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Unveiling the Landscape of STEM Education Research in Teaching: Teachers' Perceptions and Practices

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ABSTRACT

Our research focused on empirically documenting the STEM education research perceptions and practices of K-12 physics teachers in Kazakhstan. We explored how the teachers perceived and engaged with STEM educational research while implementing integrated STEM instruction and content. We recruited 50 physics teachers from a population of teachers participating in a STEM education professional development program in Almaty, Kazakhstan. To gather data from the participants, we used a translated version of the survey developed by Booher et al. (2020), "Teacher Perceptions and Use of STEM Educational Research." We collected the teachers' responses using a Google Form distributed online to the teachers attending the professional development event. We found the teachers held diverse perspectives on the benefits and value of integrating STEM education research into their teaching practices. Moreover, our analysis indicated a strong correlation between the culture of utilizing educational research in their schools and the teachers' perceptions of the benefits of the research. The importance of enhancing teacher engagement in evidence-based decision-making and teaching practices emerged as a central theme. We elaborate on the possible implications and solutions for motivating the use of STEM education research to inform curriculum design and instructional strategies that foster high-impact learning environments.

Keywords: Evidence-based practice, STEM Teaching, Education Research, Teacher Development, Teacher Perceptions

INTRODUCTION

Over time, there has been a significant focus on STEM as an academic discipline that holds great importance in achieving a competitive advantage, addressing skills gaps, and promoting innovation on a global scale. Currently, teachers of STEM education have the distinctive role in preparing students to tackle authentic problems across multiple disciplines, including healthcare, agriculture, and energy (Durik et al., 2015; Kalogiannakis & Papadakis, 2019, 2020; Martín-Páez et al., 2019; Mutseekwa, 2025; Nadelson & Seifert, 2017; Struyf et al., 2019).

In alignment with teachers of other disciplines, STEM teacher effectiveness relies on the use of research and empirical evidence of high-impact teaching practices (Booher et al., 2020; Schlag et al., 2024; Stanovich & Stanovich, 2003). The historical aspect of utilizing research to enhance effective teaching and educational methodologies has been a longstanding concern (Staub et al., 2004). Despite some recent evidence on teachers' attitudes towards STEM education research (Booher et al., 2020; Karakose et al., 2023), there is much to learn about how teachers use STEM education research to make instructional and content decisions (Vanderlinde & van Braak, 2010) what motivates them to use research, when they use the research, and the extent of their research use (Dagenais et al., 2012). In this context, researchers agree that there is a need to understand teachers' attitudes towards using research to inform their practice in STEM-integrated teaching practices (Booher et al., 2020).

To strengthen the conceptual framing of our study, we clarify that *STEM education research* in this context encompasses formal, peer-reviewed empirical studies that provide evidence-based findings about STEM teaching practices, curriculum integration, and pedagogical strategies. While we acknowledge the existence and value of practitioner-generated knowledge and localized inquiries, our focus is specifically on research that has undergone scholarly validation and contributes to the broader academic discourse in STEM education. Likewise, we use the term *teacher perceptions* to denote teachers' self-reported beliefs, attitudes, and judgments about the relevance, usefulness, and accessibility of STEM education research. *Engagement* refers to the extent to which teachers seek, interpret, and apply STEM education research to inform and adapt their instructional decisions.

Significance

Leaders in Kazakhstan are striving to enhance and implement evidence-based STEM education in schools (Balta et al., 2020). There has been a growing emphasis in Kazakhstan on promoting student engagement in youth STEM initiatives and contests. In some regions in Kazakhstan, educational leaders are offering specialized professional development programs for STEM teachers (Keniskhanova, 2020). Similar to other Asian countries, Kazakhstan faces a significant underrepresentation of women in STEM (Jean et al., 2015; Mahon & Murphy, 2019; Yatskiv, 2017), which correlates with an overall negative attitude toward STEM careers (Balta et al., 2020).

There are a few published research reports on the perceptions of STEM among Kazakhstan students (e.g., Balta et al., 2022). However, we have not found any published research examining Kazakhstan teachers's perceptions of STEM education, particularly regarding how STEM education research informs their teaching practices. Filling this research gap may motivate other researchers to conduct systematic international comparisons, ultimately contributing to efforts worldwide to promote STEM education in developing countries.

Aligned with the needs of researchers who are engaged in designing an equitable STEM educational model (Casto, 2022), empirically documenting the landscape of STEM education across different cultures and educational systems will be highly beneficial. The documentation is necessary to inform efforts to reduce gender and skill disparities in STEM. Furthermore, research is crucial for making evidence-based decisions that catalyze economic growth and promote equity and inclusion in STEM education in developing countries.

Research Focus

Thus, we sought to document perceptions and interactions with STEM education research to inform STEM teaching by teachers in Kazakhstan. The main research questions (RQs) of the study are the following:

1. To what extent do teachers engage with and apply STEM education research in their instructional practices?
2. How do institutional culture and professional context influence teachers' engagement with STEM education research?
3. What barriers do teachers perceive in accessing or using STEM education research in their teaching?
4. What factors contribute to teachers' dismissal or perceived irrelevance of STEM education research?

What demographic and contextual variables are associated with differences in teachers' perceptions and use of STEM education research?

LITERATURE REVIEW

For our research, we used Cultural-Historical Activity Theory (CHAT) (Sannino & Engeström, 2018) to frame our examination of teachers' engagement with STEM education research, considering various cultural and institutional factors. CHAT provided a lens through which we could analyze the contradictions and tensions in teachers' practices, such as the conflict between the desire to engage with research and the institutional barriers to its application. By using this framework, we were able to explore how the broader educational context, including school culture, professional development opportunities, and access to research, influences the degree to which teachers incorporate research into their teaching practices.

Teachers and STEM Education

The complexity of STEM education implementation and effectiveness is influenced by teachers' perceptions, institutional support, and engagement with research. There is empirical support for the influence of teachers' attitudes toward STEM education and successful STEM teaching (Lunenberg et al., 2014; Mater et al., 2022; Reyes, 2025; Southerland et al., 2012). However, several significant barriers to the successful implementation of STEM education exist, including inadequate professional development, limited resources, and institutional constraints (Bati & İkbal Yetişir, 2021; El-Deghaidy et al., 2017). These barriers often prevent teachers from fully engaging with STEM research, which undermines the potential for evidence-based practices.

In the examination of the role of research in informing STEM education practices. Kayan-Fadlelmula et al. (2022) and Li et al. (2020) report STEM teachers recognize the value of research; however, they often fail to incorporate research into their teaching practices due to cultural, contextual, and infrastructural challenges. Similarly, Chai (2019) and Rinke et al. (2016) argue for the importance of professional development in enabling teachers to utilize research effectively. Yet, despite the evidence, many teachers report that the research they access is often disconnected from their day-to-day instructional practices (Dagenais et al., 2012). The disconnect suggests a gap in the relevance and applicability of existing research, pointing to a need for studies that explore how research can be better integrated to inform and enhance K-12 teaching.

The Importance of Teachers Using STEM Education Research

Teachers face several barriers to using STEM education research, including limited access, inadequate training, and weak research cultures (Chai, 2019; Dagenais et al., 2012; Flake & Lubin, 2024; Margot & Kettler, 2019). However, lacking in the literature is a critical examination of the barriers in a similar analysis in the context of Kazakhstan's post-Soviet educational landscape. Many Kazakhstani schools are undergoing reform while still navigating centralized decision-making structures, uneven access to professional development, and linguistic diversity that affects research accessibility (Balta et al., 2020). Teachers in Kazakhstan encounter numerous obstacles, including pedagogical difficulties, curriculum issues, structural limitations, student-related concerns, assessment concerns, and inadequate support from fellow teachers. To enhance their implementation of STEM education, teachers need support measures such as collaborative opportunities with colleagues, high-quality curriculum resources, backing from educational districts, and high-quality, sustained professional development programs.

