



**HAL**  
open science

## Teachers' attitudes towards technology during emergency remote learning

Anat Klemer, Ruti Segal, Shirley Miedijensky, Ronit Herscu-Kluska, Anatoli  
Kouropatov

► **To cite this version:**

Anat Klemer, Ruti Segal, Shirley Miedijensky, Ronit Herscu-Kluska, Anatoli Kouropatov. Teachers' attitudes towards technology during emergency remote learning. Thirteenth Congress of the European Society for Research in Mathematics Education (CERME13), Alfréd Rényi Institute of Mathematics; Eötvös Loránd University of Budapest, Jul 2023, Budapest, Hungary. hal-04410787

**HAL Id: hal-04410787**

**<https://hal.science/hal-04410787>**

Submitted on 22 Jan 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Teachers' attitudes towards technology during emergency remote learning

Anat Klemer<sup>1</sup>, Ruti Segal<sup>2</sup>, Shirley Miedijensky<sup>2</sup>, Ronit Herscu-Kluska<sup>2</sup> and Anatoli Kouropatov<sup>3</sup>

<sup>1</sup>Western Galilee College, Faculty of Education, Israel; [Anatkl@wgalil.ac.il](mailto:Anatkl@wgalil.ac.il)

<sup>2</sup>Oranim Academic College, Faculty of Graduate Studies, Israel;

<sup>3</sup>Levinsky-Wingate College of Education, Department of Mathematics, Israel

*The results of a quantitative survey of 104 in-service mathematics and science teachers who taught remotely as a result of the COVID-19 pandemic pointed to an increase in their knowledge regarding the existence of e-learning environments. During the pandemic the teachers integrated more digital technology and their goals for using computer tools changed, such that after the pandemic these tools were used mostly to create a learning environment suitable for distance learning. Most teachers experienced difficulties in technology integration, citing not enough preparation time, logistics problems, lack of technological knowledge, and insufficient technical conditions as the reasons. The results suggest that teachers need adequate knowledge and technical support to be able to integrate computerized technologies successfully into their teaching.*

*Keywords: Attitudes towards technology, Technological Pedagogical Content Knowledge (TPACK), teacher as technology consumer, Emergency Remote Teaching (ERT).*

## Introduction

In 2020, humanity was given a glimpse into the use of widespread remote learning during an emergency (Lindblad, et al., 2021). In an attempt to contain and curb the spread of COVID-19, many governments around the world ordered immediate lockdowns, which often involved completely shutting down the schools. Almost overnight, teaching and learning in all curricular subjects assumed a new shape and began relying almost exclusively on remote online instruction.

The underlying assumption in our work is that teachers' attitudes are the key to successful educational innovation. Teachers' views regarding all aspects of their profession and their behaviour have an impact on their pedagogical approaches and teaching strategies (Lucas et al., 2021; Miedijensky, 2023; Miedijensky et al., 2021). Ongoing research on in-service teachers' attitudes towards ICT has shown that positive attitudes towards the use of digital media in class enable teachers to adapt effectively to new educational technologies. Successful technology adaptation in the school system is influenced by many factors, including teachers' awareness of the available technological environments, school resources, school culture, and teachers and students' technological knowledge and experience (Lim et al., 2013).

In this paper, we contribute to existing knowledge by examining a locality in addition to those explored in other studies. We focus on how school closure affected K-12 mathematics education in one country in the Middle East—Israel. Our paper adopts an educational perspective by focusing on the initiatives taken by non-governmental actors in order to continue teaching during a time of crisis.

## **Contribution to the literature**

The research underscores that teachers' TPACK that may be adequate for face-to-face teaching, requires expansion and adaptation for distance teaching. It highlights that teachers generally regard the purpose of computer technology tools in teaching to be primarily to create collaborative learning environments. The study proposes suggestions for deepening and expanding pre- and in-service mathematics and science teachers' TPK and TK.

## **Theoretical framework**

In recent years, the use of Information and Communication Technologies (ICT) in education has been on the rise. Studies have shown that ICT improves students' learning skills and offers them more opportunities for information searching, communication, and problem-solving. ICT also bestows competencies needed for the 21st century (Lin et al., 2013; Niess & Gillow-Wiles, 2017). Teachers play a crucial role in preparing students for the future, including by exposing them to technology and its uses (Chand et al., 2020).

