International Journal of STEM Education

EDITORIAL Open Access

Eight years of development in welcoming and engaging diverse scholars to share and promote STEM education research worldwide

Yeping Li*

Abstract

The *International Journal of STEM Education* went through eight publication cycle years from August 2014 to July 2022. The journal continues its growth trends in terms of multiple performance measures, reflecting on-going development of STEM education research and the journal's international leadership. In this editorial, I share the journal's development up to and including its eighth publication cycle year (August 2021–July 2022), and discuss the diversity trends in multiple dimensions including authorship and research topics reflected in the journal's publications.

Keywords: Altmetric, Authorship, Citation, Diversity, Impact, STEM education research, Topic, Trends

Introduction

Over the years, I have summarized and shared the journal's publication performance based on the journal's publication cycle (PC) year that started in August 2014 (Li, 2018, 2019, 2020, 2021). These yearly editorials aimed to keep the journal's broad international readership updated about the journal's performance and its growth, which reflected the rapid development of STEM (science, technology, engineering and mathematics) education research and the journal's international reach. Moreover, I took the opportunity presented by the yearly editorial to identify and discuss one important aspect that the journal has strived to achieve along the journey. Adding the eighth PC year from August 2021 to July 2022, the *International Journal of STEM Education* (IJSTEM) has furthered its growth and leadership. In this editorial, I will update the journal's performance and development, and discuss the journal's efforts in welcoming and engaging diverse scholars to share and promote STEM education research worldwide.

The following sections are organized in three main parts, the first about the journal's performance in multiple measures over the years and the second about the diversity trends in multiple dimensions reflected in the journal's publications. In the third part, I will share the journal's efforts and recent changes in the editorial board, and conclude with acknowledgements to STEM education researchers and readers around the globe for the on-going strong support that makes the journal's success possible.

The journal's performance in multiple measures

Performance progress measured by indexing services

The IJSTEM has been covered by more than 20 indexing services, notably Elsevier's Scopus that the journal started to receive it in 2018 and then Clarivate's Social Sciences Citation Index (SSCI) that started in 2019. Figure 1 summarizes the journal's performance progress over the past four years as measured by Elsevier's Scopus. It is clear that the journal continued to reach new highs in 2021 in all three metrics of Scopus as reported in June

*Correspondence: yepingli@tamu.edu
Texas A&M University, College Station, TX 77843-4232, USA

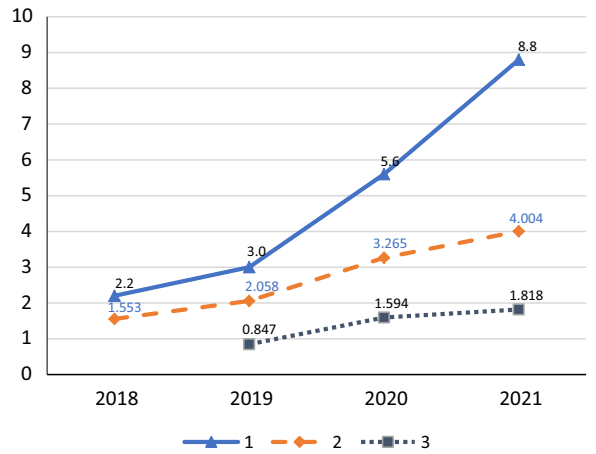

Fig. 1 Scopus metrics by calendar year (note: 1 = Scopus CiteScore, 2 = SNIP, 3 = SJR). Source: scopus.com website

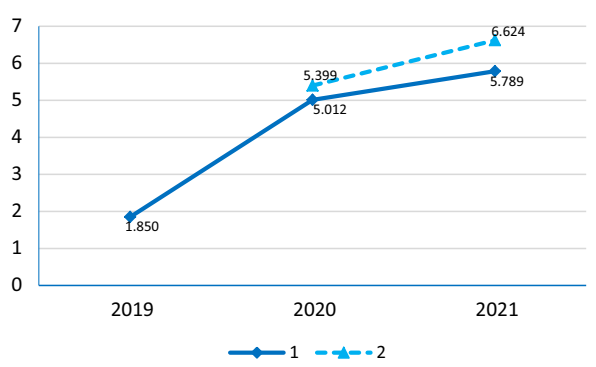

Fig. 2 Clarivate's IF by calendar year (1 = 2-year IF, 2 = 5-year IF). Source: Clarivate's journal citation reports

2022: Scopus CiteScore (CS), Source Normalized Impact per Paper (SNIP), and SCImago Journal Rank (SJR). With the calculation of weighted citations, SJR provides a measure of the journal's performance that is comparable across different fields. The SJR value has placed the journal in Quartile 1 (Q1) in the category of Education covered by Scopus since 2019. The CS of 8.8 earned the journal at #23 (98th percentile) out of 1406 journals in Education covered in 2021.

