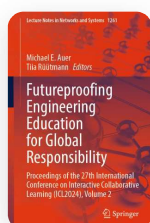


[Home](#) > [Futureproofing Engineering Education for Global Responsibility](#) > Conference paper


# Examining the Pedagogical Abilities and Needs of Kazak Physics Teachers to Implement STEM Education

| Conference paper | First Online: 21 March 2025


| pp 248–259 | [Cite this conference paper](#)



**Futureproofing Engineering Education for Global Responsibility**  
(ICL 2024)

[Tannur Bakytказы](#) , [Nurgaliyeva Kuralay](#), [Japashov Nursultan](#) & [Zhumabay Nurman](#)

 Part of the book series: [Lecture Notes in Networks and Systems](#) ((LNNS, volume 1261))



 Included in the following conference series:  
[International Conference on Interactive Collaborative Learning](#)

 422 Accesses

## Abstract

A key objective of STEM education globally is to cultivate leading experts in Science, Technology, Engineering, and Mathematics. However, despite the focus of professional development programs on strong leadership, enhancing teacher capacity, and offering

educational guidance, STEM teachers often encounter challenges adapting to transdisciplinary integration reforms in their classrooms. Hence, there is an urgent need for high-quality professional development programs that can effectively prepare teachers for implementing STEM education. To address this issue, this examines physics teachers' pedagogical needs regarding STEM education. The article aims to show teachers' experiences with STEM education across various school types and geographical locations in Kazakhstan. For this purpose, we have conducted a qualitative study, surveying 164 physics teachers in Almaty, one of Kazakhstan's biggest cities. As the study results showed, 104 teachers indicated having only a slight knowledge of STEM education, while 46 teachers reported that do not acquire any knowledge of STEM education, and 14 teachers claimed to possess expert knowledge. Furthermore, it was determined that 43.9% of the participants expressed the need for specific professional development programs to effectively implement STEM education in their classes. This study underscores the urgent necessity for targeted interventions to enhance teacher capacity in integrating STEM principles into their classrooms effectively.

 This is a preview of subscription content, [log in via an institution](#)  to check access.

### Access this chapter

Log in via an institution

### Subscribe and save

 Springer+

from €37.37 /Month

Starting from 10 chapters or articles per month

Access and download chapters and articles from more than 300k books and 2,500 journals

Cancel anytime

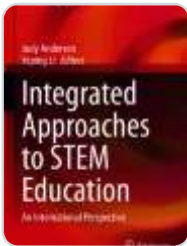
[View plans](#) 

Buy Now	
<a href="#">^ Chapter</a>	EUR 29.95 Price includes VAT (Kazakhstan)
<div>Available as PDF</div> <div>Read on any device</div> <div>Instant download</div> <div>Own it forever</div> <div>Buy Chapter</div>	
<a href="#">v eBook</a>	EUR 160.49
<a href="#">v Softcover Book</a>	EUR 199.99
Tax calculation will be finalised at checkout Purchases are for personal use only	
<a href="#">Institutional subscriptions →</a>	

Similar content being viewed by others



STEAM and AI: Tool for Teaching Physics



Integrated STEM in Australian Public Schools: Opening Up Possibilities for...



STEM Education in the Spanish Context: Key Features and Issues

## Explore related subjects

Discover the latest articles, books and news in related subjects, suggested using machine learning.

[Education](#)

[Education in Physics](#)

[Education Science](#)

[Engineering and Technology Education](#)

[Teaching and Teacher Education](#)

[Science Education](#)

## References

---

1. Asghar, A., Ellington, R., Rice, E., Johnson, F., Prime, G.M.: Supporting STEM education in secondary science contexts. *Interdisc. J. Probl.-Based Learn.* 6(2), 85–125 (2012). <https://doi.org/10.7771/1541-5015.1349>

[Article](#) [Google Scholar](#)

2. Schulz, S., Pinkwart, N.: Physical computing in STEM education. In: WiPSCE '15 09–11 November 2015, London, UK (2015)

[Google Scholar](#)

3. Tiflis, O., Saralar-Aras, I.: STEM education programme for teachers. In: The British Society for Research into Learning Mathematics. BSRLM Spring Conference, pp. 1–2 (2021)

[Google Scholar](#)