One important model for understanding how technology is integrated into teaching is the TPACK (Technological, Pedagogical, and Content Knowledge) model (Koehler & Mishra, 2009, based on Shulman, 1986). This model, which combines Technological Knowledge, Pedagogical Knowledge, and Content Knowledge, can be used for understanding the goals of integrating technology into teacher education, mapping teacher knowledge, and developing research tools. The model's complexity is reflected in the common components of its basic knowledge. For example, TCK (technological content knowledge) refers to knowledge about how technology can create different representations for a specific concept. TPK (Technological Pedagogical Knowledge) implies familiarity with the range of technologies that can be integrated into teaching and understanding how their use can affect teaching methods. These knowledge components became of paramount importance during Emergency Remote Teaching (ERT) (Green et al., 2020; Marissa & Allahji, 2021). TPACK implies that all three bodies of knowledge intersect at various levels of complexity (Klemer et al., 2020a, 2020b; Segal et al., 2021). The model has become a useful framework to understand the goals involved in integrating technology into teacher education, as well as mapping teacher knowledge and developing research tools, because it encompasses the knowledge teachers require to effectively integrate technology during their teaching (Nantschev et al., 2020). According to the literature, when teachers incorporate ICT into their teaching, their students are motivated to learn and achieve. Teachers are more likely to use a specific technology when they are aware of its purpose and benefits and do not find it too complicated to use. Nevertheless, despite technology's perceived usefulness and ease of use, teachers tend to prefer traditional teaching methods (Urezm et al., 2018). Among the main factors affecting the use of ICT in teaching and learning are a positive attitude, self-efficacy, and the ability to use ICT. Teachers need time to experience ICT tools and evaluate whether they are appropriate to teaching and learning so that they can be comfortable using technology and its innovations (Chiu & Churchill, 2016).

The literature reveals a growing interest in understanding the impact of the COVID-19 pandemic on teachers' ICT use. Studies have explored teachers' views on ICT use before and after the pandemic. For instance, Rodríguez-Muñiz et al. (2021) reported that, prior to the pandemic, teachers perceived

themselves as prepared to use technology in emergency situations. However, during the pandemic, they realized that they needed additional knowledge and training to manage remote teaching successfully. This view still stands today, in the post-pandemic period. Several studies have highlighted the insufficient technological knowledge of teachers to manage remote teaching effectively (Soeung & Chim, 2022). Despite the challenges, teachers have taken the initiative to offer local solutions for remote teaching by integrating various technologies into their teaching practice. For example, some teachers have combined electronic assessment with automated feedback, resulting in successful outcomes. Policymakers need to find global solutions and prioritize training teachers for distance teaching as well as the cultivation of teachers' TPACK to ensure effective technology integration in education (Milner et al., 2021).

Hence, this study examines the following questions: (1) Has there been a change in math and science teachers' Technological Knowledge (TK) regarding ICT environments and their integration into teaching since the outbreak of the COVID-19 pandemic? (2) Have math and science teachers' attitudes about the purpose of ICT tools changed since the outbreak of the COVID-19 pandemic? (3) What difficulties did math and science teachers experience regarding integrating ICT tools into teaching before the outbreak of COVID-19 and what are the difficulties they have experienced since?

## **Methodology**

A convenience sample of 104 mathematics ( $n = 86$ ) and science ( $n = 18$ ) in-service teachers participated in this study. The teachers were contacted via social networks of mathematics and science teachers (e.g., Facebook, WhatsApp groups). Most (49%) had 16 or more years of teaching experience, 30.8% had 6-15 years, and 20.2%, 1-5 years' experience. Most teachers in Israel teach more than one class level: about half (48%) taught in an elementary and/or middle school and about half (52%) in middle school and/or high school.

A 23-questions validated questionnaire based on Haspekian (2014) was adapted for this study. The original French was translated into English and then into Hebrew. To adapt it to the current study, we changed the references in the questionnaire to also include science teachers. Then we adapted the questions to the express purpose of the present study, that is comparing attitudes before and since the COVID-19 pandemic by repeating each set of questions twice, asking about their attitudes first before the pandemic and then during the pandemic. We also added some statements to assess to what degree teachers used technologies in their instruction (before and after the pandemic). The content and construct validity of the adapted questionnaire was established by three experts in mathematics education and two experts in science education. The questionnaire included the following:

