Lecture Notes in Networks and Systems 988

Álvaro Rocha · Hojjat Adeli ·
Gintautas Dzemyda ·
Fernando Moreira ·
Aneta Poniszewska-Marańda *Editors*

Good Practices and New Perspectives in Information Systems and Technologies

WorldCIST 2024, Volume 4

Springer

Álvaro Rocha · Hojjat Adeli ·
Gintautas Dzemyda · Fernando Moreira ·
Aneta Poniszewska-Marańda
Editors

Good Practices and New Perspectives in Information Systems and Technologies

WorldCIST 2024, Volume 4

Springer

Editors
Álvaro Rocha
ISEG
Universidade de Lisboa
Lisbon, Portugal

Hojjat Adeli
College of Engineering
The Ohio State University
Columbus, OH, USA

Gintautas Dzemyda
Institute of Data Science and Digital Technologies
Vilnius University
Vilnius, Lithuania

Fernando Moreira
DCT
Universidade Portucalense
Porto, Portugal

Aneta Poniszewska-Marańda
Institute of Information Technology
Lodz University of Technology
Łódz, Poland

ISSN 2367-3370 ISSN 2367-3389 (electronic)
Lecture Notes in Networks and Systems
ISBN 978-3-031-60223-8 ISBN 978-3-031-60224-5 (eBook)
https://doi.org/10.1007/978-3-031-60224-5

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

(Re)thinking Teacher Training in the Digital Age: Teacher Training Models for Online Practice

Bruno F. Gonçalves[1(✉)], Piedade Vaz-Rebelo[2], Maria Teresa R. Pessôa[2], and Vítor Gonçalves[1]

[1] Basic Education Research Center, Polytechnic Institute of Bragança, Bragança, Portugal
bruno.goncalves@ipb.pt

[2] Center for Interdisciplinary Studies of the 20th Century, University of Coimbra, Coimbra, Portugal

Abstract. In recent years, the need to train teachers to teach online has been highlighted, not only because of the exponential growth of technologies in all economic sectors of society, but also because of the very need for education to modernize and, through this, innovate in the digital sphere. The covid-19 pandemic has only demonstrated, now unequivocally, the urgency of teacher training in the field of online teaching, as well as the need for instructional design and evaluation of training models to support learning. It is precisely because of these two assumptions that there is an urgent need to develop research in the area that allows us to (re)think teacher training in the digital age so that teachers can participate in training actions and, through them, acquire fundamental skills for the realization of online teaching. In this sense, through a systematic review of the literature, we sought to identify and characterize training models geared towards teaching practice in online education. In this way, it may be possible to contribute to the development of a matrix for the instructional design of a teacher training model that prepares these professionals for online education. The results show that, although the literature has made an indispensable contribution to reflection on teacher training models, we recognize that more research is needed in the area, since the literature is deficient in terms of the subject under analysis.

Keywords: Digital technologies · Instructional design · Online teaching · Teacher training · Training models

1 Introduction

In the last two decades in particular, several studies and references have appeared in the literature on the competences that teachers must have in order to exercise the teaching profession [1–6]. However, there is still very little research into the digital competences of teachers in online teaching or the most suitable models for both online teaching and teacher training for this practice. Thus, although the last few decades have shown a steady growth in online education, with institutions offering more online courses and

Á. Rocha et al. (Eds.): WorldCIST 2024, LNNS 988, pp. 110–119, 2024.
https://doi.org/10.1007/978-3-031-60224-5_12

programs [7, 8], there are still numerous questions about online teaching. In fact, we have good examples at international level of higher education institutions that have been very successful in implementing online teaching in some of the curricular units they offer, for example: Queen's University, Massachusetts Institute of Technology (MIT), National Taiwan University, Stanford University, University of Melbourne, Duke University, among others. At a national level, not many institutions offer training in online education, but the work done in this area by the Universidade Aberta (uab) is recognized. Perhaps because there is still little use of online learning, the Portuguese government has set itself targets of training around 3,000 people by 2023 and up to 50,000 people by 2030 in distance learning [9]. Based on the assumption that these objectives should actually be met, it is becoming urgent to address this issue, because if the number of students in online education increases, more teachers are needed to train these students. Although experts in the field have identified many techniques, methods and approaches to help train and support online instructors [10], they can now be improved to meet the objectives set by the Portuguese government [9] and the sustainable development goals identified by the United Nations [11].