Figure 2 provides the journal's up-to-date performance measured by impact factor (IF) from Clarivate since IF year 2019. Two IFs are typically provided by Clarivate: 2-year IF and 5-year IF that differ in terms of the number of years being covered for calculating IF. IJSTEM did not receive 5-year IF until IF year 2020. Figure 2 shows that the journal reached new highs in IF year 2021 in both IF measures reported in June 2022. The 2-year IF value placed the journal at #17 out of 267 journals covered by SSCI (Social Science Citation Index) in the category of "Education & Educational Research", #4 out of 44 journals in the sub-category of "Scientific Disciplines". The 2-year IF continues to place the journal in Journal Impact Factor (JIF) Quartile 1 (Q1) among these 267 journals in IF year 2021.

Both the measures of Elsevier's Scopus and Clarivate's IF show the consistent and steady improvement of the journal's publication citation performance over the past several years. Specifically, the journal's publication citation performance in the eighth PC year provides a further confirmation about the journal's leadership in sharing and promoting STEM education research internationally as discussed before (Li, 2020, 2021).

To learn more about the journal's publication citation performance, we can take a closer look at some of the highly cited publications. For articles published in 2019–2020, Table 1 shows the top 10 most-cited publications in descending order for IF year 2021. It is clear that the vast majority of these 10 most-cited publications in 2019–2020 are on diverse topics in STEM education rather than one of the component disciplines of STEM, consistent with what was noticed before from examining the highly cited publications in previous editorials (Li, 2020, 2021). The result further confirms the journal's original publication emphasis on STEM education (Li, 2014).

Table 1 also shows that the 10 most-cited publications had an average of 18 citations per article with a range of 9–55 citations in 2021. Moreover, 6 out of these 10 most-cited articles were published in 2020, which contributed an average of about 15 citations per article in 2021. The result suggests that the journal recent publications had been well received and cited in IF year 2021. As the citation performance of publications in 2020 and 2021 will be included and reported for IF year 2022, we can expect to learn more next year about possible short-term trends in article citations.

Performance progress measured in terms of the number of publication accesses

The number of full-text article accesses is another important measure of a journal's performance as used in previous editorials (e.g., Li, 2021; Li et al., 2019). Figure 3 shows the total number of times that the journal publications were accessed by year. It is clear that the journal publications continued to attract many more views and downloads in 2021, with a total of 1,179,755 accesses, which is about a 80% increase, or a net 523,200 more accesses than the 656,555 accesses in 2020. The performance in 2021 marked the first time for the journal to have more than 1 million full-text accesses a year,

Table 1 Top 10 most-cited articles published in 2019–2020 for IF year 2021

Title (publication date)	Author(s)	Citations for IF year 2021*
Teachers' perception of STEM integration and education: a systematic literature review (2019-01-14)	K. C. Margot & T. Kettler	55
Research and trends in STEM education: a systematic review of journal publications (2020-03-10)	Y. Li, et al.	23
Developing student 21st Century skills in selected exemplary inclusive STEM high schools (2019-11-25)	S. M. Stehle & E. E. Peters-Burton	18
Evidence of STEM enactment effectiveness in Asian student learning outcomes (2020-07-10)	B. Wahono, et al.	17
Factors influencing participation of underrepresented students in STEM fields: matched mentors and mindsets (2020-04-21)	K. Kricorian, et al.	13
Reviewing assessment of student learning in interdisciplinary STEM education (2020-06-09)	X. Gao, et al.	13
Increasing high school teachers self-efficacy for integrated STEM instruction through a collaborative community of practice (2020-04-16)	T. R. Kelley, et al.	12
Initial implementation of active learning strategies in large, lecture STEM courses: lessons learned from a multi-institutional, interdisciplinary STEM faculty development program (2020-02-05)	E. Borda, et al.	10
Universal Design for Learning in postsecondary STEM education for students with disabilities: a systematic literature review (2019-03-04)	J. Schreffler, et al.	10
Evidence that communities of practice are associated with active learning in large STEM lectures (2019-01-14)	J. H. Tomkin, et al.	9

