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STEM, Online, and Innovative Mathematics Teaching Strategies for All Students

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This Special Issue of the Journal of Mathematics Education [JME] is based on the theme of the 2021 virtual conference of Classroom Teaching Research for All Students (CTRAS). The theme of the conference was *STEM and Online Teaching Strategies for All Students.* The intent was to address mathematics education in terms of "innovative teacher education and classroom teaching practices, online teaching strategies, and research initiatives in STEM [science, technology, engineering, and mathematics] integration to support all students' mathematics learning in a meaningful and connected way" (CTRAS 2021 submissions announcement). In this editorial, we focus on three aspects of this theme involving STEM, online, and innovative teaching practices in relation to mathematics education with connections to CTRAS presentations that include the four articles of this JME special issue.

Mathematics in STEM Education

In the last decade, STEM education has received significant attention as concerns grow about preparing students for a changing global economy and workforce needs. As Bybee (2013) pointed out, the overall purpose of STEM education is to further develop a STEM literate society. Thus, STEM education has become a key policy initiative in many education systems around the world. However, STEM education has different meanings or purposes in practice, which could enhance or limit the learning of mathematics. Bybee also suggested that the "purpose of STEM education is to develop the content and practices that characterize the respective STEM disciplines" (p. 4), a purpose that aligns with meaningful learning of mathematics. But the lack of this purpose and the treatment of mathematics in STEM education have been ongoing concerns. As Maass et al. (2019) explained, based on their literature survey, "While it is widely acknowledged that mathematics underpins all other STEM disciplines, there is clear evidence it plays an understated role in integrated STEM education" (p. 869).

The National Council of Supervisors of Mathematics (NCSM) and the National Council of Teachers of Mathematics (NCTM) joint position paper on *Building STEM Education on a Sound Mathematical Foundation* (NCSM-

NCTM, 2018) "affirm(s) the essential role of a strong foundation in mathematics as the center of any STEM education program" (p.1). They suggest:

> A well-designed and effective STEM program is going to have a strong mathematics component, a strong science component, and many opportunities to use mathematical and scientific thinking, reasoning, and modeling across disciplines to tackle real problems that involve any or all of the STEM fields. (p. 2)

Maass et al. (2019) also highlighted three possibilities for advancing the role of mathematics within STEM education, "(1) the acquisition of twenty-first century skills; (2) meaningful inclusion of mathematical modelling in school education; and (3) education for responsible citizenship" (p. 873). However, "Mathematics goes beyond serving as a tool for science, engineering, and technology to develop content unique to mathematics and apply content in relevant applications outside of STEM fields" (NCSM-NCTM, 2018, p. 3). Thus, "when incorporating mathematics as part of a STEM activity, it is important to ensure that the mathematics is consistent with standards for the targeted grade level(s) in terms of content as well as the level and kind of thinking called for (Larson, 2017)" (NCSM-NCTM, 2018, p. 2).

In addition to mathematics playing an important role in STEM education, STEM tasks or activities could play an important role in mathematics classrooms to support all students' mathematics learning in a meaningful and connected way. For example, as authentic tasks (i.e., tasks that replicate real-world challenges and standards of performance that experts or professional typically face in the field (Koh & Chapman, 2019), STEM tasks can be used to engage students in doing mathematics as mathematicians and learning mathematics in realistic contexts. STEM activities could also play a pivotal role in building innovative, resilient, and culturally rich communities for all students (Nicol et al., 2020) and allow all students to demonstrate their understanding of mathematics in a work-based, contextual environment (Kennedy & Odell, 2014). In addition,

> Engineering design … offers an approach that nurtures and supports students' development of their problem-solving abilities …. The design process both reinforces and extends how students think about problems and offers tools that can help students creatively expand their thinking about solving problems of all types. (NCSM-NCTM, 2018, p. 3)

However, how mathematics gets taken up in STEM education or STEM activities get integrated in mathematics classrooms depends on the teacher and teacher education.

