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A Systematic Review of Research Articles on Science Education Published in the ESERA Proceedings from 2011 to 2017

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Abstract

The purpose of this study was to analyze the research articles published from four of the proceedings of the European Science Education Research Association (ESERA) between 2011 and 2017 in light of their research strands, approaches, purposes, data types, instruments, and samples. The major goal was to categorize papers and identify research trends related to their methodological components in the field of science education. A total of 1193 papers were analyzed. The results showed an increasing emphasis on some themes, such as "pre-service science teacher education" (12% of the papers), "in-service science teacher education, continued professional development" (9% of the papers), and "environmental, health and informal-outdoor science" (8% of the papers). Most of the research published in these ESERA proceedings was descriptive, followed by developmental research. Regarding research approaches, the papers used quantitative and mixed data methods more than qualitative methods. This study could be beneficial to the field of science education research in all countries. It could help scholars identify gaps in research in science education and understand the state of research about different subjects, places, research design, etc. These results revealed the importance of studying science educational issues that were not the focus of previous studies, such as the reflective and critical thinking abilities and argumentative abilities of in-service and pre-service teachers, as well as students. It is recommended that further trend studies should be carried out on research articles, focusing on these issues.

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Introduction

The purpose of research is to add value to our knowledge. This value can be amplified by reviewing the research to understand the priorities and trends in a specific field worldwide. Many researchers have conducted studies to identify the research trends in an academic discipline or in a particular area of research within a discipline. Studies dealing with research trends can help in many ways. For example, Lee, Driscoll, and Nelson (2004) argued that these studies can facilitate the progress of research itself; they highlight research gaps and priorities and guide fields in deciding the future of their research.

Many science education scholars within academic and scientific communities (Chiappetta, 1976; Abd-El-Khalick & Lederman, 2000; Lee, Wu, & Tsai, 2009; Cavas, Cavas, Ozdem, Rannikmae, & Ertepinar, 2012; Shahid & Misra, 2013; Cavas, 2015) have focused on research trend studies. They believe that interdisciplinary research represents an important approach to addressing increasingly complex problems related to the field of science education. Other educators (Jacobs & Frickel, 2009; Paletz, Smith-Doerr, & Vardi, 2010; Wagner et al., 2001; Millar & Dillman, 2011) think that research trend studies may enhance the quality and measurements of research, thus satisfying the demands of all stakeholders. However, Perraton (2000) indicated that research trend studies lack theoretical underpinnings. In this regard, Perraton (2000, p. 2) stated that "research questions are rarely posed within a theoretical framework or based on its fundamental concepts and constructs" (p. 2). However, these shortages may be compensated for by the considerable advantages that can be gained from conducting such studies. We argue that research trend studies can help in solving problems related to science education. For example, they can help uncover the reasons underlying students' lack of interest in disciplines in the field of science education and subject areas such as natural sciences, engineering and technology, medical sciences, agricultural sciences, and veterinary sciences, which can help policy makers and academicians find ways to resolve this problem. Further, these studies can help improve teacher preparation and professional development programs.

Studies on research trends play a prominent role in identifying new areas of research that are worthy of study, which could improve the development processes of countries and societies. This can be achieved if the urgent educational issues that contribute to development are addressed in countries whose development plans depend on scientific research conducted according to a research map that draws on international research trends in science education. Moreover, research in the field of science education is of great importance in higher education because it represents the major milestone of postgraduate study at universities and scientific institutes. In the absence of scientific research, universities lose their value and status in society because they might not be able to contribute effectively to the development of scientific knowledge among their students or in society as a whole (Arai et al., 2007). To gain a better understanding of science education, it is important to conduct studies on research trends in academic articles related to science education, published in well-known conference proceedings or respected professional journals (Henson, 2001). As a result, studies of global research trends in science education in particular have recently gained special attention from scholars (Rennie, 1998; Eybe & Schmidt, 2001; Tsai & Wen, 2005; Lee et al., 2009; Cavas et al., 2012; Cavas, 2015). Many of these studies have focused on the analysis of journals within the framework of science education. There are several other specific review studies in subjects related to science education, such as scientific literacy (Deboer, 2000; Laugksch, 2000), constructivist models of science instruction (Chiappetta, 1976; Driver & Easley, 1978), the nature of science (Lederman, 1992; Abd-El-Khalick & Lederman, 2000), the laboratory in science education (Hofstein & Lunetta, 1982, 2004), attitudes towards science (Gardner, 1975; Gauld & Hukins, 1980; Osborne, Simon, & Collins, 2003), and argumentation (Duschl & Osborne, 2002; Ozdem, Erduran, & Park, 2011).