*Based on citation counts from Clarivate's journal citation reports

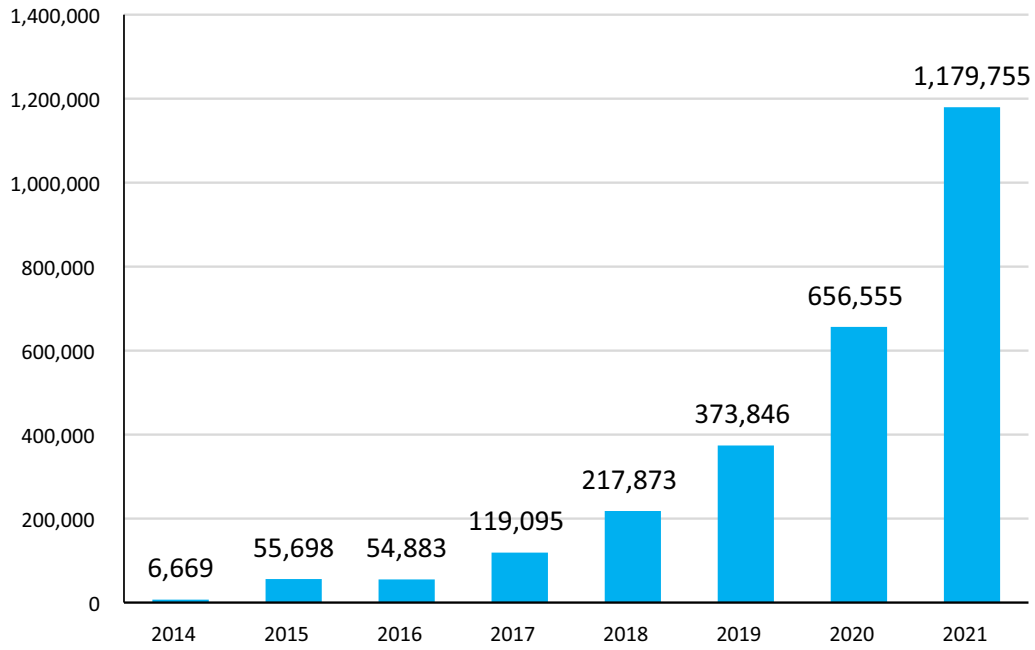

Fig. 3 Number of full-text accesses* by calendar year (Source: Springer). * Accesses are defined as the number of times full text or PDF versions of articles are accessed directly from the journal website and SpringerLink. Downloads are defined as HTML, LookInside, PDF, and Epub clicks. Please note that accesses do not include article downloads from mirror databases such as PubMed Central

a milestone that was achieved in the eighth year of the journal's publication history.

To further examine journal publication accesses, we can take a closer look at some highly accessed articles. Table 2 shows the top 10 most-accessed articles in 2021 in descending order. There were an average of 35,470 full-text accesses for each of these articles with a range of 23,739 to 67,178 accesses, indicating the high popularity and interest of these articles on diverse topics to the journal's international readership. The bold titles refer to those 6 articles that also made to the list of top 10 most-accessed publications in 2020 (Li, 2021). In comparison,

Table 2 Top 10 full-text article accesses in 2021

Title (publication date)	Author (country/region*)	Full-text accesses
Multiple-true–false questions reveal more thoroughly the complexity of student thinking than multiple-choice questions: a Bayesian item response model comparison (2019-05-10)	C. E. Brassil et al. (USA)	67,178
Teachers' roles and identities in student-centered classrooms (2018-09-14)	L. S. Keiler (USA)	45,478
Research and trends in STEM education: a systematic review of journal publications (2020-03-10)	Y. Li et al. (USA)	39,225
Students' reasons for STEM choices and the relationship of mathematics choice to university admission (2019-12-13)	Satu Kaleva et al. (Finland)	35,080
Developing student 21st Century skills in selected exemplary inclusive STEM high schools (2019-11-25)	S. M. Stehle & E. E. Peters-Burton (USA)	32,411
Problematizing teaching and learning mathematics as "given" in STEM education (2019-12-19)	Y. Li & A. H. Schoenfeld (USA)	31,498
A conceptual framework for integrated STEM education (2016-07-19)	T. R. Kelley et al. (USA)	29,591
Exploring the factors that influence the career decision of STEM students at a university in South Africa (2020-12-01)	E. N. Abe & V. Chikoko (South Africa)	25,410
Change theory and theory of change: what's the difference anyway? (2020-01-17)	D. L. Reinholz & T. C. Andrews (USA)	25,089
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 (2018-05-16)	K. A. Blotnicky et al. (Canada)	23,739

Source: Springer

*Country/region refers to where the corresponding author's research organization or institution was located at the time of publication

these 6 articles had an average of 39,452 accesses per article, exceeding the overall average article accesses (35,470) for these top 10 most-accessed articles. The result suggests the on-going high interest in these 6 articles on diverse topics in the global community.