Initial teacher preparation programs should include an intentional focus on the preparation of high-quality STEM teachers for PreK–12 schools. But STEM education courses for teachers could have the same issues as courses for school students regarding the understated role of mathematics as discussed above. Such courses offer preservice teachers opportunities to develop useful twenty-first century skills that could be applied to the teaching of mathematics but not contribute to important aspects of their learning of mathematics knowledge for teaching (both content and pedagogical content knowledge). For example, Chapman and Dodsworth (2019) found that elementary teachers, at the end of a STEM education course, were unaware of connections between the engineering design process and mathematical processes (e.g., problem solving and modelling) and there were limitations in the mathematics concepts they were able to attend to in the STEM activities they engaged in. According to NCSM-NCTM (2018), "Teachers assigned to teach STEM in an integrative way may or may not be dealing with deficiencies in their content knowledge" (p.3). This could also be the case for preservice teachers in STEM courses that do not intentionally address mathematics. Thus, while a focus on, for example, curriculum integration, technology integration, and critical-thinking skills in these courses is important, explicit attention to preservice teachers' mathematics content knowledge is of significant importance for them to understand the "M" in STEM and how to meaningfully engage all students in STEM tasks.

Chapman's (2021) keynote presentation at CTRAS addressed the use of mathematics *concept study* in a STEM education course for preservice teachers as a means to help them to understand the "M" in STEM. The course is framed in problem-based learning and centered around three learning tasks: (a) identifying STEM tasks and conducting a *concept study* of mathematics concepts; (b) creating a STEM task for the theme "[to] make the world a better place" and designing, building and programing a robot to complete the task; and (c) designing a STEM inquiry unit for teaching the STEM task in (b) and applying the concept-study approach to unpack mathematics and science concepts contained within unit that students will learn. Chapman's presentation focused on learning task 1, in which students learned how to conduct the concept study. In learning task 1, students had to: find (e.g., online) and explore the nature of three STEM tasks; choose one of the three tasks that they could use to teach mathematics; develop a plan to design the prototype to solve the task and describe the possible prototype; identify two mathematics concepts used in the design and development of prototype that are connected to the official mathematics curriculum for a secondary school grade; and conduct a concept study of the mathematics concepts. The concept study included considering the meanings of the concept, multiple representations (images, analogies and exemplars used for mathematics and mathematics education), applications of the concept (contemporary role/place outside school), curriculum connections, and misconceptions.

Chapman (2021) reported on the experience of a class of 36 preservice secondary teachers majoring in different STEM and humanities disciplines, all of whom could potentially teach mathematics or integrate STEM tasks in their teaching. They were in semester 1 of their 2-year B.Ed. program and the course was mandatory. Initial challenges they had to deal with included: understanding the difference between a mathematics concept and process (e.g., problem solving which they initially considered to be a mathematics concept); seeing or identifying secondary school level mathematics concepts in the solution of the STEM task (e.g., planning and constructing the prototype); and understanding the concept-study process (e.g., thinking of the concept in different ways from what they learned in school). With the instructor's intervention and the help of other resources (e.g., online references) as required by the problem-based learning approach, the preservice teachers were able to deal with these challenges with various levels of success and further developed their concept-study skills through the application in the next two learning tasks. In general, the concept study in the STEM education course helped the preservice teachers to: start thinking about a mathematics concept in multiple ways regarding its structure, meanings, representations, and application to a real-world context/situation; learn how to think about the mathematics embedded in a STEM task; learn something new about the mathematics concepts; learn a process to deepen their understanding of mathematics concepts; and learn how to seek out resources to extend their knowledge. Chapman concluded that this form of concept study has the potential to help preservice teachers to make sense of mathematics concepts teachers need to know for teaching within the context of STEM tasks. It is one way to help teachers to recognize the importance of mathematics as a separate and an integrated discipline in relation to STEM**.** Without the concept study, these teachers would not have addressed deficiencies in their knowledge of the mathematics in relation to the STEM task and mathematics in general as also suggested in NCSM-NCTM (2018).

Online Teaching in Mathematics Education

The 21st century digital age opened both opportunities and challenges in mathematics education. NCTM (2000) promoted technology as being essential in teaching and learning mathematics with a focus on both *content specific* and *content neutral* technological tools (NCTM, 2011).

> [Content specific] technologies support students in exploring and identifying mathematical concepts and relationships. Content-neutral technologies include communication and collaboration tools and Web-based digital media, and these technologies increase students' access to information, ideas, and interactions that can support and enhance sense making, which is central to the process of taking ownership of knowledge. (NCTM, 2011, np)

Recent research publications have been addressing the use and challenges of such technologies in mathematics classrooms. For example, Clark-Wilson et al.'s (2021) book on *Mathematics Education in the Digital Age* details the impacts this digital age has, and will continue to have, on the parallel aspects of learning and teaching mathematics within formal education systems and settings. Other publications focus on pedagogies for preservice and inservice teachers. For example, *The Handbook of Research on Transforming Mathematics Teacher Education in the Digital Age* (Niess et al., 2016) features research on the development of educators' knowledge for the integration of technologies to improve classroom instruction. It includes addressing how instructors of mathematics teachers must and can think beyond their own backgrounds in order to incorporate current and emerging technologies into their efforts to prepare student teachers to teach mathematics. However, less attention has been given to online teaching, particularly at school level.

