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Exploring Physics Education Research: Popular Topics in Prestigious International Journals in the Period of 2009-2019

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Abstract: Knowing the history of research conducted by the researchers in the past will help in shaping current and future exploration in the field. This study aims to find out which research topics that were popular in 2009-2019 in well-respected international journals. Employing a descriptive method, this research collected the data from 3 major ranking journals about science/physics education, namely the International Journal of Science Education (IJSE), Research in Science Education (RISE), and Science Education (SE). The data collection was carried out from April to September 2020 by extracting journals from the Clarivate Analytics WoS online database system. The most popular topics physics researchers in IJSE, RISE and SE journals in the period of 2009-2019 are science learning: contexts, characteristics and interactions (13.50%), science learning: development of student understanding (9.35%), and curriculum and assessment (8.47%), while the topics of religious beliefs, methodological issues, textbook analysis (2.76%) and pre-service science teacher education (3.89%) gained the least attention. In addition, USA was the country that contributed the most articles in IJSE, RISE, and SE journals is USA with the percentage of 35.30% or about five times higher than the UK and Australia which ranked second and third with the percentage of 7.21% and 6.46%, respectively.

INTRODUCTION

One of the crucial tasks of educators and researchers is disseminating knowledge and their work to the public through publishing articles in journals [1]. In academia, publications might be the identity of the researchers among the academic community. A researcher can be more widely recognized and build a good reputation along with the popularity of their research [2]. Publication activities are also needed to enhance their professional careers such as for promotion to higher position in office, program grants, or excellence awards [3,4].

Publications in international journals is very much encouraged. Publishing articles in foreign journals can broaden the author's perspective (Science of European). However, when researchers wish to be recognized internationally, they must consider publishing their articles in reputable journals [5] which is indexed by reputable international databases, for instance, Web of Science (WoS), Scopus, and Social Sciences Citation Index (SSCI) [6,7,8] since those journals usually publish superior articles which offer well-built research methodology and great discussion of the findings [2].

However, to publish an article in well-respected journal needs enormous efforts. One of the main factors inhibiting educators from publishing in international journals is lack of confidence in the quality of research they conduct and the articles they write [9]. Many of them perceived that they cannot meet the international journal standard in terms of writing style, data analysis, or language use, so the possibility of being accepted is low. Another challenge is that many academics, particularly those in their early career, found it difficult to identify significant research topic that contributes a novelty and understand the current research practices in their field [10]. Therefore, information about the research trends needs to be updated periodically and systematically to provide a clear picture of what has been investigated in the past to present and what can be examined further in the future [11,12].

Research on physics education trends is still rarely conducted by physics researchers [13]. Physics education research (PER) is the study of how people learn, teach, and understand physics and how to elevate the quality of physics teaching in any level of education that offer physics courses. In addition, physics education research is a

research area that combines education research that is influenced by social studies, psychology, and physics that is a traditional academic subject [14]. In secondary education level, Research on Physics Education mainly act as a guidance to see whether a curriculum works successfully and how to improve the teaching and learning of physics [15]. Meanwhile, in higher education, PER emphasizes studies on teaching models, methods, and techniques to be applies in classrooms in order to strengthen student’s understanding, abilities, and skills through effective and enjoyable learning [16]. However, there has been a shift in the focus of physics education research during the last few years [17]. PER is not anymore limited to revealing the drawbacks in students’ learning and conventional instruction but has started to explore the area of assessment, evaluation, and redesign of physics teaching [18].

Among the leading international journals that publish physics education articles are Science Education (SE), International Journal of Science Education (IJSE), and Research in Science Education (RISE). These 3 journals have high impact factors and are in the Q1 Quartile of the Scimago journal and country ranking data that make them very prominent among the physics researchers’ community. SE publishes 6 issues a year exploring science curriculum, instruction, learning, policy and preparation of science teachers aiming to fosterand update knowledge of science education theory and practice. IJSE publishes 18 issues yearly containing articles that focus on the teaching and learning of science in any level of education in order to bridge the gap between research and practice and to provide information, ideas and opinion. RISE publishes 6 issues annually and considerspapers that explore areas such as STEM, health, environment, cognitive science, neuroscience, psychology and higher education where science education is fore-fronted.

Research Questions

1. What research topics were popular in distinguished international journal for the period of 2009-2019?
2. What countries did contribute the most articles in distinguished international journal for the period of 2009-2019?