Among the top 10 most-accessed articles in 2021, the majority (seven out of 10) had their corresponding authors from the United States. The other three had the corresponding author from three other countries (i.e., Canada, Finland, and South Africa). In comparison, there were only two publications in the most-accessed article list in 2020 contributed by scholars from two other countries (Australia and Canada) (Li, 2021). The result may suggest an increasing tendency in the international community to learn about views and research works from publications contributed by scholars outside of the United States, consistent with a prediction made in a previous yearly editorial (Li, 2021).

Checking further about the subject content covered by these 10 most-accessed articles, it is clear that the majority of these 10 most-accessed articles are about STEM, rather than an individual STEM discipline. The content focus on STEM is generally consistent with the top 10 most-cited list (Table 1). The results confirm that the journal has been valued for its leadership role in sharing and promoting STEM education research.

Performance progress measured in terms of altmetrics

One performance measure for scholarly publications that has increasingly gained publishers' and researchers' attention over the past decade is altmetrics (Elmore, 2018; Garcia-Villar, 2021), provided by a London-based company (https://www.altmetric.com/). Altmetrics stands for alternative metrics, which aim to complement traditional performance metrics such as citation counts and downloads. Altmetric provides a digital impact measure by tracking what people are saying about research articles online from multiple media data sources, including social media (Twitter and Facebook), traditional media (newspaper stories, etc.), and blogs. Altmetric then aggregates all of the information ("mentions") to calculate and provide the Altmetric Attention Score (AAS), a weighted count of the different sources that mention the article.

Springer started to use Altmetric data for every article available on SpringerLink in 2014 (https://www.springer.com/gp/about-springer/media/press-releases/corporate/springer-now-sharing-data-from-altmetric-on-springerlink/23770). SpringerOpen includes altmetrics as part of article metrics (https://www.springeropen.com/get-published/indexing-archiving-and-access-to-data/article-metrics). Figure 4 shows that the journal's total numbers of tweets and article mentions have been in overall upward trends, with a dip in 2016 and then 2019, respectively, that might associate with the decreased number of publications counted in these two years. Tweets have been the dominant type of article mentions over the

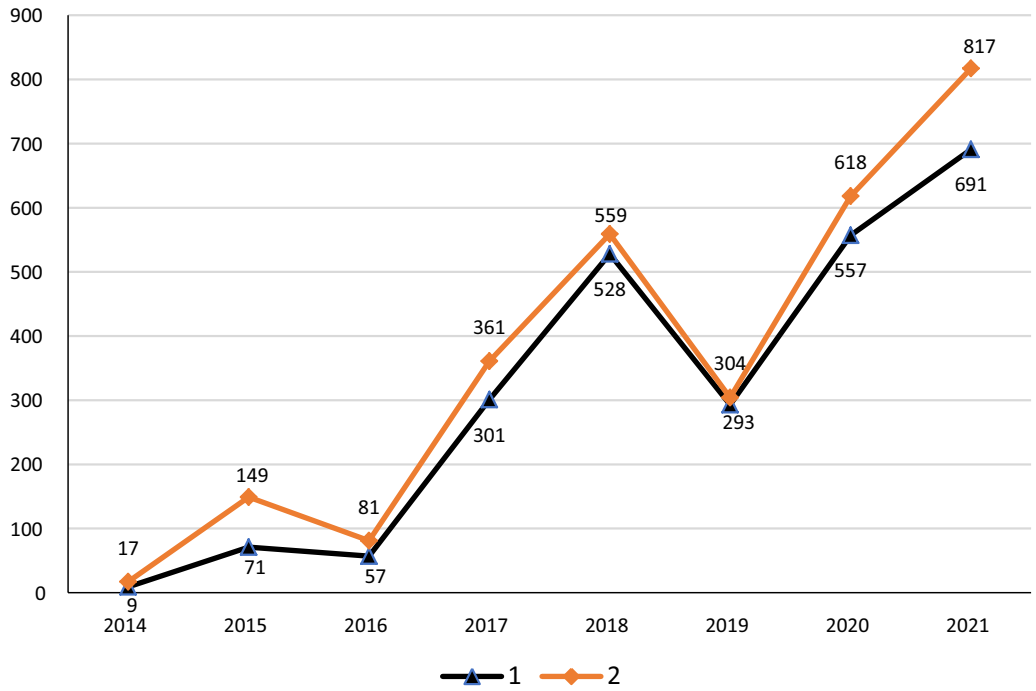

Fig. 4 Numbers of tweets and mentions by calendar year (1 = total # of tweets, 2 = total # of article mentions*) (Source: Springer, obtained on Oct 10th, 2022). * The number of article mentions in the social media is provided by Altmetric, which monitors article mentions on Twitter, Facebook, Google +, Reddit, Blogs, news outlets and Faculty of 1000 reviews. Articles can only be counted if the DOI is included in the article

years. It is clear that the journal's publications received increasing digital attention over the past two years (2020 and 2021), in terms of either tweets alone or article mentions. There is also an increasing number of article mentions, excluding tweets, over the past two years. The result suggests an increasing diversity trend for the journal's publications in attracting digital attention beyond tweets.