Initially, online teaching in mathematics education was associated with online distance education (e.g., Borba et al., 2010). With the increasing availability of online technology tools, online or hybrid classes such as "flipped classrooms" started to emerge in schools and later other approaches with some guidance from research. For example, the 2016 focus issue of the *Mathematics Teachers* addressed the theme *Teaching Mathematics Online* and presented findings and advice for teachers beginning to teach online. It includes: ways to use online tools in face-to-face classrooms to enhance student learning; changes a teacher had to make to his classroom teaching methodology in order to encourage online students to engage with course content and with one another; and some difficulties inherent in maintaining an active collaborative environment in an online course and possible solutions. Another example is Fernández et al. (2017) who described a specific case of online teaching with the goal to familiarize teachers who are interested in synchronous online instruction with some of the modifications and possibilities that can arise in this new environment.

The covid-19 pandemic has significantly influenced the role of online learning in mathematics education at school and postsecondary levels. When teaching and assessment were moved online suddenly in the midst of the global pandemic, teachers had to deal with a myriad of challenges that included redesigning curriculum and learning tasks and learning and relearning a new technology. Activities that were designed to be carried out face-to-face had to be re-designed using, for example, breakout rooms, digital whiteboards, or screenshare. Online education resources (e.g., Borba et al., 2010; Salmon, 2011) that had been neglected became essential teaching and learning guides for some mathematics educators and education researchers.

Studies emerging on mathematics teachers' experience during the initial year of the pandemic include examining how teachers who had to quickly learn how to teach and engage students in an online environment experienced and perceived the dramatic, drastic, and sudden change (Albano et al., 2021) and investigating what distance practices in secondary mathematics education have emerged and how teachers experienced them (Drijvers et al., 2021). Similarly, an online survey of international STEM faculty members (Sedaghatjou et al., 2021) revealed that online pedagogy and assessment were the most disruptive dimensions of e-learning when many instructors struggled to adapt their instructional plans and assessment methods or learning tasks to online learning environment. They were also not accustomed to some of the new technologies while teaching online.

While a few studies have addressed teachers' experience with online learning during the pandemic, there has been less attention on the use of online learning in teacher education. One study that addressed preservice teachers' online learning was presented at CTRAS 2021 by Shuhua An. An (2021) addressed *Challenges and Strategies for Pre-Service Teachers' Learning in Mathematics Methods Classes During Pandemic*. She made the case that during the pandemic, the increased challenges in online learning needed to be identified and addressed by the best practice strategies. She reported on a study that identified some of the challenges preservice teachers experienced in their online mathematics methods courses. Findings of the study indicated that these challenges included social and emotional struggles, time management, technology difficulties, zoom fatigue, and content-related learning difficulties.

An's (2021) study also investigated the instructional and learning strategies used in the methods courses to help the preservice teachers to deal with their challenges. Five categories of strategies were used by the instructors to meet the challenges and ensure the success in both teaching and learning: (a) communication (weekly announcements, emails, virtual office hours, and ask-the-instructor sites); (b) organization (learning modules, weekly checklist); (c) collaboration (group roles, learning and social community, group projects with samples and templates, Discussion Board sharing and feedback); (d) quality tasks (MSAW tasks: model-strategy-application of the week); and (f) nurturing SEL skills (selfcare skills, lesson opening with announcement and sharing, and breakout room activities). The strategies identified by preservice teachers that they used to deal with their challenges included peer support, constant communication, staying organized, starting assignments ahead of time, utilizing the textbook, and attending zoom class meetings and taking notes.

An (2021) also reported on the findings of analysis on both qualitative and quantitative data sets regarding shifts in the preservice teachers' mathematics-education-related characteristics resulting from their participation in the online classes. The findings of this analysis showed that the preservice teachers enhanced their disposition on their beliefs in the importance of mathematical modeling and confidence in their ability of modeling mathematics. They also enhanced their confidence in effective teaching and readiness of teaching. An's study suggests that to address challenges in adopting online teaching in methods courses, both instructors and preservice teachers need to adopt and participate in innovative teaching practices to achieve positive outcomes in their learning. Engaging the preservice teachers in such practices could also model for them strategies that they could adopt in any future online teaching with their students.

