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Linking K-12 STEM Pedagogy to Local Contexts: A Scoping Review of Benefits and Limitations

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Student engagement and learning in science, technology, engineering and mathematics (STEM) fields in primary and secondary schools is increasingly being emphasized as the importance of STEM skills for future careers is realized. Localized learning has been identified as a group of pedagogical approaches that may enhance learning in STEM by making the relevance of STEM clear to students and providing stronger connections to students' lives and contexts. This paper reports on a scoping review that was conducted to identify the benefits and limitations of localized learning in primary and secondary school STEM disciplines. A secondary aim of the review was to identify strategies that increase the effectiveness of localized learning these disciplines. Following literature searches of four databases, 1923 articles were identified. Twenty-five studies met the inclusion criteria. Potential benefits of localized learning included increases in enjoyment of STEM, improvements in learning, more positive STEM career aspirations, and development of transferable skills. The main challenges of these pedagogical approaches were time restrictions and lack of community involvement. Strategies for enhancing the impact of localized pedagogy included professional development for teachers (in STEM content knowledge, integration of localized pedagogy, and capacity to address socio-scientific issues), integration of technology, whole-school implementation of the pedagogical approach, and integration of the wider community into STEM education. These findings provide support for localized learning as an effective pedagogical approach to enhance STEM learning in schools, while emphasizing the critical roles of teachers and communities in supporting students to realize the relevance of STEM in their lives.

Keywords: stem education, localized pedagogy, contextualized curriculum, scoping review, student engagement

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INTRODUCTION

Science, technology, engineering, and mathematics (STEM) fields are viewed as vital contributors to economic growth and innovation (Freeman et al., 2019). STEM skills and competencies are key to increasing the quality of the STEM workforce and related research, and are also viewed as highly transferable skills that increase employability in non-STEM sectors (Marginson et al., 2013). STEM education also contributes to the development of scientific literacy, which allows individuals to think critically about science, understand what is and is not science, and use scientific understanding to make evidence-based decisions (Yacoubian, 2018). The importance of STEM education is underscored by government policies worldwide that seek to increase achievement and participation in STEM areas (Education Council, 2015; Freeman et al., 2019).

CONCERNS WITH STEM PARTICIPATION AND EDUCATION

Given the aforementioned importance of STEM, a lack of skilled workers in STEM fields is a significant concern in many countries (van Tuijl and van der Molen, 2016). While shortages in STEM fields are not ubiquitous, areas such as information and communications technology, physics, engineering, and advanced mathematics are commonly identified as areas of need. Such shortages are thought to partially stem from a "leaky pipeline" in STEM education, whereby students opt out of STEM subjects at varying points in their secondary and tertiary education (Blickenstaff, 2005; Watt et al., 2012). Engagement and interest in STEM subjects during primary and secondary schooling is therefore critical, as student attitudes are associated with their choices to pursue STEM subjects and careers (Wang and Degol, 2013; Dowker et al., 2016). Research suggests that student engagement in mathematics and science education changes during the course of formal schooling, with decreases in engagement commonly reported in the early years of secondary school (Plenty and Heubeck, 2013; Potvin et al., 2018).

A further issue of concern is the underrepresentation of women, ethnic minorities, and people from low socio-economic backgrounds in STEM fields, limiting the pool from which highly skilled individuals can be drawn (Marginson et al., 2013). A lack of diverse representation in STEM fields is also problematic because it leads to a narrower range of perspectives that can contribute to solving problems and driving innovation (van den Hurk et al., 2019). Research shows that gender differences in STEM attitudes and aspirations emerge during the school years. For example, a recent meta-analysis of "draw a scientist" studies found that children were significantly more likely to draw a scientist as male by 7–8 years of age, while younger children were no more likely to draw a male than female scientist (Miller et al., 2018). Gender differences in attitudes towards STEM subjects are apparent in the early years of secondary school, with girls tending to have less positive attitudes in comparison to boys (Berger et al., 2020). Further, girls are less likely to aspire to STEM careers than males (Archer et al., 2014; Holmes et al., 2018). Taken together, these findings suggest that gender differences emerge during childhood and adolescence, which potentially contribute to the leaky pipeline in STEM education.