In this sense, there is a need to develop a systematic literature review that will allow us to identify and characterize the models oriented towards teacher training for online teaching, but also to understand what has been done in the area so far. In fact, there are some recent studies [12–19] that have contributed to literacy in the area and to changing the current paradigm. In addition to the United Nations' goals [11] for sustainable development and the Portuguese government's goals [9] especially for 2030, other studies that have been developed also point to the urgency of training teachers for online teaching. These studies will be duly addressed in the results section.

2 Methodology

Through this research we sought to carry out a systematic literature review with the aim of identifying and characterizing training models for pedagogical practice in online teaching. For this, the systematic literature review was adopted as the investigative methodology to support the study. The systematic literature review will be carried out with the support of a pre-defined set of criteria that will be essential for the selection of information on the theme addressed, namely: (i) Time interval: 2018–2023; (ii) Documents: reference articles and doctoral thesis; (iii) Search language: Portuguese and English; (iv) Bibliometric databases: Scopus and Web of Science; (v) Other databases: Google Scholar; Scielo; Springer; B-on; (vi) Keywords in Portuguese: "Modelos de formação de professores para a prática online"; "Formação de professores para o ensino online"; "Desenvolvimento profissional de professores para a prática online"; "Modelos de formação de professores"; "Modelos de desenvolvimento professional de professores" (vii) Keywords in English: "Models of teacher training for online practice"; "Teacher training for online teaching"; "Professional development of teachers for online practice"; "Models of teacher training"; "Models of teacher professional development"; (viii) All teachers at all levels of education, with the exception of higher education.

It should be noted that we initially tried to find models of teacher training geared towards practice in online teaching, but we found that there is little literature on this

subject. We therefore decided to extend the study and include two more keywords: "Models of teacher training"; "Models of teacher professional development".

Based on the criteria previously established, the general framework of the documents found is presented (Table 1):

Table 1. General table of documents found.

ID	Article name	Year	Authors
1	Concepções e modelos de formação de professores: reflexões e potencialidades	2018	Raul Sardinha Netto & Maria Antonia Ramos de Azevedo [20]
2	Teacher professional development models for effective teaching and learning in schools	2019	Ceren Çetin & Mustafa Bayrakcı [21]
3	A professional development process model for online and blended learning: Introducing digital capital	2019	Brent Philipsen [22]
4	Improving teacher professional development for online and blended learning: a systematic meta-aggregative review	2019	Brent Philipsen, Jo Tondeur, Natalie Pareja Roblin, Silke Vanslambrouck, Chang Zhu [17]
5	Os Modelos de Formação de Professores/as da Educação Básica: quem formamos?	2020	Camila Lima Coimbra [23]
6	A pedagogical model for effective online teacher professional development—findings from the Teacher Academy initiative of the European Commission	2020	Benjamin Hertz, Hannah Grainger Clemson, Daniella Tasic Hansen, Diana Laurillard, Madeleine Murray, Luis Fernandes, Anne Gilleran, Diego Rojas Ruiz, Danguole Rutkauskiene [24]
7	Professional Development for Online Teaching: A Literature Review	2020	Leary, H., Dopp, C., Turley, C., Cheney, M., Simmons, Z., Graham, C. R., & Hatch, R. [25]
8	Innovating teachers' professional learning through digital technologies	2020	Andreea Minea-Pic [26]
9	Successful design and delivery of online professional development for teachers: A systematic review of the literature	2021	Leicha A. Bragg, Chris Walsh, Marion Heyeres [27]
10	Modelos formativos da docência: considerações acerca das racionalidades técnica, prática e crítico- reflexiva na formação de professores	2021	Caio Corrêa Derossi, Karen Laíssa Marcílio Ferreira [28]

(*continued*)

Table 1. (*continued*)

ID	Article name	Year	Authors
11	Modelos de Formação Docente: movimentos e reflexões para uma abordagem teórico-prática	2021	Alexander Montero Cunha [29]
12	Blended Learning in Teacher Education & Training	2021	Eileen Kennedy [30]
13	Teaching in Secondary Education Teacher Training with a Hybrid Model: Students' Perceptions	2022	José Luis Martín-Núñez, Juan Luis Bravo-Ramos, Susana Sastre-Merino, Iciar Pablo-Lerchundi, Arturo Caravantes Redondo and Cristina Núñez-del-Río [31]
14	Distance Education for Teacher Training: Modes, Models, and Methods	2023	Mary Burns [32]
15	Online Learning Standards: Steps to Introduce a Distributed Leadership Approach to Training Teachers for Online Teaching and Learning	2023	Geraldine Grimes, Fiona Boyle, Michael Noctor [33]

Eight documents were excluded because they were outside the lines of the research and, in this sense, fifteen documents were considered for the purposes of this research.

