining the factors that specifically affect women and the differences between men and women, especially in studies dealing with the Computer Sciences. Furthermore, there are few studies that analyze the effect of informal educational experiences among women. Given that this kind of experiences has become very popular in recent years among women, future research should analyze their impact on the choice of STEM studies. Taking into account the current relevance of the social media, additional research on their impact on the choice of studies should be conducted. It would also be necessary to analyze the situation in underdeveloped countries, especially among women, given that this field is currently a driver of economic development.

1. Introduction

Disciplines in the field commonly referred to as STEM, an acronym for Science, Technology, Engineering and Mathematics, play a very important role in today's society, and are considered by some organizations (e.g. UNESCO, WBG, OECD), as fundamental

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disciplines for human development, improved competitiveness and the economic prosperity of a country [1]. The STEM field is associated with low unemployment rates and good economic prospects. However, despite the auspicious prospects, many countries face the problem of an inadequate supply of STEM graduates. For this reason, there is great interest in changing the current enrollment trend in the field, which raises the question of why more students do not choose studies in STEM. A large body of literature has addressed this issue from a variety of perspectives.

Particularly noteworthy is the gender gap in enrollment rates. According to the Organization for Economic Cooperation and Development (OECD), among incoming university students, women account for 16% in the STEM field in the EU and 15.5% in OECD countries [2].

The field of ICT (Information and Communication Technologies) has also been investigated in great detail, and the situation is even more dramatic. Over the last decade, there has been little or no progress in the percentage of women enrolled in the field. The percentage of female enrollments has remained below 10 percent over the last 10 years in many of the OECD countries [3,2]. An extreme example is the case of Belgium, where the number of female ICT enrollments is below 5% [2].

In general, this situation contrasts with the fact that the labor market currently offers good opportunities for the ICT sector, and in general, in the field of engineering. According to Eurostat data, the number of people employed as ICT specialists has grown by 50.5% in the period between 2012 and 2021 [4]. This increase is 8 times larger than the corresponding increase in total employment (6.3%).

Faced with the apparent contradiction that the number of enrollments in the STEM field, and in particular in ICT, which have not followed the expected evolution in a strategic sector with good job opportunities, various initiatives aimed at promoting these disciplines among young people, and especially among women, have been launched from different areas (e.g.: [5], [2], etc.). Many studies have also been conducted on the factors that affect a student's choice of a college degree in STEM. It is imperative to investigate the causes of the current situation, in order to design effective remedial policies.

This paper presents a systematic mapping study of published studies on the factors, direct or indirect, that affect students when choosing a university degree in the field of Computer Science, or more generically, in the STEM field. The aim of the study is to provide an overview of the existing research trends, as well as to taxonomically structure the set of primary studies. This will make it possible to provide a global, orderly overview to guide future research.

2. Background

2.1. Systematic mapping studies

A Systematic Mapping Study (SMS), also known as a scoping study, is a practice grounded on evidence-based research. SMS is a methodology that provides an overview of a given area of research. It involves reviewing the literature of a given research area, structuring it by compiling an overview of what has been published and classifying and counting the contributions in each classification category. This allows the coverage of the research to also be determined. This methodology was initially used in medical research and it has subsequently been adopted in other areas of knowledge. B. Kitchenham [6] was one of the pioneers in adapting systematic literature reviews for use in fields other than medicine. As a result of this adaptation, K. Petersen released the first guidelines for conducting systematic mapping studies in non-medical areas [7,8].

An SMS is a type of study that follows a sequence of precise methodological steps, thus reducing research bias. Our study is based on well-established and evaluated review protocols for extracting, analyzing, and reporting results.

The systematic mapping study has been conducted using the guidelines by Petersen [7,8] and Kitchenham [6]. The process consists of three main steps:

- Planning: refers to the activities prior to the review. This phase includes the identification of the need for a review and the definition of a review protocol that defines the research questions, the inclusion and exclusion criteria, the sources of the studies to be reviewed, the search string and the categories of the classification.
- Execution: in this phase, the review process defined during the planning phase is implemented. This process is iterative and may require revisions. At the end of this phase, the relevant documents will have been extracted by matching the search string and then applying the inclusion and exclusion criteria.
- Disseminating the review: final phase that consists of reporting the results of the review. In this phase the results of the study are used to answer the research questions.

3. Research method

We conducted a Systematic Mapping Study to provide an overview of the existing research trends with regard to the factors that directly or indirectly affect a student's decision to choose a STEM degree, with a particular focus on degrees in the field of Computer Science. The guidelines and process proposed by Petersen [8] are followed. The main focus is on classification, conducting a thematic analysis to answer the research questions.

Fig. 1 shows the mapping process, which includes searching for relevant publications, defining a classification scheme and mapping the publications. The remainder of this section describes the steps in this process.

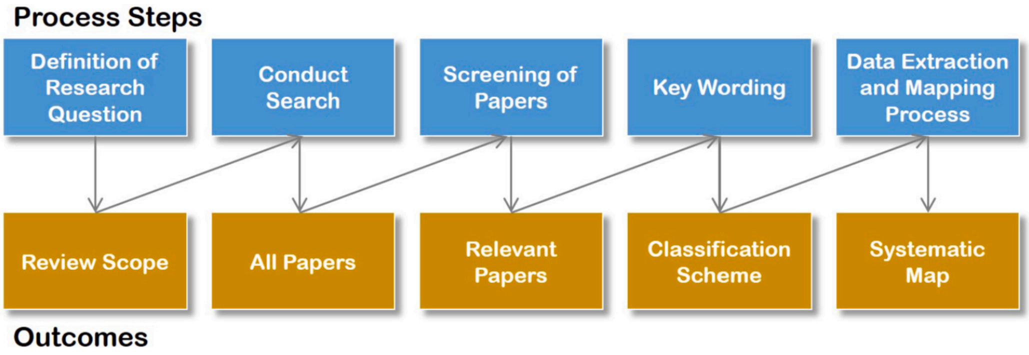

Fig. 1. The Systematic Mapping Process.

Table 1
Search string terms.

Type	Main term	Alternative terms
Population	Computer Science	
Population	STEM	science, technology, engineering and maths
Intervention	motives	motivation
		attraction
Intervention	Systematic mapping	systematic review
		SLR review
		State of the art

3.1. *Research planning*

Research planning is the most relevant phase of the overall process, as the activities outlined at this stage will shape the research protocol. The planning phase begins with the identification of the need for the SMS, the identification of the research questions and the description of the review process. Once these parameters have been defined, we can formulate a review protocol. The following sections detail each of these aspects.

3.1.1. *Need for a review identification*

As indicated by Petersen [8], before starting an SMS, it is necessary to identify and evaluate any existing systematic reviews (referred to as secondary studies) on the topic of interest. For this purpose, the same search protocol was followed as indicated in the study identification phase (see the Search String section). A search string was constructed and an automatic search was performed on the selected databases. In this manner, the protocol was defined prior to identifying the existence of secondary studies.

The search string has been constructed based on the one defined in the review protocol. In this case, we are interested in systematic mapping studies. After carrying out a few pilot searches, we found it necessary to expand upon the number of results. To this end, some of the restrictions on the search string used for the selection of the primary studies had to be lifted. Table 1 shows the terms used in the original search string, as well as the alternative terms added in relation to systematic mapping.

Ultimately, the search string used in Scopus and Web of Science (WOS) on the title, abstract and keywords fields was the following:

(stem OR "science, technology, engineering and maths" OR "computer science") AND (motivation* OR motives OR attraction) AND ("systematic review" OR "systematic map*" OR "SLR review" OR "state of the art")

The result of the search was 179 studies. A similar protocol to that applied in the SMS was then applied in the selection of the studies. The difference was in the inclusion/exclusion criteria. In this case only studies that gave an overview, summary or compendium of the factors related to the choice of a university degree in the field of Computer Science or more generically in the STEM field were included.

After applying the protocol we found a systematic secondary study [9] related to the topic at hand although it is not focused on the analysis of factors affecting the choice of studies. Instead, the article deals tangentially with factors related to study choice and focuses on the improvement of perception toward computer studies by young women through exposure to relevant activities. This study is part of the final set of selected studies.

3.1.2. *Research questions (RQ)*

Given the lack of secondary studies, we believe that conducting an SMS to find out what the research trends are regarding the factors that determine the choice of a STEM degree is justified. The SMS we conducted in this paper aims to give a comprehensive overview of the current state of the art. To achieve this goal, the research questions shown in Table 2 have been designed.

Table 2
Research questions to be answered by the review.

Research Question	Sub-question
RQ1. What are the factors that directly or indirectly affect student enrollment in STEM careers, or specifically in CS careers?	SRQ1.1: What factors have been identified and in which studies are they addressed? SRQ1.2: What factors have been specifically identified for CS?
RQ2. How have these changed over time?	SRQ2.1. How has interest in the subject evolved over time? SRQ2.2. What is the temporal relationship between the identified factors and the year of publication of the studies?
RQ3. What research methods are used to conduct the study? What are the most frequently applied research methods, and in what study context?	
RQ4. What countries have been studied?	
RQ5. What are the main frameworks adopted in the studies?	

Table 3
Application of the PICO model.

Type	Search criteria
Population	Studies related to university studies in Computer Science, or more generally, in STEM
Intervention	Identification of the motivations for enrollment

3.2. Search strategy

The aim of the SMS is to find as many primary studies as possible that are related to the research questions, using an unbiased and well-planned search strategy. In this section, we describe our search strategy by explaining the scope of the search, the search method adopted, and the search string.

3.2.1. Scope

To identify the primary studies, it was decided to perform an automated search using scientific databases as indicated by Petersen [8]. The automated search has been complemented with a backward snowballing of all remaining studies after a full text reading.

The multidisciplinary nature of this study makes it difficult to choose specific scientific databases. It was considered appropriate to use Web of Science (WOS) in conjunction with Scopus, the two most universal and commonly used databases in the different fields of science to search for scientific literature [10,11]. Both are international in scope, multidisciplinary and with a broad coverage of the main sources of scientific literature.

As recommended by Petersen [8], we used a tool to manage the references extracted from the databases; specifically, we used the Mendeley reference management tool. Additionally, spreadsheets and a MySQL relational database were used to record the extracted data.

Regarding the temporal scope, it was decided not to place any limitation on the temporal start of the search. Although the term STEM began to be used in the early 1990s (e.g. CAHSEE[1] or NSF[2]), these disciplines already formed a *de facto* block with certain common characteristics, which motivated the use of the acronym from then on. Regarding the end date, the search includes publications up to and including the year 2021.

3.2.2. Search string

To perform the automated search, a search string was constructed after a series of pilot searches. The recommendations by Kitchenham and Charters [6] were followed, and the PICO (Population, Intervention, Comparison, and Outcome) model was used to determine the criteria for the search string (see Table 3).

The analysis of the research questions has made it possible to extract terms for the construction of the initial search string. Based on the initial search, iterative improvements were made taking into account the synonyms and variants of the terms. In this iterative process, some synonyms that contributed a lot of noise to the list of results were discarded.

Table 4 presents the terms selected by the search string used for the literature analysis.

Finally, the search string used in Scopus and WOS for the title, abstract and keyword fields was as follows:

((stem OR "science, technology, engineering and maths" OR "computer science") AND (degree OR "Higher education" OR *graduate* OR career OR (universit* AND stud*)) AND (motivation* OR motives OR attraction) AND (enroll* OR participation OR choice))

[1] Center for the Advancement of Hispanics in Science and Engineering Education.
[2] National Science Foundation.

Table 4
Search string.

Type	Main term	Alternative terms
Population	Computer Science	
Population	STEM	science, technology, engineering and maths
Population	university studies	degree
		undergraduate education
		career
Intervention	enroll	participation
		engage
		choice
Intervention	motives	motivation
		attraction

Fig. 2. Study selection strategy.

Table 5
Inclusion/Exclusion criteria.

Inclusion criteria	
I1	Any study that focuses on identifying students motivations to choose a Computer Science or, more generally, a STEM degree.
Exclusion criteria	
E1	Studies on retention, motivation to stay in the STEM field, and/or those associated with improvements in teaching, institutional support (mentoring), etc.
E2	Studies that describe interventions, at school or out-of-school, in order to improve students engagement in STEM but without analyzing the impact of the intervention.
E3	Studies that do not specifically analyze the motivations for pursuing a STEM degree or a CS degree.
E4	Studies presenting non-peer reviewed material. This decision is based on the common knowledge that peer-reviewed articles are authoritative indicators of quality in the field.
E5	Studies in languages other than English, Spanish or French. This decision is due to the fact that neither author has access to publications in other languages.
E6	Studies presenting summaries of conferences/editorials or guidelines/templates for conducting mapping studies.
E7	Studies not accessible in full-text version.
E8	Studies that are duplicates of other studies.

The only change to the list of selected terms has been to add the metacharacter * to include variants of the terms (e.g. undergraduate, students, etc.).

3.3. Study selection

To select the final set of studies, we designed a 5-step selection strategy, which is an adaptation of the steps proposed by Petersen et al. [8] and Kitchenham and Charters [6].

In Fig. 2, we provide an overview of the study selection process and the resulting number of papers at each stage. Fig. 2 also shows the backward snowballing process, which we have carried out in the last stage of our study selection strategy, to identify as many primary studies as possible.

The studies were selected by screening on the basis of titles, abstracts or full text. This was done by applying the inclusion and exclusion criteria defined in the planning phase, which can be found in Table 5. Only studies dealing specifically with STEM or CS degrees were analyzed. Therefore, studies on factors affecting the choice of any degree, which are undoubtedly related to the subject matter, have been excluded. In cases where no decision could be made, a review of the entire text was carried out.

The inclusion and exclusion criteria were applied by the first author. The validation process can be seen in section 3.5 (Validity Threats).

In the remainder of this section, we provide details for each stage of the study selection strategy shown in Fig. 2.

3.3.1. Stage 1. Automatic search

The process begins by applying the search string to the selected databases. Since this is a multidisciplinary study, no automatic filters have been performed on the areas of knowledge. A total of 1134 documents were obtained.

Table 6
Data extracted from primary studies.

Data item
Full reference
Year of publication
Source (conference / journal)
Degree studied (STEM / CS)
Country studied, if any
Term(s) used to refer to the factors that directly or indirectly affect student enrollment in STEM careers
Framework adopted, if any
Type of study (Empirical: qualitative, quantitative; longitudinal, non-longitudinal / non-Empirical).
Educational level of the sample (only applies to empirical studies)
Sample size (only applies to empirical studies)
Was an intervention performed? (Yes/No)
Gender gap focus (yes/no)

3.3.2. Stage 2. Removal of duplicates

An automatic deletion of duplicates was then performed, using the Mendeley reference manager. In addition, the first author manually reviewed the list of articles to identify duplicate records not detected by Mendeley. As a result, 295 articles were excluded. Following this stage, we ended up with 839 remaining primary studies.

3.3.3. Stage 3. Exclusion by title and abstract

From this data set, a two-stage screening was performed. In the first phase, the exclusion criteria were applied to the titles of the selected documents to determine whether they fall within the context of the research, i.e., whether they are in line with the objectives of the SMS. As a result, 473 articles were excluded, leaving a total of 366 primary studies. The main reason for the elimination of such a large number of documents was that many of the retrieved documents were not related to the objectives of the study, because no filtering by areas of expertise could be performed. In the second phase of article selection, the abstracts of all the previously selected articles were read and the count was reduced to 217; i.e., 149 articles were excluded.

3.3.4. Stage 4. Exclusion by full-text reading

In this stage, full-text reading was performed to exclude papers that do not fall within the scope of the research. Ultimately, 143 articles were selected as primary studies. At this stage, 74 articles were excluded after applying the exclusion criteria.

3.3.5. Stage 5. Backward snowballing

In order to identify as many primary studies as possible, we conducted a backward snowballing process.