(1) Ten questions to determine socio-demographic variables: gender, primary teaching language, teaching seniority (number of teaching years), discipline, institution, and habits regarding reading professional literature. (2) One yes/no question regarding math and science teachers' TK before and since the outbreak. (3) A list of five ICT tools (for example: "applets") that were to be ranked based on the extent of the teachers' use of each tool before the pandemic ( $\alpha=.824$ ) and since its outbreak ( $\alpha=.803$ ). (4) Three statements about the possible purposes of ICT in teaching (for example: "As a tool for creating a learning environment") to examine teachers' attitudes towards ICT in teaching before ( $\alpha=.657$ ) and during ( $\alpha=.759$ ) the pandemic. (5) Four statements giving possible reasons for

not incorporating technology into teaching. For example: "It takes too much preparation time" ( $\alpha=.580$ ). For parts 3,4, and 5, the teacher was requested to rank their level of agreement with each item/statement from 0 (disagree) to 3 (strongly agree). The adapted questionnaire was validated by three experts in mathematics education and two experts in science education plus an expert (PhD) on research methods and evaluation in education. The validity process involved discussing each item in the questionnaire after which changes, if required, were implemented until at least 80% agreement was reached. It was then tested in a pilot study with small groups of mathematics and science teachers, after which the statement formulations were refined accordingly. The questionnaire was then distributed to the intended recipients via email and teachers' professional social networks.

The data were analysed using SPSS 25. Descriptive analyses include frequencies, percentages, means, and standard deviations. Correlations between discrete data were analysed using the  $\chi^2$  test, and correlations between continuous variables were analysed using the Pearson correlation coefficient ( $r$ ) and the Spearman's rank correlation.

## Results

The findings described in this paper are a part of a larger study. The participating teachers were asked to answer the following question: "Before the pandemic, did you know about any computer programs/environments for teaching mathematics/science that were accessible to students at the institution where you teach? Are you more aware of such possibilities now?"

57.7% of the teachers reported that they had been familiar with computer programs available at their school before the pandemic, whereas 67.3% indicated that they acquired this knowledge post-pandemic, pointing to a significant rise ( $\chi^2= 20.55, p < .000$ ).

A significant correlation ( $\chi^2 = 9.48, p = .009$ ) was found between teaching seniority and percentage of respondents who reported being aware of the existence of computer programs/environments for teaching mathematics/science before the pandemic. A similar trend (although not significant,  $\chi^2= 4.74, p = .094$ ) was observed regarding their reported knowledge of such options since the pandemic.

The teachers rated the frequency with which they integrated computerized technological tools into their teaching pre- and post-outbreak (see Table 1).

The table shows a significant increase in the extent of integration of technological tools when comparing their use before the pandemic and during. A similar and significant trend was found for all the tools, however, during the pandemic, the tools that were most used were applets ( $M = 2.60, SD = .69$ ), designated sites ( $M = 2.58, SD = .77$ ), collaborative tools ( $M = 2.42, SD = .88$ ), and the calculator ( $M = 2.11, SD = 1.06$ ). With respect to the spreadsheet, its use was relatively low before the pandemic (19.2% of respondents reported extensive use,  $M = 1.41, SD = 1.02$ ) and this increased only slightly (to 32.7%,  $M = 1.81, SD = 1.06$ ) during. In addition, significant high positive correlations were found between the integration of technological tools into instruction before the pandemic and integration during school closures ( $r = .63, p < .000$ ). Furthermore, over 70% of the teachers reported that they avoided incorporating technologies because of the amount of preparation time required.

**Table 1**

*Difference in the extent of incorporation of ICT in teaching before the COVID-19 Pandemic and since the outbreak of Corona, and correlations between both measurements (N = 104)*

	Before the COVID-19 Pandemic		Since the Outbreak of Corona		Differences		Correlations	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>t(df=103)</i>	<i>p</i>	<i>r</i>	<i>p</i>
Sum of incorporation (0-15)	9.30	3.62	11.51	3.30	-7.27	.000	.60	.000
Spreadsheet (such as Excel)	1.41	1.02	1.81	1.06	-4.72	.000	.67	.000
Applets	2.05	0.94	2.60	0.69	-6.35	.000	.45	.000
Designated sites	2.11	0.88	2.58	0.77	-5.92	.000	.52	.000
Collaborative tools	1.78	0.97	2.42	0.88	-7.11	.000	.51	.000
Calculator	1.95	1.10	2.11	1.06	-2.41	.018	.82	.000

Range: 0-3

## Discussion

This study sought to paint a picture that could help construct teaching and learning processes during emergencies by analysing whether the pandemic caused a change in teachers' attitudes towards the use of digital tools.

The results indicate that 57.7% of the teachers had been familiar with computer programs available at their school before the pandemic, whereas 67.3% indicated that they acquired this knowledge post-pandemic, pointing to about a 10% increase in participants who had increased their TK as a result of the pandemic. Since the pandemic brought on such an extreme change in the teaching platform worldwide, such a small increase seems surprising. We can assume that this is because most of the teachers knew about e-learning environments available for teaching mathematics/science prior to the outbreak and used the tools they were already familiar with, making only minimal attempts to integrate new ones.