Many studies dealing with descriptive systematic reviews or research trends were conducted in recent years (Berge & Mrozowski, 2001; Rai & Kumar, 2002; Chang, Chang, & Tseng, 2010; Çalık, Ünal, Coştu, & Karataş, 2008; Lin, Lin, & Tsai, 2014; Cavas et al., 2012; Cavas, 2015; Tanwarat & Chatree, 2018; Lin, Lin, Potvin, & Tsai, 2019). Cavas (2015) analyzed articles published in five volumes and 20 issues of Science Education International (SEI) journals between 2011 and 2015 according to the authors' nationality and research topics. He found that the topics most frequently investigated by the researchers during this period were teacher education, learning concepts and learning context. In contrast, the least investigated topics were those related to the "history, philosophy, epistemology, and nature of science "and "informal learning." In addition, Rai and Kumar (2002) indicated a growing interest in the fields of engineering and medicine and showed that saturation in basic science research only suggested a shift from science to technology. They found that a growing trend in the number of Ph.D. degrees awarded in mathematics was the only exception in basic sciences and may be indicative of the importance of the subject in the present Information and Communications Technology (ICT) revolution.

Moreover, Chang et al. (2010) employed multi-stage clustering technique to investigate with what topics, to what development trends, and from whose contribution the journal publications constructed as a science education research field, emphasized in articles published in four international journals: *International Journal of Science Education*, *Journal of Research in Science Teaching*, *Research in Science Education*, and *Science Education* from 1990 to 2007. They found that the most studied topics were those related to Conceptual Change and Concept Mapping. They found also that there was an increasing focus on topics related to Professional Development, Nature of Science and Socio-Scientific Issues, and Conceptual Change and Analogy.

In addition, Tanwarat & Chatree (2018) analyzed research papers related to science education in articles published in the Journal of Research in Science Teaching, Science Education, and the International Journal of Science Education during the period from 2007 to 2016, according to the authors' nationality, informal science education research topics, research paradigms, methods of data collection and data analysis. The results showed that students' informal learning, public understanding in science, and informal perspectives, policies and paradigms were the top three research topics. they also uncover a growing acceptance of qualitative research methods and analyses. Lin et al. (2014) found that the context of students' learning, science teaching, and students' conceptual learning were the top three topics of research in the published papers. Their research revealed that learning context replaced students' conceptual learning over the past 15 years and continue to rank first until 2012. They found also that recently, science educators had highlighted research related to argumentation, inquiry-based learning, and scientific modeling.

Finally, Lin et al. (2019) analyzed research articles published in *Science Education*, *Journal of Research in Science Teaching*, and *International Journal of Science Education* from 2013 to 2017, and found that studies related to issues related to STEM education and undergraduate research experiences were gradually being highlighted. Their results indicated that the top three topics that continued to be emphasized in science educational research are the context of students' learning, science teaching, and students' conceptual learning. However, research related to topics such as conceptual understanding, alternative conceptions, and conceptual change declined during this period. Previous studies did not investigate articles published in gatherings such as ESERA, NARST, or other important international gatherings or regular events. Further, they did not address some of the topics dealt with in this study, such as research purpose, research types, research instruments, etc.