Focusing on student barriers to learning STEM, Shernoff et al. (2017) documented a lack of physical resources and technology, students' attitudes, disparities in skills and knowledge gaps among students, insufficient student interest and engagement, limited collaboration opportunities, excessive paperwork, and a lack of administrative support from the school district. STEM teachers expressed the need for additional resources and technology support, including facilitated collaboration, increased professional development opportunities, greater student interest in STEM topics, and new standards focusing on fewer topics in greater depth.

By examining teachers' perceived difficulties in integrating STEM education research in distance teaching, Tzafilkou et al. (2022) concluded there are multiple significant barriers, including a lack of student interaction and engagement, inefficiency of digital infrastructure, deficiencies in students' and teachers' digital skills, the consistent lack of appropriate space and equipment, and demanding teaching workloads. Despite the recognized difficulties, teachers generally had a positive perception of STEM teaching. It is important to note Tzafilkou et al. found differences in STEM teaching perceptions and experiences based on teacher gender, age, and STEM teaching subjects. Rinke et al. (2016) emphasizes the benefits of STEM teachers being able to plan and design instructional materials using problem-solving approaches, authentic applications, and content-driven dialogue. Thus, there is an impetus for teachers to engage with STEM education research to enhance the potential for evidence-based decision-making (Dinglasan & Weible, 2025; Grewe, 2025; Semyonov-Tal, 2021).

Through a systematic analysis of publicly funded projects research and trends in STEM education, Li et al. (2020) identified five key research foci. The research areas included interdisciplinary approaches to STEM teaching and learning, technology integration, diversity and equity considerations, assessment practices, and the influence of collaborative partnerships on advancing STEM education. The evidence indicates that while teachers generally recognize the importance and potential benefits to considering STEM education, they face challenges in actually engaging with STEM education research to inform their teaching (Luft, 2025).

Addressing the challenges of teaching STEM content may require targeted professional development, adequate resources, and supportive school environments. The additional or modified may improve teachers' perceptions and enhance their effectiveness as STEM educators. Understanding how teachers perceive STEM education can provide valuable insights into STEM instructional practices.

Overall, the reviewed literature provides valuable insights into the current landscape of STEM education research, informing future directions for enhancing STEM teaching and learning practices. However, as observed,

country-specific research studies are limited. Thus, to fill the gap, future research needs to be conducted on identifying needs and trends in STEM educational research across diverse cultures, particularly cultures concentrated in developing countries.

Teachers' Attitudes towards STEM Education Research

Dagenais et al. (2012) review of the literature on teacher engagement with evidence-based practices revealed a disconnect between teachers' attitudes and their actual use of empirical research to inform their teaching. Researchers aiming to enhance teacher knowledge and practice have different expectations compared to teachers, as teachers generally acknowledge the value of educational research. Still, only a small number of them incorporate it into their teaching. The frequency of teachers consulting education research for guidance is relatively low, typically once or twice a year. Additionally, some teachers may resist using research due to the perception that it is irrelevant to their specific teaching contexts and the overall learning environment of their schools (Behrstock et al., 2009; Cain, 2015).

Evidence-based practice is a crucial process in the preparation of various professionals, including social workers (Grass, 2024; Webb, 2001; Yizdiz & Ecevit, 2024), psychologists (Anderson, 2006), and nurses (Nadelson & Nadelson, 2014). These professionals frequently recognize the importance of having the skills needed to assess and interpret research outcomes and ensure that professional practices and interventions are supported by evidence of effectiveness. However, Dagenais et al. (2008) discovered that teachers are less motivated to seek and rely on research in their practice. According to Dagenais et al., the lack of motivation may be attributed to the lack of preparation and expectations within the teaching profession to use research to enhance evidence-based teaching practices. Although Dagenais et al. (2012) did not reach a conclusive finding, they did identify several factors associated with teachers' consideration of educational research: perception of its lack of relevance and alignment with their practice, insufficient or unproductive relationships and communication with researchers, inadequate preparation and capacity for practitioners to understand and engage in research, and an unsupportive culture, priorities, resources, and leadership within educational institutions regarding the use of research in guiding practice.

To address the research gap, Booher et al. (2020) conducted a mixed survey on a sample of 452 K-12 STEM teachers to determine the level at which they use research to inform their practice. Booher et al. evaluated teachers' perspectives on the practicality of utilizing research to enhance their teaching, the prevailing research culture within their schools, the obstacles they encounter when using research, their tendency to disregard research, and their level of involvement with research reports. Based on the results, teachers view research favorably and recognize its value in informing their professional practices. Nevertheless, they encounter various challenges in locating reliable research sources and effectively applying research findings to improve their teaching methods. It is important to note the Booher et al. study exclusively focused on K-12 teachers, and while the results are significant, they may not necessarily be directly applicable to other educational contexts or cultures.

The variety of influences and outcomes associated with using educational research to inform practice highlights the importance of understanding how teachers' perceptions and interactions with related and relevant research inform their practices. Further, the limited number of empirical studies on teacher perceptions and engagement with STEM education research to inform their practice, particularly in different cultural settings, provides additional support for the research. Thus, our goal was to address the research gap and investigate the perceptions and interactions of STEM education research among STEM teachers in Kazakhstan.

The reviewed literature shows the significance of understanding how teachers engage with STEM education research in diverse educational contexts. However, most extant studies focused on Western settings, leaving a gap in knowledge regarding post-Soviet countries such as Kazakhstan. The following section outlines the methodology used to address the research questions and gather empirical data in this unique context.

METHOD

Our research objective centered on investigating the viewpoints and enactments of STEM education among physics teachers. Specifically, we were interested in understanding teachers' perspectives and engagements with educational research while incorporating integrated STEM instruction and content.

Participants

The participants in our research were K-12 physics teachers attending a STEM professional development program in Almaty, Kazakhstan. There were 127 teachers registered in the STEM program, of which 68 agreed to participate in the research project. After data screening for incomplete surveys, our project sample consisted of 50 teachers.

The 50 participants in the sample were, on average, 31.60 years old (*SD* = 9.57) and had been teaching an average of 8.40 years (*SD* = 9.36). Women comprised 70.00% of our participants, and men comprised 30.00%. A majority of the participants (68.00%) indicated that they taught in a suburban community, followed by rural communities (22.00%) and urban communities (10.00%). The teachers indicated that they taught a varying number of grades, ranging from sixth to twelfth grade. Ten percent of teachers taught a single grade, and 10% taught two grade levels. Thirty percent taught three grade levels, and 16% taught four different grade levels. The remaining teachers (34%) taught to five or more different grade levels. Most of the participants (62.00%) indicated that they have a master's degree, followed by a bachelor's degree (26.00%) and a PhD (6.00%). Participating teachers specified that they have participated in an average of 60 hours (*SD* = 47.00) of professional development. The distribution of the participants' self-reported knowledge of STEM education research was as follows: 12% had little knowledge, 46% had some knowledge, 30% had good knowledge, and 12% had expert knowledge. Forty-eight percent of teachers shared that they acquired STEM knowledge from journals, while 52% obtained STEM knowledge from the Internet, school programs, and regional professional development offerings.

Instrument

We used the STEM educational research survey developed by Booher et al. (2020) to gather our data. After gaining permission from the developers, we translated the instrument into Kazakh. The first author translated the survey into Kazakh, and two English-language scholars who were native speakers of Kazakh independently reviewed the translation. The inconsistencies between the translation checks were resolved through a meeting. To assess the clarity and cultural appropriateness of the translated instrument, we conducted a pilot test with two K-12 teachers in Kazakhstan. Their feedback indicated confusion regarding one item, "I do NOT feel that I can use STEM educational research to justify what I think is correct instruction" which we rephrased for better clarity without altering its original meaning. These steps ensured both linguistic accuracy and cultural appropriateness of the final Kazakh version.