The starting set of the process was made up of the items resulting from step 4. From this set, relevant works were identified from the reference list of the articles. The referenced works were included according to the inclusion and exclusion criteria defined earlier in this section. As a result of this stage, 110 articles were added to the initial set, resulting in a final set of 253 primary studies that are relevant to our SMS.

In the process of constructing the search string, some synonyms that contributed too much noise to the list of results were discarded. We found that the references in the list obtained from the snowballing used these discarded synonyms or, in some cases, other synonyms. We understand that the reduction of synonyms was a lesser evil, since they contributed to a large increase in references unrelated to our objective. The most significant case are the synonyms of Computer Science, such as Information Technology (IT) or Information and Communication Technology (ICT), for example. The computer science disciplines include a number of majors that are classified by somewhat different titles at different universities, but the most frequently endorsed major is computer science [12].

The final set of primary studies can be found in the Appendix A, sorted by author. These studies are discussed in greater detail in the following sections.

3.4. Data extraction and classification

The analysis of the articles aims to retrieve information in order to answer each research question. To this end, based on the full-text reading of the articles, data extraction and classification were performed to answer the research questions.

To extract data from the primary studies, we developed the template shown in Table 6. The data selection described in the template was performed based on the previously defined RQs. The extraction process was performed by the first author and reviewed and confirmed by the remaining authors. The extracted data were reviewed by all authors, in a series of periodic meetings scheduled for this purpose.

In the process of extracting the data, we proceeded to categorize the factors that affect students when choosing a degree in the STEM or CS field. The process consisted of several iterations, in which categories were added, modified and removed over time to ensure the validity and consistency of the results. The result of the classification of the factors can be seen in Fig. 3. Examples of each factor have also been included in order to facilitate understanding.

1. Environtmental factors	1.1. Educational experiences	1.1.1. Formal (at school)		i.e. science fair, research experience, hands-on projects, real-life applications in science classes, science clubs, science field trips, etc.
		1.1.2. Informal (out-of-school)		i.e. summer camp, extracurricular science activities, etc.
	1.2. Classroom environment			i.e. instructional design of classes, teachers' individual support, comprehensible teaching, connection to students' every day experiences, etc.
	1.3. Science capital			i.e. exposure to science / computers (at home), practitioners, science experiences or tool access, etc.
	1.4. School characteristics			i.e. school location, type of school, school curriculum, etc.
	1.5. Family background (socioeconomic & cultural status)			i.e. parents education, parents work (related to first-generation college students), parental income (socioeconòmic status), number of books at home and frequency of museum visitation, parental beliefs, family values, structure of familiy (single parent / 2 parent), etc.
	1.6. Social backgound / Cultural Milieu			i.e. stereotype threat, cultural barriers, social roles, national gender equality (Global Gender Gap Index), overall life satisfaction (OLS), dominant educational & social representation of science (masculine, clever), etc.
2. Social influencers / suport - recognition	2.1. Parents / Family			
	2.2. Peers / Schoolmates			
	2.3. Teachers / Academic advisors / Academic mentors			
	2.4. Role models			
	2.5. Social media			
3. Personal factors	3.1. Psychological	3.1.1. Utility beliefs (regarding self, society, other fields)	3.1.1.1 Individual personal values	i.e. help people, change the world, time for family (balanced work-family preferences), person-thing orientation, agency beliefs, etc.
			3.1.1.2.Career prospects	i.e. job oportunities, good salaries, reputation of the field, etc.
		3.1.2. Affinity & attitudes	3.1.2.1. Self perception (confidence)	i.e. science self-concept, self-efficacy, self-esteem, expectancy, etc.
			3.1.2.2. Interest	i.e. hobbies related to the subject, curiosity, etc.
			3.1.2.3 Enjoyment	i.e. satisfaction, affinity, pleasure, etc.
			3.1.2.4 Activity preferences	
			3.1.2.5 Perceptions of the subject	i.e. Emotional Connection, perceptions about science and scientists' work, importance, inventing/discovering new things, stereotyped science as masculine or feminine, etc.
			3.1.2.6 STEM belonging / identity	i.e. ability belonging, social belonging, identity (subjective task values), attainment, etc.
		3.1.3. Personality factors		i.e. mindset (malleable/fixed), personality (big five), learning strategies, occupational personality, etc.
		3.1.4. Childhood Preferences/Abilities		i.e. preference for spatial toys, etc.
	3.2. Academic	3.2.1. Educational choices		i.e. subject choices in secondary school, etc.
		3.2.2. Academic performance		i.e. academic achievement, performance in science/math, grades in math/physics/chemistry, GPA (Grade point average), cognitive ability, etc.
		3.2.3.(STEM / CS) career knowledge		i.e. student knowledge of mathematics and science requirements that lead to STEM careers, etc.
		3.2.4. STEM subject engagement		i.e. math engagement, science engagement, etc.
	3.3 Social identity			i.e. group importance, friendship group climate, Gender composition of friends, gender self-schema (feminity), masculinity, etc.

Fig. 3. Classification Factors with examples.

Three broad categories (level 1) and 14 subcategories (level 2) have been identified. In some cases, it has been necessary to establish categories at levels 3 and 4, in order to make the classification more precise.

The spreadsheet assisted the data extraction and classification processes, in order to organize information and manage SMS activities.

3.5. Validity threats

For any empirical study, the discussion of validity threats is important and constitutes a quality criterion for study selection [8]. In this section, aspects of the research process that may pose validity threats are presented, along with the actions taken to mitigate them.

During the primary study identification phase, it should be ensured that the maximum number of primary studies have been included. In order to achieve this, different tests were performed with different search strings, adding synonyms of the keywords. In the process of constructing the search string, some synonyms that added too much noise to the list of results were discarded. We understand that the reduction of synonyms was a lesser evil, considering that they contributed to a large increase in references unrelated to our objective. However, it is possible that not all primary studies were identified by discarding some of the alternative terms. To mitigate this threat and identify as many primary studies as possible, snowballing was performed. It was found that some of the references in the list obtained from the snowballing used some of the discarded synonyms.

The primary study selection phase, specifically the exclusion stages (stage 3 and stage 4), was mainly carried out by the first author. This process involves a certain degree of subjectivity, which can lead to bias. To avoid or minimize bias, a series of periodic meetings were scheduled with the other authors to discuss and refine the final set of included and excluded studies, and a series of measures were taken at these stages:

- The complete list of primary studies excluded by title by the first author was reviewed by the remaining authors. In case of discrepancy, the study was not excluded.
- Among the studies not excluded by title, the first author selected a subgroup of 10% of the studies and assigned half (5% of the studies) to each of the remaining authors. In the case of any discrepancy, the study was not excluded.
- Among the studies not excluded by title or abstract, the first author selected a subgroup with 10% of the studies and half (5% of the studies) were assigned to each of the remaining authors. If a disagreement arose among them, a discussion was held until agreement was reached.

To define the data extraction model, the first author read a randomly selected set of primary studies. This set of studies was used to construct an initial data extraction form, based on the previously defined research questions, and to conduct a pilot data extraction. Following the pilot data extraction process, some fields were added to the form to capture relevant outcomes, while others that were unnecessary were removed. To reduce data extraction bias, a series of iterations were carried out and meetings were scheduled with the other authors to agree on the final data extraction model.

During the categorization process, the first author created the categories and performed the classification of the terms extracted during data extraction. This task can also lead to biases. In order to reduce this threat, the second and third authors evaluated the extracted data and the generalization process performed. Nevertheless, since this step involves human judgment, the threat cannot be fully eliminated [8].

In order for other researchers to be able to perform an SMS like ours and draw the same conclusions, a detailed description of the data extraction and classification has been made. The traceability between the extracted data and the conclusions has been reinforced by generating tables and graphics directly from the data. In our opinion, slight differences based on publication selection bias and misclassification would not alter the main conclusions drawn in our SMS.

4. Results of the review

This section presents the results of the systematic mapping study carried out according to the research protocol detailed above. The research method yielded 253 primary studies, which are listed alphabetically by author in Appendix A. The identified studies were analyzed to answer the research questions. The remainder of this section is structured by research question.

4.1. RQ1. What are the factors that directly or indirectly affect student enrollment in STEM careers, or specifically in CS careers?

This research question has been divided into 2 sub questions:

4.1.1. SRQ1.1. What factors have been identified and in which studies are they addressed?

The set of primary studies selected come from different fields, due to the multidisciplinary nature of the subject. The terms used to identify each factor in the different fields of study can be diverse, as can the point of view or approach to the study. In this sense, the theoretical framework used in the different studies has strongly influenced the characterization of the factors.

The categorization process consisted of identifying synonyms and hierarchizing the identified terms. Some of the studies analyze the chosen factors without any categorization, while others include a categorization of the analyzed factors (i.e. [13], [14], etc.). The categories used in these studies have been analyzed and an attempt has been made to unify them, using generic terms not associated with a specific theoretical framework. It is worth mentioning that, in most cases, the categories identified in a study correspond to the subject matter of the study and not to generic categories.

Fig. 3 is based mainly on the non-empirical studies that analyze, even partially, the state of the art. In this categorization, no distinction has been made among the factors, although there are studies that distinguish among factors with a direct or indirect influence, i.e. factors that influence other factors.

The gender of the subjects was identified in 98.8% of the studies analyzed. Some of the studies adopt a binary perspective of *male* or *female*, but in a few recent studies a wider categorization is used (including *transgender*, *cisgender*, *gender-queer* and others).

On the other hand, there are approximately 50% of the articles (126 of the 253) that deal with the topic studied from the point of view of the *gender gap*.

Fig. 4 shows which and how many studies analyze each of the identified factors. Note that the same study may appear more than once, if more than one factor is analyzed.

In order to identify the studies, the coding indicated in the detailed list in Appendix A has been used.

Table 7 shows how many of the analyzed studies analyze each factor, and the percentage each represents out of the total number of studies. The table presents the information for the entire set of studies (253 studies) by the subset of studies that analyze only STEM degrees (215 studies), and by the subset of studies that analyze only CS degrees (38 studies). For each group, we show how many of the studies do and do not adopt a gender gap perspective and the percentage they represent in that group.

The values reflected in Table 7 are the direct result of the classification. When a study does not specify sub-factors, it is counted as belonging to the corresponding generic factor. For example, if a study analyzes the Educational Experiences factor without specifying whether they are formal or informal, it is counted as factor 1.1. In no case have the values associated with explicit sub-factors been computed in their generic factor. It should be noted that the same study may have been counted more than once, by analyzing more than one factor.

Table 7 shows that there are some factors that are rarely reflected in the studies, especially among those using the gender gap perspective. In this sense, we can single out three factors: those that analyze the impact of social media (factor 2.5), the preference of academic activities (factor 3.1.2.4), and academic engagement in STEM subjects (factor 3.2.4). Among the most analyzed factors, factor 3.1.2.1, related to the student's confidence within the field of knowledge, stands out.

On the other hand, a paired-sample analysis of the difference between the percentages of studies that analyze the gender gap (126 studies) and those that do not (127 studies) has been carried out. Fig. 5 shows a box plot identifying values outside the interquartile range set at 1.5 over the matched samples. An outlier related to the incidence of informal educational experiences is observed (factor 1.1.2). This is one of the most analyzed factors (27 studies) when the gender gap is not taken in account, and one of the least studied when the gender gap perspective is applied.

Table 7
Number of studies by factor.

Factor	First year publication	All studies						STEM studies						CS studies					
		253		126		127		215		102		113		38		24		14	
		Num. studies	%	gender gap POV	%	non gender gap POV	%	Num. studies	%	gender gap POV	%	non gender gap POV	%	Num. studies	%	gender gap POV	%	non gender gap POV	%
1.1	2008	22	8.7	14	11.1	8	6.3	14	6.5	8	7.8	6	5.3	8	21.1	6	25.0	2	14.3
1.1.1	2008	36	14.2	13	10.3	23	18.1	32	14.9	11	10.8	21	18.6	4	10.5	2	8.3	2	14.3
1.1.2	2007	34	13.4	7	5.6	27	21.3	31	14.4	4	3.9	27	23.9	3	7.9	3	12.5	0	0.0
1.2	2005	14	5.5	9	7.1	5	3.9	12	5.6	7	6.9	5	4.4	2	5.3	2	8.3	0	0.0
1.3	2004	20	7.9	10	7.9	10	7.9	12	5.6	4	3.9	8	7.1	8	21.1	6	25.0	2	14.3
1.4	2000	19	7.5	9	7.1	10	7.9	14	6.5	5	4.9	9	8.0	5	13.2	4	16.7	1	7.1
1.5	1999	71	28.1	30	23.8	41	32.3	68	31.6	28	27.5	40	35.4	3	7.9	2	8.3	1	7.1
1.6	1999	34	13.4	23	18.3	11	8.7	27	12.6	18	17.6	9	8.0	7	18.4	5	20.8	2	14.3
2	2005	23	9.1	11	8.7	12	9.4	13	6.0	5	4.9	8	7.1	10	26.3	6	25.0	4	28.6
2.1	1991	79	31.2	38	30.2	41	32.3	66	30.7	28	27.5	38	33.6	13	34.2	10	41.7	3	21.4
2.2	2000	40	15.8	19	15.1	21	16.5	31	14.4	12	11.8	19	16.8	9	23.7	7	29.2	2	14.3
2.3	1991	40	15.8	25	19.8	15	11.8	33	15.3	19	18.6	14	12.4	7	18.4	6	25.0	1	7.1
2.4	2010	15	5.9	12	9.5	3	2.4	12	5.6	10	9.8	2	1.8	3	7.9	2	8.3	1	7.1
2.5	2013	3	1.2	1	0.8	2	1.6	2	0.9	0	0.0	2	1.8	1	2.6	1	4.2	0	0.0
3.1.1	1999	63	24.9	35	27.8	28	22.0	55	25.6	31	30.4	24	21.2	8	21.1	4	16.7	4	28.6
3.1.1.1	1992	28	11.1	19	15.1	9	7.1	25	11.6	17	16.7	8	7.1	3	7.9	2	8.3	1	7.1
3.1.1.2	1991	44	17.4	25	19.8	19	15.0	29	13.5	15	14.7	14	12.4	15	39.5	10	41.7	5	35.7
3.1.2	1999	27	10.7	8	6.3	19	15.0	24	11.2	7	6.9	17	15.0	3	7.9	1	4.2	2	14.3
3.1.2.1	1985	103	40.7	57	45.2	46	36.2	92	42.8	48	47.1	44	38.9	11	28.9	9	37.5	2	14.3
3.1.2.2	1991	84	33.2	44	34.9	40	31.5	70	32.6	36	35.3	34	30.1	14	36.8	8	33.3	6	42.9
3.1.2.3	1985	31	12.3	19	15.1	12	9.4	29	13.5	18	17.6	11	9.7	2	5.3	1	4.2	1	7.1
3.1.2.4	2018	4	1.6	1	0.8	3	2.4	4	1.9	1	1.0	3	2.7	0	0.0	0	0.0	0	0.0
3.1.2.5	1992	17	6.7	12	9.5	5	3.9	12	5.6	7	6.9	5	4.4	5	13.2	5	20.8	0	0.0
3.1.2.6	2005	33	13.0	20	15.9	13	10.2	31	14.4	18	17.6	13	11.5	2	5.3	2	8.3	0	0.0
3.1.3	2001	9	3.6	3	2.4	6	4.7	7	3.3	2	2.0	5	4.4	2	5.3	1	4.2	1	7.1
3.1.4	2008	7	2.8	4	3.2	3	2.4	5	2.3	2	2.0	3	2.7	2	5.3	2	8.3	0	0.0
3.2.1	1985	8	3.2	3	2.4	5	3.9	8	3.7	3	2.9	5	4.4	0	0.0	0	0.0	0	0.0
3.2.2	1999	60	23.7	30	23.8	30	23.6	59	27.4	29	28.4	30	26.5	1	2.6	1	4.2	0	0.0
3.2.3	2004	13	5.1	5	4.0	8	6.3	11	5.1	4	3.9	7	6.2	2	5.3	1	4.2	1	7.1
3.2.4	2012	4	1.6	1	0.8	3	2.4	4	1.9	1	1.0	3	2.7	0	0.0	0	0.0	0	0.0
3.3	1985	5	2.0	4	3.2	1	0.8	5	2.3	4	3.9	1	0.9	0	0.0	0	0.0	0	0.0