The reason behind the selection of ESERA conference proceedings for examination in this study is that this proceeding has been conducted regularly for a long time, attended by experts in science education from many countries. In addition, ESERA proceedings address aspects that are of great importance to science education research (Sormunen, Hartikainen-Ahia, & Jäppinen, 2017). Initially, we selected NARST annual conferences for the analysis of the articles related to science education. However, after analyzing a few articles, we found that we could not get the information we needed. The reason for this was that most of the presented articles have been published as short abstracts. Next,

we shifted our selection to a similar gathering, which publishes either full texts or expanded abstracts. The best alternative was the ESERA conferences, which specialize in science education.

In addition, the strands for each conference organized by ESERA, such as *"discourse and argumentation in science education,"* requires researchers to reflect on the most modern approaches to science education. A great number of researchers and prominent educators from developed and developing countries attend the conference proceedings and participate in their proceedings. These researchers and educators share their experiences with one another, thus enriching science education knowledge with their thoughts and skills. Majority of the participants come from European countries, which represent a rich mine for modern information and ideas about science education. As a result, participants from other parts of the world gain new knowledge about science education, which may enable them to participate in the improvement of science education in their countries. These arguments suggest that analyzing research papers from ESERA conference proceedings would add fruitful information and new ideas to the field of science education for countries around the globe. Studying research trends in science education through studies published in ESERA could lead to the development of teachers, without which science education would not progress. It may also have a direct impact on the reform of science education because most of the researchers participating in ESERA conferences usually come from prominent institutions and have extensive experience in the field of science education. It could also help scholars identify gaps in research between each country and the rest of the world.

In addition, research studies on science education, especially those published in ESERA conference proceedings, have not been addressed in analyses of research trends at the global and local levels. Thus, the present study aimed to determine the global trends in all aspects of science education research presented at ESERA conference proceedings. This may aid in the design of diagnostic studies on the reality, characteristics and aspects of science education in general and enable the design of a map to guide research in science education, ensuring that it is in line with global trends.

The purposes of the study:

This study aimed to analyze research published in ESERA conference proceedings from 2011 to 2017 in light of research strands, approaches, purposes, types of the data, instruments, and samples. Consequently, it addressed the following questions:

1. What strands of focus were emphasized in the proceedings of ESERA conference proceedings from 2011 to 2017?
2. What are the research approaches of articles published at the ESERA conference on science education from 2011 to 2017?
3. What are the purposes of the analyzed research related to science education published in the proceedings of ESERA conference proceedings from 2011 to 2017?
4. What types of data were collected in the analyzed research related to science education published in the proceedings of ESERA conference proceedings from 2011 to 2017?
5. What instruments were used in the analysis of research related to science education published in the proceedings of ESERA conference proceedings from 2011 to 2017?
6. What research samples were targeted by the research studies related to science education research studies published in the proceedings of ESERA conference proceedings from 2011 to 2017?

Method

In approaching the task, we decided to systematically review research articles in terms of research strands, approaches, purposes, data types, instruments, samples of articles related to science education published at an international conference. We selected a popular international gathering that publishes full texts or expanded abstracts: The European Science Education Research Association (ESERA). We selected four conference proceedings held in the years from 2011–2017. ESERA conference proceedings specialize in science education and are held bi-annually. We analyzed all articles presented in 2011, 2013, 2015, and 2017. The number of analyzed articles was 1193.

We selected ESERA for this research analysis because it uses strict regulations for the selection of the papers to be presented during the conference. The papers submitted to the conference are given to two independent referees. Then they are accepted "if both referees evaluated the proposal as high quality, i.e., average is 80 out of 100. "The paper is rejected automatically "if both referees evaluated the quality as poor, i.e., average is below 40 out of 100. "Papers with average between 40/100 and 80/100 are sent to manual review and the scientific committee makes the final decision of acceptance/rejection/change to another format on the basis of recommendations from strand chairpersons. Therefore, only good quality papers and outstanding researchers can participate in ESERA conference proceedings. These participants come from different parts of the world. As a result, analyzing the ESERA proceedings books may reveal important trends that could help us as well as other concerned science educators in different parts of the world in reforming science education and improving science education research according to these trends.