RESPONSE SURFACE METHODOLOGY

Employing a descriptive approach, this research maps the trend of physics education research in prestigious international journals in the period of 2009-2019. The data were obtained from three well-respected journalspublished by credible publishers and indexed in a reputable international database,namely Web of Science (WoS) or Scopus with a journal SJR of at least 0.8. Therefore, data collection was carried out by extracting the journals from Clarivate Analytics' WoS online database system. The system retrieves enriched metadata from the literature on various international journals ranked as Q1 and indexed in Scopus and SSCI journals are the top 3 ranked journals on the subject of science/physics education.

TABLE 1. International journals as the source of the data

No.	Name of Journal	SJR	Category	H-Index	Publisher	URL
1	Science Education (SE)	2,0 5	Q1	108	John Wiley & Sons Inc.	https://onlinelibrary.wiley.com/journal/1098237x
2	International Journal of Science Education (IJSE)	1,0 2	Q1	102	Taylor & Francis	https://www.tandfonline.com/toc/tsed20/current
3	Research in Science Education (RISE)	0,8 9	Q1	50	Springer	https://www.springer.com/journal/11165

After extracting the articles from the journals, the data were analyzed by using network analysis via a software called R-studion. The data obtained were, then, classified and displayed according to the desired structure. The following is the flow chart of the research that had been completed.

In analyzing the articles in IJSE, RISE, and SE journals, the researchers only focused on articles in the field of physics education. The total number of articles obtained in the 3 reputable international journals in the field of physics education from 2009-2019 was 1,591. This is in accordance with the requirements of the data sources mentioned in Table 1.

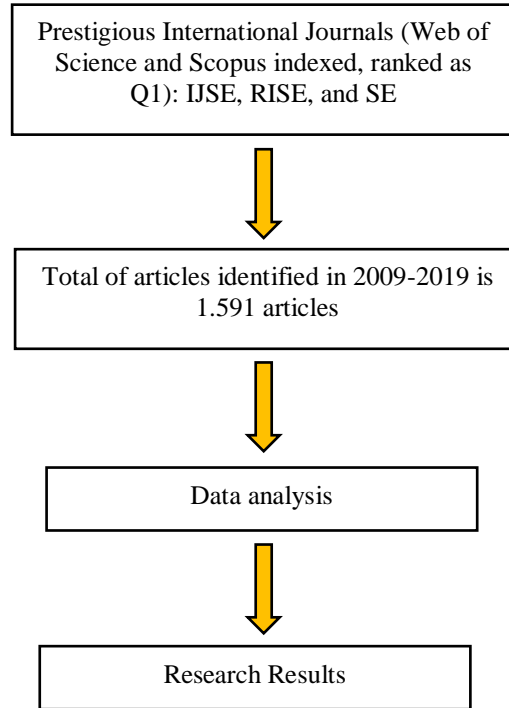


FIGURE 1. Research flow

In analyzing the data, 17 research topics in physics education were used as a reference. The research topics were taken from the topics provided at the 2019 National Association for Research in Science Teaching (NARST) Conference and the 2019 European Science Education Research Association (ESERA) Conference. The topics are:

1. Science learning: development of student understanding
2. Science learning: contexts, characteristics and interactions
3. Science teaching: primary school, middle and high school
4. College science teaching and learning
5. Science learning in informal contexts
6. Pre-service science teacher education
7. In-service science teacher education
8. Curriculum and assessment
9. Cultural, social, and gender issues
10. Technology for teaching, learning, and research
11. History, philosophy, sociology, and nature of science
12. Policy, reform, and program evaluation
13. Discourse and argumentation in science education
14. Scientific literacy and socio-scientific issues
15. Environmental education and sustainability
16. STEM/STEAM
17. Others (religious beliefs, methodological issues, textbook).

FINDINGS AND DISCUSSION

In this study, we first traced all articles published in IJSE, RISE, and SE journals from 2009-2019. Then we took and analyzed articles in the field of physics education studies. In total, there were 1,591 articles in the field of physics education which were analyzed from the three reputable international journals. The findings obtained are an overview of the shift in research topics from 2009 to 2019.

