Emergency Education Effects on Teacher Abilities and Motivation to Use Digital Technologies

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Abstract

To identify factors that can contribute toward supporting educator adoption of digital technologies beyond the emergency remote teaching response to COVID-19, we investigated how teachers' motivation and abilities related to the use of digital technologies for teaching changed since the onset of the pandemic. Two surveys and interviews were conducted with school teachers in Spain. The first survey was completed at the onset of the COVID-19 lockdown, the second survey and interviews in the weeks leading up to the school year that followed. Survey questions were from SELFIE and the Work Tasks Motivation Scale for Teachers. Moreover, we analyzed the type of advice teachers sought on Twitter during the lockdown and post-lockdown periods. Results indicate that teachers believe their proficiency in using digital technologies for teaching has improved. Teacher confidence in using technology for preparing lessons, class teaching, assessing and providing feedback, and for communicating with students and families has increased along with teacher motivation to improve their digital skills and use digital technologies for teaching. Teacher advice seeking on Twitter seemed to shift from serving immediate instructional needs to focussing on professional development and the creation of their own digital content.

Keywords

Emergency remote teaching, COVID-19, motivation, digital skills, teacher professional development

Practitioner notes

What is already known about this topic

- There is a need to enhance educator digital skills and competences for a digital transformation of education.
- The emergency remote teaching response to COVID-19 made educators increase their usage of technology.

What this paper adds

- Teachers' motivation and abilities related to the use of digital technologies for teaching have changed since the onset of the pandemic.
- Teachers believe their proficiency in using digital technologies for teaching has improved.
- Teacher confidence in using technology for preparing lessons, class teaching, assessing and providing feedback, and communication has increased.
- Teacher motivation to use digital technologies in their teaching practice increased during the pandemic.
- Teacher advice seeking on Twitter shifted from serving immediate instructional needs to focusing on professional development and the creation of their own digital content.

Implications for practice and/or policy

- COVID-19 has rapidly advanced teacher digital skills and has altered their relationships with digital technologies for teaching and learning.
- Teachers have acquired a range of new experiences related to using digital technologies for teaching from which future initiatives can build upon.

Introduction

In 2018, the European Commission (EC) released its plan for the digitisation of education (EC, 2018). The plan prioritized the aim of making better use of digital technology for teaching and learning to improve education. Indeed, several studies showed that there was a lack of digital skills among educators (e.g., Ainley & Carstens, 2018; Foutsitzi & Caridakis, 2019). The COVID-19 pandemic, which led to an emergency remote teaching response, further exposed the need for educator digital competence development (Gewerc, Persico & Rodés-Paragarino, 2020). The EC reacted to this reality with a new Digital Education Action Plan (EC, 2020) that calls for greater efforts toward enhancing digital skills and competences to support the digital transformation of education. In parallel, the emergency remote teaching response to COVID-19 has resulted in educators having to rapidly advance their usage of technology (Albó, Beardsley, Martínez-Moreno, Santos & Hernández-Leo, 2020; Littlejohn, 2020). The objective of this work is to identify factors that can contribute toward supporting educator adoption of digital technologies beyond emergency remote teaching. As such, we use a behavioral model from persuasive technologies (Fogg, 2009) to frame an investigation into how teachers' motivation and abilities related to the use of digital technologies for teaching have changed since the onset of the pandemic.

The Fogg Behavioral Model

The Fogg Behavioral Model (FBM) suggests that the performance of a target behaviour depends on the convergence of three factors: motivation, ability, and triggers. "For a person to perform a target behavior, s/he must (1) be sufficiently motivated, (2) have the ability to perform the behavior, and (3) be triggered to perform the behavior" (Fogg, 2009; p. 1). Hence, to achieve behavioural change such as having educators integrate digital technologies into their teaching practices, it is important to understand the target population's motivation, abilities, and the relationship between the two. Fogg (2019) describes how motivation and ability work together: "if one is weak, the other needs to be strong" (p. 27). In response to lockdowns at the onset of the COVID-19 pandemic, teachers throughout the world had to rapidly digitalise their teaching practices and teach remotely (Flores & Gago, 2020; Sepulveda-Escobar & Morrison, 2020; König**,** Jäger-Biela & Glutsch, 2020; Osman, 2020; Quezada, Talbot & Quezada-Parker, 2020; Ebner *et al*., 2020). They had to familiarize themselves with a variety of digital technologies and use them on a daily basis. These technologies included those that were required by external entities and those that they had discovered on their own to solve particular problems they were facing (König, Jäger-Biela & Glutsch, 2020). Previously, lack of time had been one of the main obstacles hindering teacher adoption of digital technologies (Dagnino, Dimitriadis, Asensio-Pérez, Pozzi & Rubia-Avi, 2018; Lewin, Cranmer & McNicol, 2018), however, the remote teaching experience shifted the priorities of teachers and time was no longer the main obstacle to overcome (Albó *et al*., 2020). As a result, a greater number of teachers have been exposed to the benefits of digital technologies in teaching and learning and have likely increased their confidence in using them (Albó *et al*., 2020; Giovannella, Passarelli & Persico, 2020; König, Jäger-Biela & Glutsch, 2020). Given the rapidly changing context due to the pandemic, we use FBM to frame an investigation into how teachers' motivation and abilities related to the use of digital technologies for teaching have changed since the onset of the pandemic.