We used a descriptive type of systematic content analysis which seeks to identify and describe the general trends and research results in a particular research discipline (Çalık et al., 2008; Suri & Clarke, 2009; Sözbilir, Kutu, & Yaşar, 2012; Umdu-Topsakal, Çalık, & Çavuş, 2012; Jayarajah, Saat, & Rauf, 2014; Lin et al., 2014; Selçuk, Palancı, Kandemir, & Dündar, 2014). The researchers prepared the initial version of the analysis tool, which consisted of six parts: research strands, research methods, research purposes, the type of data collected, types of instruments used, types of research samples. Research strands are specified by the conference specialists, while the other themes were identified through reading each of the published papers and choosing one of the categories specified by the tool. For example, for the research approach theme, the tool included the following options: 1) action research, 2) empirical research, 3) literature review, and 4) public opinion research. We read or scanned the whole article, especially the research methodology, to understand the research approach and then selected one of the four options or selected no data if we were unable to grasp the research approach of the type of the research. It should be noted that the tool clearly defines each theme and each part of each of the themes. We developed and used an instrument to analyze all articles from the ESERA conference proceedings held in 2011, 2013, 2015, and 2017. A total of 1193 articles were analyzed. The distribution of the analyzed papers by years was as follows: 309 papers from the year 2011, 314 papers from the year 2013, 325 papers from the year 2015, and 247 papers from the year 2017.

Quality of the research

To ensure the quality (Lincoln & Guba, 1985) and validity of the analysis tool, it was reviewed by six specialized experts—professors from departments of curricula and instruction at the college of education, King Saud University who are familiar with research trends. The tool was modified according to their remarks; in particular, some parts were changed to address language errors. The final version of the tool consisted of eight parts: research strands, the research approach, the purpose of the research, the type of data collected, the types of instruments used, the types of research samples, and the number of researchers for each paper. To ensure the reliability of the analysis, we randomly selected 48 articles (16 from each year), which comprised approximately 5% of the analyzed research articles.

To ensure reliability, two experienced professors, who specialize in science education, and are familiar with similar research analyzed the 5% sample articles. The two raters coded the selected samples of articles from each year. The inter-rater reliabilities were determined using kappa reliability coefficients (Table 3). The Kappa (Lincoln & Guba, 1985) coefficient values for the sample articles were as follows: 0.69 for 2011, 0.76 for 2013, 0.79 for 2015, and 0.66 for 2017. This means that these values range between 0.66 and 0.79. According to Altman (1991), agreement is very good if kappa values fall between 0.81 and 1.00, good if they fall between 0.61 and 0.80, moderate if they fall between 0.41 and 0.60, and poor if they are less than 0.20. Accordingly, the levels of agreement between the two raters for the analyzed articles from each of the four years were good. Additionally, analyzed articles revealed that 35 articles used the quantitative criteria to ensure the authenticity of the instruments and findings, and 13 articles used the correct qualitative criteria of dependability, conformability, credibility, and transferability (Lincoln & Guba, 1985).

These results indicate that the agreement between the two raters was high enough to allow us to use the analysis tool to study the selected articles.

Findings

This section includes details about six themes used in this analysis. These themes are research strands, research approach, research purposes, type of data collected, type of research instruments used, and types of research samples. A description of the results for each theme is presented below.

Strands

This section presents details regarding the strands of science education that were the focus of research studies from 2011–2017, as classified and assigned by the conference organizers. Strand is the name that was given by the ESERA organizers to each of the conference themes. Table 1 presents the strands that were the focus of the research studies presented at ESERA. Among the 1193 articles presented at the ESERA conference proceedings in 2011, 2013, 2015, and 2017, the predominant strands were "pre-service science teacher education"(12% of the papers); "in-service science teacher education, continued professional development" (9%); and "environmental, health and informal-outdoor science" (8%). The least dominant strands were "early years' science education "(3% of the papers), and "teaching learning sequences as innovations for science teaching and learning "(3%).