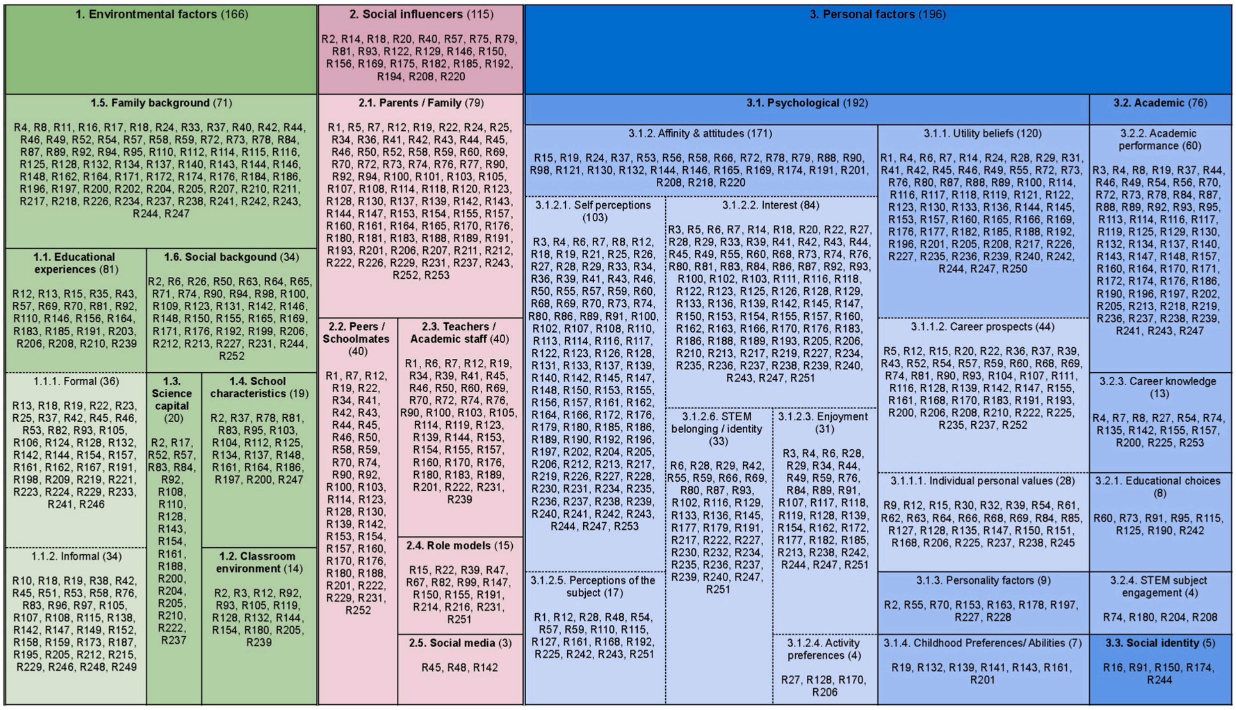

Fig. 4. Treemap: Studies by factor.

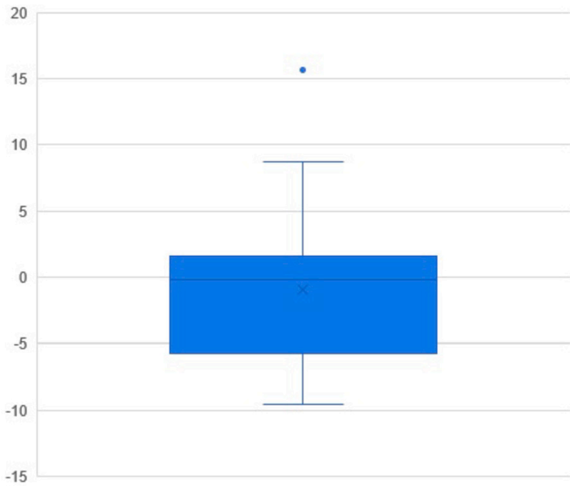

Fig. 5. Box Plot Studies with the non-gender gap POV vs. gender gap POV.

Fig. 6 shows a graph that quantifies the studies that deal with the factors of all factor subcategories (level 2). In this case, all studies that deal more precisely with factors (level 3 and 4) have been counted in the corresponding level 2 factor. Those that analyze in terms of the gender gap have also been indicated.

It can be seen that among the most studied groups of factors, psychological factors stand out (factor 3.1), followed by educational experiences (factor 1.1), family background (factor 1.5), the influence of parents and relatives (factor 2.1) and finally, academic aspects (factor 3.2). Among the least studied were the impact of social media (factor 2.5) and social identity (factor 3.3).

4.1.2. SRQ1.2. What factors have been specifically identified for CS?

Of the 253 studies analyzed, 38 deal specifically with the CS degree. Among those dealing with STEM degrees, some articles specifically analyze subsets of STEM degrees, such as mathematically-intensive STEM careers, engineering degrees, STEM degrees with a low proportion of women, differences in motivational factors among different STEM degrees, etc.

As can be seen in Table 7, the analysis of the factors studied for CS degrees (38 studies) shows significant differences with respect to the factors analyzed for STEM degrees (215 studies).

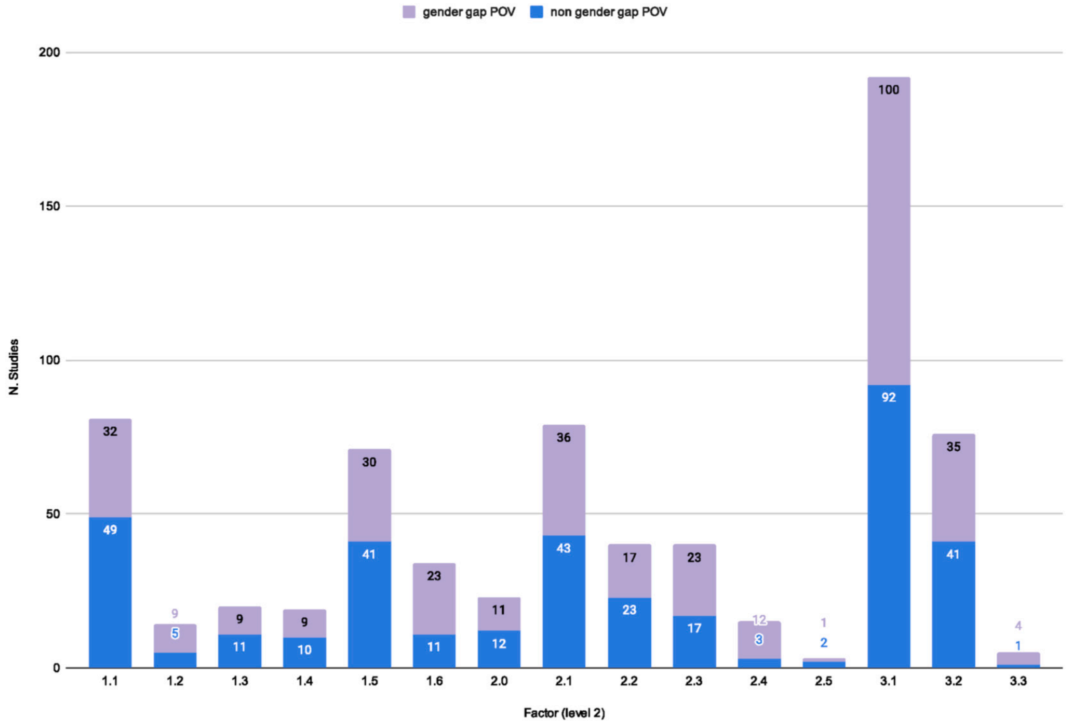

Fig. 6. Number of studies per factor (level 2).

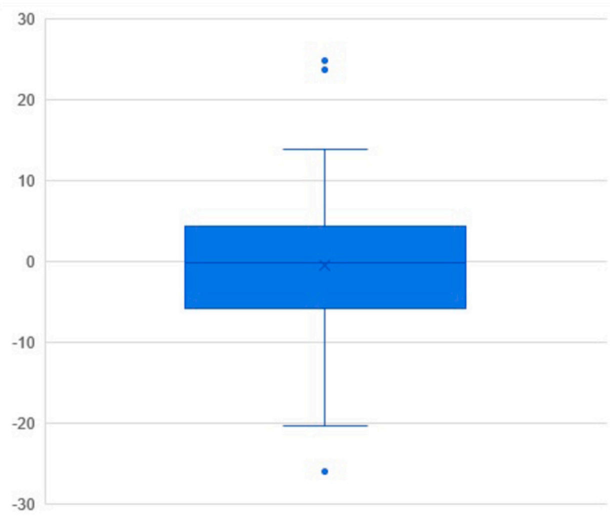

Fig. 7. Box Plot of STEM vs. CS Studies.

Approximately 63% of the studies analyze the gender gap in CS degree programs (24 of the 38). In the case of STEM studies, this figure is approximately 47% (102 out of 215). Table 7 also shows which factors are analyzed from this perspective.

Here we have also performed a paired-sample analysis of the difference between the percentages of studies analyzing STEM degrees generically (215 studies) and those analyzing CS degrees (38 studies). Fig. 7 shows a box plot identifying values outside the interquartile range set at 1.5 over the paired samples. There are 3 outliers related to family background (factor 1.5), academic performance (factor 3.2.2) and career prospects (factor 3.1.1.2). In the first 2 cases, these factors have been studied significantly more often for STEM degrees than for CS degrees. In the third case, the situation is just the opposite: this factor has been studied significantly more often for CS degrees than for STEM degrees. In fact, this is the most commonly analyzed factor among the studies dealing with Computer Science degrees. In the case of STEM degrees, as noted above, the most commonly studied factor is that related to the student's self-confidence.

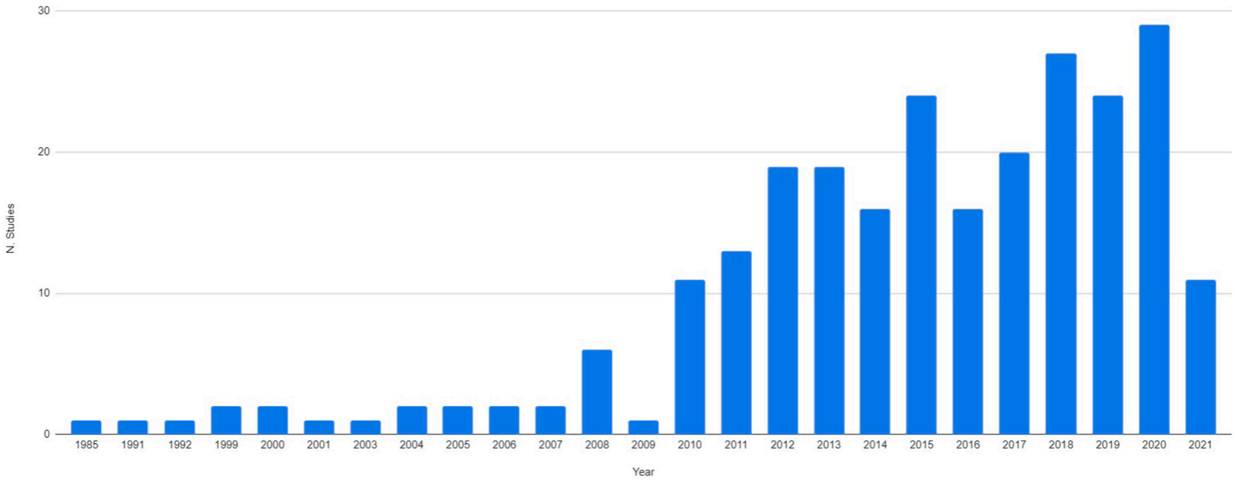

Fig. 8. Number of studies per year.

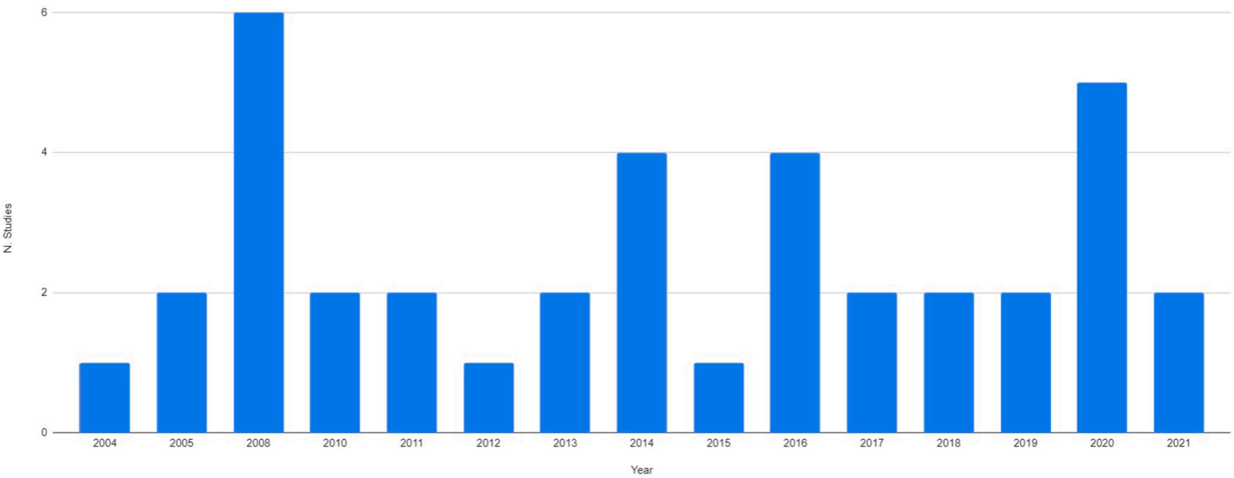

Fig. 9. CS: Number of studies per year.

4.2. RQ2. How have these changed over time?

This research question has been divided into 2 sub questions:

4.2.1. SRQ2.1. How has interest in the subject evolved over time?

The resulting set of studies were published between 1985 and 2021. Fig. 8 shows a graphic where we can see that, from 2008 to 2021, there was an increase of interest in factors that motivate the choice of a STEM degree.

Fig. 9 shows a graph that specifically considers studies that analyze factors that have influence on the choice of a CS degree. The figure shows that studies in the field have been published on a regular basis, starting in 2004.

4.2.2. SQR2.2. What is the temporal relationship between identified factors and the year of publication of the studies?

Fig. 10 shows a graph with a detailed view of the evolution of the first level factors: Environmental factors (factor 1), Social influencers (factor 2) and Personal factors (factor 3).

On the other hand, Table 7 shows the beginning of the interest in each of the factors. We analyzed each factor separately, in order to pinpoint the most recent factors to emerge in each category. In the Environmental factors category, the most recent factor was factor 1.1 (Educational experiences). In the Social influencers category, it was factor 2.5 (Social media). Finally, in the Personal factors category, we observed the emergence of factor 3.2.4 (STEM subject engagement) in 2012, followed by factor 3.1.2.4 (Activity preferences) in 2018.