LINKING STEM PEDAGOGY WITH LOCAL CONTEXTS

Participation in STEM is influenced by numerous factors that range from student-level factors (e.g., achievement, interest, and self-efficacy) to school-level factors (e.g., peer influences, pedagogical approaches, resources, subject offerings, and teacher expertise) to broader societal factors (e.g., socioeconomic status, gender norms) (Freeman et al., 2019; van den Hurk et al., 2019; van Tuijl and van der Molen, 2016). A significant body of research has focused on addressing student-level concerns, resulting in a variety of strategies designed to enhance STEM learning outcomes, engagement, and participation. Examples of such strategies include increasing awareness of STEM careers, making STEM role models available to young people, challenging stereotypes, and building student self-efficacy in STEM (van Tuijl and van der Molen, 2016). At the school-level, pedagogical approaches that contextualize and personalize STEM learning, connect STEM learning with local communities, and integrate the teaching of content with thinking skills (such as critical and creative thinking, problem solving, and flexible thinking) are also positioned as strategies that can enhance student achievement and interest in STEM (Marginson et al., 2013). The idea of localized learning has roots in economic geography, where it has been noted that local conditions and spatial proximity between stakeholders positively influences the generation of skills, processes, and products (Malmberg and Maskell, 2006). This idea of localized learning has been applied to education by researchers in the United Kingdom. The Science Capital and STEM Capital teaching approaches, encourage teachers to personalize and localize science and STEM content so that students can see how science is present in their everyday lives and in their communities, with the aim of enhancing engagement, aspiration, and achievement in science (Godec et al., 2017; Moote et al., 2020).

In this paper, our definition of localized learning includes pedagogical approaches that use local contexts to enhance the relevance and authenticity of STEM education to students in primary and secondary schools. Pedagogical approaches are an example of school-level factors, which are a promising area of research given their potential malleability (van den Hurk et al., 2019). The use of local contexts to teach STEM subjects is viewed as a useful way to increase the relevance of STEM education for students (Tytler et al., 2017), with evidence suggesting that student engagement and understanding can be enhanced by such approaches (Archer et al., 2018). These approaches have been associated with outdoor and environmental education for some time (Gruenewald, 2003), but the application of these approaches to STEM education more broadly is relatively recent.

There are a variety of ways in which STEM education can be linked with students' local context. For example, place-based learning uses student-centered learning approaches embedded in local phenomena to drive curriculum development (Smith, 2002). School-industry and school-community relationships can also be leveraged to demonstrate to students how their learning at school is linked with the "real world" work of STEM professionals (Education Council, 2015; NSW Department of Education, n.d.). Teachers can also purposefully link the content they teach with students' lives, interests, and identities to enhance sense-making and interest (Archer et al., 2018). Collectively, these pedagogical approaches are student-centered and are designed to make learning relevant and authentic while increasing students' feeling of connection and responsibility to their local community. Despite the potential benefits of using students' local contexts to teach STEM, a review of such practices is currently absent from the literature. A synthesis of this field of research is needed to identify effective strategies and approaches that contribute to enhanced student outcomes.

STUDY AIMS

The aim of this review is to examine the benefits and limitations of pedagogical approaches that link K-12 STEM curriculum to local contexts in primary and secondary schools. Specifically, the review addresses the following research questions:

(1) What are the benefits and limitations of linking K-12 STEM curriculum to local contexts for student learning?
(2) What strategies increase the effectiveness of linking K-12 STEM curriculum to local contexts?

We begin by outlining the method used to search the literature. Next, we review the empirical evidence relating to benefits and limitations of linking K-12 STEM curriculum to local contexts for student learning. We also review the strategies that have been identified to increase the effectiveness of these pedagogical approaches. Following this review of the research, we present an integrated discussion of the findings. We conclude with recommendations to guide future research in this important area.

MATERIALS AND METHODS

A scoping review surveys the research studies that have been conducted in a specific field, synthesizes those research findings, and identifies areas for further research (Booth et al., 2012). This scoping view adopted Arksey and O'Malley, (2005) five-stage framework that enabled the researchers to achieve in-depth results that were documented to ensure the review could be replicated by others. This five-stage framework involves identifying the research question/s, identifying relevant studies, study selection, charting the data, and collating, summarizing and reporting the results.