Table 3 Altmetric top 10 articles published since 2014

Score*	Title (publication date)	Author (country/region**)
310	"If you aren't White, Asian or Indian, you aren't an engineer": racial microaggressions in STEM education (2020-09-14)	M. J. Lee, et al. (USA)
204	Examining ways to meaningfully support students in STEM (2018-12-20)	L. Martin-Hansen (USA)
129	STEM education K-12: perspectives on integration (2016-03-01)	L. English (Australia)
80	The influence of active learning practices on student anxiety in large-enrollment college science classrooms (2018-06-12)	K. M. Cooper, et al. (USA)
70	Astrophotography, a portal for engaging non-STEM majors in science (2016-11-08)	M. A. De Leo-Winkler, et al. (USA)
63	Which role models are effective for which students? A systematic review and four recommendations for maximizing the effectiveness of role models in STEM (2021-12-02)	J. R. Gladstone & A. Cimpian (USA)
54	A conceptual framework for integrated STEM education (2016-07-19)	T. R. Kelley & J. G. Knowles (USA)
52	Race and gender differences in how sense of belonging influences decisions to major in STEM (2018-04-10)	K. Rainey, et al. (USA)
49	Growing a growth mindset: characterizing how and why undergraduate students' mindsets change (2020-07-08)	L. B. Limeri, et al. (USA)
42	Understanding science teachers' implementations of integrated STEM curricular units through a phenomenological multiple case study (2018-02-13)	E. A. Dare, et al. (USA)

*Based on Altmetric attention scores that were obtained on October 10th, 2022. (Source: Springer)

**Country/region refers to where the corresponding author's research organization or institution was located at the time of publication

To take a further look at the journal publications' social media impact, Table 3 provides a list of top 10 articles with the highest AAS published since 2014. These 10 articles have an average of about 105 AAS per article with a range of 42 to 310 AAS. According to Altmetric.com (https://help.altmetric.com/support/solutions/articles/6000233313-putting-the-altmetric-attention-score-in-context), AAS is not normalized and the interpretation of its impact magnitude varies from one journal to another. But in general, a score of 20 or more means that an article is attracting digital attention far more than most of its contemporaries. Thus, these articles illustrate well the broad social media attention that this journal's publications have received.

By checking these top 10 publications' topics, we noticed that these articles cover many different topics with the majority on topics related to students, such as engaging and supporting students, social, cultural, and gender issues related to STEM students. The result provides a good indication about the societal interest and attention on these issues and related research. Moreover, among the 10 articles, four were published in 2018, three in 2016, and three in 2020–2021. The result suggests that social media attention to publications may take time to accumulate and evolve. At the same time, recent publications with high AAS can well suggest 'hot' topics that have gained traction, for example, the article on racial microaggressions in STEM education (Lee et al., 2020) gained the highest AAS of 310.

We also noticed that nine out of these 10 articles were contributed by scholars in the United States, and one from Australia. The result may suggest that different social media or platforms may be used in different countries/regions and in different ways. It remains to be learned in the future how well Altmetric may be able to collect digital attention beyond those social media typically used in the West, and whether readers in different countries/regions may have different habits in using social media to share academic research publications.

The diversity trends reflected in the journal's publications

A recent review of the journal's publications over the 8-year period (2014–2021) revealed (1) on-going dynamic research on many different topic areas in STEM education with increasing quantity and high quality, (2) increased research interest and publications in STEM education at the post-secondary level, and (3) increased participation and contribution from scholars in many different fields other than education/educational research (Li & Xiao, 2022). Taking these aspects together, the review uncovered vibrant and amazing diversity trends resulted from the expanded engagement and contribution of diverse scholars from different countries/regions with various background training. The diversity trends not only reflect an overall exciting development in STEM education research worldwide, but also confirm the journal's original commitments made to the field. It is stated in the journal's inaugural editorial that IJSTEM was established to promote research on STEM education and advance the field of STEM education by

(1) providing an outlet to publish and share research from various disciplines and methods,
(2) increasing access to research findings for researchers and educators through the journal's open-access platform, and
(3) galvanizing scientists and educational researchers to further our knowledge about STEM education (Li, 2014).