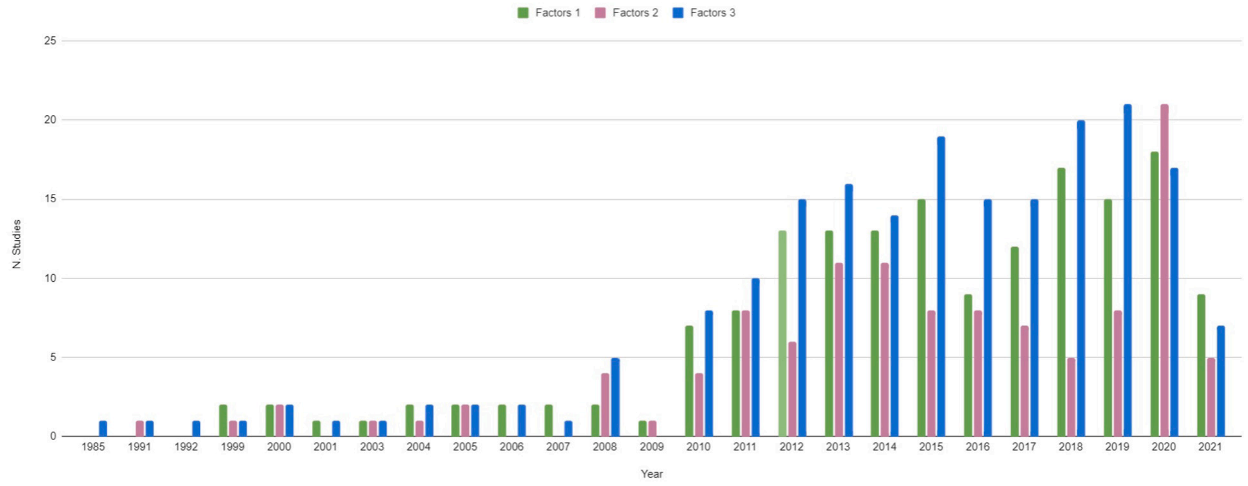

Fig. 10. Number of studies per year and factor.

Table 8
Type of research.

	Empirical	Empirical-Intervention	
Longitudinal	51	22	73
Non-longitudinal	147	11	158
Quantitative	152	20	172
Qualitative	37	5	42
Quantitative & Qualitative	9	8	17

Table 9
Educational Levels.

Level	Code	Description
Primary School	P	< 10 years old
Secondary middle school	S	11 - 13 years of age
High School	H	14 - 17 years of age
Undergraduate	U	
Adults	A	

4.3. RQ3. What research methods are used to conduct the study? What are the most frequently applied research methods, and in what study context?

Among the 253 studies that were analyzed, 231 are empirical studies and 22 are compilations of literature. Of the 231 empirical studies, there are 33 that analyze the effect of interventions in relation to one of the studied factors. Table 8 shows how many of the studies are longitudinal/non-longitudinal and how many are quantitative/qualitative.

It should be noted that in studies in which an intervention is carried out, the analysis is generally by means of pre-post or even follow-up questionnaires. Pre-post questionnaires conduct an evaluation before and after the intervention to find out whether the expected changes occurred in the participants. Follow-up questionnaires ask participants directly about the effects of the intervention.

For empirical studies, the ages of the samples have been analyzed. Table 9 shows the classification made according to the most common educational systems. The Adults category can refer to graduates, doctors or doctoral students, professionals in the sector or generically adults of various professions. In the case of longitudinal studies, the age group of the first wave has been recorded.

Table 10 shows the number of empirical studies that have been conducted for each age group. Some studies analyze different age groups; in these cases, the youngest age group has been indicated and a mark (+) has been added.

Finally, the sample sizes used in the empirical studies have also been analyzed and are shown in Table 11. Of the 231 empirical studies, 42 have a sample size of between 1000 and 2500 individuals.

4.4. RQ4. What countries have been studied?

Of all the analyzed studies, 16 do not make any reference to the country in which the study was conducted. On the other hand, there are 15 studies that analyze the same factors in several countries. In most of these cases, the number of countries studied and compared is two or three. In these cases, the study has been accounted for in each of the analyzed countries.

Table 10
Sample Educational Level.

Level	N. Studies
P	8
P+	2
S	50
S+	7
H	81
H+	3
U	65
U+	8
A	7

+: and others

Table 11
Sample Sizes.

Sample size	N. Studies
> 100000	6
> 10000	7
> 5000	18
> 2500	19
> 1000	42
> 500	25
> 400	16
> 300	15
> 200	13
> 100	25
> 50	14
> 0	29
unknown	2

Table 12
Countries studied. Top 15.

Country	N. Studies
USA	121
United Kingdom	16
Germany	11
Spain	11
Australia	7
Canada	7
Israel	5
Greece	4
Malaysia	4
China	3
Finland	3
Korea	3
South Africa	3
Switzerland	3
Thailand	3

Ten studies have been found in which larger sets of countries are studied, for example OECD countries, European countries or Latin American countries. It should also be noted that there are four studies that perform a supranational analysis, using global data.

Table 12 shows the total number of studies that have analyzed the 15 most studied countries. In first place is the USA, with 121 studies, although it should be noted that the samples are not usually distributed throughout the country, but rather they are localized in smaller areas, usually within a single state. In second place, and at a considerable distance, is the UK with 16 studies. In this case, it should be clarified that this group includes studies indicating that the sample was explicitly from Scotland or England.

Countries that are only included in one or two studies have been omitted from Table 12. The countries included in only two studies are: Estonia, Italy, Mexico, Norway, Pakistan, Russia, Serbia, the Netherlands, Turkey and UAE (the United Arab Emirates). The countries included in a single study are the following: Belgium, Brazil, Colombia, Costa Rica, Denmark, Ecuador, Indonesia, Japan, Kuwait, Philippines, Portugal, Qatar, Slovenia and Taiwan.

The countries identified are shown in Fig. 11.

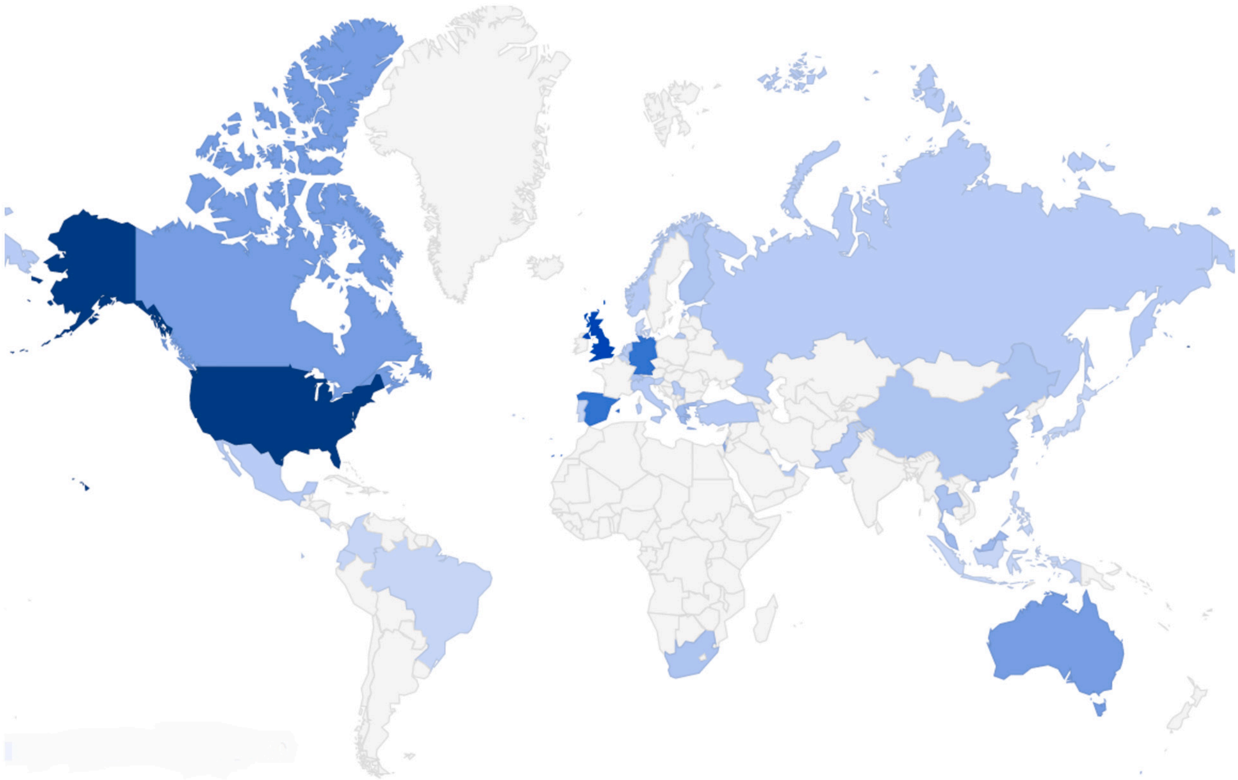

Fig. 11. Countries studied.

Table 13
Frameworks used.

Framework	N. Studies
Expectancy-Value Theory [15]	40
Social Cognitive Career Theory [16]	37
Social Cognitive Theory [17]	6
Self-Determination-Theory [18]	6
Goal-Congruity Theory [19]	5
Theory of Reasoned Action (TRA) [20] or in particular the Theory of Planned Behavior (TPB) [21]	4
Dimensional Comparison Theory [22]	3
Theory of Career Choice and Development [23]	3
Theory of Vocational Interest [24]	3
Role-Congruity Theory [25]	2

4.5. RQ5. What are the main frameworks adopted in the studies?

Of the total of 231 empirical studies, 127 studies indicate the theories that they have used as frameworks for their analyses. The main frameworks used can be found in Table 13. Frameworks that have only been used in one of the analyzed studies have not been included on the list.

Table 13 shows that the two most commonly used frameworks in these studies are Expectancy-Value Theory and Social Cognitive Career Theory.

5. Discussion and conclusion

The aim of this systematic mapping study (SMS) is to understand the lines of research in which work is being done in relation to the factors that motivate students to choose STEM or, more specifically, Computer Science (CS) degrees. The need for STEM graduates worldwide makes it necessary to clarify the causes of the insufficient number of students in these degree programs, especially in the case of women. This study fills the clear gap in the systematic mappings, with the aim of exploring and structuring the motivations for choosing a STEM degree. It also provides a taxonomy (as far as we know, the first) that structures the research literature and includes recommendations for future research.

In the set of selected studies, we omitted those that analyze student motivations in a generic fashion. Only those analyzing the factors for choosing a STEM degree or CS related degree were selected.

In the search process, some studies were selected that describe interventions aimed at increasing the number of students in STEM or CS related degrees. Among these, those that did not analyze the impact of the intervention on student interest in a STEM or CS degree were not considered.

The analysis of the 253 selected studies allowed us to identify and classify the factors related to the choice of STEM or CS degrees (Fig. 3). The selected studies come from diverse disciplines and therefore may have different perspectives. The interest in this topic has increased over the last decade, during which time 81% of the selected studies were published.

The collected studies provide partial analysis of the students' motivations for choosing a STEM or Computer Science-related degree, typically based on social theories related to the individual's interests or identity. As shown in Fig. 4, the most commonly studied factors are those in the Personal Factors category (factor 3). Of the 253 studies selected, 196 focus on these factors and 192 specifically analyze psychological factors. There is a direct relationship between interest in these factors and the most commonly used theoretical frameworks, such as the Expectancy-Value Theory (EVT) and the Social Cognitive Career Theory (SCCT). These frameworks connect the choice of a degree with the student's affinity and attitudes and their utility beliefs. Affinity and attitudes, along with utility beliefs, are by far the most frequently studied factors within the Psychological factors category. The use of well-established theoretical models, such as EVT and SCCT, helps to guide and clarify the research but, in some cases, antecedents may be left out that are related to the students' motivations. Despite the effort made in this SMS to gather the main motivational factors, there is a need for further exploration of more complex models of mediation or moderation among factors.

These theoretical models have also made it possible to analyze the motivational factor related to the good career prospects that are offered by the STEM field. In the case of Computer Science degrees, the most frequently studied factor is career prospects (factor 3.1.1.2). The possibility of obtaining quality employment in a field is one of the main reasons why students decide to choose a specific university degree [26,27]. There is a surprising discrepancy between the importance of this motivational factor and the insufficient demand in STEM degrees. Further research on this topic could help address this issue and encourage more students to pursue STEM careers.

There has been a recent effort to increase the representation of women in science and technology fields, where they have been historically underrepresented. This gender-based disparity has been analyzed in 123 articles out of a total of 253. The number of studies focusing on Computer Science degrees is even larger, with 63.2% examining the gender gap. This is likely due to ongoing concerns about the underrepresentation of women in this field. While this study focused on motivational factors for enrollment, it is possible that some studies examining barriers to degree choice may have been left out. Despite this, we believe that factors related to stereotypes and other cultural barriers have been reasonably well represented in this study.

The sociocultural environment has a significant impact on the outcome of the studies, in both studies that analyze minorities within the same country and those that analyze differences between countries with different cultural backgrounds. This impact is particularly noticeable for women, who face negative consequences from gender stereotypes. Our analysis reveals a lack of research on this topic in less industrialized countries. The final set of studies included in the SMS mainly analyzes developed and OECD countries. Out of the 237 studies that specified a country, only 11.8% focused on non-OECD countries, and 92.8% of the studies examining OECD countries were from Europe or North America. To address this imbalance, it would be advantageous for future research to concentrate on the situation in underdeveloped countries, especially as it relates to women, since STEM fields are key drivers of economic growth.

The continuous evolution of culture and technology has had a strong impact on student career decision-making. There is a growing need for research in two key areas: the impact of social media on student motivation and the significance of social identity (such as gender, group importance, emotional ties, etc.) in terms of motivation, both of which have become highly relevant in recent years. Notably, the impact of social media on student choice of a STEM degree is the least studied factor (factor 2.5). The first study that analyzes this factor is from 2013 and coincides with the rise of platforms such as Facebook, Instagram, Youtube and TikTok.

Additionally, the availability of informal educational activities for students has increased significantly in recent years and is being used as a means to close the gender gap. Further research is required to determine the impact of these activities on motivation, particularly among women who have been underrepresented in studies of the impact of informal educational experiences (factor 1.1.2). Our findings reveal a marked difference in the analysis of the incidence of these experiences, which have been well studied among men, but remain understudied among women.

This paper has presented a systematic mapping study of published studies on these factors, that directly or indirectly impact student decisions to pursue a university career in Computer Science, or more generically, in the STEM field. The study aims to provide a comprehensive overview of the current state of the art of the topic and taxonomically categorize the primary studies. To this end, we followed a systematic review protocol that allowed us to identify 253 studies. The analysis resulted in the identification of 27 motivational factors affecting student choices of STEM degrees, which were classified into four levels of categories. The analysis was thorough, based on coding and data extraction in order to answer the research questions.

The study endeavors to place future research in context, given the extensive existing body of literature, by highlighting the gaps and future challenges in this rapidly growing area of research. It also provides an up-to-date understanding of the current state of the art to inform policy makers and positively impact the promotion of STEM careers.

The study highlights the need for further research to better understand the factors that influence student decisions to pursue careers in the STEM field, particularly in Computer Science. Future work could analyze the significance of each factor in a particular population, as well as to establish the relationships among these factors. By analyzing a comprehensive list of motivational factors, policy makers can gain insights into what drives student choices and make informed decisions aimed at promoting STEM careers.

In view of the importance of sociocultural background, it would be interesting to explore motivational factors in understudied populations, such as those of less industrialized countries. And we also believe that in today's changing world, over time some factors may become relevant, while others may lose their relevance. For this reason, we would find it interesting for the empirical studies, such as the ones analyzed, to be repeated over time in order to identify changes in the importance of the students' motivational factors. The analysis we conducted has led us to conclude that future approaches might consider analyzing perceived employability in relation to the apparent discrepancy between the importance of the motivating factor related to the good career prospects offered by the CS field, or the STEM field in general, and the insufficient demand for these degrees. In none of the studies is perceived employability analyzed in relation to the motivating factor of good career prospects (factor 3.1.1.2).

It is crucial to promote STEM fields as a means of driving economic growth, but it is equally important to understand the motivations behind student decisions to pursue careers in STEM in order to take action. The present study may be useful for researchers, educators and policy makers in their efforts to promote STEM education. We suggest that practitioners use this study as a guide to the various motivational factors that have been identified in previous research, which they can then use to conduct their own research and compare their findings to those of other studies. The article can serve as a useful resource for identifying areas where further research is needed and for making informed decisions and planning interventions in the area of STEM promotion.