The focus of our scoping review was the exploration of key aspects of linking STEM pedagogy to students' local contexts. To ensure that a substantial range of literature was captured relating to this topic of interest, we posed the two research questions identified in the previous section. Key concepts and search terms were developed to capture literature that related to localized and contextualized education, STEM pedagogy and student learning. Search criteria were (curric* OR learn* OR syllab* OR educat*) NEAR/2 (local* OR personal* OR place-based) AND (STEM OR math* OR science OR tech*). The last ten years has seen the increased focus on STEM and place-based education and so this time period was initially established. Electronic databases were identified by the researchers. Search tools and Boolean operators were used to identify the relevant literature. The four databases searched in this review included A + Education, ERIC, PsycINFO and Scopus.

In the attempt to capture all relevant articles, an unmanageably large number of references was generated. Arksey and O'Malley, (2005) recommend that parameters on large numbers of references be reviewed once the sense of the volume and scope of the field is gained. The search parameters were therefore reviewed due to the large number of results generated (over five thousand articles). The time period was reduced to a five-year time period (Jan 1, 2016–Jan 1, 2021), which produced a more manageable number of articles for review.

There were 1923 articles identified using the key search descriptors. There were some articles removed from the search as they were duplicated in two to four databases. Search results were then screened using the following criteria: the article must be peer reviewed and written in English, the article must be empirical, the article must focus on STEM pedagogy, link STEM education with students' local context, and the population included in the study must be students in kindergarten to Year 12 school settings.

Titles were reviewed and a large number of articles were removed due to irrelevant focus of the articles evident in the title. A review of abstracts revealed further unrelated areas of focus. Articles were removed within this abstract screening as these articles did not have a strong focus on STEM or place-based learning; the article were based on a setting outside of the K-12 school setting; and the focus was on teachers and educators rather than student learning. A full-text screening was then undertaken. Guided by the inclusion and exclusion criteria, 25 articles were identified as relevant to the research topic. **Figure 1** illustrates the process of article selection based on the Preferred Reporting of Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Moher et al., 2009). Following Arksey and O'Malley, (2005) scoping review framework, these 25 articles were then summarized (see **Supplementary Table S1** in **Supplementary Materials**), and the findings collated and synthesized in the next section.

FINDINGS

The scoping review yielded 25 articles relevant to the research questions. The articles reported on studies conducted in six countries. Eighteen studies were conducted in the United States (US), three were conducted in Australia, and one study was conducted in each of Denmark, Hungary, Norway, and South Korea. Of the 25 studies, eight focused on students in K-5, seven studies involved middle school students, four students investigated both middle and high school students and six studies were conducted with high school students. Ten of the studies used qualitative methods only, 11 studies used a combination of qualitative and quantitative methods, with only four studies using exclusively quantitative methods and having sample sizes of more than 300 students. Articles were related to STEM with some focusing on mathematics (Althauser and Harter, 2016; Walkington and Bernacki, 2019), science (Buck et al., 2016; Francis et al., 2016; Leonard et al., 2016; Rahmawati and Koul, 2016; Gates, 2017; Zimmerman and Weible, 2017; Fűz, 2018; Bølling et al., 2019; Flanagan et al., 2019; Herman et al., 2019; Iversen and Jónsdóttir, 2019; Kermish-Allen et al., 2019; Kinslow et al., 2019; McClain and Zimmerman, 2019;