Popular Research Topics in IJSE, RISE, and SE Journals from 2009 to 2019

Based on Fig.2, it is known that in IJSE journal, the number of published articles fluctuated during the intended period. Although there was a significant decrease in 2010 (from 110 articles to 60 articles), the number gradually increased in the next four years. Then, it went up and down again until the end of the period. In RISE journal, the number of articles rose drastically in 2013 and reached the peak in 2019 with the total of 86 articles. In SE journal, the number of published articles experienced a slight fluctuation during the decade, but slowly increased until it finished with 47 articles, the highest number during the period of study.

Table 2 presents the percentage of trending physics education research topics in IJSE, RISE and SE journals. As can be seen, the research topic that is discussed the most by physics education researchers at IJSE is science learning: contexts, characteristics and interactions. There are 113 articles covering this topic. Then the second topic that is of great interest to physics education researchers is curriculum and assessment, followed by the topic of science learning: development of student understanding. The total articles published in IJSE discussing these two topics are 82 and 78 articles, respectively.

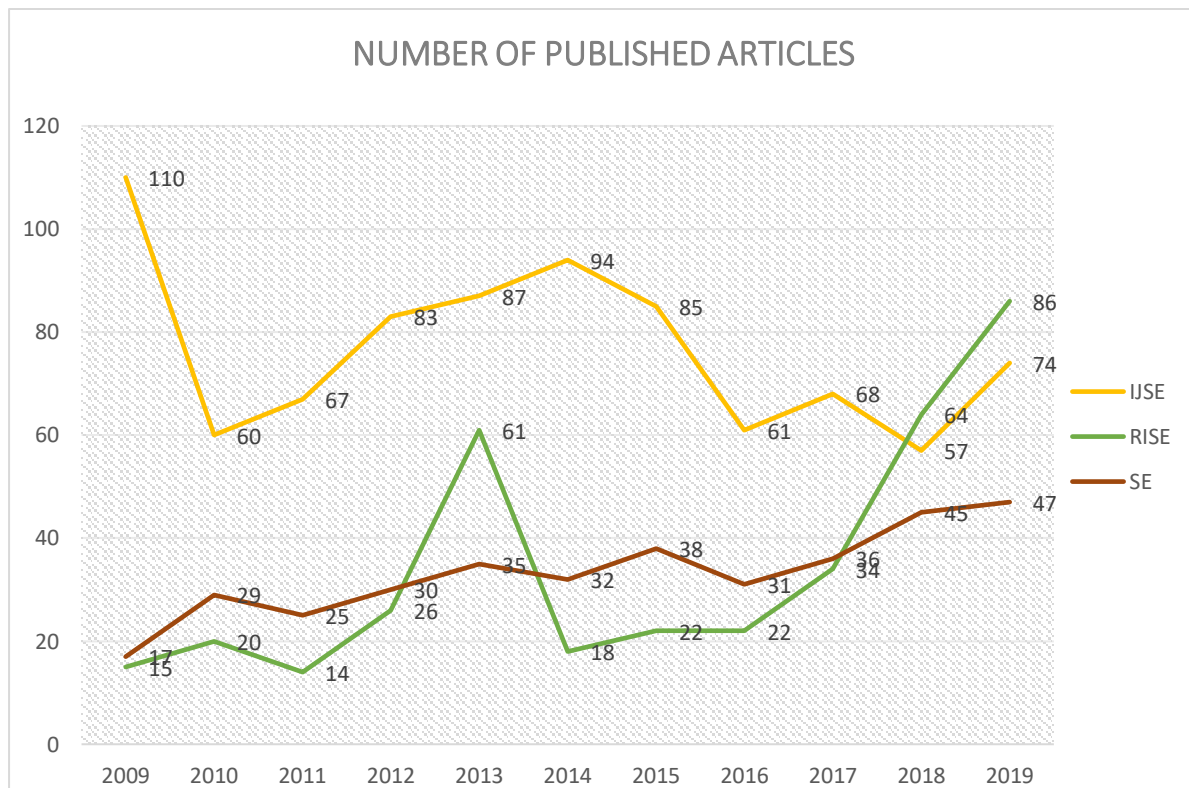


FIGURE 2. Number of articles published in three reputable international journals in the last 11 years

Furthermore, the topic of science learning: contexts, characteristics and interactions is also the topic most discussed by researchers in RISE and SE journals. The total articles covering these two topics are 57 and 45, respectively. Then, the second topic that became the trend of physics education research in the RISE journal in the 2009-2019 period was

science learning: development of student understanding. Meanwhile, in the SE journal, the topic of physics education research that ranks second is discourse and argumentation in science education. The total articles published by these two journals are 42 and 31 articles, respectively.