CRediT authorship contribution statement

All authors listed have significantly contributed to the development and the writing of this article.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

Appendix A

A.1. Coded papers reference list

Id	Reference
R1.	Abbasi M. N. & Sarwat N. Factors inducing career choice: Comparative study of five leading professions in Pakistan. Pakistan Journal of Commerce and Social Sciences (PJCSS) 8 830–845. issn: 2309-8619 (3 2014).
R2.	Adya M. & Kaiser K. M. Early determinants of women in the IT workforce: A model of girls' career choices. Information Technology and People 18 230–259. issn: 09593845 (3 2005).
R3.	Aeschlimann B. Herzog W. & Makarova E. How to foster students' motivation in mathematics and science classes and promote students' STEM career choice. A study in Swiss high schools. International Journal of Educational Research 79 31–41. issn: 08830355 (2016).
R4.	Ahmed W. & Mudrey R. The role of motivational factors in predicting STEM career aspirations. International Journal of School and Educational Psychology 7 201–214 (3 2019).
R5.	Ainane S. Bouabid A. & Sokkary W. E. Factors that influence the high percentage of women enrolled in engineering in the UAE and preparing for careers in the oil and gas industry. Global Journal of Engineering Education 21 62–68. issn: 13283154 (1 2019).
R6.	Alam M. S. Sajid S. Kok J. K. Rahman M. & Amin A. Factors that influence high school female Students' intentions to pursue science technology engineering and mathematics (STEM) education in Malaysia. Pertanika Journal of Social Sciences and Humanities 29 839–867 (2 June 2021).
R7.	Alexander P. M. et al. Factors Affecting Career Choice: Comparison Between Students from Computer and Other Disciplines. Journal of Science Education and Technology 20 300–315. issn: 10590145 (3 June 2011).
R8.	Alhaddab T. A. & Alnatheer S. A. Future scientists: How women's and minorities' math self-efficacy and science perception affect their STEM major selection. ISEC 2015 - 5th IEEE Integrated STEM Education Conference 58–63 (June 2015).
R9.	Allen J. M. Muragishi G. A. Smith J. L. Thoman D. B. & Brown E. R. To Grab and To Hold: Cultivating communal goals to overcome cultural and structural barriers in first generation college students' science interest HHS Public Access. Trans Issues Psychol Sci 1 331–341 (4 2015).
R10.	Allen P. J. et al. From quality to outcomes: a national study of after school STEM programming. INTERNATIONAL JOURNAL OF STEM EDUCATION 6. issn: 2196-7822 (1 Nov. 2019).
R11.	Alonso-Virgos L. Fondon M. D. Espada J. P. & Crespo R. G. Women in science and technology studies. A study about the influence of parents on their children's choice of speciality. And about the trend of the different specialities in Spanish students. IEEE Global Engineering Education Conference EDUCON 2021-April 122–130. issn: 21659567 (Apr. 2021).
R12.	Alshahrani A. et al. Using Social Cognitive Career Theory to Under stand Why Students Choose to Study Computer Science in ICER 2018 - Proceedings of the 2018 ACM Conference on International Computing Education Research 18 (2018) 205–214. isbn: 9781450356282.
R13.	Anderson J. & Baltes J. Robotics and AI as a motivator for the at traction and retention of computer science undergraduates in Canada in. SS-08-08 (2008) 2–7. isbn: 9781577353645.
R14.	Anderson N. Lankshear C. Timms C. & Courtney L. 'Because it's boring irrelevant and I don't like computers': Why high school girls avoid professionally-oriented ICT subjects. Computers & Education 50 1304–1318 (2008).
R15.	Archer G. et al. Understanding similarities and differences in students across first-year computing majors in. 2016-November (2016).

(*continued on next page*)

(*continued*)

Id	Reference
R16.	Archer L. Dewitt J. & Willis B. Adolescent boys' science aspirations: Masculinity capital and power. Journal of Research in Science Teaching 51 1–30. issn: 1098-2736 (1 Jan. 2014).
R17.	Archer L. et al. Science Aspirations Capital and Family Habitus: How families shape children's engagement and identification with Science. American Educational Research Journal 49 881–908 (5 2012).
R18.	Aschbacher P. R. Li E. & Roth E. J. Is science me? High school students' identities participation and aspirations in science engineering and medicine. Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching 47 564–582 (5 2010).
R19.	Aschbacher P. R. Ing M. & Tsai S. M. Is Science Me? Exploring Middle School Students' STE-M Career Aspirations. Journal of Science Education and Technology 23 735–743. issn: 15731839 (6 Nov. 2014).
R20.	Babin R. Grant K. A. & Sawal L. Identifying Influencers in High School Student ICT Career Choice. Information Systems Education Journal 8. issn: 1542-7382 (26 2010).
R21.	Backer P. R. & Halualani R. T. Impact of self-efficacy on interest and choice in engineering study and careers for undergraduate women engineering students in (2012).
R22.	El-Bahey R. & Zeid A. Women in computing: A case study about Kuwait in (2013) 1871–1877.
R23.	Ball C. Huang K.-T. Cotten S. R. & Rikard R. V. Pressurizing the STEM Pipeline: an Expectancy-Value Theory Analysis of Youths' STEM Attitudes. JOURNAL OF SCIENCE EDUCATION AND TECHNOLOGY 26 372–382. issn: 1059-0145 (4 2017).
R24.	Bannikova L. N. et al. Attraction and Retention of Women in Engineering in (ed Shaposhnikov S.) (IEEE 2018) 824–827. isbn: 978-1-5386-6757-6.
R25.	Barnes D. L. Johnson O. & Jr. O. J. The influence parent socialization and school environment has on african-American adolescent males' mathematics self-efficacy and engineering career trajectory in. 2018- Octob (IEEE 2019). isbn: 978-1-5386-1174-6.
R26.	Barth J. M. Kim H. Eno C. A. & Guadagno R. E. Matching Abilities to Careers for Others and Self: Do Gender Stereotypes Matter to Students in Advanced Math and Science Classes? SEX ROLES 79 83–97. issn: 0360-0025 (1-2 July 2018).
R27.	Blotnicky K. A. Franz-Odendaal T. French F. & Joy P. A study of the correlation between STEM career knowledge mathematics self efficacy career interests and career activities on the likelihood of pursuing a STEM career among middle school students. INTERNATIONAL JOURNAL OF STEM EDUCATION 5. issn: 2196-7822 (May 2018).
R28.	Bøe M. V. Science choices in Norwegian upper secondary school: What matters? Science Education 96 1–20. issn: 1098-237X (1 Jan. 2012).
R29.	Bøe M. V. Henriksen E. K. Lyons T. & Schreiner C. Participation in science and technology: young people's achievement-related choices in late-modern societies. Studies in Science Education 47 37–72. issn: 03057267 (1 Mar. 2011).
R30.	Boucher K. L. Fuesting M. A. Diekman A. B. & Murphy M. C. Can I work with and help others in this field? How communal goals influence interest and participation in STEM fields. Frontiers in psychology 8 901 (2017).
R31.	Brinkman B. & Diekman A. Applying the communal goal congruity perspective to enhance diversity and inclusion in undergraduate computing degrees in (2016) 102–107. isbn: 9781450338561.
R32.	Brown E. R. Thoman D. B. Smith J. L. & Diekman A. B. Closing the communal gap: The importance of communal affordances in science career motivation. Journal of Applied Social Psychology 45 662–673. issn: 00219029 (12 2015).
R33.	Buccheri G. Gürber N. A. & Brühwiler C. The Impact of Gender on Interest in Science Topics and the Choice of Scientific and Technical Vocations. International Journal of Science Education 33 159–178. issn: 14645289 (1 2011).
R34.	Buday S. K. Stake J. E. & Peterson Z. D. Gender and the Choice of a Science Career: The Impact of Social Support and Possible Selves. Sex Roles 66 197–209. issn: 03600025 (3-4 Feb. 2012).
R35.	Bush J. B. Gilmore M. R. & Miller S. B. Drag and drop programming experiences and equity: Analysis of a large scale middle school student motivation survey in (2020) 664–670.
R36.	Cabrera A. S. & Quesada R. A. Motivations of the female population in the election of the computer science career: Universidad Nacional de Costa Rica [Motivaciones de la población femenina en la elección de la carrera de informática: universidad nacional de costa rica] in (ed G. G.-H. A. R.) 2709 (CEUR-WS 2020) 71–81.
R37.	Cairns D. & Dickson M. Exploring the Relations of Gender Science Dispositions and Science Achievement on STEM Career Aspirations for Adolescents in Public Schools in the UAE. ASIA-PACIFIC EDUCATION RESEARCHER (2020).
R38.	Campbell T. Kwon H. &. Student Motivation and Interests as Proxies for Forming STEM Identities. Journal of the Korean Association for Science Education 32. Times Cited: 5 0 5 532–540. issn: 1226-5187 (3 2012).
R39.	Canetto S. S. Trott C. D. Thomas J. J. & Wynstra C. A. Making sense of the atmospheric science gender gap: Do female and male graduate students have different career motives goals and challenges? Journal of Geoscience Education 60 408–416. issn: 10899995 (4 2012).
R40.	Carrico C. Murzi H. & Matusovich H. The roles of socializers in career choice decisions for high school students in rural central Appalachia: "Who's doing what?" in. 2016-Novem (Institute of Electrical and Electronics Engineers Inc. 2016). isbn: 9781509017904.
R41.	Casas Y. & Blanco-Blanco A. Testing Social Cognitive Career Theory in Colombian adolescent secondary students: A study in the field of mathematics and science — Evaluación de la teoría cognitivo social del desarrollo de la carrera con estudiantes adolescentes colombianos de educación. Revista Complutense de Educacion 28 1173–1192 (4 2017).
R42.	Caspi A. et al. Ninth-grade students' perceptions of the factors that led them to major in high school science technology engineering and mathematics disciplines. Science Education 103 1176–1205 (5 2019).
R43.	Caspi A. et al. Children's perceptions of the factors that led to their enrolment in advanced middle-school science programmes. INTERNATIONAL JOURNAL OF SCIENCE EDUCATION 42 1915–1939 (11 July 2020).
R44.	Cass C. A. Hazari Z. Cribbs J. Sadler P. M. & Sonnert G. Examining the impact of mathematics identity on the choice of engineering careers for male and female students. Proceedings - Frontiers in Education Conference FIE. issn: 15394565 (2011).
R45.	Cerinsek G. Hribar T. Glodez N. & Dolinsek S. Which are my Future Career Priorities and What Influenced my Choice of Studying Science Technology Engineering or Mathematics? Some Insights on Educational Choice-Case of Slovenia. International Journal of Science Education 35 2999–3025. issn: 09500693 (17 Nov. 2013).
R46.	Chachashvili-Bolotin S. Milner-Bolotin M. & Lissitsa S. Examination of factors predicting secondary students' interest in tertiary STEM education. International Journal of Science Education. issn: 1464-5289 (2016).
R47.	Cheryan S. Drury B. J. & Vichayapai M. Enduring Influence of Stereo typical Computer Science Role Models on Women's Academic Aspira tions. Psychology of Women Quarterly 37 72–79. issn: 03616843 (1 Mar. 2013).
R48.	Cheryan S. Plaut V. C. Handron C. & Hudson L. The Stereotypical Computer Scientist: Gendered Media Representations as a Barrier to Inclusion for Women. Sex Roles 69 58–71. issn: 03600025 (1-2 July 2013).
R49.	Chow A. Eccles J. S. & Salmela-Aro K. Task Value Profiles Across Subjects and Aspirations to Physical and IT-Related Sciences in the United States and Finland. Developmental Psychology 48 1612–1628 (6 2012).

(*continued*)

Id	Reference
R50.	Cordero A. R. Frutos M. B. Cordero A. R. & Frutos M. B. Gender imbalances in STEM2 career choice [Elección de estudios CTIM1 y de sequilibrios de género]. ENSENANZA DE LAS CIENCIAS 33 59–76. issn: 02124521 (3 2015).
R51.	Crawford R. H. et al. Foundations and effectiveness of an after-school engineering program for middle school students in (American Society for Engineering Education 2012). isbn: 9780878232413.
R52.	Dabney K. P. Chakraverty D. & Tai R. H. The Association of Family Influence and Initial Interest in Science. Science Education 97 395–409. issn: 1098-237X (3 May 2013).
R53.	Dabney K. P. et al. Out-of-School Time Science Activities and Their Association with Career Interest in STEM. International Journal of Science Education Part B 2 63–79. issn: 21548463 (1 Mar. 2012).
R54.	Davies P. Mangan J. Hughes A. & Slack K. Labour market motivation and undergraduates' choice of degree subject. British Educational Research Journal 39 361–382. issn: 01411926 (2 2013).
R55.	Degol J. L. Wang M.-T. Zhang Y. & Allerton J. Do Growth Mind sets in Math Benefit Females? Identifying Pathways between Gender Mindset and Motivation. Journal of Youth and Adolescence 47 976–990. issn: 00472891 (5 2018).
R56.	Del Carmen Rodríguez Méndez M. Calvo J. V. P. & Inda M. Self efficacy beliefs and female choices of scientific-technological studies: a theoretical review of their relationship / Creencias de autoeficacia y elección femenina de estudios científico-tecnológicos: una revisión teórica de su relación / La croyance de l'auto-efficacité et des choix des femmes d'études de la recherche scientifique et technologique: un examen théorique de leur relation. Teoría de la Educación 24 81–104 (2012).
R57.	Denner J. O'Connor L. & Werner L. Women in community college: Factors related to intentions to pursue computer science. NASPA Journal About Women in Higher Education 8 156–171 (2 2015).
R58.	DeWitt J. & Archer L. Who Aspires to a Science Career? A comparison of survey responses from primary and secondary school students. Inter national Journal of Science Education 37 2170–2192. issn: 14645289 (13 Sept. 2015).
R59.	Dewitt J. et al. Young Children's Aspirations in Science: The Unequivocal the Uncertain and the Unthinkable. International Journal of Science Education (2013).
R60.	Dick T. P. & Rallis S. F. Factors and Influences on High School Students' Career Choices Article. Journal for Research in Mathematics Education 22 281–292 (4 1991).
R61.	Diekman A. B. Brown E. R. Johnston A. M. & Clark E. K. Seek ing Congruity Between Goals and Roles: A New Look at Why Women Opt Out of Science Technology Engineering and Mathematics Careers. Psychological Science 21 1051–1057. issn: 09567976 (8 2010).
R62.	Diekman A. B. Clark E. K. Johnston A. M. Brown E. R. & Stein berg M. Malleability in communal goals and beliefs influences attraction to STEM careers: Evidence for a goal congruity perspective. Journal of Personality and Social Psychology 101 902–918. issn: 00223514 (5 2011).
R63.	Diekman A. B. Steinberg M. Brown E. R. Belanger A. L. & Clark E. K. A Goal Congruity Model of Role Entry Engagement and Exit: Understanding Communal Goal Processes in STEM Gender Gaps. Personality and Social Psychology Review 21 142–175. issn: 10888683 (2 2017).
R64.	Diekman A. B. Weisgram E. S. & Belanger A. L. New routes to recruiting and retaining women in STEM: Policy implications of a communal goal congruity perspective. Social Issues and Policy Review 9 52–88. issn: 17512395 (1 2015).
R65.	Diekman A. B. & Steinberg M. Navigating Social Roles in Pursuit of Important Goals: A Communal Goal Congruity Account of STEM Pursuits. Social and Personality Psychology Compass 7 487–501. issn: 1751-9004 (7 July 2013).
R66.	Dorph R. Bathgate M. E. Schunn C. D. & Cannady M. A. When I grow up: the relationship of science learning activation to STEM career preferences. INTERNATIONAL JOURNAL OF SCIENCE EDUCATION 40 1034–1057. issn: 0950-0693 (9 2018).
R67.	Drury B. J. Siy J. O. & Cheryan S. When Do Female Role Models Benefit Women? The Importance of Differentiating Recruitment From Retention in STEM. Psychological Inquiry 22 265–269. issn: 1047840X (4 2011).
R68.	Eccles J. S. & Wang M.-T. What motivates females and males to pursue careers in mathematics and science? International Journal of Behavioral Development 40 100–106. issn: 01650254 (2 2016).
R69.	Edzie R. L. Alahmad M. & Ieee. Exploring the Factors that Motivate Female Students to Enroll and Persist in a Collegiate STEM Degree Program in. Times Cited: 0 Gcc 7th IEEE GCC Conference and Exhibition (GCC) Nov 17-20 2013 Doha QATAR Ieee alahmad mahmoud/0000-0002-3417-5592 2473-9383 (2013) 419–424.
R70.	Faitar G. M. & Faitar S. L. Gender Gap and Stem Career Choices in 21st Century American Education in. 106 (Elsevier BV Dec. 2013) 1265–1270.
R71.	Farenga S. J. & Joyce B. A. Intentions of Young Students to Enroll in Science Courses in the Future: An Examination of Gender Differences. Science Education 83 55–75 (1999).
R72.	Farmer H. Wardrop J. & Rotella S. Antecedent factors differentiating women and men in science/nonscience careers. Psychology of Women Quarterly 23 763–780 (4 1999).
R73.	Ferry T. R. Fouad N. A. & Smith P. L. The Role of Family Context in a Social Cognitive Model for Career-Related Choice Behavior: A Math and Science Perspective. Journal of Vocational Behavior 57 348–364 (2000).
R74.	Franz-Odendaal T. A. Blotnicky K. French F. & Joy P. Experiences and Perceptions of STEM Subjects Careers and Engagement in STEM Activities Among Middle School Students in the Maritime Provinces. CANADIAN JOURNAL OF SCIENCE MATHEMATICS AND TECHNOLOGY EDUCATION 16 153–168 (2 2016).
R75.	Garcia-Holgado A. Gonzalez-Gonzalez C. S. & Peixoto A. A Comparative Study on the Support in Engineering Courses: A Case Study in Brazil and Spain. IEEE Access 8 125179–125190. issn: 21693536 (2020).
R76.	Garcia-Holgado A. et al. The experience of women students in engineering and mathematics careers: A focus group study. IEEE Global Engineering Education Conference EDUCON 2021-April 50–56. issn: 21659567 (Apr. 2021).
R77.	García-Pérez O. et al. The influence of perceived family supports and barriers on personal variables in a Spanish sample of secondary school science-technology students. International Journal of Science Education 42 70–88. issn: 09500693 (1 2020).
R78.	Gaspard H. Willie E. Wormington S. V. & Hulleman C. S. How are upper secondary school students' expectancy-value profiles associated with achievement and university STEM major? A cross-domain compar ison. CONTEMPORARY EDUCATIONAL PSYCHOLOGY 58 149–162. issn: 0361-476X (July 2019).
R79.	Giannakos M. Exploring students intentions to study computer science and identifying the differences among ICT and programming based courses. Turkish Online Journal of Educational Technology 13 68–78 (3 2014).
R80.	Godwin A. Potvin G. Hazari Z. & Lock R. Identity Critical Agency and Engineering: An Affective Model for Predicting Engineering as a Career Choice. Journal of Engineering Education 105 312–340. issn: 2168-9830 (2 Apr. 2016).
R81.	Gomez J. Tayebi A. & Delgado C. Factors That Influence Career Choice in Engineering Students in Spain: A Gender Perspective. IEEE Transactions on Education. issn: 15579638 (2021).
R82.	Gonzĺez-Pérez S. et al. Girls in STEM: Is It a Female Role-Model Thing? Frontiers in Psychology 11. issn: 16641078 (Sept. 2020).
R83.	Gorbacheva E. Craig A. Beekhuyzen J. & Coldwell-Neilson J. ICT interventions for girls: Factors influencing ICT career intentions. Aus tralasian Journal of Information Systems 18 289–302 (3 2014).

