

A design framework for science teachers' technological pedagogical content knowledge development

Cecília Guerra^{1, 2}, António Moreira^{1, 2}, Rui Marques Vieira^{1, 2}

¹ Research Centre on Didactics and Technology in the Education of Trainers, Department of Education and Psychology, University of Aveiro, Campus Universitário, Aveiro, Portugal,
² {cguerra, moreira, rvieira}@ua.pt

Abstract. Technological pedagogical content knowledge (TPCK) represents the professional knowledge needed to integrate technology in the teaching and learning process. The purpose of this study relates to the creation of a design framework for the development of science teachers' TPCK (initial and in-service). A qualitative methodology, following a design-based-approach, was adopted to describe the strategies for science teachers' TPCK development, and design and assess an in-service science teacher education course. Data was obtained through interviews, questionnaires, using participant observation and analysis of in-service science teachers' professional portfolios. Results show that integrating technology with a research teaching perspective could be a way to develop innovative science lessons for students. A detailed description of the research methodology and findings is given.

Keywords: science teachers; technological pedagogical content knowledge development; training; design framework.

This paper was published in Springer Book "[Computer Supported Qualitative Research](#)" Edited by António Pedro Costa, Luís Paulo Reis, Francislê Neri de Souza and António Moreira.

References

1. Vieira R. M. and Tenreiro-Vieira, C.: Fostering Scientific Literacy and Critical Thinking in Elementary Science Education. *Int. J. Sci. Math. Educ.* 14, 4, 659–680 (2016).
2. Fensham, P.J.: Science Education Policy-making. Eleven emerging issues. UNESCO, Paris. (2008)
3. Barton, R.: Teaching secondary science with ICT. McGraw-Hill Education (UK), (2004).
4. van Eijck, M. and Roth, W.-M.: Rethinking the role of information technology-based research tools in students' development of scientific literacy. *J. Sci. Educ. Technol.*, 16, 3, 225–238, (2007).



5. Gerard, L. F., Varma, K., Corliss, S. B. and Linn, M. C.: Professional development for technology-enhanced inquiry science. *Rev. Educ. Res.*, 81, 3, 408–448, (2011).
6. Abdullahi, H.: The role of ICT in teaching science education in schools, *Int. Lett. Soc. Humanist. Sci.*, 19, 217–223, (2014).
7. Juuti, K. and Lavonen, J.: Design-based research in science education: One step towards methodology. *Nord. Stud. Sci. Educ.* 2, 2, 54–68, (2012).
8. Webb, M. E.: Affordances of ICT in science learning: implications for an integrated pedagogy. *Int. J. Sci. Educ.*, 27, 6, 705–735, (2005).
9. Pow, J. W. C. Li, S. C. and Fung, A. C. W.: Students' inquiry learning in the Web 2.0 age", in IFIP Conference on Information Technology in Educational Management. 107–116. (2008)
10. Osborne, J. and Hennesy, S.: Literature review in science education and the role of ICT: Promise, problems and future directions, (2003).
11. Rogers, L. and Twidle, J.: A pedagogical framework for developing innovative science teachers with ICT. *Res. Sci. Technol. Educ.*, 31, 3, 227–251, (2013).
12. Koehler, M. J. and Mishra, P.: What is Technological Pedagogical Content Knowledge (TPACK)? *Contemp. Issues Technol. Teach. Educ.*, 9, 1, 60–70, Mar. (2009).
13. McCrory, R.: Science, technology, and teaching: The topic-specific challenges of TPACK in science", *Handb. Technol. Pedagog. content Knowl. Educ.*, 193–206, (2008).
14. Graham, C. R.: Theoretical considerations for understanding technological pedagogical content knowledge (TPACK). *Comput. Educ.*, 57, 3, 1953–1960, (2011).
15. Schmidt, D. A. and Gurbo, M.: TPACK in K-6 literacy education: It's not that elementary. *Handb. Technol. Pedagog. content Knowl. Educ.*, 61–85, (2008).
16. Angeli, C. and Valanides, N.: Epistemological and methodological issues for the conceptualization, development, and assessment of ICT–TPCK: Advances in technological pedagogical content knowledge (TPCK). *Comput. Educ.*, 52, 1, 154–168, (2009).
17. Donnelly, D. F. and Boniface, S.: Consuming and creating: Early-adopting science teachers' perceptions and use of a wiki to support professional development. *Comput. Educ.*, 68, 9–20, (2013).
18. Angeli, C. Valanides, N. and Christodoulou, A.: Theoretical considerations of technological pedagogical content knowledge," *Handb. Technol. Pedagog. Content Knowl. Educ.*, 11–33, (2016).
19. Baran, E. Canbazoglu Bilici, S. and Uygun, E.: TPACK-Based Professional Development Programs in In-Service Science Teacher Education," *Handb. Technol. Pedagog. Content Knowl. Educ.*, 271–283, (2016).
20. Niess, M. L.: Technological Pedagogical Content Knowledge (TPACK) Framework for K-12 Teacher Preparation: Emerging Research and Opportunities: Emerging Research and Opportunities. IGI Global, (2016).
21. Jimoyiannis, A.: Designing and implementing an integrated technological pedagogical science knowledge framework for science teachers professional development," *Comput. Educ.*, 55, 3, 1259–1269, (2010).
22. Voogt, J. and Knezek, G.: *International handbook of information technology in primary and secondary education*, 20. Springer Science & Business Media, (2008).
23. Morais, C. Moreira, L. and Paiva, J. C.: Methodological approaches used to study Information and Communication Technologies in Education: a systematic review of the Portuguese scientific production in SCOPUS and Web of Science, *ICERI2014 Proc.*, 2176–2183, (2014).
24. Cohen, L. Manion, L. and Morrison, K.: *Research methods in education*. Routledge, (2013).
25. Barab, S. and Squire, K.: Design-based research: Putting a stake in the ground. *J. Learn. Sci.*, 13, 1, 1–14, (2004).
26. Bardin, L.: *Content analysis*. São Paulo Livraria Martins Fontes, (1977).

27. Guerra, C.; Pombo, L.; and Moreira, A. Innovative technologies in science teaching. *Primary Science*. 120. Nov/Dec, 26-28. (2011).
28. Guerra, C. Formação de Professores de Ciências para o uso de tecnologias. Tese apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Doutor em Multimédia em Educação. Aveiro: Universidade de Aveiro. (2012). Available at <http://ria.ua.pt/handle/10773/9623>.
29. Guerra, C., Vieira, R., Moreira, A. Desenvolvimento de um esquema referencial de formação de professores de ciências para o uso de tecnologias. *Enseñanza de las Ciencias*. Número Extra, p. 2136-214. (2013). ISSN: 0212-4521.