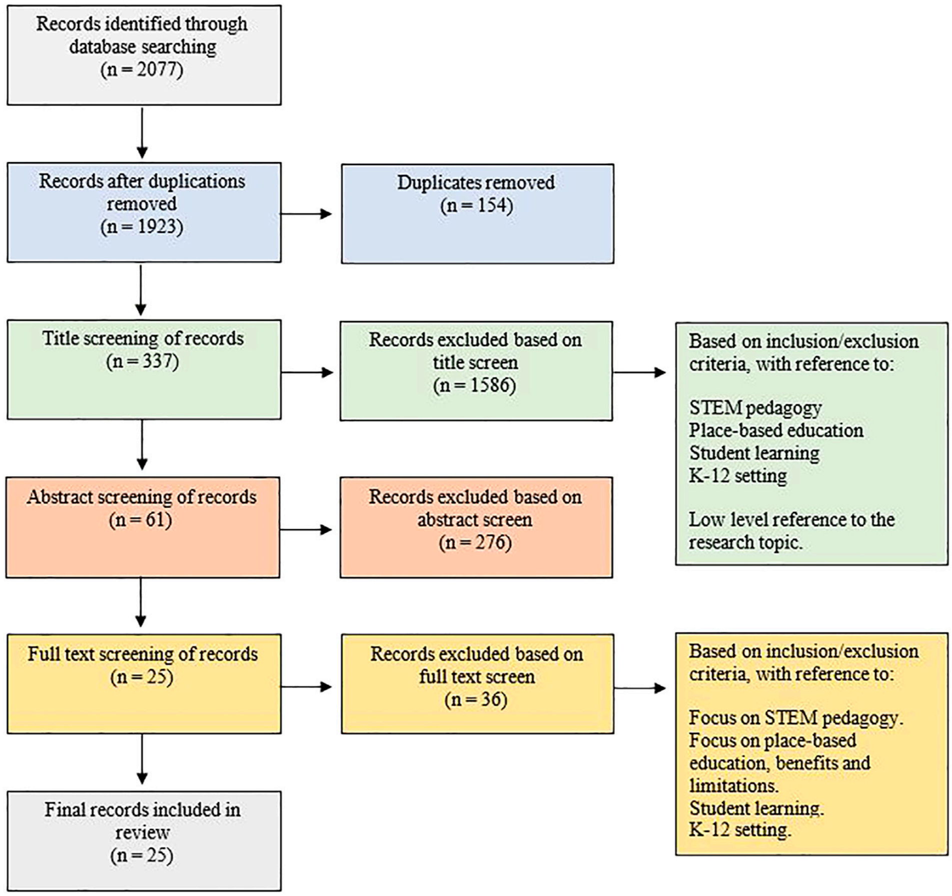

FIGURE 1 | Article selection flow diagram developed based on PRISMA.

Zimmerman et al., 2019; Littrell et al., 2020a; Littrell et al., 2020b; Land et al., 2020), technology (Litts et al., 2020), and general community issues with links to STEM pedagogy (Donnison and Marshman, 2018; Ritter et al., 2019; Kim et al., 2020). While most studies approached localized learning by taking students to community and environmental contexts outside of the classroom, other studies connected students with experts and their communities through the internet (Kermish-Allen et al., 2019) or brought the outside world into classrooms through virtual reality (Ritter et al., 2019; Boda and Brown, 2020). Another group of related articles used augmented reality and other technologies to further enhance outside-the-classroom learning experiences (Zimmerman et al., 2019; Land et al., 2020).

The articles are discussed in relation to benefits, limitations and strategies that increase the effectiveness of localized learning for STEM pedagogy and student learning.

Benefits of Localized Learning for STEM Pedagogy and Student Learning

The benefits of localized learning for STEM pedagogy and student learning included 1) increased student enjoyment, interest, and engagement, 2) longer-term learning and increased career aspirations, and 3) development of students' transferable skills (see **Figure 2**).

Increased Student Aspirations, Enjoyment, Interest, and Engagement

Increased interest and knowledge promoted students' aspirations towards careers in STEM fields (Leonard et al., 2016; Gates, 2017). Teachers from multiple articles reported that their students enjoyed hands-on activities with real-world application to their personal lives outside of the classroom (e.g., Althauser and Harter, 2016; Buck et al., 2016; Rahmawati and Koul, 2016; Gates, 2017; Zimmerman and Weible, 2017; Donnison and Marshman, 2018; Fűz, 2018; Bølling et al., 2019; Flanagan et al., 2019). There were two ways to approach the issue of personal relevance. In programs like the *Danish Ud Med Skolen* (*Taking the School Outside*) reported by Bølling et al. (2019), the integration of local cultural and historical knowledge by learning outside the classroom enhanced students' interest in subjects like science. In other programs, increases in interest and engagement were noted as a result of personalizing in-classroom instruction to students' own out-of-school interests, as in the mathematics study reported by Walkington and Bernacki (2019). In the articles reporting on a project or unit of work, students were