Digital skills of educators: SELFIE

Teachers' digital skills are often measured through the evaluation of digital competence. Ferrari (2013) defines digital competence as the "confident, critical and creative use of ICT to achieve goals related to work, employability, learning, leisure, inclusion and/or participation in society" (p. 2). Digital competence is characterized by five areas (information, communication, content-creation, safety and problem-solving) by the DigitalComp framework (Ferrari, 2013). To provide schools with an instrument to measure strengths and weaknesses of their use of digital technologies and teachers' digital competences, SELFIE (Self-reflection on Effective Learning by Fostering the use of Innovative Educational technologies) was developed (EC, 2018). SELFIE is an online tool that can be used to evaluate teachers' and students' abilities and confidence in using digital technologies (Costa, Castaño-Muñoz & Kampylis, 2020). The tool has a strong grounding in research as it is based on the European Framework for Digitally-Competent Educational Organisations (DigCompOrg) which promotes digital-age learning (Kampylis, Punie & Devine, 2015). In our study, we use SELFIE to capture snapshots of teachers' digital skills at three crucial moments of the pandemic (before the lockdown, during the lockdown, and after the lockdown) with the objective of evaluating the effects of the COVID-19 crisis on teachers' skills in using digital technologies.

Educator motivation to use digital technologies: WTMST

Research shows that teachers' positive attitudes and beliefs toward technology are key factors in determining whether or not technology integration takes place (Inan & Lowther, 2010; Hermans, Tondeur, Van Braak & Valcke, 2008; Jääskelä, Häkkinen & Rasku-Puttonen, 2017; Chiu & Churchill, 2016; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur & Sendurur, 2012). Accordingly, motivation plays an important role in the development of teachers' digital competence and abilities and use of digital technologies (Instefjord & Munthe, 2017; Lauermann & König, 2016; Nalipay, Mordeno,

Semilla & Frondozo, 2019; Vermote *et al.*, 2020). The Work Tasks Motivation Scale for Teachers (WTMST) (Fernet, Sencal, Guay, Marsh & Dowson, 2008) is a research instrument for measuring teacher motivation related to performing specific tasks. WTMST is based on self-determination theory (SDT) (Deci & Ryan, 1985) and is capable of measuring five different motivational constructs. A few studies have explored the above factors and role of teachers' motivation to rapidly adopt remote teaching in response to COVID-19 (Sangeeta & Tandon, 2020; Panisoara, Lazar, Panisoara, Chirca & Ursu, 2020) and we aim to contribute to this line of research.

Educator use of Twitter

Having educators participate in research surveys and interviews has become challenging as greater demands are being placed on them as a result of the ongoing pandemic. Consequently, online social networks like Twitter provide additional sources for collecting data on the impressions and experiences of educators. Recent work examines the activity around popular hashtags related to online pedagogy. COVID-19-specific hashtags were categorized according to their purpose: (1) stay home and stay safe, e.g., #stayhome; (2) at-home learning and new workspaces, e.g., #remoteteaching; (3) online learning as the main educational means during the pandemic; and (4) knowledge sharing of resources and ideas and maintaining continuity of learning, e.g., #remoteteaching and #remotelearning (Semingson & Kerns, 2020). Tweets with these two last hashtags were analyzed in detail by Carpenter, Krutka and Kimmons (2020). Results suggest that these online conversations became virtual spaces for meeting educators' cognitive, social, and affective needs. According to that study, these conversations were not only useful for educators to find and share pedagogical resources, but also to receive support online. In our study, we analyze the type of advice teachers sought on Twitter during the COVID-19 outbreak to explore whether differences between the lockdown and post-lockdown periods may reflect a broader change in teacher relationships with digital technologies for teaching and learning.