We calculated the Cronbach alpha reliability coefficient for the survey as a whole to be .93. The subscale Cronbach alpha reliabilities were .79 for active engagement with education research, .81 consulting STEM education research in their teaching activities, .76 for institutional culture of STEM education research use, .89 for STEM education research as a barrier, and .90 for dismissal STEM education research use, indicating internal consistency between the items. All values exceeded the commonly accepted threshold of .70 (Dijkstra & Henseler, 2015), indicating satisfactory reliability and internal consistency for each construct measured in the survey.

Data collection

We conducted our data collection online using a Google Form. We invited all the teachers attending the targeted professional development event to participate in the research project and complete the survey. We embedded a survey link into the invitations we sent to the participants. We gathered data for two weeks, with a follow-up reminder distributed eight days after the initial invitation.

Data Analysis

We started our analysis with data conditioning. We excluded the responses from the participants who completed less than 90% of the survey or had provided the same response for all questions. For the surveys completed by the remaining participants, we substituted any randomly omitted response with the series' mean to create a complete dataset (Tabachnick & Fidell, 2013). We reversed-coded the items with negative phrasing. We then computed the descriptive statistics for each item and the five sets of subscale items.

We created 100% stacked bar charts to represent the distribution of answers for each selected-response item by subscale. The decision to use 100% stacked bar charts was based on their ability to display the proportional percentages of each response item, allowing for rapid analysis and communication of the distribution of participant responses. We organized the additional descriptive and inferential statistic data in tables.

Ethical Considerations

This study was conducted in accordance with the ethical standards approved by the Institutional Review Board of Al-Farabi Kazakh National University under protocol number 1, dated 21.09.2023. Prior to participation, we provided all respondents with an informed consent statement outlining the purpose of the study, their rights as participants, and assurances of anonymity and confidentiality. Participation was voluntary, and no personally identifying information was collected. Data were stored securely and used solely for research purposes to ensure compliance with data privacy standards.

RESULTS

Overall Statistical Analysis

The standard deviations for our Likert-type items showed a moderate variation in the responses, with a range of .41, a minimum of .90, and a maximum of 1.31.

Table 1 includes the descriptive statistics for the five subscales of the survey. Our Levene's homogeneity of variance test revealed no significant differences for each subscale. However, the Shapiro-Wilk normality test indicated a non-normal distribution for subscales "Active engagement with education research" and "STEM education research in teaching activities." Therefore, for these two subscales, we made comparisons using non-parametric analyses. We applied parametric tests in the analyses of the three remaining subscales.

Table 1. Descriptive Statistics for the Five Survey Subscales

Statistic	Active engagement with education research	STEM education research in teaching activities	Institutional culture of STEM education research use	STEM education research as a barrier	Dismissal STEM education research use
N	50	50	50	50	50
Mean	3.26	3.25	2.89	3.17	3.45
Standard deviation	.863	.852	.816	.383	.794
Minimum	1.29	1.38	1.00	2.00	1.60
Maximum	5.00	4.63	4.50	3.86	4.80
Shapiro-Wilk W	.919	.929	.973	.964	.966
Shapiro-Wilk p	**.002***	**.005***	.312	.136	.160

*$p<.05$

Teachers Active Engagement with STEM Education Research

To answer the first research question, we examined the 100% stacked bar graph responses to the Likert-type items aligned with teachers' active engagement with STEM education research (see Figure 1). According to our analysis, teachers expressed a level of neutrality towards subscribing to journals that report on STEM education research and using research to defend curricular choices. However, they demonstrated a general agreement towards all other aspects of engagement with educational research, including the ability to identify high-quality research, staying up-to-date with the latest research, discussing research with other teachers, seeking support from STEM educational research, and incorporating research findings into instruction.

The outcomes displayed in Figure 1 illustrate that while a majority agreed that they use research to inform their practice and stay current to be more effective teachers (over 60% agreement), responses were more neutral or divided for items like defending curricular choices with research and subscribing to STEM journals. Notably, 24% of teachers remained neutral about defending their curricular decisions with research, and only 18% agreed or strongly agreed that subscribing to journals was important.

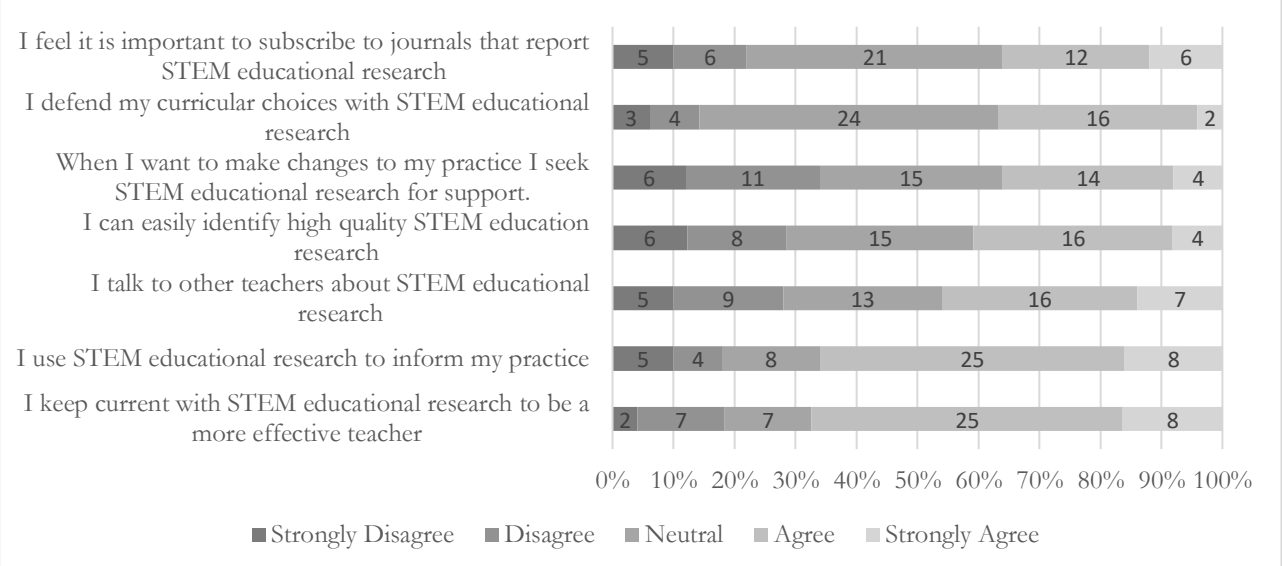

Figure 1. Teachers' Active Engagement with Education Research

Teachers' Use of STEM Educational Research in Teaching

To answer the second research question, we examined the responses to the Likert-type items aligned to teachers' use of STEM education research in their teaching using a 100% stacked bar graph (see **Figure 2**).