The data collected from the documents that emerged from the search were categorized and treated in Microsoft Excel. The study of the documents considered for the purposes of the research was carried out through content analysis, focusing on the identification and characterization of the proposed teacher training models.

3 Teacher Training Models

A few documents were found that addressed some of the models of teacher training, but not many articles addressed the practice of teachers in online teaching.

Thirty-three years ago, [34] identified a set of models aimed at the professional development of teachers, namely: observation/supervision-based, autonomous, training courses, curriculum and organizational development and action research. As early as 1997, [35] highlighted a set of models oriented towards the professional development of teachers, namely: the model of socialization into the professional culture, the technical model, the teaching model, the model that emphasizes the relationship between the personal and professional domains in teachers' work and the reflective model or practical reflection.

In the 21st century, [36] presented another model, called the interconnected model of teacher professional growth, which is divided into four distinct domains that change through the processes of 'reflection' and 'implementation', namely: the personal domain, the domain of teaching practices, the consequences for student learning and the external domain [36].

A little later, [37] identified two groups of models for teacher professional development: the first group considers professional development contexts and strategies that make use of inter-institutional cooperation, such as university-school partnerships; the second group refers to professional development strategies that do not require institutional cooperation, such as supervision of teaching practices.

[38] also identify three more models, namely: standardized development, which focuses on specific skills and content and is aimed at training trainers; self-directed, which allows for individual learning and a non-formal structure; and intensive learning by groups of teachers (learning communities), based on activities and aimed at long-term change processes [38].

In 2007, [39] presented a model describing the process of teacher professional development, the strategies to be implemented in the teaching-learning process and the evaluation of the results. The contents of the model (the curriculum, assessment and teaching) are discussed in professional learning communities, through a process of practice, feedback, reflection and evaluation of results.

In 2009, [40] proposed a typology of four models, namely: re-instrumentation, remodeling, revitalization and re-imagination [40]. Re-instrumentation corresponds to the acquisition of skills and competencies for teaching, which are understood as predominantly technical activities; remodeling integrates programs that are normally associated with curricular reforms and other changes; revitalization corresponds to the individual learning of each teacher as well as their reflexivity; and, finally, the re-imagination foresees diversified learning paths, focusing on the political and activist dimension of the teaching profession [41].

In the same year, [42], in a study related to the professional development of teachers in ICT, refer to the existence of the following set of models: school-based provision, external provision, communities of practice, teacher inquiry model, critical reflection model and case-making model.

In a recent article [20], the authors address three interesting models: the technical model, the practical model and the critical model. The technician is based on an instrumental view of education and teacher training is aimed at mastering these techniques and methods. The practical emphasizes the importance of practical experience in teacher training. In this sense, training is aimed at developing practical skills and reflecting on one's own practice. The critic starts from a broader view of education, in which the teacher is seen as an agent of social transformation. Teacher training is focused on critical reflection on one's own practice and on the social relations that permeate education.

Another recent article [26] identifies three models of teacher training: online learning, community learning and blended learning professional training. Online learning involves the use of digital technologies to provide professional learning opportunities for teachers, such as MOOC [43–45]. Learning communities promote teacher participation in online communities or teacher networks for teacher training. Participation in teacher networks has been found to be a more effective form of learning than more traditional forms of teacher training [46, 47]. The blended learning professional training combines face-to-face and online learning elements. Combining in-person and online interactions can improve teachers' professional development [43, 44].

A group of authors [25] who discuss the professional development of teachers for online teaching highlight workshops, self-learning, peer mentoring, online modules and the creation of courses as suitable models for teacher training. It is also important to note that the article highlights the importance of understanding instructors' needs and best practices for online teaching, as well as the appropriate use of different training methods.

Another group of authors [24] suggests that collaborative approach to online continued professional development can be developed as a way of addressing both teachers and education system needs. They highlight MOOC as a suitable model for teacher training.

[21] identify several models of professional development, namely: Individually guided development, observation and assessment, involvement in a development or improvement process, training, inquiry, mentoring, critical friends' group and professional development schools. Each of these models has advantages and disadvantages and it is up to teachers to select the one that best suits their reality and needs.