Physics education research topics that have been discussed the least by physics education researchers in the last 10 years (2009-2019) in the IJSE journal are religious beliefs, methodological issues, and textbook analysis. The number of articles discussing this topic is only 22 articles. Then, there are 3 research topics that are rarely discussed by Physics Education researchers in the RISE journal in the period 2009 to 2019. The three topics are science learning in informal contexts, STEM/STEAM and other topics (religious beliefs, methodological issues, textbook analysis). There were only 12 articles covering this topic in that period. Then, the topic that physics education researchers discussed the least in the SE journal was technology for teaching, learning, and research. There are only 8 articles published by SE in the period 2009 to 2019 that discuss this topic.

TABLE 2.Percentage of physics education research topics published on IJSE, RISE and SE from 2009 to 2019

Topik	IJSE	RISE	SE	Total	(%)
Science Learning: Development of student understanding	78	42	29	149	9.35
Science Learning: Contexts, Characteristics and Interactions	113	57	45	215	13.50
Science Teaching: Primary School, Middle and High School	58	32	20	110	6.91
College Science Teaching and Learning	36	13	17	66	4.14
Science Learning in Informal Contexts	31	12	24	67	4.21
Pre-service Science Teacher Education	28	18	16	62	3.89
In-service Science Teacher Education	45	18	17	80	5.02
Curriculum and Assessment	82	30	23	135	8.47
Cultural, Social, and Gender Issues	42	27	28	97	6.09
Technology for Teaching, Learning, and Research	50	14	8	72	4.52
History, Philosophy, Sociology, and Nature of Science	44	21	22	87	5.46
Policy, Reform, and Program Evaluation	44	15	19	78	4.90
Discourse and Argumentation in Science Education	54	18	31	103	6.47

Figure 3 presents the total percentage of physics education research topics published in 3 international journals of high reputation from 2009 to 2019. From the results of analysis, it was found that the topics most discussed by Physics Education researchers were science learning: contexts, characteristics, and interaction. The percentage of articles covering this topic as a whole is 13.50%. The second topic that became a trend in 3 reputable international journals analyzed was science learning: development of student understanding. There are 9.35% of articles published in IJSE,

RISE, and SE journals that discuss this topic. The third order is occupied by the topic of curriculum and assessment. The percentage of articles discussing this topic in the period 2009 to 2019 in 3 reputable international journals is 8.47%.

Lin et al. [10], conducted the similar study using the data from these three journals. They analyzed 1,088 articles published by the journals in the 5-year period, namely 2013-2017. The research showed quite similar results to this study. They found that there were three topics most favorite to the physics education researchers: the context of students' learning, science learning, and students' conceptual learning. They also unveiled that STEM educations, undergraduate research experiences, and inequality in science education were getting more attention by the researchers. Another research that involved the articles from SE, IJSE, and RISE is research conducted by Chang, Chang, and Tseng [11]. The difference is that he added one more resource that is Journal of Research in Science Education (JRSE) and analyzed articles submitted from 1990-2007. He found that conceptual change and concept mapping is the most dominant topic investigated by the researchers in the period.