Table 1. Frequencies of the research strands for research articles presented at ESERA

Strand	Year								Total	
	2011		2013		2015		2017			
	f	%	f	%	f	%	f	%	f	%
Digital and other resources for teaching/learning science	17	6	19	6	14	4	16	6	66	6
In-service science teacher education continued professional development	26	8	36	12	34	10	11	4	107	9
Pre-service science teacher education	46	15	32	10	41	13	29	12	148	12
Environmental, health and Informal-Outdoor Science	29	9	27	9	25	8	15	6	96	8
Scientific literacy and socio-scientific issues	8	3	23	7	17	5	11	4	59	5
Discourse and argumentation in science education	19	6	15	5	14	4	16	6	64	5
Cultural, Social and Gender Issues	20	6	29	9	13	4	11	4	73	6
Learning science—conceptual understanding	18	6	16	5	33	10	24	10	91	8
Learning science—cognitive, affective, and social factors	27	9	14	4	17	5	21	9	79	7
Early years science education	10	3	8	3	9	3	9	4	36	3
Teaching and learning science	40	13	0	0		0		0	40	3

Table 1. Continued

Strand	Year								Total	
	2011		2013		2015		2017			
	f	%	f	%	f	%	f	%	f	%
Nature of science, History, Philosophy, Sociology of Science	23	7	13	4	15	5	17	7	68	6
Evaluation and assessment of student learning	13	4	11	4	29	9	15	6	68	6
Science curriculum, educational policy	13	4	20	6	9	3	6	2	48	4
Teaching-learning sequences as innovations for science teaching and learning	0	0	13	4	13	4	7	3	33	3
Science in the early stage, primary and secondary school, and University	0	0	9	3	26	8	25	10	60	5
Science teaching processes	0	0	27	9	16	5	14	6	57	5
Total	309	100	312	100	325	100	247	100	1193	100

Research approaches

Table 2 shows the research approach, which comprises six types of research: Action research, empirical research, literature review, public opinion research, and literature review. Empirical research was the predominant approach, followed by action research. The least dominant approaches were opinion research, theoretical research, and literature review. It is notable that the number of action research articles increased over the years, from 11 (4%) in 2011 to 61 (20%) in 2013; and from 53 (16%) in 2015 to 48 (19%) in 2017. In contrast, the number of empirical research articles decreased over the years, from 269 (87%) in 2011 to 170 (69%) in 2017. Similarly, literature review increased over the years, from 12 out of 309 in 2011 to 22 out of 247 in 2017.

Table 2. Frequencies of the research types for the research articles presented at ESERA

Research approach	Year								Total	
	2011		2013		2015		2017			
	f	%	f	%	f	%	f	%	f	%
Action research	11	4	61	20	53	16	48	19	163	14
Empirical research	269	87	215	69	230	71	170	69	902	76
Theoretical	11	4	6	2	9	3	7	3	33	3
Public opinion research	3	1	1	0	0	0	0	0	4	0
Literature review	12	4	24	8	28	9	22	9	78	7
No information	3	1	5	2	5	2	0	0	15	1
Total	309	100	312	100	325	100	247	100	1193	100

Research purposes

Table 3 includes three types of research purposes: descriptive, developmental, and evaluative. From the table, we can deduce that descriptive studies were predominant, while evaluative research studies were the least common. The number of descriptive and developmental studies was stable over the years and did not change much from 2011 to 2017. In contrast, the number of evaluation research studies increased from 2011 to 2017.