A paper on blended-learning in teacher education and training [30] discusses the successful implementation of teacher professional development programs using blended learning approaches, as well as practical examples of their implementation in Europe. The article also presents additional information on teacher training models, such as the article by [48] on cooperative learning of teachers and teaching students and the article by [49] on teacher supply and demand issues in northern Canada.

The document "Distance Education For Teacher Training: Modes, Models and Methods" [32] presents six distance education models that we think are quite interesting and organized, namely: print-based distance education, audio-based distance education, visually-based distance education, multimedia-based distance education, online learning, mobile-based distance education. If we focus especially on the last two models, it appears that both already integrate digital technologies in the teacher training process.

It is important to highlight two models that are present in "Distance Education For Teacher Training: Modes, Models and Methods", namely online learning and mobile-based distance education. These models seem to be useful since they already take digital technologies into account in teacher training. Online learning presents itself as a scalable model that can be easily updated, provides immediate feedback and contributes to reducing the isolation of new teachers. However, its limitations include the need for regular access to computers and the internet, as well as some quality control issues. This model can be seen as a cheap and easy solution. The mobile-based distance education model, on the other hand, has accessibility and portability as its main strengths. It is easily distributed and can capitalize on technologies that teachers already have. However, it does have some associated limitations, such as the need for regular access to electricity and a cellular network or the Internet. It can also present problems regarding quality control and can easily be lost or stolen. However, these two models seem to be the ones that are currently attracting the most interest in teacher training.

Although each of the models presented identifies relevant aspects for the teacher training process, some gaps are recognized, especially regarding the integration of ICT in the teaching-learning process. In this sense, teachers must consider the benefits of each of the models or even combine them into several so that they include different opportunities and activities and, thus, it is possible to achieve the objectives of the

professional and the educational institution. In other words, according to [29], we must take into account the importance of thinking about the detailed characteristics of training based on the context it has and how restrictive it can be to think about training by framing a priori the model you intend to use.

Many of the articles do not point to concrete models, but reflect on the importance of innovative practices in teacher training [50], instructional approaches, learning and assessment communities [27], the distributed leadership approach to teacher training [33], thinking and reflection on teacher training [29]. In addition to these, others stand out, such as [51] who address the effects of strategies in teacher training. The same author, in another article [17], presents a five-phase professional development process model for OBL, offering a new approach. Finally, [23] presents and discusses three models, namely: content model, transition model and resistance model.

4 Conclusions

In this research we seek to rethink teacher training in the digital age by identifying and characterizing teacher training models for online practice. By analyzing and discussing these models, we have been able to reflect on the main characteristics of each one. These training models aim to enable teachers to face the specific challenges associated with the virtual learning environment. More specifically, the aim is to enable teachers to improve their pedagogical practices, adapt to changes in the field of education and provide more effective learning experiences for students. Thus, by implementing these models, teachers can develop the specific skills needed to offer quality education in the online environment, considering the unique characteristics of this medium. It is important to note that an effective professional development approach often combines elements of several models, adapting to the specific needs of teachers and the dynamics of the educational institution. Combining several models can contribute to a greater diversity of pedagogical approaches, meeting individual needs, integrating diverse skills and greater flexibility and resilience, among other very useful advantages for teachers.

This research also allows us to conclude that the successful implementation of these professional development models for online practice depends on the ability to address the specificities of the virtual environment, promoting not only adaptation to technological tools, but also improving pedagogical strategies to create meaningful and effective online learning experiences. In this sense, it is also clear how important it is for teachers to actively engage in the learning that takes place in this type of environment, which aims to improve the skills of these professionals to improve the quality of the teaching-learning process in online environments.

Acknowledgment. This work has been supported by FCT – Fundação para a Ciência e Tecnologia within the Project Scope: UIDB/05777/2020.

References

1. Silva, E., Loureiro, M.J., Pischetola, M.: Competências digitais de professores do estado do Paraná (Brasil). EduSer **11**(1), 61–75 (2019)