It is worth keeping in mind that using technological tools for teaching requires a change in the teaching paradigm. Before the pandemic, integration barriers prevented ICT from being widely adopted in formal education (OECD, 2015). With the onset of the pandemic, however, teachers were suddenly forced to transfer their TK to online remote teaching. The assumption is that even teachers with well-established TK would have found this difficult since the TPACK used for face-to-face teaching must be expanded and adapted for distance learning (Rodríguez-Muñoz et al., 2021). Given

the multitude of changes demanded at the time, it is logical to assume that teachers did not want to begin learning about new platforms again.

It seems reasonable that in order to mitigate the sharp changes required in teaching paradigms, teachers attempted to incorporate familiar technologies to support their teaching (Francom et al., 2021). According to the literature, teachers are inclined to adapt technological tools to their existing pedagogy (Tabach & Slutzky, 2017; Urezm et al., 2018).

The results also show that teacher seniority is correlated with teacher TK. This suggests that teachers need time to become familiar with technological educational programs and environments in order to integrate these tools and establish teaching and learning processes using them. These results are in line with Lim et al. (2018), who found that in the first stage in becoming a mathematics teacher, gaining an understanding of the structure of the relevant curriculum takes precedence over designing and creating lesson plans or implementing new pedagogical approaches for lessons.

This study sheds light on how math and science teachers viewed technology use in the classroom before and since the COVID-19 pandemic. Moreover, the study's implications underscore the need to devote more time and effort to fostering ICT learning and teaching. Doing so may result in improved in-service and pre-service teacher training, especially given the positive post-pandemic trend towards greater acceptance of digital technology in the classroom.

Nevertheless, and despite this increased acceptance, our results suggest that teachers still need to develop their TPACK, together with other skills that may influence their attitude regarding implementing computerized technology into their teaching. Doing so will ultimately lead to better learning opportunities for their students.

Further studies are needed to identify factors that may hinder TPACK acquisition or the integration of ICT into teaching and how to mitigate them, such as to examine in what way teachers' emotions influence their TPACK, an aspect that we will discuss in a future article.

## References

- Chand, V. S., Deshmukh, K. S., & Shukla, A. (2020). Why does technology integration fail? Teacher beliefs and content developer assumptions in an Indian initiative. *Educational Technology Research and Development*, 68, 2753–2774. <https://doi.org/10.1007/s11423-020-09760-x>.
- Chiu, T. K., & Churchill, D. (2016). Adoption of mobile devices in teaching: Changes in teacher beliefs, attitudes and anxiety. *Interactive Learning Environments*, 24(2), 317–327. <https://doi.org/10.1080/10494820.2015.1113709>.
- Francom, G. M., Lee, S. J. & Pinkney, H. (2021). Technologies, challenges and needs of K-12 teachers in the transition to distance learning during the COVID-19 pandemic. *TechTrends*, 65, 589–601. <https://doi.org/10.1007/s11528-021-00625-5>.
- Green, J. K., Burrow, M. S., & Carvalho, L. (2020). Designing for transition: Supporting teachers and students cope with emergency remote education. *Postdigital Science and Education*, 2, 906–922. <https://link.springer.com/article/10.1007/s42438-020-00185-6>.