Moreover, the journal is committed to be open to all issues in STEM education across all levels from pre-college through continuing education (Li, 2014). Over the past eight years, these commitments have guided the journal in its efforts to welcome and encourage diverse scholars to develop, collaborate, and share high-quality research on questions and issues important in STEM education across all school levels.

As the eighth PC year (August 2021–July 2022) covers some new publications in 2022 that were not covered in the recent calendar year-based review (Li & Xiao, 2022), this editorial extends the recent 8-year review to gain a glimpse into publication diversities in the eighth PC year. There have been a total of 60 publications in the eighth PC years. The following four sub-sections provide a summary of these publications in four aspects: research topics, school levels, the corresponding author's nationality/region, and the corresponding author's profession, respectively. To be consistent with the recent 8-year review, the same categories for each of these four aspects were used to classify and examine those new publications in 2022.

The publication diversity measured in terms of research topics

Seven topic categories (TC) used in the recent review are listed below. They were used to classify all publications included in the eighth PC year.

> TC1: Teaching, teacher, and teacher education in STEM (including both pre-service and in-service teacher education) in K-12 education;
> TC2: Teacher and teaching in STEM (including faculty development, etc.) at post-secondary level;

TC3: STEM learner, learning, and learning environment in K-12 education;
TC4: STEM learner, learning, and learning environments (excluding pre-service teacher education) at post-secondary level;
TC5: Policy, curriculum, evaluation, and assessment in STEM (including literature review about a field in general);
TC6: Culture, social, and gender issues in STEM education;
TC7: History, epistemology, and perspectives about STEM and STEM education.

Figure 5 shows that every TC has publications, with TC5 having the most publications followed by TC4. The results suggest active research in all seven TCs together with a great many publications on policy, curriculum, evaluation, and assessment in STEM (TC5) and STEM learner, learning, and learning environments at the post-secondary level (TC4), a trend consistent with what were found and reported in the recent 8-year review (Li & Xiao, 2022). Moreover, TC2 with nine publications now makes it the number #3 category, surpassing research publications on STEM teaching or learning at the K-12 school level. Putting publications in TC4 and TC2 together confirms a trend of increased publications on issues in STEM education at the post-secondary level, diversifying research topics that were typically centered at the K-12 school level just a few years ago.

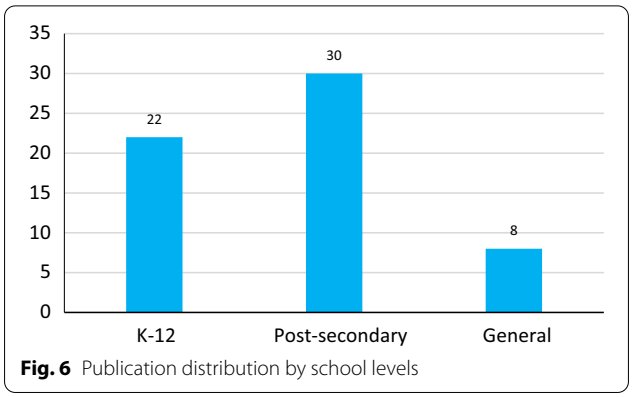

Fig. 6 Publication distribution by school levels

The publication diversity measured in terms of school level in focus

Consistent with the diversity trend in TC observed in research publications in the eighth PC year, Fig. 6 shows that research publications on issues at the post-secondary level continue to have more than those at the K-12 school level or in the "general" category (i.e., for those publications on questions or research work either pertinent to all school levels or across the boundary of K-12 school and college). At the same time, it should be noted that the difference between the number of publications on issues at the K-12 school level vs. those at the post-secondary level is notably decreased, in comparison to the differences over the past four years (Li & Xiao, 2022). The results suggest that STEM education research at the K-12 level continues to be dynamic and produce an impressive number of high-quality scholarly work all the time.