(*continued on next page*)

(*continued*)

Id	Reference
R84.	Gottfried A. E. et al. Pathways from parental stimulation of children's curiosity to high school science course accomplishments and science career interest and skill. International Journal of Science Education. issn: 1464-5289 (2016).
R85.	Graziano W. G. Habashi M. M. Evangelou D. & Ngambeki I. Orientations and motivations: Are you a "people person" a "thing person" or both? Motivation and Emotion 36 465–477. issn: 01467239 (4 2012).
R86.	Gudel K. Heitzmann A. & Mueller A. Self-efficacy and (vocational) interest in technology and design: an empirical study in seventh and eighth-grade classrooms. INTERNATIONAL JOURNAL OF TECHNOLOGY AND DESIGN EDUCATION 29 1053–1081. issn: 0957- 7572 (5 Nov. 2019).
R87.	Guo J. Wang M.-T. Ketonen E. E. Eccles J. S. & Salmela-Aro K. Joint trajectories of task value in multiple subject domains: From both variable- and pattern-centered perspectives. Contemporary Educational Psychology 55 139–154. issn: 0361476X (2018).
R88.	Guo J. Marsh H. Parker P. Morin A. & Dicke T. Extending expectancy value theory predictions of achievement and aspirations in science: Di mensional comparison processes and expectancy-by-value interactions. Learning and Instruction 49 81–91 (2017).
R89.	Guo J. Marsh H. W. Parker P. D. Morin A. J. & Yeung A. S. Expectancy-value in mathematics gender and socioeconomic background as predictors of achievement and aspirations: A multi-cohort study. Learning and Individual Differences 37 161–168 (2015).
R90.	Habib H. Ateeq M. Umer A. Rehman M. U. & Ieee. Motivational and Influential Factors for Choice of CS Major: A Gender Aware Study in (2014) 84–91. isbn: 978-1-4799-3591-8.
R91.	Hackett G. Role of Mathematics Self-Efficacy in the Choice of Math Related Majors of College Women and Men. A Path Analysis. Journal of Counseling Psychology 32 47–56. issn: 00220167 (1 Jan. 1985).
R92.	Hazari Z. et al. Interest in STEM is contagious for students in biology chemistry and physics classes. Science Advances 3. issn: 23752548 (8 2017).
R93.	Hazari Z. Sonnert G. Sadler P. M. & Shanahan M. C. Connecting high school physics experiences outcome expectations physics identity and physics career choice: A gender study. Journal of Research in Science Teaching 47 978–1003. issn: 1098-2736 (8 Oct. 2010).
R94.	Hoffman H. L. Louis T. S. & Hoffman J. L. Understanding the influ ence of parent engineers on the college major choice of their daughters. Journal of Women and Minorities in Science and Engineering 16 237–256 (3 2010).
R95.	Homer M. Ryder J. & Banner I. Measuring determinants of post compulsory participation in science: a comparative study using national data. British Educational Research Journal 40 610–636. issn: 1469- 3518 (4 Aug. 2014).
R96.	Hughes R. An investigation into the longitudinal identity trajectories of women in science technology engineering and mathematics. Journal of Women and Minorities in Science and Engineering 21 181–213. issn: 10728325 (3 2015).
R97.	Hur J. W. Andrzejewski C. E. & Marghitu D. Girls and computer science: experiences perceptions and career aspirations. Computer Science Education 27 100–120. issn: 08993408 (2 2017).
R98.	Hyun-dong L. Longhurst M. L. Freeman M. K. & Hyundong L. An Exploratory Study of Middle School Students' Motivation in Science: Comparing a STEM Education Program in Korea and the USA. Journal of Science Education 43 1–16. issn: 1225-3944 (1 Apr. 2019).
R99.	Ikkatai Y. et al. Effect of providing gender equality information on students' motivations to choose STEM. PLoS ONE 16 (6 June 2021).
R100.	Inda-Caro M. Rodríguez-Menéndez C. & Peña-Calvo J.-V. Spanish High School Students' Interests in Technology: Applying Social cognitive Career Theory. Journal of Career Development 43 291–307 (4 2016).
R101.	Ing M. Can Parents Influence Children's Mathematics Achievement and Persistence in STEM Careers? Journal of Career Development 41 87–103. issn: 08948453 (2 2014).
R102.	Ito T. A. & McPherson E. Factors Influencing High School Students' Interest in pSTEM. FRONTIERS IN PSYCHOLOGY 9. issn: 1664- 1078 (2018).
R103.	Jawitz J. Case J. & Tshabalala M. Why NOT engineering? The pro cess of career choice amongst South African female students. Why NOT Engineering? The Process of Career Choice amongst South African Fe male Students*. International Journal of Engineering Education 16 470–475 (6 2000).
R104.	Jian H.-L. Sandnes F. Huang Y.-P. & Huang Y.-M. Cultural fac tors influencing Eastern and Western engineering students' choice of university. European Journal of Engineering Education 35 147–160 (2 2010).
R105.	Jones G. Taylor A. & Forrester J. H. Developing a Scientist: A ret rospective look. International Journal of Science Education 33 1653–1673. issn: 14645289 (12 2011).
R106.	Jones L. C. R. McDermott H. J. Tyrer J. R. & Zanker N. P. Fu ture engineers: the intrinsic technology motivation of secondary school pupils. EUROPEAN JOURNAL OF ENGINEERING EDUCATION 43 606–619. issn: 0304-3797 (4 SI 2018).
R107.	Jones M. G. Childers G. Corin E. Chesnutt K. & Andre T. Free choice science learning and STEM career choice. International Journal of Science Education Part B: Communication and Public Engagement 9 29–39. issn: 21548455 (1 2019).
R108.	Jones M. G. Chesnutt K. Ennes M. Mulvey K. L. & Cayton E. Understanding science career aspirations: Factors predicting future science task value. Journal of Research in Science Teaching 58 937–955. issn: 1098-2736 (7 Sept. 2021).
R109.	Kaarst-Brown M. L. Hall H. & Guzman I. R. A Cultural Perspective on Individual Choices of STEM Education and Subsequent Occupations (2010).
R110.	Kang H. et al. How do middle school girls of color develop STEM identities? Middle school girls' participation in science activities and identification with STEM careers. SCIENCE EDUCATION 103 418–439. issn: 0036-8326 (2 Mar. 2019).
R111.	Kori K. Pedaste M. Altin H. Tonisson E. & Palts T. Factors That Influence Students' Motivation to Start and to Continue Study ing Information Technology in Estonia. Ieee Transactions on Education 59. Times Cited: 13 Pedaste Margus/H-3139-2012; Tonisson Eno/ Pedaste Margus/0000-0002-5087-9637; Tonisson Eno/0000-0002-9118- 0937 1 14 23 1557-9638 255–262. issn: 0018-9359 (4 2016).
R112.	Korkmaz H. Factors Influencing Students' Career Chooses in Science and Technology: Implications for High School Science Curricula. Procedia Social and Behavioral Sciences 197 5–07 (2015).
R113.	Koul R. Lerdpornkulrat T. & Poondej C. Gender contentedness in aspirations to become engineers or medical doctors. European Journal of Engineering Education 42 1422–1438. issn: 03043797 (6 2017).
R114.	Koul R. Lerdpornkulrat T. & Chantara S. Relationship Between Career Aspirations and Measures of Motivation Toward Biology and Physics and the Influence of Gender. Journal of Science Education and Technology 20 761–770. issn: 10590145 (6 Dec. 2011).
R115.	Kutnick P. J. Chan Y. Y. & Lee P. Y. Engineering education opportunities perception and career choice of secondary school students in Hong Kong SAR China in (American Society for Engineering Education 2012).
R116.	Lauermann F. Tsai Y.-M. & Eccles J. S. Math-related career aspirations and choices within Eccles et al.'s expectancy-value theory of achievement-related behaviors. Developmental Psychology 53 1540–1559. issn: 00121649 (8 2017).
R117.	Lazarides R. & Lauermann F. Gendered paths into STEM-related and language-related careers: Girls' and boys' motivational beliefs and career plans in math and language arts. Frontiers in Psychology 10. issn: 16641078 (JUN 2019).
R118.	Lazarides R. Rubach C. & Ittel A. Adolescents' perceptions of socializers' beliefs career-related conversations and motivation in mathematics. Developmental Psychology 53 525–539 (3 2017).

(*continued*)