Table 3. Frequencies of research purposes for the research articles presented at ESERA

Research purposes	Year								Total	
	2011		2013		2015		2017			
	f	%	f	%	f	%	f	%	f	%
Descriptive	245	79	244	7	242	74	180	73	911	76
Developmental	49	16	50	2	48	15	35	14	182	15
Evaluation	12	4	7	0	31	10	32	13	82	7
No information	3	1	11	0	4	1	0	0	18	2
Total	309	100	312	9	325	100	247	100	1193	100

Data collection types

Table 4 includes the type of the data collected in the research studies presented at the ESERA conference proceedings in 2011, 2013, 2015, and 2017. Three types of data were used: quantitative, qualitative and mixed. Researchers used quantitative and mixed data type more than qualitative type. However, there are no obvious trends in any of these types as we progress from 2011 to 2017.

Table 4. Frequencies of the types of data used in the research articles presented at ESERA

Types of the Collected Data	Year								Total	
	2011		2013		2015		2017			
	f	%	f	%	f	%	f	%	f	%
Quantitative	101	33	93	30	111	34	99	40	404	34
Qualitative	92	30	100	32	82	25	70	28	344	29
Mixed	99	32	92	29	101	31	78	32	370	31
No information	17	6	27	9	31	10	0	0	75	6
Total	309	100	312	100	325	100	247	100	1193	100

Research Instruments

Table 5 presents the five types of instruments used in the research studies presented at ESERA. These instruments were used either alone or in combination. Closed and open questionnaires, used alone or with other types of instruments, were the most commonly used. Tests were second, and observation was third. Scales and interviews were the least frequently used instruments. We determined the frequencies of use for each tool, whether used alone or in combination with other tools. From Table 6, we could conclude that most of the articles used mixed and qualitative methodology because they used more than one tool for gathering data, among which are observation, interview or analysis.

Table 5. Frequencies of the types of instruments used in the research articles presented at ESERA

Types of Research Instruments	Year								Total	
	2011		2013		2015		2017			
	f	%	f	%	f	%	f	%	f	%
Test	53	17	58	19	67	21	58	23	236	20
Test and Interviews	7	2	14	4	12	4	8	3	41	3
Test and Observation	10	3	16	5	7	2	7	3	40	3
Test and Questionnaire	13	4	12	4	10	3	9	4	44	4
Test, Questionnaire, and Interviews	7	2	18	6	5	2	5	2	35	3
Questionnaire	61	20	57	18	59	18	58	23	235	20
Questionnaire and Interviews	16	5	13	4	11	3	11	4	51	4
Content Analysis Card	27	9	22	7	28	9	17	7	94	8

Table 5. Continued

Types of Research Instruments	Year								Total	
	2011		2013		2015		2017			
	f	%	f	%	f	%	f	%	f	%
Interview Card	18	6	18	6	25	8	13	5	74	6
Observation Card	40	13	28	9	37	11	27	11	132	11
Questionnaire and Observation	0	0	0	0	1	0	2	1	3	0
Observation, Interview, and Content analysis card	3	1	8	3	18	6	22	9	52	4
Observation and Interview	6	2	18	6	15	5	10	4	49	4
No information	48	16	30	10	30	9	0	0	107	9
Total	309	100	312	100	325	100	247	100	1193	100

Research samples

Regarding the types of samples targeted by researchers, Table 6 shows that teachers were the population most frequently used as samples by the researchers participating in ESERA: approximately 385 (32%) research studies targeted science teachers' samples. General education secondary school students (grades 10—12) occupied the second position; 147 (12%) articles used this population as samples for their studies. University students, including pre-service teachers, held the third position and were targeted as study samples by 146 (12%) articles. It is notable that approximately 80 (7%) articles targeted both teachers and students. In contrast, only three articles used all levels of general education students (grades k-3, 4–6, 7–9, and 10–12) as their study samples. Few researchers targeted more than one level in their studies. We noted from data in Table 7 that there is scarcity of research targeting (k-3) classes.