While research on the teachers in dealing with online teaching during the pandemic is important, ongoing research is needed to understand ongoing challenges of online teaching and possible solutions. One area of particular concern is the disparities perpetuated by the pandemic regarding educational opportunities due to the digital divide regarding access to appropriate technologies for online teaching, teachers' inadequate preparation in using technologies to design and deliver online instruction, and teachers' lack of support and resources for creating a more inclusive, caring, and equitable online-learning environment for all students. It is clear that situations such as unequal access to computers, tablets, and internet and unequal availability of space and uninterrupted time at home place will require special consideration in using online learning so that it does not perpetuate social and cultural injustices that privileges certain groups of learners.

Innovative Teaching in Mathematics Education

Innovative teaching could involve any non-traditional teaching approach in the mathematics classroom. This could include STEM and online or technological teaching practices as noted in the preceding sections. It could include alternative assessment methods such as formative assessment (National Council of Supervisors of Mathematics/Association of Mathematics Teacher Educators ([AMTE-NCSM], 2014) or technology-enhanced authentic assessment (Koh, 2022; Koh et al., 2022) and equity-based pedagogical approaches for today's linguistically and culturally diverse classrooms. There are, however, specific principles and standards (e.g., NCTM, 2000; 2014) that provide guidance of best practices underlying innovative teaching in mathematics. For example, NCTM (2014) recommends innovative *Mathematics Teaching Practices* that include: implementing tasks that promote reasoning and problem solving; using and connecting mathematical representations; facilitating meaningful mathematical discourse; posing purposeful questions; supporting productive struggle in learning mathematics; and elicit and use evidence of student thinking. In addition, both NCTM 2000 and 2014 highlight principles regarding the use of technology and equity as fundamental to a high-quality mathematics education. Equity includes providing strong support that enables all students to be mathematically successful and accommodating differences to meet a common goal of high levels of learning by all students (NCTM, 2014). These examples of principles and practices are directly and indirectly represented in all of the articles of this JME special issue based on papers presented at CTRAS 2021.

The four articles of this JME issue offer research on different topics that represent the theme of CTRAS regarding innovative classroom teaching practices and online/technological teaching strategies associated with STEM-based courses to support all students' mathematics learning in a meaningful and connected way. But the underlying theme of the four articles we highlight in this overview of them is *innovative teaching practices*. The articles collectively address a variety of innovative teaching approaches at the elementary and postsecondary levels and take into consideration students with diverse learning needs.

The first article by Trini Lewis, Marisol Ruiz, and Jennifer Nunez addresses an innovative teaching approach based on the MALITLA (acronym for mathematics, literacy, and language) model they developed to improve children's mathematics vocabulary knowledge. The design of the model was guided by: (a) the interdisciplinary literature on mathematics assessment, literacy, and language acquisition; (b) translanguaging theory (Garcia & Wei, 2014); and (c) current pedagogical practices effective for improving language development. Thus, the model offers a unique way to support young multilingual children's learning of mathematics. The efficacy of the model was investigated in an action research study of second-grade multilingual learners. A key finding of the study was that the MALITLA model components were effective for improving the students' conceptual knowledge and application of the mathematics vocabulary words in instructional and assessment activities. The MALITLA components functioned to introduce, review, practice, apply and assess the words. Thus, the study contributes insights to mathematics education on the relationship between language proficiency and mathematical learning as well as confirms the significance of a language-based approach with scaffolds to support multilingual children's mathematical competencies.

In addition, the use of translanguaging mathematics talk in which the teacher posed higher order thinking questions in the children's heritage language and their second language during instruction indicates an innovative approach that can be integrated in mathematics classrooms to support all students' learning. The literature has pointed out that translanguaging is an effective pedagogy for engaging English language learners to learn content and language at the same time. According to Tai (2022), it helps the teacher to bridge the gap between students' everyday life culture (cultural knowledge) and the cultures of school science and mathematics. Translanguaging also promotes students' social inclusion in linguistically and culturally diverse classrooms (García & Wei, 2014). Many have deemed translanguaging a pedagogy for equity, inclusion, and social justice in linguistically and culturally diverse classrooms (e.g., Fu et al., 2019; García & Wei, 2018; Tai, 2022; Veliz, 2021). Thus, the Lewis et al.'s study offers further evidence of this view of translanguaging.