- Haspekian, M. (2014). Teachers' instrumental geneses when integrating spreadsheet software. In A. Clark-Wilson, O. Robutti, & N. Sinclair (Eds.), *The Mathematics Teacher in the Digital Era*, Vol. 2, 241–275. Springer. [https://doi.org/10.1007/978-94-007-4638-1\\_11](https://doi.org/10.1007/978-94-007-4638-1_11).
- Klemer, A., & Rapoport, S. (2020). Origami and GeoGebra activities contribute to geometric thinking in second graders. *Eurasia Journal of Mathematics, Science and Technology Education*, 16(11). <https://doi.org/10.29333/ejmste/8537>.
- Klemer, A. Rapoport, S., & Lev, Z, H. (2020). Building a computerised dynamic representation as an instrument for mathematical explanation of division of fractions. *International Journal of Mathematical Education in Science and Technology*, 51(2), 247–264. <https://doi.org/10.1080/0020739X.2019.1648888>.
- Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education*, 9(1), 60–70.
- Lim et al., Lim, C. P., Zhao, Y., Tondeur, J., Chai, C. S., & Tsai, C. C. (2013). Bridging the gap: Technology trends and use of technology in schools. *Educational Technology & Society*, 16(2), 59–68.2013
- Lim, W., Son, J. W., & Kim, D. J. (2018). Understanding preservice teacher skills to construct lesson plans. *International Journal of Science and Mathematics Education*, 16(3), 519–538. <https://doi.org/10.1007/s10763-016-9783-1>.
- Lin, T. C., Tsa, S.C., Chai, S. C., & Lee, H. M. (2013). Identifying science teachers' perceptions of technological pedagogical and content knowledge (TPACK). *Journal of Science Education and Technology*, 22(3), 325–336. <https://doi.org/10.1007/s10956-012-9396-6>.
- Lucas, M., Bem-Haja, P., Siddiq, F., Moreira, A., & Redecker, C. (2021). The relation between in-service teachers' digital competence and personal and contextual factors: What matters most? *Computers & Education*, 160,104052. <https://doi.org/10.1016/j.compedu.2020.104052>.
- Lindblad, S., Wärvik, G. B., Berndtsson, I., Jodal, E. B., Lindqvist, A., Messina Dahlberg, G., Papadopoulous, D., Runesdotter, C., Samuelsson, K., Udd, J., & Wyszynska Johansson, M. (2021). School lockdown? Comparative analyses of responses to the COVID-19 pandemic in European countries. *European Educational Research Journal*, 20(5), 564–583. <https://doi.org/10.1177/147490412111041237>.
- Marissa, D. N., & Allahji, W. (2021). Exploring EFL teachers' technological pedagogical content knowledge and student engagement in an emergency remote teaching context. In *Emergency remote teaching and beyond* (pp. 485–506). Springer. [https://doi.org/10.1007/978-3-030-84067-9\\_22](https://doi.org/10.1007/978-3-030-84067-9_22).
- Miedijensky, S. (2023). Metacognitive knowledge and self-regulation of in-service teachers in an online learning environment. In D. Glick, J. Bergin, & C. Chang (Eds.). *Supporting self-regulated learning and student success in online courses*. IGI Global (*In press*). <https://doi.org/10.4018/978-1-6684-6500-4.ch007>.



- Miedijensky, S., Sasson, I., & Yehuda, I. (2021). Teachers' learning communities for developing high order thinking skills – A case study of a school pedagogical change *Interchange*, 52, 577–598. <https://doi.org/10.1007/s10780-021-09423-7>.
- Milner, A. L., Mattei, P., & Ydesen, C. (2021). Governing education in times of crisis: State interventions and school accountabilities during the COVID-19 pandemic. *European Educational Research Journal*, 20(4), 520–539. <https://doi.org/10.1177/14749041211022198>.
- Nantschev, R., Feuerstein, E., González, R. T., Alonso, I. G., Hackl, W. O., Petridis, K., Triantafyllou, E., & Ammenwerth, E. (2020). Teaching approaches and educational technologies in teaching mathematics in higher education. *Education Sciences*, 10(12), 354–365. <https://doi.org/10.3390/educsci10120354>.
- Niess, M. L., & Gillow-Wiles, H. (2017). Expanding teachers' technological pedagogical reasoning with a systems pedagogical approach. *Australasian Journal of Educational Technology*, 33(3). <https://doi.org/10.14742/ajet.3473>.
- OECD (2015). *Students, computers and learning*. OECD Publishing. <https://doi.org/10.1787/9789264239555-en>.
- Rodríguez-Muñiz, L. J., Burón, D., Aguilar-González, Á., & Muñoz-Rodríguez, L. (2021). Secondary mathematics teachers' perception of their readiness for emergency remote teaching during the COVID-19 pandemic: A case study. *Education Sciences*, 11(5), 228. <https://doi.org/10.3390/educsci11050228>.
- Segal, R., Oxman, V., & Stupel, M. (2021). Using dynamic geometry software to enhance specialized content knowledge: Pre-service mathematics teachers' perceptions. *International Electronic Journal of Mathematics Education*, 16(3), em0647. <https://doi.org/10.29333/iejme/11065>.
- Soeung, S., & Chim, V. (2022, April). Cambodian teachers' perceptions of online teaching: During and beyond the COVID-19 pandemic. In *FIRE: Forum for International Research in Education* (Vol. 7, No. 3, pp. 38–53). <https://doi.org/10.32865/fire202273291>.
- Tabach, M., & Slutzky, G. (2017). Studying the practice of high school mathematics teachers in a single computer setting. In *Innovation and technology enhancing mathematics education* (pp. 215–233). Springer. [https://doi.org/10.1007/978-3-319-61488-5\\_10](https://doi.org/10.1007/978-3-319-61488-5_10).
- Urezm, D., Volman, M., & Kral, M. (2018). Teacher educators' competences in fostering student teachers' proficiency in teaching and learning with technology: An overview of relevant research literature. *Teacher and Teacher Education*, 70, 12–23. <https://doi.org/10.1016/j.tate.2017.11.005>.