Table 6. Frequencies of the types of samples used in the research articles presented at ESERA

Types of Research Samples	Year								Total	
	2011		2013		2015		2017			
	f	%	f	%	f	%	f	%	f	%
Books, Documents, Electronic programs, and Films	16	5	24	8	22	7	38	15	100	8
Science teachers	101	33	107	34	90	28	87	35	385	32
General education students (10–12)	46	15	38	12	32	10	31	13	147	12
University students	21	7	26	8	64	20	35	14	146	12
General education students (7–9)	26	8	22	7	17	5	13	5	78	7
Teachers and students	18	6	24	8	21	6	17	7	80	7
General education students (4–12)	0	0	1	0	10	3	8	3	19	2
General education students (4–9)	2	1	6	2	2	1	0	0	10	1
General education students (7–12)	3	1	5	2	5	2	3	1	16	1
General education students (k-12 grade students)	1	0	1	0	1	0	0	0	3	0
General education students (k-6 grade students)	2	1	1	0	12	4	5	2	20	2
General education students (K-3 grade students)	11	4	6	2	7	2	5	2	29	2
General education students (4–6 grade students)	11	4	9	3	10	3	5	2	35	3
No information	51	17	42	13	32	10	0	0	125	10
Total	309	100	312	100	325	100	247	100	1193	100

Discussion

The aim of this paper was to analyze the science education research published in the international conference proceedings of ESERA in the years from 2011 to 2017. The results of this study are divided into seven parts, and six of these will be considered in this discussion.

The first part of the results addresses the strands of the research studies presented at ESERA. The results indicate that researchers are paying more attention to pre-service science teacher education, in-service science teacher education or continued professional development. This may be due to the noticed weakness of teachers in the classroom (Parliament of Victoria, Education and Training Committee, 2005; Schmidt, Cogan, & Houang, 2011; Voss, Kunter, & Baumert, 2011). Most of the reform movements in science education concentrated on the curricula and students and ignored teacher development to be able to cope with the reforms. As previous studies have asserted, these issues have a direct impact on science education (Pilo & De Paz, 2001; Thinwiangthong & Inprasitha, 2014). Additionally, it was argued that without the development of teachers, science education would not progress (Hofstein, 2005; Darling-Hammond & Richardson, 2009; & Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2012). Interestingly, the strand related to teaching-learning sequences as innovations for science teaching and learning was the least frequently represented, when it should be among the most important domains, subjected to thorough studies because of its relationship to the development of science education and hence students' achievement and learning outcomes (Méheut & Psillos, 2004). Research-based teaching-learning sequences may encourage students' active involvement in learning by concentrating on their previous ideas, knowledge, and ways of reasoning. Indeed, and this was perhaps the most striking point of convergence, its goal is for learners to understand and learn some conceptual elements of a given targeted content.

The results of the research approaches section reveal that, in addition to empirical research, researchers have started to pay more attention to action research and they may have considered its importance for developing teachers' practices. Meanwhile, researchers are paying less attention to studies that focus on opinion, theoretical research, and literature review. The results also indicated that researchers in science education shifted their focus from empirical research to other types of research. Although empirical research is important, it might not provide rich and deep information regarding phenomena related to science education that could contribute to the reform of science education (Hooper & Larsson, 2015). Even though action research might be classified by some educators as a form of empirical research (Skinner, 2013), it was separated because it is performed by educators about their own practices, and represents applied, problem-based research that makes researchers interactive, collaborative, iterative and active participants in their field (Campbell, 2010). The action research process is characterized by its ability to both generate and employ knowledge (Skinner, 2013).

The results of the research purposes theme indicate that descriptive research was predominant, followed by developmental and evaluative research. These results are reasonable because descriptive studies can be used to describe and interpret the current status of the use of questionnaires and/or tests (Fox & Bayat, 2007). In addition, developmental research is just one type of descriptive research that studies changes in behavior over time (Leedy & Ormrod, 2001). Developmental research studies received less attention than descriptive research and more attention that evaluative research. This form of research requires more time to complete than other types of studies. Evaluative research is a research approach used to evaluate the results against hypothesized standards (Suchman, 1967). It is also used to gather information that is necessary for judging science education issues as aligned with science education and new-generation standards.