4. Dare, E.A., Ellis, J.A., Roehrig, G.H.: Driven by beliefs: understanding challenges physical science teachers face when integrating engineering and physics when integrating engineering and physics. *J. Pre-Coll. Eng. Educ. Res.* **4**(2), 5 (2014). <https://doi.org/10.7771/2157-9288.1098>
5. Kertil, M., Gurel, C.: Mathematical modeling: a bridge to STEM education. *Int. J. Educ. Math. Sci. Technol.* **4**(1), 44 (2016). <https://doi.org/10.46328/ijemst.v4i1.77>
6. Kim, C., Kim, D., Yuan, J., Hill, R.B., Doshi, P., Thai, C.N.: Robotics to promote elementary education pre-service teachers' STEM engagement, learning, and teaching. *Comput. Educ.* **91**, 14–31 (2015). <https://doi.org/10.1016/j.compedu.2015.08.005>

[Article](#) [Google Scholar](#)

7. Guan, N.H., Bunyamin, M.A.H., Khamis, N.: Perspectives of STEM education from physics teachers' points of view: a quantitative study. *Univers. J. Educ. Res.* **8**(11C), 72–82 (2020). <https://doi.org/10.13189/ujer.2020.082309>. <http://www.hrpub.org>
8. Dominguez, A., et al.: Integration of physics and mathematics in STEM education: use of modelling. *Educ. Sci.* **14**(1), 20 (2023)

[Google Scholar](#)

9. Kazakhstan Ministry of Education and Science: National Report of the Republic of Kazakhstan on the Implementation of the Global Education 2030 Agenda (2020). [http://planipolis.iiep.unesco.org/sites/planipolis/files/ressources/kazakhstan\\_national\\_report\\_on\\_the\\_implementation\\_of\\_the\\_global\\_education\\_2030\\_agenda.pdf](http://planipolis.iiep.unesco.org/sites/planipolis/files/ressources/kazakhstan_national_report_on_the_implementation_of_the_global_education_2030_agenda.pdf)
10. Қазақстан Республикасы әділет министрлігі [KZ adilet]. Қазақстанның Yshinshi zhaңғыruy: zhahandyқ bәsekege қабilettilik (2017 a). <https://adilet.zan.kz/kaz/docs/K1700002017>. Accessed 31 Jan 2017

11. Japashov, N., Naushabekov, Z., Ongarbayev, S., Postiglione, A., Balta, N.: STEM career interest of Kazakhstani middle and high school students. *Educ. Sci.* **12**, 397 (2022).  
<https://doi.org/10.3390/educsci12060397>
12. Egemen Qazaqstan: “Ұстаздар үйінде” kezdesu өтті (2020 a).  
<https://egemen.kz/article/256603-ustazdar-uyinde-kezdesu-otti>. Accessed 20 Nov 2020
13. Egemen Qazaqstan: Қазақстанда ауыл мектептерін қолдау бойынша зһаңа зһоба iske қосылды (2020 b). <https://egemen.kz/article/242772-qazaqstanda-auyl-mektepterin-qoldau-boyynsha-dganha-dgoba-iske-qosyldy>. Accessed 17 July 2020
14. Kurmangaliyev, A.: Issues of ICT Integr. Rural Second. Sch. Kazakhstan. *Sci. J. Astana IT Univ.* **5**, 84–93 (2021)  
[Google Scholar](#)
15. Abdalbakioglu, M., Kolushpayeva, A., Balta, N., Japashov, N., Bae, C.L.: Open lesson as a means of teachers’ learning. *Educ. Sci.* **12**(10), 692 (2022)  
[Google Scholar](#)
16. Smanova, K.N.: Can we overcome the achievement gap between urban and rural students in Kazakhstan through school resources: evidence from PISA 2018. In: *Proceedings of the 5th International Conference on Education and Multimedia Technology*, pp. 321–326 (2021)  
[Google Scholar](#)
17. Balta, N., Japashov, N., Bakytказы, T., Abdikadyr, B., Nurgaliyeva, K.: High school physics teachers’ pedagogical discontentment: the effect of curriculum improvement and professional development programs. *Heliyon* **10**(2) (2024)

18. Ejiwale, J.A.: Barriers to successful implementation of STEM education. J. Educ. Learn. (EduLearn) 7(2), 63–74 (2013)

[MATH](#) [Google Scholar](#)

19. Zhumabay, N., et al.: Designing effective STEM courses: a mixed-methods study of the impact of a STEM education course on teachers' self-efficacy and course experiences. Front. Educ. – Front. Media SA 9, 1276828 (2024)

[Google Scholar](#)

20. Stratton, S.J.: Population research: convenience sampling strategies. Prehosp. Disaster Med. 36(4), 373–374 (2021). <https://doi.org/10.1017/S1049023X21000649>