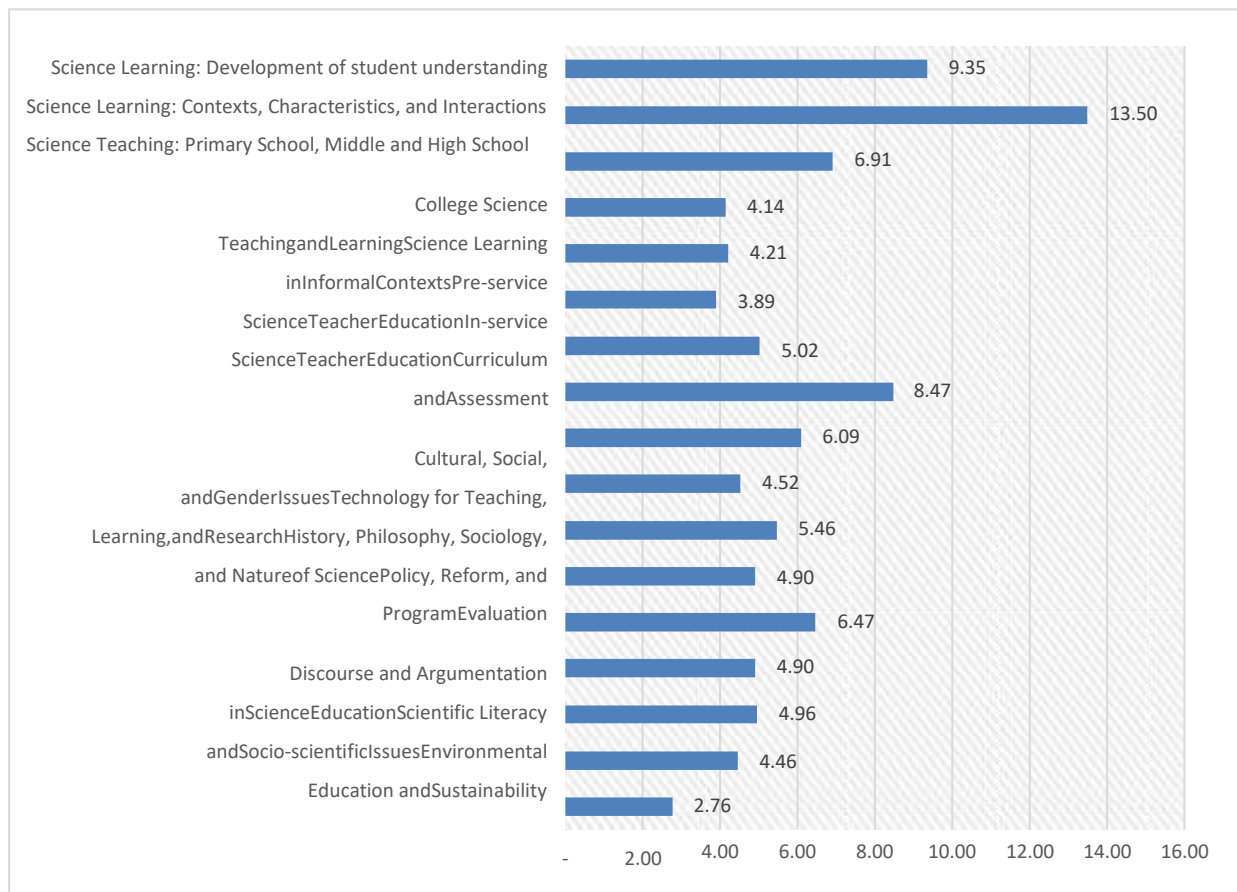


FIGURE 3. Total percentage of research topics on IJSE, RISE and SE from 2009 to 2019

Countries with the Most Published Papers in IJSE, RISE and SE from 2009-2019

To analyze the contribution of research by country, each article published in IJSE, RISE and SE during the period 2009-2019 was marked one point. Articles with multiple authors from different countries were assessed using the formula proposed by Tsai and Wen [3]. Table 4 shows the countries with the highest number of authors in IJSE, RISE and SE journals. As can be seen, the USA is the country that has the highest percentage of authors in the three reputable journals. The percentage of article writers with USA affiliation in IJSE is 28.09%, RISE is 18.33% and a staggering 67.22% in SE. One of the factors causing the large percentage of authors with USA affiliation is the master and doctoral students who study in the USA. They used university affiliations in the USA in their articles. In addition, the SE journal is a journal published in the IJSE so it is a little easier for writers in the USA to publish their articles.

The UK is the second country with the most authors on the IJSE and SE. However, in the RISE journal, UK ranks

5th, beaten by the number of authors from Australia, Sweden and Turkey. Countries in Asia also took part in the writing articles in this reputable journal. Several countries in Asia have entered the top 10 of the number of writers in the IJSE, namely China, Taiwan and Turkey. In the RISE and SE journals, Israel was also included in the top 20 contributors to articles. Interestingly, in the RISE journal, South Africa ranks 9th as the largest contributor of articles. The number of articles published by South Africa was 11.40 with a percentage of 3.01%. Thus, the authors of the most articles in international reputable journals have spread from all continents including America, Europe, Asia, Australia and Africa.