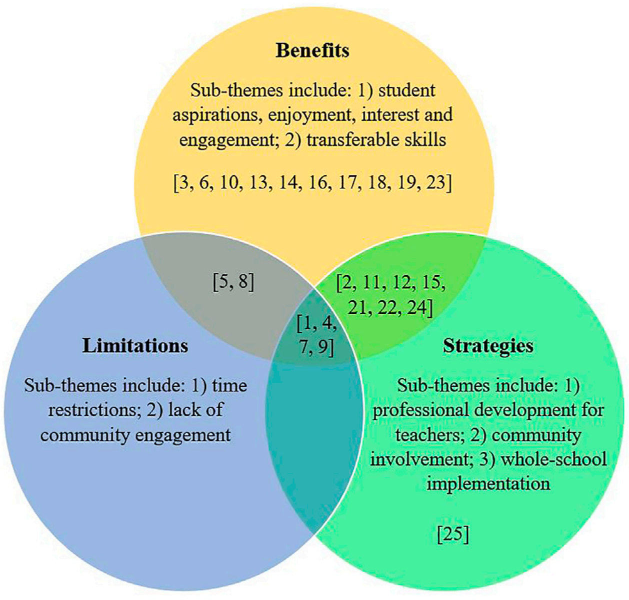

FIGURE 2 | Overarching themes emerging from the studies (numbes refer to **Supplementary Table S1** in Supplementary Metrial).

observed to take "ownership" of their own learning (Buck et al., 2016; Leonard et al., 2016; Rahmawati and Koul, 2016; Donnison and Marshman, 2018; Flanagan et al., 2019; Land et al., 2020). Some articles (Rahmawati and Koul, 2016; Donnison and Marshman, 2018) identified that students had an opportunity to develop a critical voice and that they led the learning with their teachers only assisting when necessary. Students who were previously disengaged with STEM learning in the classroom showed an increase engagement in a localised setting (Althauser and Harter, 2016; Rahmawati and Koul, 2016) because students came to see subjects like science as personally relevant (Littrell et al., 2020a; Littrell et al., 2020b; Boda and Brown, 2020). In summary, it was found that the use of authentic instruction to teach STEM in the context of real-world circumstances promoted longer-term learning and increased student comprehension of the relevance of STEM in the real world (e.g., Althauser and Harter, 2016; Leonard et al., 2016; Rahmawati and Koul, 2016; Gates, 2017; Zimmerman and Weible, 2017; Bølling et al., 2019; Ritter et al., 2019; Littrell et al., 2020a; Littrell et al., 2020b).

Development of Students' Transferable Skills

Articles reported that implementation of localized learning for STEM pedagogy enabled students to develop good decision-making skills in real-world situations which may ultimately lead to students becoming active and informed citizens about socio-scientific issues (Althauser and Harter, 2016; Donnison and Marshman, 2018; Fűz, 2018; Herman et al., 2019; Kinslow et al., 2019; Ritter et al., 2019; Kim et al., 2020). Many of the programs supported the development of students' socio-scientific reasoning skills and scientific literacy competencies (Kinslow et al., 2019). In many of the studies students worked in teams in undertaking community-based STEM projects (Francis et al., 2016; Rahmawati and Koul, 2016; Zimmerman and Weible, 2017; Donnison and Marshman, 2018; Flanagan et al., 2019; Litts et al., 2020). Team work enabled students to develop their ability to collaborate and work in productive team settings and to develop negotiation and shared responsibility (Francis et al., 2016; Rahmawati and Koul, 2016; Zimmerman and Weible, 2017; Donnison and Marshman, 2018; Flanagan et al., 2019). Students developed communication skills in liaising with community members and other schools (Leonard et al., 2016; Zimmerman and Weible, 2017; Flanagan et al., 2019; Litts et al., 2020). Students benefited particularly from liaising with experts in their field (Leonard et al., 2016; Kermish-Allen et al., 2019; McClain and Zimmerman, 2019).

Several articles identified the psychological and sociological benefits of students participating in their community which included an increased sense of empowerment, pride, and respect for their local community (Leonard et al., 2016; Zimmerman and Weible, 2017; Donnison and Marshman, 2018; Flanagan et al., 2019). This empowerment often manifested as compassion for nature and people impacted by socio-scientific issues (Herman et al., 2019; Iversen and Jónsdóttir, 2019), resulting in pro-activeness and advocacy within their local community (Donnison and Marshman, 2018; Flanagan et al., 2019). During and after the learning experiences, students were able to connect and learn together with others in their community including peers, family, and STEM professionals using correct field-specific terminology (Buck et al., 2016; Zimmerman and Weible, 2017). One article identified that students invited parents and family members into their learning based on their own personal excitement and interest in the content (Buck et al., 2016). Other studies reported that participation in localised learning lead to students formulating further questions for future inquiry beyond the initial sequence of teaching and learning (Buck et al., 2016; Francis et al., 2016; Zimmerman and Weible, 2017; Donnison and Marshman, 2018; Flanagan et al., 2019).