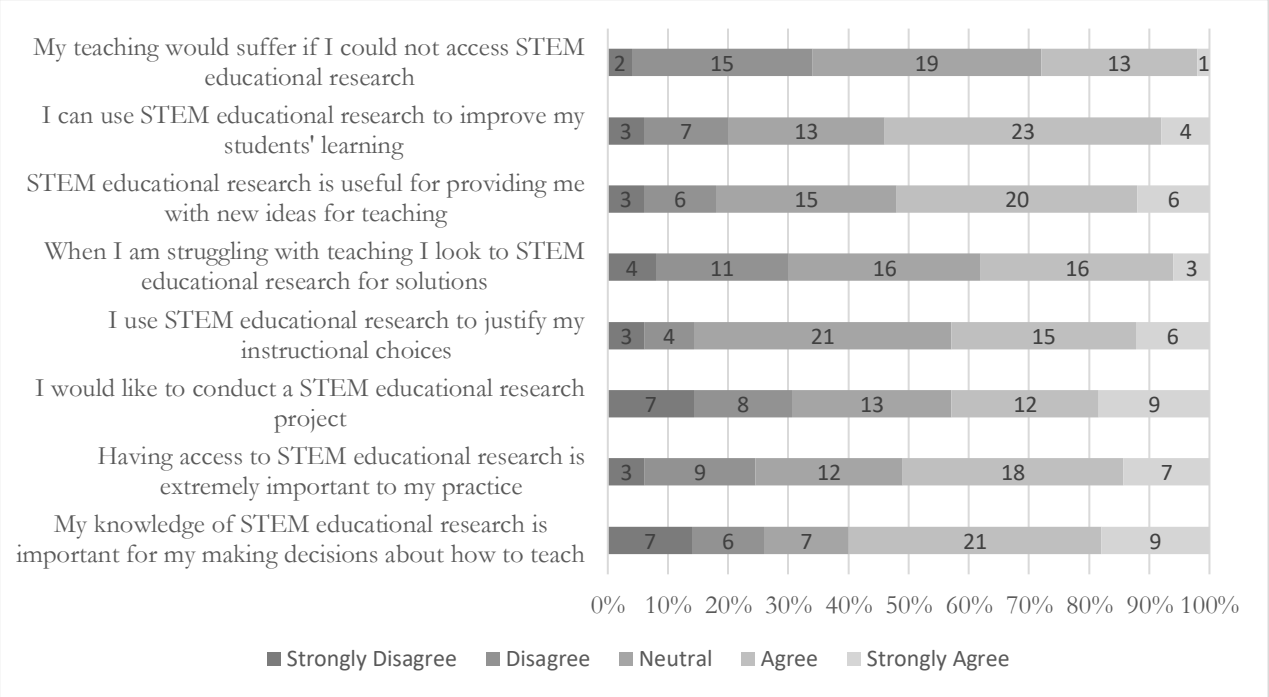

Figure 2. Teachers' Use of Education Research In Their Teaching

As displayed in **Figure 2**, approximately 60% of the participants agreed to some degree on the significance of education research for their instructional decisions. Additionally, over half of the participants concurred that research could offer fresh perspectives, access to research is crucial for their practice, and research can enhance student learning. However, a majority of the participants remained neutral about seeking research-based solutions, using research to validate their teaching choices, and the negative impact on their teaching if they lacked access to research. Lastly, the participants were almost equally split on whether to conduct a research project.

The Culture of Using Education Research

To answer the third research question, we examined the responses to our Likert-type items related to working in a school with a culture that supports engaging with STEM education research using a 100% stacked bar graph (see **Figure 3**).

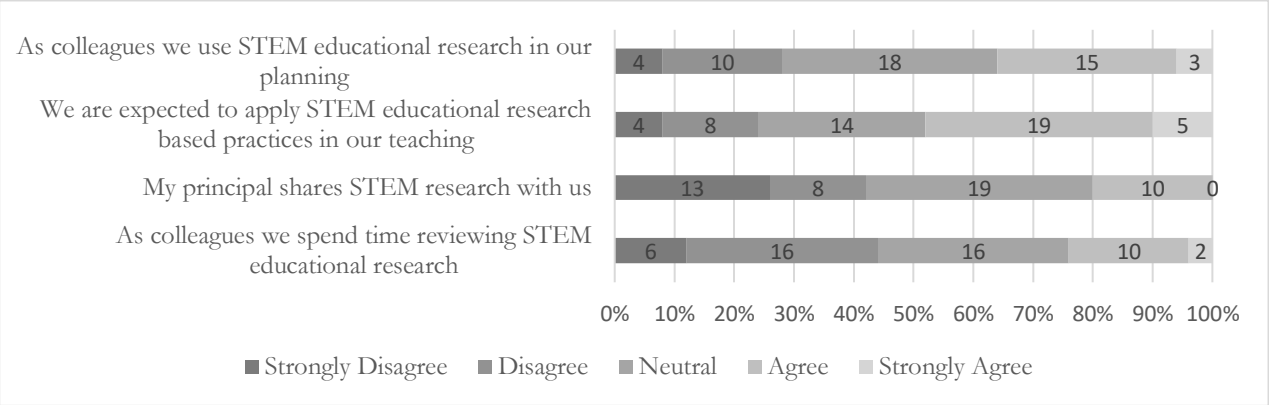

Figure 3. Institutional Support of STEM Education Research

Figure 3 shows that merely 20% of teachers concurred that their principals share education research with them. Correspondingly, most participants disagreed or held a neutral stance on spending time reviewing STEM education research as colleagues (96%) or using the research in their planning (64%). On the other hand, approximately 48% of the participants agreed or strongly agreed regarding the expectation of applying research-based practices in their STEM teaching.

STEM Education Research as a Barrier

To answer the fourth research question, we examined the responses to the Likert-type items aligned with perceptions of STEM education research as a barrier to effective teaching using a 100% stacked bar graph (see **Figure 4**).

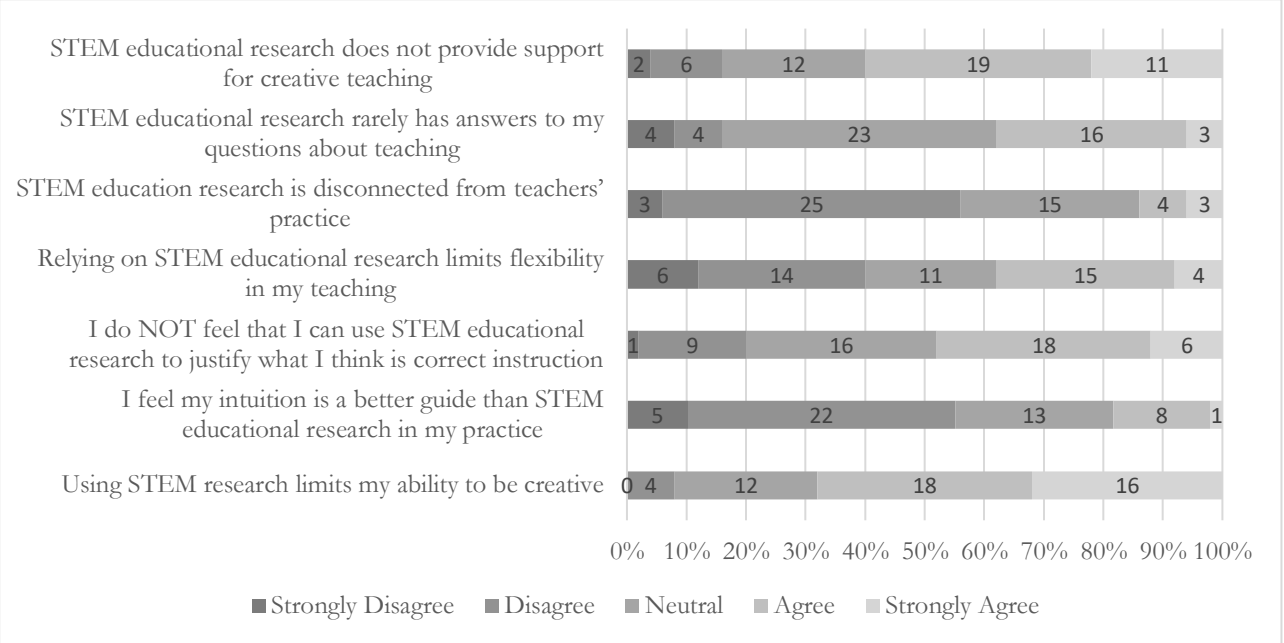

Figure 4. STEM Education Research as a Barrier

As indicated in **Figure 4**, a higher percentage of teachers disagreed rather than agreed regarding two possible obstacles. These barriers pertain to STEM education research being disconnected from the practical aspects of teaching (56%) and considering intuition as a superior guide compared to STEM education research (54%). On the other hand, a higher number of teachers agreed rather than disagreed with two different potential barriers. These barriers included STEM education research not offering solutions to teaching-related queries and the teachers' intuition being able to guide instructional choices better than STEM education research. The majority of teachers also concurred that research constrains creativity (68%) and does not support innovative teaching methods (60%). Lastly, there was a nearly equal distribution in the number of participants who agreed and disagreed with the statement that STEM education research limits flexibility.