2. UNESCO: Competency Standards Modules. ICT competency standards for teachers: competency standards modules. UNESCO, Paris (2009). http://unesdoc.unesco.org/images/0015/001562/156207por.pdf
3. Carretero, S., Vuorikari, R., Punie, Y.: DigComp 2.1: the digital competence framework for citizens with eight proficiency levels and examples of use. Joint Research Centre (Seville site) (2017)
4. Ainley, J., Carstens, R.: Teaching and learning international survey (TALIS) 2018 conceptual framework (2018)
5. UNESCO: UNESCO ICT Competency Framework for Teachers. Paris United Nations Education (2011)
6. Redecker, C.: European Framework for the Digital Competence of Educators: DigCompEdu. Publications Office of the European Union, Luxembourg (Luxembourg) (2017). https://doi.org/10.2760/178382, https://doi.org/10.2760/159770 (online)
7. Allen, I.E., Seaman, J.: Changing Course: Ten Years of Tracking Online Education in the United States. ERIC (2013)
8. Allen, I.E., Seaman, J.: Online Report Card: Tracking Online Education in the United States. ERIC (2016)
9. Governo de Portugal: Um 'contrato para a Legislatura' com o Ensino Superior para 2020–2023, orientado para estimular a convergência de Portugal com a Europa até 2030 (2019)
10. Lackey, K.: Faculty development: an analysis of current and effective training strategies for preparing faculty to teach online. Online J. Distance Learn. Adm. **14**(4), 8 (2011)
11. United Nations General Assembly: Resolution adopted by the General Assembly on 25 September 2015. United Nations, Washington (2015)
12. Allela, M., Ogange, B., Junaid, M., Prince, B.: Evaluating the Effectiveness of a Multi-modal Approach to the Design and Integration of Microlearning Resources in In-Service Teacher Training (2019)
13. Brinkley-Etzkorn, K.E.: Learning to teach online: measuring the influence of faculty development training on teaching effectiveness through a TPACK lens. Internet High. Educ. **38**, 28–35 (2018)
14. Brown, J., Brock, B., Závodská, A.: Higher Education in the 21st century: A New Paradigm of Teaching, Learning and Credit Acquisition. In: Proceedings of 14th IAC 2019, p. 87 (2019)
15. Gegenfurtner, A., Ebner, C.: Webinars in higher education and professional training: a meta-analysis and systematic review of randomized controlled trials. Educ. Res. Rev. 100293 (2019)
16. Kebritchi, M., Lipschuetz, A., Santiague, L.: Issues and challenges for teaching successful online courses in higher education: a literature review. J. Educ. Technol. Syst. **46**(1), 4–29 (2017)
17. Philipsen, B., Tondeur, J., Roblin, N.P., Vanslambrouck, S., Zhu, C.: Improving teacher professional development for online and blended learning: a systematic meta-aggregative review. Educ. Technol. Res. Dev. **67**(5), 1145–1174 (2019)
18. Singh, R.N., Hurley, D.: The effectiveness of teaching and learning process in online education as perceived by university faculty and instructional technology professionals. J. Teach. Learn. Technol. **6**(1), 65–75 (2017)
19. Vagarinho, J.P., Llamas-Nistal, M.: Process-oriented quality in e-learning: a proposal for a global model. IEEE Access **8**, 13710–13734 (2020)
20. Netto, R.S., de Azevedo, M.A.R.: Concepções e modelos de formação de professores: reflexões e potencialidades. Bol. Técnico do Senac **44**(2) (2018)
21. Çetin, C., Bayrakcı, M.: Teacher professional development models for effective teaching and learning in schools. Online J. Qual. High. Educ. **6**(1), 32–38 (2019)
22. Philipsen, B.: A professional development process model for online and blended learning: introducing digital capital. Contemp. Issues Technol. Teach. Educ. **19**(4), 850–867 (2019)