The results concerning the type of data collected reveal that the researchers used quantitative and mixed data more than qualitative information. This might indicate that researchers avoid qualitative methods because they may not prefer deep investigations and a thorough understanding of phenomena related to all areas of science education. Qualitative research and its approaches and methods can contribute to operations management (OM) research (Slack, Lewis, & Bates, 2004). The qualitative approach uses interviews, open-ended questions, or focus groups and intends to gain a deep understanding of a phenomenon through comprehensive description. In most cases, a small number of participants are involved in this type of research because such research endeavors may require several resources and considerable amounts of time. In comparison, the quantitative approach surveys a large number of individuals and applies statistical techniques to identify general patterns of a phenomenon. A third type, mixed-method research, combines quantitative and qualitative methods. This integrated method provides a better understanding of the research problem than the use of one method alone (Molina-Azorín, 2011; Molina-Azorín & Cameron, 2015).

Regarding the research instruments used in the research studies presented at ESERA, the results show that test and questionnaires were used most often, whether alone or with other types of instruments. These findings indicate that tests are suitable instruments for gathering information or reporting the status of science education issues and concepts. This means that researchers may prefer quantitative research and avoid qualitative and mixed method research, because they would not spend time and more effort to conduct an in-depth investigation on issues related to science education. We determined the frequencies of use for each tool, whether alone or in combination with other instruments, and found that test came first, followed by test questionnaires. Observations and interviews were the instruments least frequently used by researchers. This may indicate that researchers prefer to use tests and, or questionnaires to collect data and gather information regarding the status of science education issues and concepts.

Concerning the samples targeted by researchers, results shows that teachers represented most frequently used population and samples for the researchers participating in ESERA proceedings from 2011 to 2017. General education secondary school students (grades 10—12) occupied the second position in researchers' attention, and university students held the third position. This means that most researchers targeted only one level of general education, such as secondary, middle, or elementary education. Few researchers targeted more than one level in their studies. We noted that there is scarcity of research targeting general education students (grades k-3, 4–6, 7–9, and 10–12) and (k-3) classes as their study samples. This could be because a majority of these studies are conducted by individuals, who are either graduate students or university researchers who engage in research to get promoted, and therefore, they design semi-experimental or descriptive research to avoid the higher cost of other types of research, which require the inclusion of wider society and larger samples (Nascimento & Vieira, 2011; Rebolj & Dyes, 2013).

Conclusion and Suggestions

This paper presents the results of a descriptive systematic content analysis approach to science education-related research published in the ESERA conference proceedings from 2011 through 2017. The findings revealed an increasing emphasis on research on pre-service science teacher education, in-service science teacher education, continued professional development, and environmental, health and informal-outdoor science.

It showed also that researchers prefer descriptive studies and developmental research; and they prefer quantitative and mixed data methods more than the qualitative method. The research articles were analyzed in order to extract the value and appropriateness of the trends with respect to research strands, approaches, purposes, data types, instruments, and samples. Based on the findings of this study, we recommend that science educators achieve optimal benefits from the current trends through the acquisition of knowledge about the successful preparation of CPD programs, frameworks, approaches, and models that are emerging, and design such programs accordingly. Research trend

studies help in identifying new areas of research that are worthy of study, which could improve the development processes of countries and societies and contribute to the advancement of research (Lee et al., 2004). In addition, this study may pave the road for future science education reform, and help address urgent educational issues. Future research should examine trends related to specific issues, such as inquiry, constructivism and argumentation. It should consider the following points. First, it is necessary to conduct detailed research that concentrates on more specific science educational issues such as research trends on argumentation, inquiry, pre-service teacher preparation, etc. The limitation of this study is that research in other languages such as French, Chinese, have not been considered in this analysis because we are not familiar with these languages. We have also limited our study to ESERA conferences. However, due to the fact that researchers from all over the world participated in the targeted conferences, which publishes in the English-Language, this limitation may not hinder our efforts to share our work with the rest of the world and contribute to the development of our science education system.

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