Dismissal STEM Education Research Use

To answer the fifth research question, we examined the responses to the Likert-type items describing the dismissal of STEM education research use with a 100% stacked bar graph (see **Figure 5**).

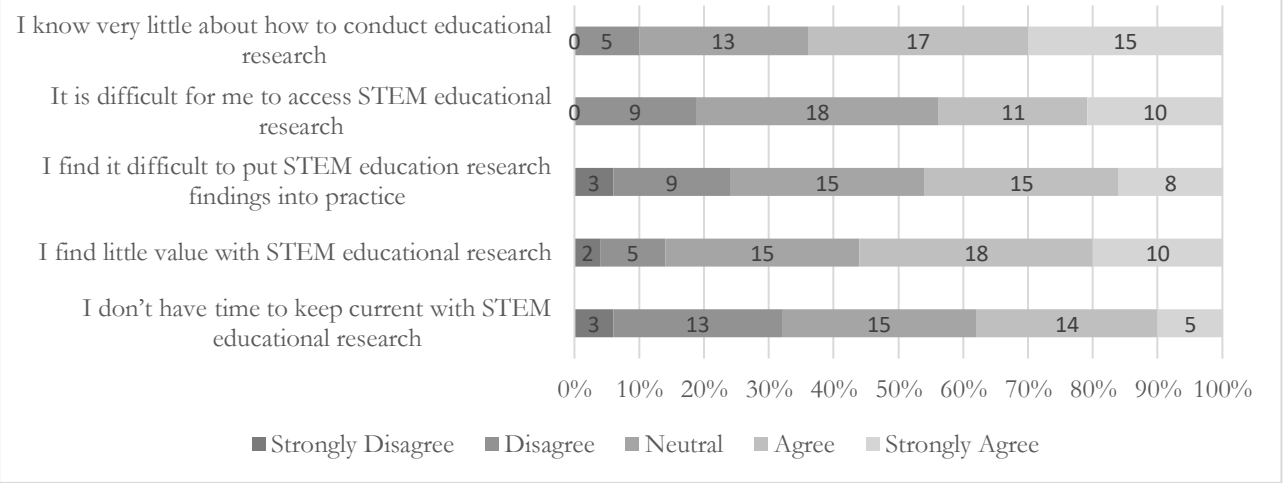

Figure 5. Dismissal of STEM Education Research Use

Figure 5 graphically portrays that most participants (64%) admitted having limited knowledge of how to conduct educational research, and a significant number also viewed STEM educational research as having little value (56%). The third most common reason cited by the participants for disregarding research was the perceived difficulty in putting it into action (46% agreed to some extent), followed by lack of time to engage in research (38% agreed to some degree). Additionally, more teachers agreed than disagreed that limited access to STEM education research is an issue (42% agreed to some extent, and 18% disagreed to some extent). A majority of the participants (56% agreeing to some extent) also concurred with the idea that STEM education research holds little value.

Facets of Teacher Perceptions of STEM Education Research

To answer our final research question, we compared the facets of teacher perceptions of and practices using STEM education research to inform their teaching. We present the mean score of each subscale of the survey dimension in **Figure 6**.

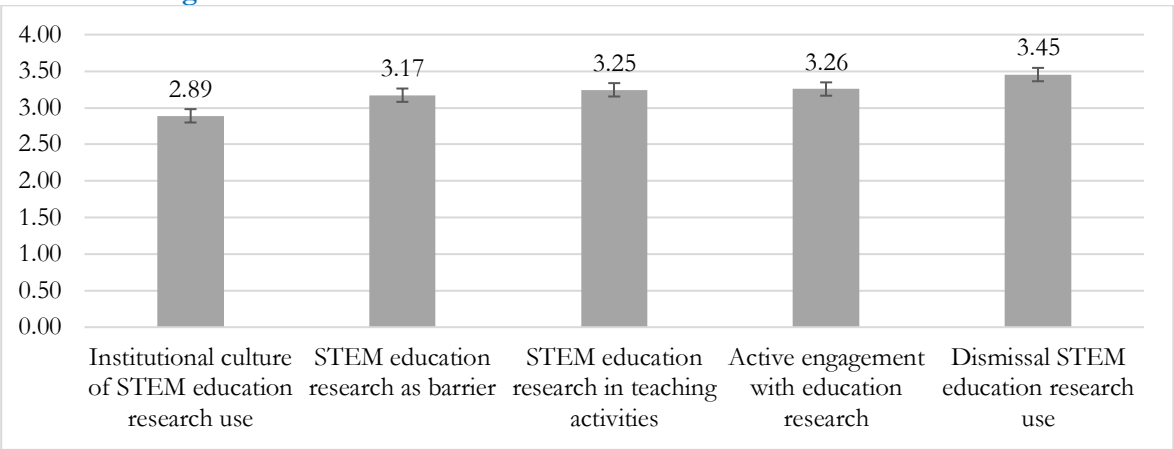

Figure 6. Mean of STEM Education Research Facets

The results displayed in **Figure 6** indicate the participants tended to have a low opinion of the support available for working in environments that promote the use of STEM education research to inform teaching (M = 2.89, SD = .82). Similarly, the participants held neutral perceptions of the barriers to using STEM education research (M = 3.17, SD = .38), suggesting that they did not perceive the research as a significant obstacle to creativity and innovation in their teaching. The teachers were relatively neutral in terms of the application of STEM education research in their teaching (M = 3.25, SD = .85), active engagement with research (M = 3.26, SD = .86), and dismissal of research (M = 3.45, SD = .79). The composite average of all items was 3.20 (SD = .65), indicating that the participants held ambivalent perceptions of using STEM education research to inform their teaching. We continued our analysis by examining the correlations among the subscales (see **Table 2**).

Table 2. Correlations Among the Survey Subscales

	Active engagement with education research	STEM education research in teaching activities	Institutional culture of STEM education research use	STEM education research as a barrier
STEM education research in teaching activities	.903**	—		
Institutional culture of STEM education research use	.666**	.711**	—	
STEM education research as a barrier	-.186	-.192	-.201	—
Dismissal of STEM education research use	-.176	-.194	-.137	.459 **

*** $p < .05$, ** $p < .01$**

Variables Linked to Teachers' Perceptions of Education Research

To identify the factors related to teachers' perceptions and use of STEM education research, we examined various characteristics of our participants along with their scores on each dimension of the survey, as shown in **Table 3.**

Table 3. Correlation Significance (p) Between Research Scores and Demographic Variables

	Age	Years teaching	Hours of PD	Knowledge	Gender	School location
Active engagement	.533	.983	.812	.144	.845	.850
Teaching activities	.208	.613	.945	.532	.643	.785
Institutional culture	.095	.156	.209	.366	.100	**.040***
Research as a barrier	**.034***	**.016***	.429	.979	.365	.106
Dismiss research use	.494	.354	.306	.990	.800	.315

Note: All numbers in this table represent *p* values; * $p<.05$

We discovered that the institutional culture score was associated with school location ($F = 7.54$, $df1 = 2$, $df2 = 14.01$, $p = .006$). Our follow-up Games-Howell post hoc test analysis revealed a significant difference between rural-urban ($p = .048$) and suburban-urban ($p = .008$) teachers. In other words, institutional support for STEM education research was higher in rural schools ($M = 3.14$) compared to both urban ($M = 2.20$) and suburban ($M = 2.93$) schools. We also found STEM education research as a barrier was positively associated with age ($p = .034$) and years of teaching ($p = .016$).

DISCUSSION, IMPLICATIONS, AND FUTURE RESEARCH

Our research goal was to document the knowledge and use of educational research in teaching among STEM teachers in Kazakhstan. We sought to provide baseline data as a foundation for future research. We sought to fill a gap in the research detailing STEM teacher perceptions and practices in Kazakhstan. In our discussion, we posit possible explanations for the findings and the implications of our results on teacher preparation and practices and suggest directions for future research to address gaps in empirical support detailing STEM teaching in Kazakhstan.