[Article](#) [MATH](#) [Google Scholar](#)

21. Bybee, et al.: The BSCS 5E instructional model and 21st century skills. Colorado Springs. BSCS, vol. 24 (2009)

[Google Scholar](#)

22. Brooks, J.G., Brooks, M.G.: In search of understanding: the case for constructivist classrooms. ASCD (1999)

[Google Scholar](#)

23. Shulman, L.S.: Those who understand: knowledge growth in teaching. Educ. Res. 15(2), 4–14 (1986)

[Google Scholar](#)

24. Altynsarin: Altynsarin National Academy of Education. Methodological recommendations for the introduction of STEM knowledge. In: Kazakh: Altynsarin atyndary Ұлттық bilim akademijasy. STEM bilimdi engizu boıynsha әdistemelik ұsynymdar. — Astana: Y. Altynsarin atyndary Ұлттық bilim akademijasy, p. 160 (2017). [https://online.zakon.kz/Document/?doc\\_id=33787765&show\\_di=1&pos=4;-71#pos=4;-71](https://online.zakon.kz/Document/?doc_id=33787765&show_di=1&pos=4;-71#pos=4;-71)
25. Polgampala, A.S.V., Shen, H., Huang, F.: STEM teacher education and professional development and training: challenges and trends. Am. J. Appl. Psychol. 6(5), 93–97 (2017)
- [Google Scholar](#)
26. Balta, N., Dzhapashov, N., Salibasic, D., Mesic, V.: Development of the high school wave optics Test. J. Turk. Sci. Educ. 19(1), 306–331 (2022)
- [Google Scholar](#)
27. National Research Council, Division of Behavioral, Social Sciences, Board on Testing, Assessment, Board on Science Education, & Committee on Highly Successful Schools or Programs for K-12 STEM Education: Successful K-12 STEM education: Identifying effective approaches in science, technology, engineering, and mathematics. National Academies Press (2011)
- [Google Scholar](#)

## Acknowledgment

---

The work was carried out with the financial support of the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan grant project AP26101691 – Scientific and pedagogical basics of secondary school learner’s professional orientation for future scientific and engineering careers through STEM.

## Author information

---



## Authors and Affiliations

Al-Farabi Kazakh National University, Almaty, Kazakhstan

Tannur Bakytказы & Nurgaliyeva Kuralay

State University of New York at Albany, New York, USA

Japashov Nursultan

Abai Kazakh National Pedagogical University, Almaty, Kazakhstan

Zhumabay Nurman

School-Gymnasium N202, Almaty, Kazakhstan

Tannur Bakytказы & Zhumabay Nurman

## Corresponding author

Correspondence to [Tannur Bakytказы](#).

## Editor information

---

## Editors and Affiliations

CTI Global, Frankfurt, Germany

Michael E. Auer

Tallinn University of Technology, Tallinn, Estonia

Tiia Rüütman

## Rights and permissions

---

[Reprints and permissions](#)

## Copyright information

---

© 2025 The Author(s), under exclusive license to Springer Nature Switzerland AG

## About this paper

---

## Cite this paper

Bakytказы, T., Kuralay, N., Nursultan, J., Nurman, Z. (2025). Examining the Pedagogical Abilities and Needs of Kazak Physics Teachers to Implement STEM Education. In: Auer, M.E., R  t  mann, T. (eds) Futureproofing Engineering Education for Global Responsibility. ICL 2024. Lecture Notes in Networks and Systems, vol 1261. Springer, Cham.  
[https://doi.org/10.1007/978-3-031-85649-5\\_25](https://doi.org/10.1007/978-3-031-85649-5_25)

[.RIS  ](#) [.ENW  ](#) [.BIB  ](#)

DOI	Published	Publisher Name
<a href="https://doi.org/10.1007/978-3-031-85649-5_25">https://doi.org/10.1007/978-3-031-85649-5_25</a>	21 March 2025	Springer, Cham
Print ISBN	Online ISBN	eBook Packages
978-3-031-85648-8	978-3-031-85649-5	<a href="#">Intelligent Technologies and Robotics</a>
		<a href="#">Intelligent Technologies and Robotics (R0)</a>
		<a href="#">Springer Nature</a>
		<a href="#">Proceedings excluding Computer Science</a>

## Keywords

[School type](#) [Teachers' attitude to STEM](#) [STEM education](#)

## Publish with us

[Policies and ethics](#)   