The second article by Pi-Jen Li addresses an innovative teaching approach involving a conjecturing-based teaching model. The model consists of five stages: 1. *Constructing cases* by individual students followed by sharing the cases with group members. 2. *Formulating conjectures* based on stage 1 group-cases. 3. *Validating conjectures* with more cases beyond the initial group cases. 4. *Generalizing conjectures* into true conjectures via restricted conditions. 5. *Justifying* conjectures by convincing others to accept them. Li engaged elementary students in this model to investigate the impact of a collaborative group of diverse mathematics ability students on group members' psychological safety and cognition. The study focused on one collaborative-learning group of four sixth-grade students, two being "better-achievers" and two "struggling" or "lower-achieving" students in mathematics. The aim of the study was to explore how the better-achievers raised struggling students' psychological safety and cognition in collaborative group discussion in the context of conjecturing-based teaching. The results of the study indicated:

1. Verbal iteration was the main way of the better-archivers interacting with the struggling students, while non-verbal (including gestures) was the main interaction between the two struggling students.
2. Students demonstrated ability for using questioning in group learning.
3. Students' questioning provided a way of raising the struggling students' security and allowing them to take risks to ask questions.
4. Lower-achieving and better-achieving students in a group, without the teacher's assistance, were able to effectively collaborate autonomously throughout group discussions and positively impact psychological safety.
5. The two ways used by better-achievers to raise the struggling students' psychological safety were not offering them direct answers in order to allow them to think and asking questions for them to share their thinking.
6. The better-achievers enhanced their academic-related skills and interpersonal skills of groupwork.

Li's study contributes an exemplar of researching the psychological safety and cognitive learning of struggling students in group discussion when engaged in conjecturing-based teaching. It demonstrates how group discussion is beneficial to raise students' psychological safety. It is distinct from previous studies on psychological safety in that the participants were elementary school students in a mathematics classroom rather than employees at a workplace. The teaching approach, being based on conjecturing, also recognizes an important aspect of doing mathematics. Conjecturing offers students opportunity to reveal their conceptions, enhance their mathematical thinking and reasoning, and foster their interest in mathematics learning (Kasmer & Kim, 2010; Lim et al., 2010). The study also shows that nonverbal communication such as gesturing is a meaningful way for struggling students to share their work in group discussion. Gestures have been established as important for learning (e.g., Abrahamson, 2004) and collaborative gestures were found to have the potential to provide learners with additional tools that facilitate mathematical communication and proof (Walkington et al., 2018). In general, the study suggests important ways in which students of diverse mathematical ability or achievement can work in a collaborative group to support and enhance each other's meaningful learning of mathematics.

The third article by Scott A. Courtney, Christine K. Austin, and Kristine C. Glasener addresses innovative teaching strategies from the perspective of tertiary teachers based on their understanding of developmental mathematics, the students enrolled in developmental mathematics, and the resources they utilized to support developmental mathematics instruction. The article reports on a study in which a reflective investigation methodology that included teacher documentation work was used to investigate two exemplary tertiary teachers of developmental mathematics courses for postsecondary students. Findings of the study indicated:

1. The teachers understood development mathematics as content "foundational" to students' subsequent mathematics courses, which was dependent on each student's needs. Their actions focused on highlighting the foundational to subsequent mathematics courses aspect of development mathematics rather than a remedy for "missing, weak, or fragile" knowledge conception and were dependent on each student's needs.
2. The teachers understood their students as individuals with varying mathematics and school experiences in need of a caring environment and a sense of belonging as learners of and contributors to mathematics. Their actions focused on affective aspects of their students.
3. The teachers understood the resources they used as tools to support each student, based on their individual needs, as they engaged with mathematics and interacted with their classmates and the teacher. Their actions with respect to these tools focused on their students' individual needs. For all three of these findings, students' needs or the affective aspects of the students noted by the authors consisted of anxiety, beliefs, emotions, feelings, frustration, interest, identity, motivation, persistence, self-efficacy, and values.