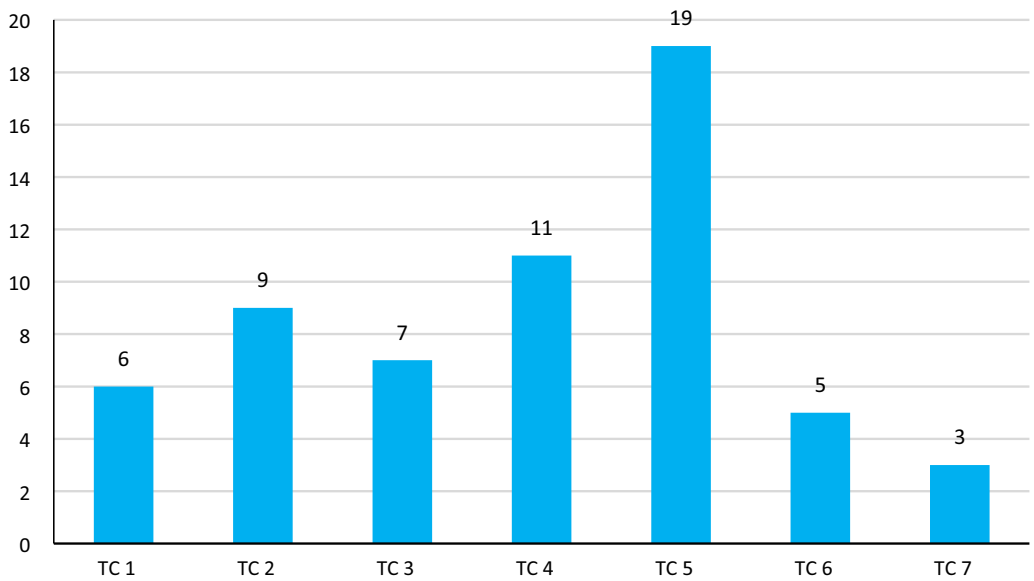

Fig. 5 Publication distribution by seven topic categories

The publication diversity measured in terms of the corresponding author's nationality/region

Examining the corresponding author's nationality/region of journal publications helps us to gain some insights about the international diversity in research engagement and contribution to a field. Figure 7 shows 37 publications (62%, out of 60 publications) with the corresponding author from the United States and the remaining 23 publications (38%) with the corresponding author from 12 other countries/regions. The result suggests a notable trend of increased international diversity from what we learned from previous journal publication reviews (Li et al., 2019, 2020). About 75% journal publications were typically contributed by U.S. scholars either in this journal's publications from 2014 to 2018 (Li et al., 2019) or publications from 36 journals from 2000 to 2018 (Li et al., 2020). It should also be noted that researchers in mainland China contributed 6 publications in the eighth PC year, which represents a dramatic increase in the number of publications in this journal from that country/region. The increasing international diversity in the corresponding authorship speaks clearly about the active engagement and contribution of STEM education researchers from diverse countries/regions, especially those in Asia. The increased number of publications contributed from Asia confirms a prediction made in a previous review of this journal's publications (Li et al., 2019).

The publication diversity measured in terms of the corresponding author's profession

The recent review of the journal's publications over the 8-year period (2014–2021) added a new dimension about the publication's corresponding authorship: author's profession (Li & Xiao, 2022). To simplify the classification of the author's profession, a differentiation between those specialized in education/educational research and others ("STEM+") was made to gain an overview of the profession of those researchers actively contributed to STEM education scholarship development.

Figure 8 shows similar numbers of publications with the corresponding author in education (31) or STEM+ (29) in the eighth PC year. The result confirms the diversity trend in the corresponding author's profession uncovered in the recent review (Li & Xiao,