Limitations of Localized Learning in the STEM Disciplines

The main limitations of localized learning in the STEM disciplines were time restrictions and lack of community involvement.

Time Restrictions

Some articles recognized time as a limitation to the implementation of localized learning for STEM pedagogy and student learning (Althauser and Harter, 2016; Buck et al., 2016; Francis et al., 2016). Teachers reported that localized lessons can be long and therefore ensuring the allocation of enough time became a challenge (Althauser and Harter, 2016). Another significant challenge related to the logistics of organizing journeys outside the school grounds (Fűz, 2018). One study also reported that managing student behavior outside the classroom affected the quality and duration of learning activities (Francis et al., 2016). Preparation for localized learning was also identified as an obstacle. Time to collaborate with other staff members was difficult to attain (Althauser and Harter, 2016) and it was reported that localized learning took a lot of time away from other curriculum areas (Buck et al., 2016; Fűz, 2018). Time was required to ensure that students had the relevant prior knowledge before leaving the classroom and learning in localized contexts (Althauser and Harter, 2016; Fűz, 2018).

Lack of Community Engagement

Some studies reported that one challenge of implementing localized learning for STEM pedagogy was gaining the participation of community members (Buck et al., 2016; Gates, 2017). Despite teacher and student attempts to gather information from community organizations and businesses, sometimes there was no response or no relevant information was provided (Buck et al., 2016; Fűz, 2018). One positive outcome of this was that it gave students insight into the complexities of managing divergent interests in relation to real-life problems and situations (Buck et al., 2016; Donnison and Marshman, 2018).

Strategies to Increase the Effectiveness of Localized Learning in STEM Disciplines

In consideration of the benefits and limitations, the articles identified several strategies to increase the effectiveness of localized learning for STEM pedagogy and student learning. Strategies included an increase in professional development for teachers, whole-school implementation, and ensuring community involvement.

Professional Development for Teachers

While most articles focused on student learning and experience, teachers' understanding of localized pedagogy was identified as a key determinant of the effectiveness of the teaching and learning that occurred (Buck et al., 2016; Iversen and Jónsdóttir, 2019). In one study, teachers who undertook workshop-based professional development reported an increase in knowledge of subject content and confidence in their ability to implement localized pedagogy (Althauser and Harter, 2016). The students of teachers who had undertaken professional development showed an increase in subject content knowledge in comparison to students of teachers who had not (Althauser and Harter, 2016). Further evidence for this observation is provided by Buck et al. (2016). In addition to subject content knowledge and pedagogical strategies, there is also recognition that teachers often are not adequately prepared to address controversial socio-scientific issues (Buck et al., 2016; Iversen and Jónsdóttir, 2019). Given the controversy that can surround issues like climate change, this is an important area for upskilling teachers through professional development. Finally, teachers may need significant professional development in order to deploy the virtual and augmented reality technologies which can further enhance students' localized learning experiences (Ritter et al., 2019; Zimmerman et al., 2019; Boda and Brown, 2020; Land et al., 2020).

Whole-School Implementation

In some studies, teachers reported that localized learning for STEM pedagogy would be best implemented as a whole-school approach, despite these articles reporting studies that were integrated at only specific grade levels (Althauser and Harter, 2016; Francis et al., 2016). Articles highlighted that localized learning for STEM pedagogy should be embedded within the current curriculum, rather than added as an additional inclusion (Buck et al., 2016). This may also assist in mitigating the limitation of time restrictions. It was reported that school teachers need further resources and should have flexibility in selecting their own resources for STEM pedagogy as this can lead to an increased likelihood of teachers using these materials in the future (Althauser and Harter, 2016).

Community Involvement

One key benefit of localized pedagogy to enhance student learning is community involvement. The involvement of the community increases home-school-community partnerships and supports students as they make decisions about their future careers (Rahmawati and Koul, 2016; Zimmerman and Weible, 2017). While community members, STEM professionals, and business people are important stakeholders in localized pedagogies, as previously discussed, any difficulties engaging with them can constrain the effectiveness of localized learning. A potential solution to mitigate this limitation is to consider less than obvious partnerships and innovative ways to collaborate within the community (Gates, 2017). For instance, online platforms like those used by Kermish-Allen et al. (2019) can enable synchronous and asynchronous collaboration independent of location that ameliorates difficulties in organizing a single time and place for face-to-face meetings. Other innovative options include the use of virtual and augmented reality to bring the outside world into classrooms or enhance outside-the-classroom experiences (Ritter et al., 2019; Zimmerman et al., 2019; Boda and Brown, 2020; Land et al., 2020).