Id	Reference
R119.	Lazarides R. & Watt H. Girls' and boys' perceived mathematics teacher beliefs classroom learning environments and mathematical career intentions. Contemporary Educational Psychology 41 51–61 (2015).
R120.	Lee M. Shin D. D. & Bong M. Boys are Affected by Their Parents More Than Girls are: Parents' Utility Value Socialization in Science. JOURNAL OF YOUTH AND ADOLESCENCE 49 87–101. issn: 0047-2891 (1 SI 2020).
R121.	Lee Y. Capraro M. M. & Viruru R. The Factors Motivating Students' STEM Career Aspirations: Personal and Societal Contexts. Inter national Journal of Innovation in Science and Mathematics Education 26 36–48 (5 2018).
R122.	Lent R. W. Lopez A. M. B. Lopez F. G. & Sheu H.-B. Social cognitive career theory and the prediction of interests and choice goals in the computing disciplines q. Journal of Vocational Behavior 73 52–62 (2008).
R123.	Lent R. W. Lopez F. G. Sheu H.-B. & Lopez A. M. Social cognitive predictors of the interests and choices of computing majors: Applicability to underrepresented students. Journal of vocational Behavior 78 184–192 (2011).
R124.	Lepe M. D. Olmstead W. Russell C. Cazarez L. & Austin L. Using Science Fiction Prototyping to Decrease the Decline of Interest in STEM Topics at the High School Level in (ed Preuveneers D.) 19 (IOS PRESS 2015) 189–196.
R125.	Lichtenberger E. & George-Jackson C. Predicting High School Students' Interest in Majoring in a STEM Field: Insight into High School Students' Postsecondary Plans. Journal of Career and Technical Education 28 19–38 (1 2013).
R126.	Lin L. Lee T. & Snyder L. A. Math self-efficacy and STEM intentions: A person-centered approach. Frontiers in Psychology 9 2033. issn: 16641078 (OCT. 2018).
R127.	Lips H. M. Gender- and science-related attitudes as predictors of college students' academic choices. Journal of Vocational Behavior 40 62–81. issn: 0001-8791 (1 Feb. 1992).
R128.	Luttenberger S. Paechter M. & Ertl B. Self-concept and support experienced in school as key variables for the motivation of women enrolled in STEM subjects with a low and moderate proportion of females. Frontiers in Psychology 10. issn: 16641078 (JUN 2019).
R129.	Mahadeo J. Hazari Z. & Potvin G. Developing a computing identity framework: Understanding computer science and information technology career choice. ACM Transactions on Computing Education 20 7–714 (1 2020).
R130.	Maksimovic J. Z. Osmanovic J. S. & Mamutovic A. S. Perspectives of stem education regarding serbian secondary school students' motivation for career choice. JOURNAL OF BALTIC SCIENCE EDUCATION 19 989–1007. issn: 16483898 (6 2020).
R131.	Maldonado C. et al. More females than males? Deciphering the psychosocial characteristics that attract girls into engineering in Puerto Rico in (American Society for Engineering Education 2007) 1053–1059.
R132.	Maltese A. V. & Tai R. H. Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S. students. Science Education 95 877–907. issn: 1098-237X (5 Sept. 2011).
R133.	Mangu D. M. Lee A. R. Middleton J. A. & Nelson J. K. Motivational factors predicting STEM and engineering career intentions for high school students. Proceedings - Frontiers in Education Conference FIE 2015. issn: 15394565 (Dec. 2015).
R134.	Mann A. Legewie J. & DiPrete T. A. The role of school performance in narrowing gender gaps in the formation of STEM aspirations: A cross national study. Frontiers in Psychology 6 171. issn: 16641078 (FEB 2015).
R135.	Masnick A. Valenti S. Cox B. & Osman C. A multidimensional scaling analysis of students' attitudes about science careers. International Journal of Science Education 32 653–667 (5 2010).
R136.	Matusovich H. M. Streveler R. A. & Miller R. L. Why Do Students Choose Engineering? A Qualitative Longitudinal Investigation of Students' Motivational Values. Journal of Engineering Education 99 289–303. issn: 2168-9830 (4 Oct. 2010).
R137.	Mau W. C. Factors That Influence Persistence in Science and Engineering Career Aspirations. The Career Development Quarterly 51 234–243. issn: 2161-0045 (3 Mar. 2003).
R138.	Mazumder Q. & Aluko O. A pre-engineering program to motivate high school students towards engineering in (American Society for Engineering Education 2010).
R139.	Mishkin H. Wangrowicz N. Dori D. & Dori Y. J. Career Choice of Undergraduate Engineering Students in. 228 (Elsevier July 2016) 222–228.
R140.	Moakler M. W. & Kim M. M. College Major Choice in STEM: Re visiting Confidence and Demographic Factors. The Career Development Quarterly 62 128–142. issn: 2161-0045 (2 June 2014).
R141.	Moe A. Jansen P. & Pietsch S. Childhood preference for spatial toys. Gender differences and relationships with mental rotation in STEM and non-STEM students. Learning and Individual Differences 68 108–115. issn: 1041-6080 (2018).
R142.	Mohtar L. et al. A model of interest in stem careers among secondary school students. Journal of Baltic Science Education 18 404–416 (3 2019).
R143.	Muenks K. Peterson E. G. Green A. E. Kolvoord R. A. & Uttal D. H. Parents' Beliefs about High School Students' Spatial Abilities: Gender Differences and Associations with Parent Encouragement to Pursue a STEM Career and Students' STEM Career Intentions. Sex Roles 82 570–583. issn: 03600025 (9-10 2020).
R144.	Mujtaba T. & Reiss M. J. A SURVEY OF PSYCHOLOGICAL MOTIVATIONAL FAMILY AND PERCEPTIONS OF PHYSICS EDUCATION FACTORS THAT EXPLAIN 15-YEAR-OLD STUDENTS' ASPIRATIONS TO STUDY PHYSICS IN POST-COMPULSORY ENGLISH SCHOOLS. International Journal of Science and Mathematics Education 12 371–393. issn: 1573-1774 (2 Mar. 2014).
R145.	Murphy S. MacDonald A. Wang C. A. & Danaia L. Towards an Understanding of STEM Engagement: a Review of the Literature on Motivation and Academic Emotions. Canadian Journal of Science Mathematics and Technology Education 19 304–320. issn: 14926156 (3 2019).
R146.	Myers K. K. Jahn J. L. S. Gailliard B. M. & Stoltzfus K. Vocational Anticipatory Socialization (VAS): A Communicative Model of Adolescents' Interests in STEM. MANAGEMENT COMMUNICATION QUARTERLY 25 87–120. issn: 0893-3189 (1 Feb. 2011).
R147.	Nadelson L. Mooney D. K. Rush-Byers J. & Dean N. Why i am an engineering major: A cross-sectional study of undergraduate students in (American Society for Engineering Education 2014).
R148.	Nagengast B. & Marsh H. W. Big fish in little ponds aspire more: Mediation and cross-cultural generalizability of school-average ability effects on self-concept and career aspirations in science. Journal of Educational Psychology (2012).
R149.	Nawawi N. M. et al. The perception of pre-university students on STEM. Journal of Physics: Conference Series 1882 012155. issn: 1742- 6596 (1 May 2021).
R150.	Nehmeh G. & Kelly A. Women physicists and sociocognitive considerations in career choice and persistence. Journal of Women and Minorities in Science and Engineering 24 95–119. issn: 10728325 (2 2018).
R151.	Ngambeki I. et al. Differences in person-thing orientation in stem majors across three countries in (European Society for Engineering Education (SEFI) 2010).
R152.	Nite S. B. et al. Science Technology Engineering and Mathematics (STEM) Education: A Longitudinal Examination of Secondary School Intervention in. 2015-Febru (IEEE 2015). isbn: 978-1-4799-3922-0.
R153.	Nugent G. et al. A Model of Factors Contributing to STEM Learning and Career Orientation. International Journal of Science Education 37 1067–1088. issn: 14645289 (7 May 2015).

(*continued on next page*)

(*continued*)

Id	Reference
R154.	Oliver M. C. Woods-McConney A. Maor D. & McConney A. Female senior secondary physics students' engagement in science: a qualitative study of constructive influences. INTERNATIONAL JOURNAL OF STEM EDUCATION 4. issn: 2196-7822 (2017).
R155.	Olmedo-Torre N. et al. Do female motives for enrolling vary according to STEM profile? IEEE Transactions on Education 61 289–297. issn: 00189359 (4 2018).
R156.	Ong S. L. & Ling J. P. W. Factors Influencing Pre-University Students' Interests towards STEM Programs and Careers. IEEE Region 10 Humanitarian Technology Conference R10-HTC (2020).
R157.	Oon P.-T. Cheng M. M. W. & Wong A. S. L. Gender differences in attitude towards science: methodology for prioritising contributing factors. INTERNATIONAL JOURNAL OF SCIENCE EDUCATION 42 89–112 (1 2020).
R158.	Ortiz A. M. Amaya L. R. Warshauer H. K. Torres S. G. & Scanlon E. They choose to attend academic summer camps? A mixed methods study exploring the impact of a NASA academic summer pre engineering camp on middle school students in a latino community. Journal of Pre-College Engineering Education Research 8 22–30. issn: 21579288 (2 2018).
R159.	Ortiz A. M. Warshauer H. K. Torres S. G. & Amaya L. R. The influence of early STEM career exploration as related to motivation and self-determination theory in. 2018-June (American Society for Engineering Education 2018).
R160.	Padwick A. Davenport C. Strachan R. Shimwell J. & Horan M. Tackling the digital and engineering skills shortage: Understanding young people and their career aspirations. Proceedings - Frontiers in Education Conference FIE 2020-October (Oct. 2020).
R161.	Papastergiou M. Are Computer Science and Information Technology still masculine fields? High school students' perceptions and career choices. Computers & Education 51 594–608. issn: 0360-1315 (2 Sept. 2008).
R162.	Pellegrini G. & Saracino B. Adolescents and Scientific Careers. Interests Scholastic Experiences and the Opinions of Italian Students. SOCIOLOGIA NAUKI I TEHNOLOGIJ-SOCIOLOGY OF SCIENCE & TECHNOLOGY 9 86–100. issn: 2079-0910 (1 2018).
R163.	Perera H. N. & Mcilveen P. Vocational interest profiles: Profile replicability and relations with the STEM major choice and the Big-Five. Journal of Vocational Behavior 106 84–100 (2018).
R164.	Perez-Felkner L. McDonald S.-K. Schneider B. & Grogan E. Female and male adolescents' subjective orientations to mathematics and the influence of those orientations on postsecondary majors. Developmental Psychology 48 1658–1673 (6 2012).
R165.	Petersen J. & Hyde J. S. Gender-Related Academic and Occupational Interests and Goals. Advances in Child Development and Behavior 47 43–76. issn: 00652407 (2014).
R166.	Petersen J. L. & Hyde J. S. Trajectories of self-perceived math ability utility value and interest across middle school as predictors of high school math performance. EDUCATIONAL PSYCHOLOGY 37 438–456. issn: 0144-3410 (4 2017).
R167.	Piesch H. Gaspard H. Parrisius C. Wille E. & Nagengast B. How can a relevance intervention in math support students' career choices? Journal of Applied Developmental Psychology 71 101185. issn: 0193- 3973 (Nov. 2020).
R168.	Potvin G. et al. Gendered interests in electrical computer and biomedical engineering: Intersections with career outcome expectations. IEEE Transactions on Education 61 298–304. issn: 00189359 (4 Nov. 2018).
R169.	Potvin P. & Hasni A. Interest motivation and attitude towards science and technology at K-12 levels: a systematic review of 12 years of educational research. Studies in Science Education. issn: 1940-8412 (2014).
R170.	Rafanan R. J. L. Guzman C. Y. D. & D.V. J. R. Pursuing stem careers: Perspectives of senior high school students. Participatory Educational Research 7 38–58. issn: 21486123 (3 2020).
R171.	Riegle-Crumb C. & Moore C. The Gender Gap in High School Physics: Considering the Context of Local Communities. Social Science Quarterly 95 253–268. issn: 1540-6237 (1 Mar. 2014).
R172.	Riegle-Crumb C. Moore C. & Ramos-Wada A. Who wants to have a career in science or math? exploring adolescents' future aspirations by gender and race/ethnicity. Science Education 95 458–476. issn: 1098- 237X (3 May 2011).
R173.	Roberts T. et al. Students' perceptions of STEM learning after participating in a summer informal learning experience. International Journal of STEM Education 5. issn: 21967822 (1 2018).
R174.	Robnett R. D. & Leaper C. Friendship Groups Personal Motivation and Gender in Relation to High School Students' STEM Career Interest. Journal of Research on Adolescence 23 652–664. issn: 10508392 (4 2013).
R175.	Rodd M. Reiss M. & Mujtaba T. Undergraduates talk about their choice to study physics at university: what was key to their participation? Research in Science and Technological Education 31 153–167. issn: 14701138 (2 2013).
R176.	Rodríguez C. Inda M. & Fernńdez C. M. Influence of social cognitive and gender variables on technological academic interest among Spanish high-school students: testing social cognitive career theory. International Journal for Educational and Vocational Guidance 16 305–325. issn: 15731782 (3 Oct. 2016).
R177.	Rohde J. A. et al. Investigating the Intersection of Career Aspirations and Engineering Beliefs in First Year Engineering Students in. 2018 - Octob (IEEE 2019). isbn: 978-1-5386-1174-6.
R178.	Rosenbloom J. L. Ash R. A. Dupont B. & Coder L. Why are there so few women in information technology? Assessing the role of personality in career choices q. Journal of Economic Psychology 29 543–554 (2008).
R179.	Ross M. Capobianco B. & Godwin A. Repositioning race gender and role identity formation for black women in engineering. Journal of Women and Minorities in Science and Engineering 23 37–53 (1 2017).
R180.	Rowan-Kenyon H. T. Swan A. K. & Creager M. F. Social Cognitive Factors Support and Engagement: Early Adolescents' Math Interests as Precursors to Choice of Career. The Career Development Quarterly 60 2–15. issn: 2161-0045 (1 Mar. 2012).
R181.	Rozek C. S. Svoboda R. C. Harackiewicz J. M. Hulleman C. S. & Hyde J. S. Utility-value intervention with parents increases students' STEM preparation and career pursuit. Proceedings of the National Academy of Sciences of the United States of America 114 909–914. issn: 00278424 (5 2017).
R182.	Säde M. et al. Factors That Influence Students' Motivation and Perception of Studying Computer Science in (Association for Computing Machinery Inc 2019) 873–878. isbn: 978-1-4503-5890-3.
R183.	Sahin A. Gulacar O. & Stuessy C. High School Students' Perceptions of the Effects of International Science Olympiad on Their STEM Career Aspirations and Twenty-First Century Skill Development. Research in Science Education 45 785–805. issn: 15731898 (6 Dec. 2015).
R184.	Sainz M. & Muller J. Gender and family influences on Spanish students' aspirations and values in stem fields. INTERNATIONAL JOURNAL OF SCIENCE EDUCATION 40 188–203. issn: 0950-0693 (2 2018).
R185.	Sainz M. et al. Gendered Motivations to Pursue Male-Dominated STEM Careers Among Spanish Young People: A Qualitative Study. Journal of Career Development 47 408–423. issn: 0894-8453 (4 2020).
R186.	Sakellariou C. & Fang Z. Self-efficacy and interest in STEM subjects as predictors of the STEM gender gap in the US: The role of un observed heterogeneity. International Journal of Educational Research 109 101821 (2021).
R187.	Salmi H. Thuneberg H. Bogner F. X. & Fenyvesi K. Individual Creativity and Career Choices of Pre-teens in the Context of a Math-Art Learning Event. Open Education Studies 3 147–156. issn: 2544-7831 (1 Jan. 2021).

(*continued*)