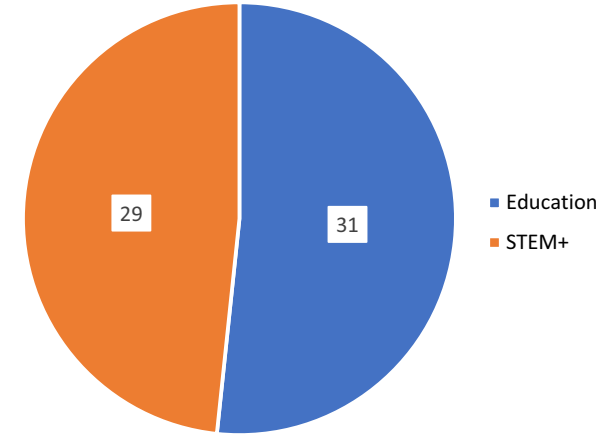

Fig. 8 Publication distribution by the corresponding author's profession

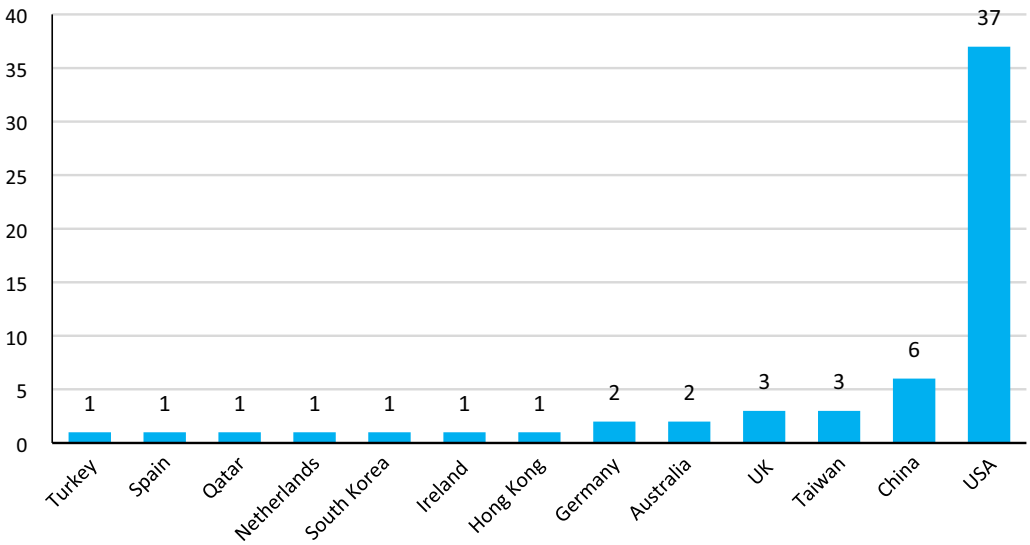

Fig. 7 Publication distribution by the corresponding author's nationality/region

2022), with active participation and contribution to STEM education scholarship from researchers with diverse discipline training.

Coda

The journal's stellar performance in the eighth PC year in terms of both traditional measures (citations and accesses/downloads) and altmetrics are clear indications of on-going development of STEM education research and the journal's solid leadership in the field. Moreover, reviews of the journal's publications over the past eight years (2014–2021) and in the eighth PC year (August 2021–July 2022) revealed diversity trends in multiple dimensions, including research topics, school levels in focus, nationality/region of the corresponding authors and their professions. The diversity trends suggest the exciting and dynamic evolution of STEM education as a field, with the expanded engagement of diverse scholars who are interested in identifying and studying important issues in STEM education worldwide.

At the same time, the diversity trends also reflect the journal's years of efforts in welcoming and engaging internationally diverse researchers and readers from different disciplines. As engagement is a multifaceted construct including cognitive, emotional, and behavioral engagement (Fredricks et al., 2004), engaging researchers and readers requires to have such a mindset, passion, and actions. The journal has strived for excellence in quality and global impact through welcoming international contributions on diverse topics, inviting diverse scholars with different cultural and disciplinary backgrounds to help review manuscripts, and having scholars from different countries/regions and with diverse background training and research experiences to serve on the editorial board. In addition, the journal aims to keep communicating with the broad international community of STEM education about its publications and performance, through regularly updating publication performance information on the journal website and social media, providing periodic reviews of the journal's publications and performance, and listening and responding to different inquiries. In return, as discussed in previous editorials (e.g., Li, 2018, 2019), the journal has gained the on-going strong support and engagement of numerous and diverse authors, reviewers, and readers worldwide, which have made the journal's success possible. Thank you all for making and keeping the journal as an important and international gathering place in STEM education.

I would like to take this opportunity to share some changes related to the journal's editorial board. Here is the difficult one. Dr. Jeffrey E. Froyd, the journal's associate editor, passed away on October 5th, 2022. He was 68 years old. Froyd had been recognized as a pioneer and leader in engineering education. In addition to his impactful teaching and research, he also served as editor-in-chief of the *IEEE Transactions on Education,* a senior associate editor for the *Journal of Engineering Education,* and of course the first associate editor of this journal (IJSTEM) from the beginning. In memory of Jeffrey Froyd, another editorial with a collection of tributes is in preparation and will be published soon in IJSTEM.

As the journal continues to grow, Springer agrees that the journal needs more associate editors. I am happy to share that Dr. Thomas K.-F. Chiu from the Chinese University of Hong Kong (Hong Kong) and Dr. Meixia Ding from Temple University (USA) recently accepted to serve as associate editors starting this fall. I am confident that Dr. Chiu and Dr. Ding will bring new perspectives, energy, and experience to further the journal's development.

Last but not least, I want to take this opportunity to thank again all the members of the journal's editorial board, and staff members at SpringerOpen, for their dedicated support. It is a great pleasure to work together with them all.

Abbreviations

CS: CiteScore; IF: Impact factor; IJSTEM: International Journal of STEM Education; JIF: Journal Impact Factor; K-12: Kindergarten–Grade 12; PC: Publication cycle; SJR: SCImago Journal Rank; SNIP: Source Normalized Impact per Paper; SSCI: Social Science Citation Index; STEM: Science, Technology, Engineering, and Mathematics; STEM+: Disciplines or fields other than education, including those commonly considered under the STEM umbrella plus some others; TC: Topic category.

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Declarations

Competing interests

There is no competing interest, as this is a single authored article.

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