Active Pursuit of Education Research by Teachers

Our findings revealed that teachers tended to be neutral toward the importance of STEM education research in their practice, although the teachers often justified their decisions by referencing research. At the same time, the participants reported using STEM education research to inform their practice and staying current with research to be effective educators. The participants' responses suggest a potential misalignment between their use of research to justify existing choices and their use of research to shape their practices. We speculate teachers may hold diverse views on what constitutes STEM education research, which likely influences their interactions and application of research in their teaching practices. It is also possible that teachers recognize the importance of research-based practices and, thus, understand they should be using research to make decisions. Still, they may have little or no control over some of their decisions to engage with research to inform their practices. Our findings suggest that there is a need for deeper insight into how teachers perceive the best ways to access and apply STEM education research in their practice, a gap that remains underexplored in the current literature.

Our results align with those of Booher et al. (2020), who found teachers tend to value educational research but struggle to translate it into practice. However, Kazakhstani teachers in our study reported more ambivalence and dismissal of the utility of research, which may reflect contextual differences in access, professional autonomy, and institutional culture.

Teachers' Use of Educational Research in Teaching

The participants generally agreed that STEM educational research could help generate new ideas for teaching leading to improved student learning. However, the participants also indicated they were neutral toward using

educational research to justify their instructional choices. Similar to our previous findings and those of Behrstock et al. (2009) and Cain (2015), discontinuity appears to exist between the participants' perceptions and practices. The findings suggest that teachers may think about STEM education research differently from how they apply research in their teaching. One potential implication is that teachers may be making instructional choices that are not grounded in evidence, which could influence both their teaching effectiveness and their students' learning outcomes. Further research is needed to examine how teachers consider evidence-based practices and what they regard as valid evidence when making decisions regarding teaching and learning.

Our findings revealed that while teachers acknowledged the value of STEM education research and reported using it to improve student learning, many remained neutral about employing it to justify instructional decisions. This discrepancy aligns with Behrstock et al. (2009) and Cain (2015), who observed similar gaps between teacher perceptions and practices.

The Culture of Using Education Research

We found a relatively weak culture of sharing and discussing educational research among the participants. Our finding suggests that participants may consider education research independently of their colleagues, which may limit their scope for considering and discussing the potential benefits or limitations of the research as applied to practice. A related implication is the potential for highly individualized selection of the educational research they might consider along with individualized integration of the research into practice. The more significant ramification is the likely potential for nominal influence of research on teacher practice and student learning. Further investigation is needed to empirically document the cultural barriers limiting a culture of collectively considering and discussing STEM education research among teachers.

Consistent with findings from research on teachers in Gulf Cooperation Council (GCC) countries (Kayan-Fadlelmula et al., 2022), our study also found that institutional culture plays a significant role in shaping teachers' engagement with research. Particularly, rural teachers reported stronger research cultures than their urban counterparts. These patterns indicate the potential influence of geographical and institutional factors on teacher-research interactions.

STEM Education Research as a Barrier

Participants tended to perceive educational research as a constraint on creative teaching and as a hindrance to aligning the research with their perceptions of effective instruction. The teachers tended not to not consider their intuition was a better guide than research for engaging in effective instruction but were also neutral toward considering research to inform their decisions, which reflected limitations in their flexibility. We speculate the teachers may interpret or consider research in ways inconsistent with the intentions for those conducting and reporting STEM education research. Furthermore, we also posit the teachers may be considering a limited scope of the STEM education research canon, focusing on the research that confirms engaging in more traditional approached and less on research aligned with innovative practices. The implication of our finding is the potential for situations similar to those reported by Dagenais et al. (2012), as the teachers seemed to be turned off by educational research due to the perception the research is not only irrelevant but also stifling their creativity. Further research is needed to examine how variations in the levels of innovation reported in STEM education research influence teachers' perceptions of the research relevance and usefulness for fostering creative practices.

Dismissal STEM Education Research Use

Another finding was that most participants agreed that research had little value for them and they held limited knowledge of how to conduct a publishable research project. Additionally, the participants tended to recognize limited access to research and lack of time to locate and interpret educational research as potential justifications for dismissing research. We speculate that the large percentage of participants who indicated they did not know how to carry out a research project is reflective of their limit knowledge of educational research in general. A key implication for the teacher limited knowledge of educational research is they may create unsupported justifications for dismissing the research as having value or not being aligned with their practice. The lack of expertise in conducting educational research may also impact the motivation to seek research to inform their practices and how they interpret research findings. An interesting direction for future research is exploring how engaging teachers in authentic education research projects might influence their understanding and perceptions of the research in the context of their teaching.

Facets of Teacher Perceptions of STEM Education Research

Several significant positive correlations were detected, as well as one negative correlation, and several nonsignificant relationships among the subscales. Our results indicate that the different facets of perceptions and

engagement in STEM educational research may be related or independent. The culture of using STEM education research association with active engagement in research and applying research in teaching activities suggests that school culture may be a critical influence on teacher consideration of STEM education research. The dismissal of the relationship between considering STEM education research and engaging with STEM education research as a barrier suggests that teachers are likely to dismiss the use of research. The implication of the finding is there may be multiple potential benefits for enhancing the culture of accessing, reviewing, and applying STEM education research in schools.

An intriguing finding was that teachers in rural schools reported stronger institutional cultures for supporting educational research use than their urban counterparts. This phenomenon may be partially explained by the relatively small size of rural schools, where close-knit professional communities and direct leadership can have greater influence on levels of collaboration and communication, factors that have been documented as being associated with teacher engagement in research (e.g., Dagenais et al., 2012). In the Kazakhstani context, teachers in rural areas may have greater access to professional development through targeted government programs aimed at reducing urban-rural disparities. International comparisons suggest that similar patterns have been observed in regions where resource-constrained schools build stronger internal professional learning cultures or communities out of necessity (e.g., Levin, 2008).

PRACTICAL IMPLICATIONS AND RECOMMENDATIONS

Our study offers distinct implications for practice, policy, and future research. Based on our evidence we contend teacher practice could be enhanced if schools invest in structured, peer-led mentoring systems where teachers with experience in research engagement experience guide newer colleagues in the practice. Establishing school-based "research facilitators" or research communities of practice can also motivate teachers to engage in collaborative reading and applying evidence based practices. For policy, the Ministry of Education could expand access to national platforms such as *BILIMLand* to include summaries of recent STEM education research in Kazakh and Russian. Policymakers might also fund micro-credentialing or certificate programs that reward teachers for integrating research into lesson planning. The expansion would lower barriers to accessing educational research, which may result in higher levels of engagement in evidence based practices.

Based on our findings, we recommend that teachers engage with STEM education research through structured professional learning communities and targeted professional development that focuses on enhancing teacher capacity for applying evidence-based finding in their practice. School leaders should cultivate a culture of research use by leveraging their position to allocate time for collaborative reflection, facilitate access to relevant studies, and partner with educational researchers to promote a culture of research consideration and integration. Policymakers are urged to support open-access research repositories in regional languages, incentivize teacher-researcher collaboration, and strengthen teacher education programs with a focus on research literacy and translation to practice. We argue these efforts can enhance the translation of research to practice leading to evidence-based teaching in STEM education.

LIMITATIONS AND DELIMITATIONS

Our first limitation concerns the depth of the statistical analyses. While the descriptive and correlational analyses revealed key trends in teacher engagement with STEM education research, such as high perceived value but limited institutional support and application in practice, the absence of multivariate or regression analyses constrains our ability to model the influence of demographic variables or contextual factors on these patterns. For example, while correlations indicated links between school culture and active research engagement, we were unable to determine the relative contribution of each factor. Future studies employing regression or structural equation modeling could provide more robust quantitative support for explaining and documenting these relationships.

A second limitation concerns the focus on physics teachers. It may be possible that teachers in other disciplines may have different perspectives and engage in different practices. Thus, future research may involve recruiting a more diverse group of teachers to determine if there are differences in perspectives and practices by STEM discipline.