IMPLICATIONS FOR RESEARCH AND PRACTICE

The purpose of a scoping review is to survey the range of research studies that have been conducted in a specific field, to synthesize those research findings and to identify the gaps that may emerge as fruitful areas for further research (Booth et al., 2012). In this review we have collected studies focusing on the use of local contexts as a vehicle for making STEM subjects more relatable, interesting, and purposeful for students in the formal years of schooling, with a view to decreasing student disengagement with STEM. We found that the majority of studies emanated from the United States and that most involved qualitative research methods with relatively small sample sizes. Only eight studies could be considered large scale with sample sizes of more than 100 (Althauser and Harter, 2016; Gates, 2017; Fűz, 2018; Flanagan et al., 2019; Ritter et al., 2019; Walkington and Bernacki, 2019; Boda and Brown, 2020; Kim et al., 2020). The remaining 17 studies had a mean sample size of 35.7 students, reporting on small-scale interventions using a range of data collection techniques, including pre- and post-assessments, interviews, observations and collection of classroom artefacts.

Despite the variation in the size of the studies, the findings across the studies were largely consistent, presenting a positive view of the benefits of teaching STEM by linking with local contexts. Innovative pedagogies such as project-based learning or inquiry-based learning could be vehicles for promoting student learning in localized contexts, the evaluation of which could be a focus for future research. There was broad agreement that student enjoyment and interest in STEM subjects was improved due to perceptions of increased relevance of STEM content. A theoretical perspective which aligns with these findings underpins the Science Capital teaching approach (Godec et al., 2017), a pedagogical method designed to increase students' science capital. Recently, the model has been expanded to STEM capital by incorporating technology, engineering, and mathematics (Moote et al., 2020). Science capital and STEM capital are multi-dimensional constructs that include scientific literacy, science-related attitudes, values and dispositions, knowledge about the transferability of science skills, science media consumption, participation in out-of-school science learning contexts, familial science skills and qualifications, connections with scientists and discussions of science in everyday life (Godec et al., 2017). In the scoping review, several of these dimensions were found to be positively impacted by pedagogical approaches linked to local contexts. In particular, several studies reported increases in student STEM knowledge (Althauser and Harter, 2016; Buck et al., 2016; Leonard et al., 2016; Gates, 2017; Herman et al., 2019; Kermish-Allen et al., 2019; Kinslow et al., 2019; Ritter et al., 2019; Land et al., 2020; Litts et al., 2020), more positive dispositions towards STEM subjects (Buck et al., 2016; Francis et al., 2016; Leonard et al., 2016; Rahmawati and Koul, 2016; Gates, 2017; Zimmerman and Weible, 2017; Donnison and Marshman, 2018; Fűz, 2018; Bølling et al., 2019; Flanagan et al., 2019; Herman et al., 2019; McClain and Zimmerman, 2019; Littrell et al., 2020a; Littrell et al., 2020b; Boda and Brown, 2020; Land et al., 2020), the valuing of activities to develop transferable STEM skills (Francis et al., 2016; Leonard et al., 2016; Rahmawati and Koul, 2016; Zimmerman and Weible, 2017; Donnison and Marshman, 2018; Flanagan et al., 2019; McClain and Zimmerman, 2019; Litts et al., 2020), and opportunities to engage with science experts (Leonard et al., 2016; Kermish-Allen et al., 2019; McClain and Zimmerman, 2019). Increases in science capital are associated with the likelihood of pursuing post-compulsory STEM qualifications (Moote et al., 2019), therefore, teaching approaches that have the potential to increase students' science capital could impact on the long term aspirations of students in STEM fields. However, relatively few studies that met the inclusion criteria explicitly measured impacts on career and education aspirations, indicating an important area for future research (Leonard et al., 2016). The studies included in this scoping review consistently point to outcomes for students which are aligned with increases in science capital, indicating that teaching STEM through purposeful links with local contexts could be a promising means of addressing the current concerns with STEM participation and engagement in schools.