Table 5 shows the 10 countries that have the highest percentage of articles in the three reputable international journals. As can be seen, the USA is the country that has the highest score with a percentage of the number of authors of 35.30%. This percentage is almost 5 times greater than the number of articles published on behalf of the UK as the second country with the most authors. Furthermore, Australia ranks 3rd with the highest number of authors in these three reputable journals at 6.46%. Interestingly, the three countries that have the highest scores are countries where the official language is English.

TABLE 4. Top 10 Countries ranking and publication percentage in IJSE, RISE and SE from 2009 to 2019

Ranking	IJSE(N=845)			RISE(N=379)			SE(N=367)		
	Country	Score	(%)	Country	Score	(%)	Country	Score	(%)
1	USA	237.34	28.09	USA	69.48	18.33	USA	254.77	67.22
2	UK	77.42	9.16	Australia	49.99	13.19	UK	18.20	4.80
3	Australia	46.84	5.54	Sweden	30.87	8.15	Sweden	14.06	3.71
4	Germany	43.13	5.10	Turkey	23.11	6.10	Netherland	11.41	3.01
5	China	36.12	4.27	UK	19.05	5.03	Taiwan	9.20	2.43
6	Taiwan	35.41	4.19	Germany	16.20	4.27	Norway	8.60	2.27
7	Turkey	30.08	3.56	Canada	14.32	3.78	Canada	7.18	1.89
8	Sweden	28.71	3.40	Israel, Spain	12.17	3.21	Germany	7.00	1.85
9	Netherland	23.8	2.82	South Africa	11.40	3.01	Australia	5.91	1.56
10	Canada	22	2.60	Finland	11.08	2.92	Israel	3.87	1.02

TABLE 5. Top 10 Countries ranking and percentage of publications in total from 2009 to 2019 in reputable international journals

Rank	N=1591		
	Countries	Score	Percentage
1	USA	561.59	35.30
2	UK	114.67	7.21
3	Australia	102.74	6.46
4	Sweden	73.64	4.63
5	Germany	66.33	4.17
6	Turkey	54.99	3.46
7	Taiwan	54.81	3.45
8	China	46.19	2.90
9	Netherlands	44.99	2.83
10	Canada	43.5	2.73

Sweden and Germany rank 4th and 5th with the percentages of the number of articles published by authors from these two countries are 4.63% and 4.17%, respectively. Both countries are countries whose official language is not English. Turkey is the country in Asia that has the most authors in the three internationally reputed journals analyzed. Then followed by Taiwan and China. The percentage of articles published by authors from these three Asian countries are 3.46%, 3.45% and 2.90%, respectively. Finally, Netherlands, and Canada ranks 9th and 10th with the percentage of the number of authors are 2.83% and 2.73%, respectively. This has shown that the 10 countries with the most authors of articles in international reputable journals have spread across all Continents. However, there are no countries from the African continent that are included in the top 10 rankings.

Not many researches explored the contributing authors in these three journals. Cavas examined the articles in Science Education International (SEI) journal which is indexed by ERIC (Education Resources Information Center); The Asian Education Index; Education Research Complete Database; Index Copernicus Journals Master List; DOAJ Directory of Open Access Journals; and The Education Research Global Observatory [5]. During the period of 2011-2015, he analyzed 126 articles submitted by 281 authors from 43 countries. From the result of analysis, it was known that Turkish physicists have successfully contributed the most articles for this journal, followed by American and Australian researchers. This is quite different from this current research which found that USA dominated the three journals by always being in the first place throughout the period of 2009-2019.

CONCLUSION

Based on the results of the study, it can be concluded that:

1. The topics of physics education research that are trending in IJSE, RISE and SE journals as representatives of well-respected international journals in the 2009-2019 period are science learning: contexts, characteristics and interactions (13.50%), science learning: development of student understanding (9.35%), and curriculum and assessment (8.47%). Meanwhile, the research topics of religious beliefs, methodological issues, textbook analysis (2.76%) and pre-service science teacher education (3.89%) are research topics that are rarely discussed by physics education researchers in the 2009-2019 period.
2. The country that has contributed the most articles in IJSE, RISE, and SE journals is USA with the percentage of 35.30% or about five times higher than the UK and Australia which ranked second and third with the percentage of 7.21% and 6.46%, respectively. These top 3 countries are English speaking countries representing three different continents, namely America, Europe, and Australia. Asia is represented by Turkey, Taiwan, and China, while Africa has no representative in the top 10 article contributors by countries.

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