Additionally, we are unsure which sources of STEM education research the participants considered and how they utilize those to inform their practices. While we assume the participants held a similar perspective on STEM education research to those held by STEM education researchers, their responses indicate this may not be the case. Future research needs to include opportunities to collect participants' definitions and uses of STEM education research to inform their practices.

Another limitation is a lack of awareness of the participant's ability to access STEM education research and what research they may be unable to access. While open-access STEM education research reports are abundant, accessing the reports requires suitable internet connections, which may be limited in rural communities. Thus, in future research, there would be a benefit to providing participants with specific STEM education research documents to ensure consistency in teacher access and content.

The fifth limitation of our study is that the translated survey instrument did not undergo a formal back-translation process. The translation was reviewed collaboratively by bilingual experts and piloted with local teachers using cognitive interviews to ensure semantic clarity and contextual appropriateness. However, the absence of back-translation may limit the assurance of full conceptual equivalence between the original and translated versions.

Finally, while the descriptive statistics provide a foundational understanding, we acknowledge the need for more robust inferential and multivariate analyses to further unpack these relationships, an avenue we recommend for future studies using larger and more diverse samples.

CONCLUSION

The goal of our research was to document the perceptions and engagement of Kazakhstan teachers with STEM education research. We found the teachers held conflicting perspectives on the benefits and value of using STEM education research in their practices, and the culture of research use seemed to predict their perceptions of the benefits of using the research. Evidence-based decision-making is critical to enhancing teacher effectiveness and student learning. Thus, using STEM education research to design curriculum and inform instruction may enhance the potential for creating high-impact learning environments. The results underscore the importance of integrating STEM education research into teaching practices and provide insights into how educators in Almaty, Kazakhstan, perceive and engage with research. By addressing the practical implications, educational stakeholders can work together to improve STEM education and enhance the learning experiences of students in the region.

Our research raised multiple questions that need to be answered to further understand teacher interactions with STEM education research. Thus, we hope others will be inspired by our investigation and expand upon our research to better understand teachers' perceptions and interactions with STEM education research.

Our study presents important empirical findings about the under-explored educational context of Kazakhstan by examining how secondary school teachers engage with STEM education research. Beyond its geographical uniqueness, this study contributes to theoretical knowledge by applying Cultural-Historical Activity Theory (CHAT) to interpret the interplay between individual perceptions and institutional research culture. It advances comparative education by demonstrating how contextual factors such as language, centralized reforms, and rural-urban dynamics shape research use in ways that differ from Western-centric models. Finally, our research could be used to review STEM education policy by identifying structural barriers and recommending context-sensitive mechanisms such as localized research dissemination platforms and differentiated professional development, to promote evidence-informed teaching through the translation of research to practice.

REFERENCES

Anderson, N. B. (2006). Evidence-based practice in psychology. *American Psychologist*, *61*(4), 271–285. https://doi.org/10.1037/0003-066X.61.4.271

Balta, N., Cessna, S. G., & Kaliyeva, A. (2020). Surveying Kazakh high school students' attitudes and beliefs about physics and learning with the Colorado learning attitudes about science survey. *Physics Education*, *55*(6), 065019. https://doi.org/10.1088/1361-6552/abad4a

Balta, N., Japashov, N., Mansurova, A., Tzafilkou, K., Oliveira, A. W., & Lathrop, R. (2023). Middle- and secondary-school students' STEM career interest and its relationship to gender, grades, and family size in Kazakhstan. *Science Education*, *107*(2), 401-426. https://doi.org/10.1002/sce.21776

Bati, K., & İkbal Yetişir, M. (2021). Examination of Turkish Middle School STEM teachers' knowledge about computational thinking and views regarding information and communications technology. *Computers in the Schools*, *38*(1), 57–73. https://doi.org/10.1080/07380569.2021.1882206

Behrstock, E., Drill, K., & Miller, S. (2009). *Is the supply in demand? Exploring how, when, and why teachers use research.* Learning Point Associates. https://eric.ed.gov/?id=ED512564

Booher, L., Nadelson, L. S., & Nadelson, S. G. (2020). What about research and evidence? Teachers' perceptions and uses of education research to inform STEM teaching. *Journal of Educational Research*, *113*(3), 213–225. https://doi.org/10.1080/00220671.2020.1782811

Cain, T. (2015). Teachers' engagement with published research: Addressing the knowledge problem. *The Curriculum Journal*, *26*(3), 488–509. https://doi.org/10.1080/09585176.2015.1020820

Casto, A. R. (2022). A re-envisioned multicultural STEM education for all. *Education Sciences*, *12*(11), 1-10. https://doi.org/10.3390/educsci12110792

Chai, C. S. (2019). Teacher professional development for science, technology, engineering and mathematics (STEM) education: A review from the perspectives of technological pedagogical content (TPACK). *Asia-Pacific Educational Research*, *28*, 5–13. https://doi.org/10.1007/s40299-018-0400-7

Dagenais, C., Abrami, P., Bernard, R., Janosz, M., & Lysenko, L. (2008). *Integrating research-based information into the professional practices by teachers and school administrators: Towards a knowledge transfer model adapted to the educational environment.* Canadian Council.

Dagenais, C., Lysenko, L., Abrami, P. C., Bernard, R. M., Ramde, J., & Janosz, M. (2012). Use of research-based information by school practitioners and determinants of use: A review of empirical research. *Evidence & Policy: A Journal of Research, Debate and Practice*, *8*(3), 285–309. https://doi.org/10.1332/174426412X654031

Dijkstra, T. K., & Henseler, J. (2015). Consistent partial least squares path modeling. *MIS Quarterly*, *39*, 297-316. https://doi.org/10.25300/MISQ/2015/39.2.02

Dinglasan, A. J., & Weible, J. L. (2025). Higher education STEM faculty views on collaborative assessment and group testing. *Journal of Research in Science, Mathematics and Technology Education, 8*(SI), 315-335. https://doi.org/10.31756/jrsmte.4113SI

Durik, A. M., Hulleman, C. S., & Harackiewics, J. M. (2015). One size fits some: Instructional enhancements to promote interest. *Interest in Mathematics and Science Learning*, *1*(1), 49–62. https://doi.org/10.3102/978-0-935302-42-4_3

El-Deghaidy, H., Mansour, N., Alzaghibi, M., & Alhammad, K. (2017). Context of STEM integration in schools: Views from in-service science teachers. *Eurasia Journal of Mathematics Science, Technology Education, 13,* 2459–2484. https://doi.org/10.12973/eurasia.2017.01235a

Flake, S., & Lubin, R. (2024). Proto-Narrative: A Critical Exploration of the Cultural Identities Held by Black Women in STEM. *Journal of Ethnic and Cultural Studies, 11*(5), 178–192. https://doi.org/10.29333/ejecs/2061

Grass, K. (2024). The Three Logics of Qualitative Research: Epistemology, Ontology, and Methodology in Political Science. *American Journal of Qualitative Research, 8*(1), 42-56. https://doi.org/10.29333/ajqr/14083

Grewe, F. (2025). The Need for Diffraction in STEM-Fields: An Ethical Feminist Consideration of the Concept of Gender Scripting. *Feminist Encounters: A Journal of Critical Studies in Culture and Politics,* 9(2), 28. https://doi.org/10.20897/femenc/16786

Jean, V. A., Payne, S. C., & Thompson, R. J. (2015). Women in STEM: Family-related challenges and initiatives. In M. Mills (Ed.), *Gender and the work-family experience* (pp. 291–311). Springer. https://doi.org/10.1007/978-3-319-08891-4_15

Karakose, T., Polat, H., Yirci, R., Tülübaş, T., Papadakis, S., Ozdemir, T. Y., & Demirkol, M. (2023). Assessment of the relationships between prospective mathematics teachers' classroom management anxiety, academic self-efficacy beliefs, academic amotivation and attitudes toward the teaching profession using structural equation modelling. *Mathematics, 11*(2), 449. https://doi.org/10.3390/math11020449