While the studies presented a consistent view of the benefits of teaching STEM with links to local contexts, there were also concerns raised about this approach. From a teaching perspective, time factors were identified as an impediment across a number of studies. The Science Capital Teaching Approach (Godec et al., 2017) recognizes the importance of out-of-school science experiences as a key contributor to the development of science capital, however, teachers identified that a major difficulty was the time required to plan these experiences, in conjunction with ensuring that other curriculum requirements were met. Also, difficulties were reported in relation to garnering the support of community and industry partners necessary to enable authentic STEM learning contexts. While these kinds of partnerships are encouraged, particularly for careers education (Foundation for Young Australians, 2019), there is little systematic support available for teachers aiming to leverage these connections to improve teaching in STEM subjects. Multiple studies reported difficulties in establishing these networks so that STEM teaching and learning could be meaningfully linked to local contexts (Buck et al., 2016; Gates, 2017; Fűz, 2018).

The scoping review revealed that the challenge of gaining community and industry support was linked to the issue of lack of teacher time for planning and insufficient professional development for teachers. The pace at which scientific and technological advances have progressed poses an ongoing challenge for teachers in keeping up to date with new knowledge, integrating localized STEM learning into the curriculum and in developing the pedagogical skills to cope with contentious socio-scientific issues (Althauser and Harter, 2016; Buck et al., 2016). Taking a whole school approach to teaching in this way was recommended by several studies (Althauser and Harter, 2016; Buck et al., 2016; Francis et al., 2016), highlighting that a localized approach to STEM teaching is optimized when it is embedded across the curriculum and supported through teacher and community collaboration. Educational jurisdictions are putting in place system wide approaches to assist teachers to engage with industry (NSW Department of Education, n.d.), however there is no associated research evidence that measures the impact of these initiatives.

The research under consideration for this scoping review provides a positive picture of the benefits of teaching K-12 STEM by linking to local contexts. Although the studies were, with a few exceptions, mostly small scale, they reported similar findings in terms of the educational value of the programs, particularly as a means of increasing student interest and enjoyment in STEM. Given the consistent positive findings, the challenge for educational practitioners and researchers is to devise programs that can be conducted at scale, ensuring widespread availability and testing of the benefits to students. Transforming educational practices on a large scale is a challenge and requires not only evidence-based programs, but also effective approaches to implementation in order to ensure fidelity (Adelman and Taylor, 2007; Fixsen et al., 2013). For educational programs to be effectively implemented they must take into account staff willingness to undertake changed approaches, the capacity of teachers to implement new programs, the beliefs of school staff in relation to the value of the programs and alignment with the local context of the school (Redding et al., 2017). In a similar vein, this scoping review points to the need for rigorous research-based development and evaluation of programs on a large scale, across multiple school and district contexts, while also recognizing that there will be contextual differences in implementation in different locations.

CONCLUSION

Given the importance of STEM knowledge and skills in our increasingly complex, scientific, technological and data-based society, it is imperative that we find ways to better engage a broader range of students in STEM disciplines in school. Positioning STEM learning in relation to students' local contexts, in order to increase relevance, is one means of achieving this aim. For this approach to be successful, however, teachers need the expertise and time to link curriculum content to their local contexts in meaningful ways so that students experience STEM learning that is both purposeful and appealing.

This scoping review has examined five years of research from 2016 to 2020, providing insights into how STEM education practitioners are leveraging the benefits of incorporating STEM learning within local contexts to improve student learning. We find widespread evidence of increases in student enjoyment of learning and in their aspirations for STEM-related career aspirations. Also, there is evidence that students developed transferable skills such as the capacity to collaborate, communicate and to develop real-world decision making skills through engagement in learning within their local contexts. While some limitations were noted, such as a lack of teacher time and low levels of community involvement, these were generally operational in nature, rather than negative outcomes for students. The challenge for educators and community members interested in STEM education is to find ways to embed localized learning within the constraints of the school curriculum and to foster cooperative structures to support teachers to more readily engage with STEM contexts outside of the school. This scoping review provides clear evidence of the benefits of localized STEM learning and points to the needs for further work to ensure that such benefits can be propagated at scale to maximize learning outcomes for students.

AUTHOR CONTRIBUTIONS

KH, EH, and NB conceptualised the scoping review and defined the search parameters and methods. In 2019, MW conducted the literature searches, screened the articles, summarised the final articles, and drafted the methods and findings. In 2021, NB updated the literature searches, article screening, and article summaries. EH updated and finalised the introductory sections and methods, NB updated and finalised the findings section, and KH drafted and finalised the discussion and conclusion sections.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2021.693808/full#supplementary-material

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