These findings regarding the teachers' thinking and actions in teaching developmental mathematics align with innovative teaching practices connected to learner-centered pedagogy. Unlike traditional pedagogy that is teacher-centered, these teachers' practices promoted and supported in their students caring relations and a sense of belonging as learners of and contributors to mathematics. By taking into account the learners' social-emotional needs and other psychological aspects in learning, the teachers were able to create a more inclusive and caring community in their mathematics classes to support meaningful learning by all students. Although the participants in this study were postsecondary teachers, these ideas of practices to meet students' needs are relevant to K-12 classrooms. The study also provides researchers and mathematics teacher educators with a framework focused on teachers' documentation work that supports identification of the schemes of meanings with which teachers teach. Furthermore, the framework has the potential to support the design of productive professional learning experiences for both preservice and inservice teachers.

The fourth article by Andrea Honal and Alexander Jaensch addresses innovative teaching and learning practices involving the use of technology tools in postsecondary STEM-based courses. In this study, the authors used *new technology tools* or *new technologies* or *innovative technologies* to refer to a broad range of current technological tools and digital media that can be used to transform postsecondary education in innovative or non-traditional ways to support students' learning in ways that are meaningful to the students. These technologies include videos, podcasts, learning apps, virtual reality, emails, text, social media, and video conferencing platforms. The quantitative, comparative study investigated similarities and differences of the usage and assessment of new technology and innovative tools by postsecondary students from Germany, China, Brazil, and USA in learning STEM content. The samples of participants consisted of a mix of business and technical/STEM students who were in master's and bachelor's degree programs and had to take technical or mathematics-oriented courses as part of their programs. The aims of the study included comparisons of the participants' level and type of usage of relevant tools in their learning, satisfaction with their own and instructors' technological competence, and prior educational information technology background. The findings of the study included that the students from different countries used similar tools for learning STEM-related content in addition to other study content; the students saw a benefit in using apps for their learning; and technological communication channels most frequently used by the students for communication with their lecturers were text messages and e-mail with more differences between the countries for text compared to emails. Across all four samples, the students indicated that they were satisfied with their own as well as their lecturers' level of technological competence and that technologies were present during their high school education. The authors concluded that all students had a high usage level of new technologies and access to modern technological equipment, but comparing the status quo of new technology among the four countries, the USA and China were slightly ahead in this field.

While Honal et al. made a strong case for innovative teaching in universities using innovative technological tools, the findings suggested limitations in how available technologies were being used and the need for change. Thus, they suggested that technology and pedagogy can work hand-in-hand to facilitate the change needed by providing teachers with tools to enhance their lessons and creating more fluid learning ecosystems to transform classrooms into innovative learning spaces of the future. This suggestion is relevant to both school and postsecondary levels of mathematics education. So, it is important to consider the urgent need to provide professional learning and support for all levels of teachers and instructors to enhance their digital literacy. When teaching and assessment were moved online suddenly in the midst of the global pandemic, many teachers and instructors reported that they needed more training on the use of technology. The most recently release of the TIMSS results revealed that 72 percent of United States students had teachers who reported needing more professional learning and support in technologies (Sparks, 2021).

In presenting the four articles in this JME special issue, we highlighted the innovative teaching aspect of the studies as a common underlying theme. However, each article addresses other important methods and findings that are insightful and meaningful to the teaching of mathematics and mathematics teacher education. In general, they are representative of CTRAS 2021 theme and directly and indirectly address the three areas of STEM, online learning, and innovative teaching in mathematics education.

Future Research

CTRAS 2021 theme of *STEM and Online Teaching Strategies for All Students*, with a focus on innovative teacher education and classroom teaching practices, online teaching strategies, and research initiatives in STEM integration to support all students' mathematics learning in a meaningful and connected way, is one that requires ongoing attention in research. For example studies on teacher education practices should include investigating: (a) innovative STEM and online approaches to support prospective teachers' learning and classroom teachers' practice, and (b) equity, diversity, and inclusion strategies in STEM and online teacher education courses. Studies on online teaching strategies should include investigating: (a) effective online instructional approaches, learning activities, and assessment approaches, and (b) equity, diversity, and inclusion strategies in online teaching. Studies on STEM integration should include investigating: (a) STEM activities in teaching mathematics and to assess mathematics learning; (b) equity, diversity, and inclusion initiatives in STEM education; and (c) assessment of STEM literacy, identity, and interest in online and blended learning environments. In general, to support CTRAS goals of classroom teaching research for all students, research should aim to seek innovative ways to design a more inclusive, just, and equitable learning environment for their students.

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