23. Coimbra, C.L.: Os Modelos de Formação de Professores/as da Educação Básica: quem formamos? Educ. Real. **45**(1) (2020)
24. Hertz, B., et al.: A pedagogical model for effective online teacher professional development—findings from the Teacher Academy initiative of the European Commission. Eur. J. Educ. **57**(1), 142–159 (2022)
25. Leary, H., et al.: Professional development for online teaching: a literature review. Online Learn. **24**(4), 254–275 (2020)
26. Minea-Pic, A.: Innovating teachers' professional learning through digital technologies (2020)
27. Bragg, L.A., Walsh, C., Heyeres, M.: Successful design and delivery of online professional development for teachers: a systematic review of the literature. Comput. Educ. **166**, 104158 (2021)
28. Derossi, C.C., Ferreira, K.L.M.: MODELOS FORMATIVOS DA DOCÊNCIA: CONSIDERAÇÕES ACERCA DAS RACIONALIDADES TÉCNICA, PRÁTICA E DA REFLEXÃO NA FORMAÇÃO DE PROFESSORES. Cad. da Pedagog. **15**(33) (2021)
29. Cunha, A.M.: MODELOS DE FORMAÇÃO DOCENTE: movimentos e reflexões para umaabordagem teórico-prática. Formação@ Docente **13**(1), 150–170 (2021)
30. Kennedy, E.: Blended learning in teacher education & training: findings from research & practice. Brussels, Belgium Eur. Sch. Retrieved May, vol. 18, p. 2021 (2021)
31. Martín-Núñez, J.L., Bravo-Ramos, J.L., Sastre-Merino, S., Pablo-Lerchundi, I., Caravantes Redondo, A., Núñez-del-Río, C.: Teaching in secondary education teacher training with a hybrid model: students' perceptions. Sustainability **14**(6), 3272 (2022)
32. Burns, M.: Distance Education for Teacher Training: Modes, Models, and Methods. Educ. Dev. Center, Inc. (2023)
33. Grimes, G., Boyle, F., Noctor, M.: Online learning standards: steps to introduce a distributed leadership approach to training teachers for online teaching and learning. All Irel. J. High. Educ. **15**(3) (2023)
34. Sparks, D., Loucks-Horsley, S.: Models of staff development. Handb. Res. Teach. Educ. **3**, 234–250 (1990)
35. Calderhead, J., Shorrock, S.B.: Understanding teacher education: case studies in the professional development of beginning teachers. Psychology Press (1997)
36. Clarke, D., Hollingsworth, H.: Elaborating a model of teacher professional growth. Teach. Teach. Educ. **18**(8), 947–967 (2002)
37. Villegas-Reimers, E.: Teacher professional development: an international review of the literature. International Institute for Educational Planning Paris (2003)
38. Gaible, E., Burns, M.: Using Technology to Train Teachers: Appropriate Uses of ICT for Teacher Professional Development in Developing Countries. Online Submission (2005)
39. Lumpe, A.T.: Research-based professional development: teachers engaged in professional learning communities. J. Sci. Teach. Educ. **18**(1), 125–128 (2007)
40. Sachs, J.: Aprender para melhorarou melhorar a aprendizagem: O dilema do desenvolvimento profissional contínuo dos professors. Aprendiz. e Desenvolv. Prof. Profr. Context. e Perspetivas, pp. 99–118 (2009)
41. Gonçalves, T., Gomes, E.: Re-imaginar o desenvolvimentoprofissional contínuo de professores: O projecto 10X10 da Fundação Calouste Gulbenkian. Medi@ ções **2**(2), 63–80 (2014)
42. Daly, C., Pachler, N., Pelletier, C.: Continuing professional development in ICT for teachers: a literature review (2009)
43. Matzat, U.: Reducing problems of sociability in online communities: integrating online communication with offline interaction. Am. Behav. Sci. **53**(8), 1170–1193 (2010)
44. Matzat, U.: Do blended virtual learning communities enhance teachers' professional development more than purely virtual ones? A large scale empirical comparison. Comput. Educ. **60**(1), 40–51 (2013)

45. McConnell, T.J., Parker, J.M., Eberhardt, J., Koehler, M.J., Lundeberg, M.A.: Virtual professional learning communities: teachers' perceptions of virtual versus face-to-face professional development. J. Sci. Educ. Technol. **22**, 267–277 (2013)
46. Vangrieken, K., Meredith, C., Packer, T., Kyndt, E.: Teacher communities as a context for professional development: a systematic review. Teach. Teach. Educ. **61**, 47–59 (2017)
47. Lantz-Andersson, A., Lundin, M., Selwyn, N.: Twenty years of online teacher communities: a systematic review of formally-organized and informally-developed professional learning groups. Teach. Teach. Educ. **75**, 302–315 (2018)
48. Kimmelmann, N., Lang, J.: Linkage within teacher education: cooperative learning of teachers and student teachers. Eur. J. Teach. Educ. **42**(1), 52–64 (2019)
49. Kitchenham, A., Chasteauneuf, C.: Teacher supply and demand: issues in northern Canada. Can. J. Educ. **33**(4), 869–896 (2010)
50. Coutinho, C.P., Lisbôa, E.S.: Perspetivandomodelos de formação de professores que integram as TIC nas práticas letivas: um contributo para o estado da arte (2011)
51. Philipsen, B., Tondeur, J., McKenney, S., Zhu, C.: Supporting teacher reflection during online professional development: a logic modelling approach. Technol. Pedagog. Educ. **28**(2), 237–253 (2019)