Id	Reference
R188.	Sanchez-Gordon M. & Colomo-Palacios R. Factors influencing Soft ware Engineering Career Choice of Andean Indigenous. Proceedings - 2020 ACM/IEEE 42nd International Conference on Software Engineering: Companion ICSE-Companion 2020 264–265 (Oct. 2020).
R189.	Sandrin S. & Borror C. M. Student Perceptions and Interest in Engineering: Effects of Gender Race/Ethnicity and Grade Level in (2013).
R190.	Sass S. & Kampa N. Self-Concept Profiles in Lower Secondary Level - An Explanation for Gender Differences in Science Course Selection? FRONTIERS IN PSYCHOLOGY 10. issn: 1664-1078 (2019).
R191.	Sasson I. Becoming a Scientist-Career Choice Characteristics. INTER NATIONAL JOURNAL OF SCIENCE AND MATHEMATICS EDUCATION 1–15. issn: 15731774 (Feb. 2020).
R192.	Sathapornvajana S. & Watanapa B. Factors Affecting Student's Intention to Choose IT Program. Procedia Computer Science 13 60–67. issn: 1877-0509 (Jan. 2012).
R193.	Savić M. et al. Students' preferences in selection of computer science and informatics studies a comprehensive empirical case study. Computer Science and Information Systems 18 251–283 (1 Jan. 2020).
R194.	Saw G. K. Leveraging Social Capital to Broaden Participation in STEM. Policy Insights from the Behavioral and Brain Sciences 7 35–43. issn: 23727322 (1 2020).
R195.	Saw G. K. Swagerty B. Brewington S. Chang C.-N. & Culbertson R. Out-of-school time STEM program: Students' attitudes toward and career interests in mathematics and science. International Journal of Evaluation and Research in Education 8 356–362. issn: 22528822 (2 2019).
R196.	Sax L. J. Kanny M. A. Riggers-Piehl T. A. Whang H. & Paul son L. N. "But I'm Not Good at Math": The Changing Salience of Mathematical Self-Concept in Shaping Women's and Men's STEM Aspirations. Research in Higher Education 56 813–842. issn: 1573188X (8 Dec. 2015).
R197.	Schoon I. Teenage job aspirations and career attainment in adulthood: A 17-year follow-up study of teenagers who aspired to become scientists health professionals or engineers. International Journal of Behavioral Development 25 124–132. issn: 01650254 (2 2001).
R198.	Schuette K. & Koeller O. 'Discover Understand Implement and Trans fer': Effectiveness of an intervention programme to motivate students for science. International Journal of Science Education 37 2306–2325. issn: 0950-0693 (14 2015).
R199.	Schuster C. & Martiny S. E. Not Feeling Good in STEM: Effects of Stereotype Activation and Anticipated Affect on Women's Career Aspirations. Sex Roles 76 40–55. issn: 03600025 (1-2 2017).
R200.	Seymour L. Hart M. Haralamous P. Natha T. & Weng C. .-. Inclination of Scholars to Major in Information Systems or Computer Science in (2004) 97–106.
R201.	Shaaban K. Investigating the reasons for choosing a major among the engineering students in Qatar. IEEE Global Engineering Education Conference EDUCON 10-13-April-2016 57–61. issn: 21659567 (May 2016).
R202.	Shapka J. D. Domene J. F. & Keating D. P. Trajectories of career aspirations through adolescence and young adulthood: Early math achievement as a critical filter. Educational Research and Evaluation 12 347–358. issn: 13803611 (4 Aug. 2006).
R203.	Sharma K. Torrado J. C. Gómez J. & Jaccheri L. Improving girls' perception of computer science as a viable career option through game playing and design: Lessons from a systematic literature review. Entertainment Computing 36 100387. issn: 1875-9521 (Jan. 2021).
R204.	Sheldrake R. & Mujtaba T. Children's Aspirations Towards Science related Careers. CANADIAN JOURNAL OF SCIENCE MATHEMATICS AND TECHNOLOGY EDUCATION 20 7–26. issn: 1492-6156 (1 SI Mar. 2020).
R205.	Sheldrake R. Mujtaba T. & Reiss M. J. Science teaching and students' attitudes and aspirations: The importance of conveying the applications and relevance of science. INTERNATIONAL JOURNAL OF EDUCATIONAL RESEARCH 85 167–183. issn: 0883-0355 (2017).
R206.	Shin S. Rachmatullah A. Roshayanti F. Ha M. & Lee J.-K. Career motivation of secondary students in STEM: a cross-cultural study be tween Korea and Indonesia. INTERNATIONAL JOURNAL FOR EDUCATIONAL AND VOCATIONAL GUIDANCE 18 203–231. issn: 0251-2513 (2 July 2018).
R207.	Simunovic M. Babarovic T. Simunović M. & Babarović T. The role of parents' beliefs in students' motivation achievement and choices in the STEM domain: a review and directions for future research. SOCIAL PSYCHOLOGY OF EDUCATION 23 701–719. issn: 1381-2890 (3 July 2020).
R208.	Skultety L. & George C. E. "I'm in the mathematical sciences be cause..." examining underrepresented students' motivations for pursuing math. Journal of Women and Minorities in Science and Engineering 25 25–52. issn: 10728325 (1 2019).
R209.	Smit R. Robin N. Toffol C. D. & Atanasova S. Industry-school projects as an aim to foster secondary school students' interest in technology and engineering careers. International Journal of Technology and Design Education 2019 31:1 31 61–79. issn: 1573-1804 (1 July 2019).
R210.	Smith S. Sobolewska E. Bhardwaj J. & Fabian K. Exploring women's motivations to study computer science in. 2018-Octob (IEEE 2018). isbn: 978-1-5386-1174-6.
R211.	Sonnert G. Parents who influence their children to become scientists: Effects of gender and parental education. Social Studies of Science 39 927–941. issn: 03063127 (6 Dec. 2009).
R212.	Stanko T. Zhirosh O. & Krasnikhin D. Why girls with an interest in IT in high-school do not choose an IT career. Proceedings of 2014 Inter national Conference on Interactive Collaborative Learning ICL 2014 131–137 (Jan. 2014).
R213.	Stoet G. & Geary D. C. The Gender-Equality Paradox in Science Tech nology Engineering and Mathematics Education. Psychological Science 29 581–593. issn: 09567976 (4 2018).
R214.	Stout J. G. Dasgupta N. Hunsinger M. & McManus M. A. STEMing the Tide: Using Ingroup Experts to Inoculate Women's Self-Concept in Science Technology Engineering and Mathematics (STEM). Journal of Personality and Social Psychology 100 255–270. issn: 00223514 (2 2011).
R215.	Stringer K. Mace K. Clark T. & Donahue T. STEM focused extracurricular programs: who's in them and do they change STEM identity and motivation? Research in Science and Technological Education 38 507–522. issn: 02635143 (4 2020).
R216.	Subía L. T. & Gámez B. The Gender Gap broad the path for Women in STEM. Eighth International Conference on Technological Ecosystems for Enhancing Multiculturality (2020).
R217.	Svoboda R. C. Rozek C. S. Hyde J. S. Harackiewicz J. M. & Destin M. Understanding the Relationship Between Parental Education and STEM Course Taking Through Identity-Based and Expectancy-Value Theories of Motivation. AERA OPEN 2 (3 2016).
R218.	Tai R. H. Liu C. Q. Maltese A. V. & Fan X. Planning early for careers in science. Science 312 1143–1144. issn: 00368075 (5777 May 2006).
R219.	Taskinen P. H. Schütte K. & Prenzel M. Adolescents' motivation to select an academic science-related career: the role of school factors individual interest and science self-concept. Educational Research and Evaluation 19 717–733. issn: 13803611 (8 2013).
R220.	Taylor R. C. Using the theory of planned behaviour to understand students' subject choices in post-compulsory education. RESEARCH PAPERS IN EDUCATION 30 214–231. issn: 0267-1522 (2 Mar. 2015).
R221.	Thisgaard M. & Makransky G. Virtual learning simulations in high school: Effects on cognitive and non-cognitive outcomes and implications on the development of STEM academic and career choice. Frontiers in Psychology 8. issn: 16641078 (MAY 2017).
R222.	Tillberg H. K. & Mcgrath J. Attracting Women to the CS major. Frontiers: A Journal of Women Studies 26 126–140 (1 2005).
R223.	Torres-Ramos S. et al. Towards increasing of STEM-women professionals by implementing projects that reduce the gender gap: A study case in Universidad de Guadalajara. ACM International Conference Proceeding Series 20 166–172 (Oct. 2020).
R224.	Tran Y. Computer Programming Effects in Elementary: Perceptions and Career Aspirations in STEM. Technology Knowledge and Learning 23 273–299. issn: 22111662 (2 2018).

(*continued on next page*)

(*continued*)

Id	Reference
R225.	Trigo A. M. Leao C. P. & Soares F. To be or not to be an engineer? - Perceptions among 3rd cycle basic school students in (eds Jardim Goncalves R. et al.) 2018-Janua (IEEE 2017) 1344–1349. isbn: 978- 1-5386-0774-9.
R226.	Turner S. L. Steward J. C. & Lapan R. T. Family Factors Associated With Sixth-Grade Adolescents' Math and Science Career Interests. The Career Development Quarterly 53 41–52. issn: 2161-0045 (1 Sept. 2004).
R227.	Van Aalderen-Smeets S. I. & van der Molen J. H. Modeling the relation between students' implicit beliefs about their abilities and their educational STEM choices. International Journal of Technology and Design Education 28. issn: 09577572 (1 2018).
R228.	Van Aalderen-Smeets S. I. van der Molen J. H. W. & Xenidou-Dervou I. Implicit STEM ability beliefs predict secondary school students' STEM self-efficacy beliefs and their intention to opt for a STEM field career. JOURNAL OF RESEARCH IN SCIENCE TEACHING 56 465–485. issn: 0022-4308 (4 2019).
R229.	VanMeter-Adams A. Frankenfeld C. L. Bases J. Espina V. & Liotta L. A. Students who demonstrate strong talent and interest in STEM are initially attracted to STEM through extracurricular experiences. CBE Life Sciences Education 13 687–697. issn: 19317913 (4 2014).
R230.	Van Tuijl C. & van der Molen J. H. Study choice and career development in STEM fields: an overview and integration of the research. International Journal of Technology and Design Education 26 159–183. issn: 1573-1804 (2 Apr. 2016).
R231.	Varma R. Why so few women enroll in computing? Gender and ethnic differences in students' perception. Computer Science Education 20 301–316. issn: 08993408 (4 Dec. 2010).
R232.	Veldman J. Laar C. V. Thoman D. B. & Soom C. V. "Where will I belong more?": The role of belonging comparisons between STEM fields in high school girls' STEM interest. Social Psychology of Education 24 1363–1387. issn: 15731928 (5 Oct. 2021).
R233.	Vennix J. den Brok P. & Taconis R. Do outreach activities in secondary STEM education motivate students and improve their attitudes towards STEM? INTERNATIONAL JOURNAL OF SCIENCE EDUCATION 40 1263–1283. issn: 0950-0693 (11 2018).
R234.	Verdín D. & Godwin A. Physics identity promotes alternative careers for first-generation college students in engineering in. 2017-June (American Society for Engineering Education 2017).
R235.	Vinni-Laakso J. et al. The Relations of Science Task Values Self Concept of Ability and STEM Aspirations Among Finnish Students From First to Second Grade. FRONTIERS IN PSYCHOLOGY 10. issn: 1664-1078 (July 2019).
R236.	Wang M.-T. Degol J. & Ye F. Math achievement is important but task values are critical too: Examining the intellectual and motivational factors leading to gender disparities in STEM careers. Frontiers in Psychology 6. issn: 16641078 (FEB 2015).
R237.	Wang M.-T. Ye F. & Degol J. L. Who Chooses STEM Careers? Using A Relative Cognitive Strength and Interest Model to Predict Careers in Science Technology Engineering and Mathematics. Journal of Youth and Adolescence 46 1805–1820. issn: 00472891 (8 2017).
R238.	Wang M. T. Eccles J. S. & Kenny S. Not Lack of Ability but More Choice: Individual and Gender Differences in Choice of Careers in Science Technology Engineering and Mathematics. Psychological Science 24 770–775. issn: 14679280 (5 2013).
R239.	Wang M.-T. Educational and Career Interests in Math: A Longitudinal Examination of the Links Between Classroom Environment Motivational Beliefs and Interests. Developmental Psychology 48 1643–1657 (6 2012).
R240.	Wang M.-T. & Degol J. Motivational Pathways to STEM Career Choices: Using Expectancy-Value Perspective to Understand Individual and Gen der Differences in STEM Fields. Developmental Review 33 304–340 (4 2013).
R241.	Wang X. Why Students Choose STEM Majors: Motivation High School Learning and Postsecondary Context of Support. American Educational Research Journal 50 1081–1121. issn: 00028312 (5 2013).
R242.	Watt H. M. G. et al. Gendered Motivational Processes Affecting High School Mathematics Participation Educational Aspirations and Career Plans: A Comparison of Samples From Australia Canada and the United States. Developmental Psychology 48 1594–1611 (6 2012).
R243.	Watt H. M. G. et al. Mathematics-a Critical Filter for STEM-Related Career Choices? A Longitudinal Examination among Australian and US Adolescents. Sex Roles 77 254–271. issn: 03600025 (3-4 2017).
R244.	Wegemer C. M. & Eccles J. S. Gendered STEM career choices: Altruistic values beliefs and identity. Journal of Vocational Behavior 110 28–42. issn: 00018791 (2019).
R245.	Weisgram E. & Diekman A. Family Friendly STEM: Perspectives on Recruiting and Retaining Women in STEM Fields. International Journal of Gender Science and Technology 8 38–45. issn: 2040-0748 (1 2015).
R246.	Wieselmann J. R. Roehrig G. H. & Kim J. N. Who succeeds in STEM? Elementary girls' attitudes and beliefs about self and STEM. SCHOOL SCIENCE AND MATHEMATICS 120 233–244. issn: 0036- 6803 (5 May 2020).
R247.	Wille E. et al. It Takes Two: Expectancy-Value Constructs and Vocational Interests Jointly Predict STEM Major Choices. CONTEMPORARY EDUCATIONAL PSYCHOLOGY 61. issn: 0361-476X (2020).
R248.	Winn G. L. Re-assessing the effects of summer camp on STEM enrollments using an innovative survey strategy in (American Society for Engineering Education 2012). isbn: 9780878232413.
R249.	Wosu S. & Lovell M. Project care: The effect of enrichment of academic impact skills on Academic Performance Improvement (API) for stem careers in (American Society for Engineering Education 2007).
R250.	Yang Y. & Barth J. M. Gender differences in STEM undergraduates' vocational interests: People-thing orientation and goal affordances. Journal of Vocational Behavior 91 65–75 (2015).
R251.	Young D. Rudman L. Buettner H. & McLean M. The Influence of Female Role Models on Women's Implicit Science Cognitions. Psychology of Women Quarterly 37 283–292 (3 2013).
R252.	Zamora-Hernandez I. Rodriguez-Paz M. X. Gonzalez-Mendivil J. A. Zarate-Garcia J. A. & Nolazco-Flores J. A. Successful strategies for the attraction of more women into engineering in southern Mexico in (ed G.R. R. T. C. A. A.) 2020-April (IEEE Computer Society 2020) 673–678. isbn: 9781728109305.
R253.	Zhang L. & Barnett M. How high school students envision their STEM career pathways. Cultural Studies of Science Education 10 637–656. issn: 18711510 (3 Sept. 2015).

References

[1] UNESCO, Incheon declaration and framework for action for the implementation of sustainable development goal 4, https://unesdoc.unesco.org/ark:/48223/pf0000245656, 2016.
[2] OECD, Education at a glance 2021, https://doi.org/10.1787/b35a14e5-en, 2021.
[3] OECD, The ABC of Gender Equality in Education, OECD Publishing, 2015.
[4] EUROSTAT, Ict specialists in employment, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=ICT_specialists_in_employment, 2022, retrieved 3 May 2022.

[5] UNESCO, Resource guide: building girls' interest in stem education, https://unesdoc.unesco.org/ark:/48223/pf0000372310?8 = null&queryId = 1805e104-dbe0-4f41-a8db-037e47e6dd42, 2019.
[6] B. Kitchenham, S. Charters, Guidelines for performing systematic literature reviews in software engineering, technical report ebse-2007-01, 2007.
[7] K. Petersen, R. Feldt, M. Mattsson, S. Mujtaba, Systematic Mapping Studies in Software Engineering, 2008, towards PhD View project EASE Theme E-Decision support for software testing View project Systematic Mapping Studies in Software Engineering.
[8] K. Petersen, S. Vakkalanka, L. Kuzniarz, Guidelines for conducting systematic mapping studies in software engineering: an update, Inf. Softw. Technol. 64 (2015) 1–18.
[9] K. Sharma, J.C. Torrado, J. Gómez, L. Jaccheri, Improving girls' perception of computer science as a viable career option through game playing and design: lessons from a systematic literature review, Entertain. Comput. 36 (2021).
[10] A.N. Guz, J.J. Rushchitsky, Scopus: a system for the evaluation of scientific journals, Int. Appl. Mech. 45 (4) (2009) 351–362.
[11] E.S. Vieira, J.A. Gomes, A comparison of Scopus and Web of Science for a typical university, Scientometrics 81 (2) (2009) 587–600.
[12] R. Lent, F. Lopez, H.B. Sheu, A. Lopez, Social cognitive predictors of the interests and choices of computing majors: applicability to underrepresented students, J. Vocat. Behav. 78 (2011) 184–192.
[13] L. Skultety, C.E. George, "I'm in the mathematical sciences because. . . " examining underrepresented students' motivations for pursuing math, J. Women Minor. Sci. Eng. 25 (2019) 25–52.
[14] I. Sasson, Becoming a scientist-career choice characteristics, Int. J. Sci. Math. Educ. (2020) 1–15.
[15] J. Eccles, Expectancies, Values and Academic Behaviors, Freeman, San Francisco, 1983, pp. 75–146.
[16] R.W. Lent, S.D. Brown, G. Hackett, Social cognitive career theory, in: Career Choice and Development, vol. 4, 2002, pp. 255–311.
[17] A. Bandura, A cognitive theory: an agentic perspective, Annu. Rev. Psychol. 52 (2001).
[18] E.L. Deci, R.M. Ryan, Self-Determination Theory, vol. 1, Sage Publications Ltd., 2012, pp. 416–436.
[19] A.B. Diekman, M.P. Joshi, T.M. Benson-Greenwald, Goal Congruity Theory: Navigating the Social Structure to Fulfill Goals, Elsevier, 2020, pp. 189–244.
[20] M. Fishbein, I. Ajzen, Belief, attitude, intention, and behavior: an introduction to theory and research, Philos. Rhetor. 10 (1977).
[21] I. Ajzen, From Intentions to Actions: A Theory of Planned Behavior, Springer Berlin Heidelberg, 1985, pp. 11–39.
[22] J. Möller, H.W. Marsh, Dimensional comparison theory, Psychol. Rev. 120 (2013) 544.
[23] J.L. Holland, Making Vocational Choices: A Theory of Careers, Prentice-Hall, Englewood Cliffs, 1973.
[24] J.L. Holland, Making Vocational Choices: A Theory of Vocational Personalities and Work Environments, Psychological Assessment Resources, 1997.
[25] A. Diekman, A. Eagly, Of men, women, and motivation: a role congruity account, in: Handbook of Motivation Science, 2008, pp. 434–447.
[26] A. Skatova, E. Ferguson, Why do different people choose different university degrees? Motivation and the choice of degree, Front. Psychol. 5 (2014) 1244.
[27] N. Olmedo-Torre, F.S. Carracedo, M.N.S. Ballesteros, D. Lopez, A. Perez-Poch, M. Lopez-Beltran, Do female motives for enrolling vary according to stem profile?, IEEE Trans. Ed. 61 (2018) 289–297.