Kalogiannakis, M., & Papadakis, S. (2019). Pre-service kindergarten teachers' acceptance of "ScratchJr" as a tool for learning and teaching computational thinking and science education. *The Journal of Emergent Science* (JES), 15, 31–34. ASE in partnership with the Primary Science Teaching Trust (PSTT). ISSN: 2046-4754. https://www.researchgate.net/publication/336022829_Pre-service_kindergarten_teachers'_acceptance_of_'ScratchJr'_as_a_tool_for_learning_and_teaching_Computational_Thinking_and_science_education

Kalogiannakis, M., & Papadakis, S. (2020). The use of developmentally mobile applications for preparing pre-service teachers to promote STEM activities in preschool classrooms. In S. Papadakis & M. Kalogiannakis (Eds.), *Mobile learning applications in early childhood education*, (pp. 82-100). IGI Global Scientific Publishing. https://doi.org/10.4018/978-1-7998-1486-3.ch005

Kayan-Fadlelmula, F., Sellami, A., Abdelkader, N., & Umer, S. (2022). A systematic review of STEM education research in the GCC countries: trends, gaps and barriers. *International Journal of STEM Education*, *9*(1), 2. https://doi.org/10.1186/s40594-021-00319-7

Keniskhanova, A. (2020). *Understanding Kazakhstani students' willingness to communicate in English in senior secondary STEM subjects* (Doctoral dissertation, Nazarbayev University Graduate School of Education).

Levin, B. (2008). *How to change 5000 Schools: A practical and positive approach for leading change at every level*. Harvard Education Press.

Li, Y., Wang, K., Xiao, Y., Froyd, J. E., & Nite, S. B. (2020). Research and trends in STEM education: a systematic analysis of publicly funded projects. *International Journal of STEM Education*, *7*(1), 17. https://doi.org/10.1186/s40594-020-00213-8

Luft, J. A. (2025). Commentary: Supporting and ensuring the well-being of early career science teacher. *Journal of Research in Science, Mathematics and Technology Education, 8*(2), 89- 93. https://doi.org/10.31756/jrsmte.825

Lunenberg, M., Dengerink, J., & Korthagen, F. (2014). *The professional teacher educator: Roles, behaviour, and professional development of teacher educators*. Sense Publishers. https://doi.org/10.1007/978-94-6209-518-2

Mahon, D., & Murphy, D. (2019). Do students develop the way universities say they do? Staff perceptions of student development of graduate attributes in the context of a transnational partnership in Kazakhstan. *The European Educational Researcher*, *2*(2), 145–164. https://doi.org/10.31757/euer.225

Margot, K. C., & Kettler, T. (2019). Teachers' perception of STEM integration and education: a systematic literature review. *International Journal of STEM Education*, *6*(1). https://doi.org/10.1186/s40594-018-0151-2

Martín-Páez, T., Aguilera, D., Perales-Palacios, F. J., & Vílchez-González, J. M. (2019). What are we talking about when we talk about STEM education? A review of literature. *Science Education*, *103*(4), 799–822. https://doi.org/10.1002/sce.21522

Mater, N. R., Haj Hussein, M. J., Salha, S. H., Draidi, F. R., Shaqour, A. Z., Qatanani, N., & Affouneh, S. (2022). The effect of the integration of STEM on critical thinking and technology acceptance model. *Educational Studies*, *48*(5), 642-658. https://doi.org/10.1080/03055698.2020.1793736

Mutseekwa, C. (2025). Towards an integrated model for orienting preservice science teachers for 21st-century teaching. *International Educational Review, 3*(1), 1-19. https://doi.org/10.58693/ier.311

Nadelson, L. S., & Seifert, A. L. (2017). Integrated STEM defined: Contexts, challenges, and the future. *The Journal of Educational Research, 110*(3), 221-223. https://doi.org/10.1080/00220671.2017.1289775

Nadelson, S., & Nadelson, L. S. (2014). Evidence-based practice article reviews using CASP tools: A method for teaching EBP. *Worldviews on Evidence Based Nursing, 11*(5), 344-346. https://doi.org/10.1111/wvn.12059

Reyes, R. L. (2025). Integrating real-world problems into chemistry curricula: Enhancing relevance and student engagement. *Forum for Education Studies*, *3*(2), 2177. https://doi.org/10.59400/fes2177

Rinke, C. R., Gladstone-Brown, W., Kinlaw, C. R., & Cappiello, J. (2016). Characterizing STEM teacher education: Affordances and constraints of explicit STEM preparation for elementary teachers. *School Science Mathematics Journal, 116*, 300–309. https://doi.org/10.1111/ssm.12185

Schlag, R., Stegmann, K., & Sailer, M. (2024). The role of feedback type and peer interaction on knowledge acquisition in a flipped classroom on social science research methods. *The European Educational Researcher, 7*(2), 21-40. https://doi.org/10.31757/euer.722

Sannino, A., & Engeström, Y. (2018). Cultural-historical activity theory: Founding insights and new challenges. *Cultural-historical Psychology*, *14*(3), 43-56. https://doi.org/10.17759/chp.2018140304

Semyonov-Tal, K. (2021). Ethnicity, Spatial Segregation and Length of Stay in Emergency Medicine Departments: The Case of Israel. *Journal of Ethnic and Cultural Studies, 8(*2), 209–224. https://doi.org/10.29333/ejecs/628

Shernoff, D. J., Sinha, S., Bressler, D. M., & Ginsburg, L. (2017). Assessing teacher education and professional development needs for the implementation of integrated approaches to STEM education. *International Journal of STEM Education, 4*, 13. https://doi.org/10.1186/s40594-017-0068-1

Southerland, S. A., Nadelson, L. S., Sowell, S., Saka, Y., Kahveci, M., & Granger, E. M. (2012). Measuring one aspect of teachers' affective states: Development of the science teachers' pedagogical discontentment scale. *School Science and Mathematics*, *112*(8), 483–494. https://doi.org/10.1111/j.1949-8594.2012.00168.x

Stanovich, P. J., & Stanovich, K. E. (2003). *Using research and reason in education: How teachers can use scientifically based research to make curricular & instructional decisions.* National Institute for Literacy, US Department of Education. https://doi.org/10.1037/e563842009-001

Staub, F. C., Ralle, B., & Eilks, I. (2004). Transforming educational theory into useable knowledge: A case of co-constructing tools for lesson design and reflection. In B. Ralle, I. Eilks (Eds.), *Quality of practice-oriented research in science education* (pp. 41-52). Shaker.

Struyf, A., De Loof, H., Boeve-de Pauw, J., & Van Petegem, P. (2019). Students' engagement in different STEM learning environments: integrated STEM education as promising practice? *International Journal of Science Education*, *41*(10), 1387–1407. https://doi.org/10.1080/09500693.2019.1607983

Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistics (6th ed.)*. Boston, MA: Pearson.

Tzafilkou, K., Perifanou, M., & Economides, A. A. (2022). STEM distance teaching: Investigating STEM teachers' attitudes, barriers, and training needs. *Education Sciences*. *12*(11), 790. https://doi.org/10.3390/educsci12110790

Vanderlinde, R., & van Braak, J. (2010). The gap between educational research and practice: Views of teachers, school leaders, intermediaries and researchers. *British Educational Research Journal*, *36*(2), 299–316. https://doi.org/10.1080/01411920902919257

Webb, S. A. (2001). Some considerations on the validity of evidence- based practice in social work. *British Journal of Social Work*, 31(1), 57–79. https://doi.org/10.1093/bjsw/31.1.57

Yatskiv, I. (2017). Why don't women choose STEM? Gender equality in stem careers in Latvia. *International Journal on Information Technologies & Security*, 1, 79–88.

Yildiz, M., & Ecevit, T. (2024). Impact of STEM on Primary School Students' 21st Century Skills, NOS, and Learning Experiences. *Asian Journal of Instruction, 12*(2), 21-37. https://doi.org/10.47215/aji.1395298