Framed within the FBM, our research questions (RQ) focus on identifying teacher motivation levels (including concerns), and abilities (including confidence) in using digital technologies for teaching and learning. The questions relate to the effects of COVID-19 on: teacher abilities to use digital technologies for teaching and learning (RQ1); teacher confidence in using digital technologies for teaching and learning (RQ2); teacher motivation to improve their digital skills (RQ3); teacher motivation to use or adopt technology in their teaching (RQ4); and teacher concerns regarding the use and adoption of technology in education (RQ5). In sum, to contribute to research on educator experiences related to teaching during the COVID-19 pandemic and research on teacher adoption of digital technologies, we conducted a study to assess how teacher motivation and abilities related to the use of digital technologies for teaching have changed since the onset of the pandemic. We made use of validated research instruments (SELFIE, WTMST) and had the same participants complete surveys during two separate time periods (four months apart). To contextualize teacher responses, interviews were conducted and a Twitter analysis carried out.

Methodology

We conducted a survey research study (Krosnick, 1999) using a convergent mixed method design (Fetters, Curry & Creswell, 2013). Participating school teachers completed two surveys and then participated in a follow-up interview. The first survey was completed at the onset of the COVID-19 lockdown (see *S1* in Figure 1). The second survey and follow-up interviews were conducted four months later, in the weeks leading up to the school year that followed (see *S2* and *INT* boxes in Figure 1). The retrospective interviews were carried out to explore the cases and key results in more detail. Moreover, to further contextualize and triangulate the questionnaire and interview responses, we analyzed teacher messages related to advice seeking that were posted on social media (Twitter) during the lockdown and post-lockdown periods.

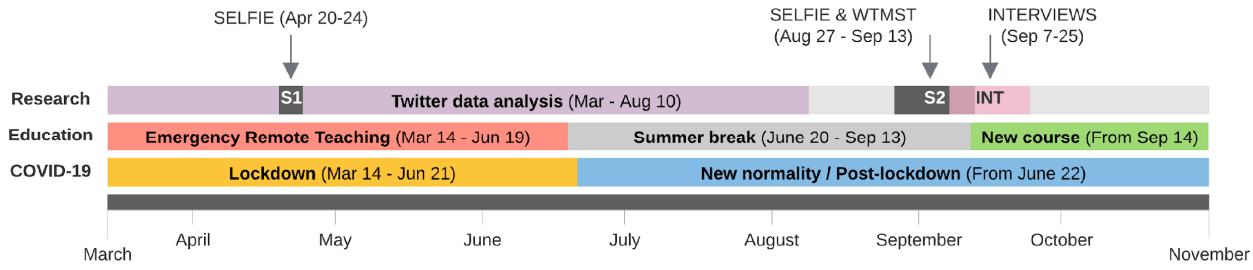

Figure 1. Research timeline versus Education and COVID-19 timelines in Spain.

Participants and Sample

Primary and secondary school teachers (17 teachers, 10 females) from Catalonia (northeastern Spain) completed the two surveys. Most teachers were from secondary education (16) with only one from primary education. Teachers were from public (7) and semi-private schools (10). Semi-private, also called semi-public schools, are publicly subsidized schools that are operated privately. This model is widespread across Spain with proportions of around 50-50 for cities like Madrid or Barcelona (Calsamiglia, 2014). This has implications in internal school ways of functioning and in the type of contracts teachers hold (teachers in public schools are civil servants). Yet, teachers in semi-public schools usually have access to resources and training offered by the governments. Teaching experience varied with seven

teachers having more than 20 years of experience, four between 10 to 20 years, and six having 10 or fewer years of experience. Three participants were between 25 to 29 years of age; one between 30 to 39; seven between 40 to 49; four between 50 to 59; and two over 60 years of age. Among the 17 teachers who participated in the surveys, 9 (4 females) were interviewed. Table 1 presents the profiles of the interviewees.

Table 1. Interview participants' demographics

ID	Context	School	Teaching experience (years)	Age	Approach in using DT*	In-class teaching time using DT in the 3 months before the lockdown
T1	Secondary	Semi-private	6-10	30-39	a	26-50%
T2	Secondary	Semi-private	>20	50-59	a	76-100%
T3	Secondary	Public	>20	40-49	c	51-75%
T4	Primary	Public	>20	50-59	a	11-25%
T5	Secondary	Semi-private	<1	25-29	c	76-100%
T6	Secondary	Public	3-5	25-29	a	76-100%
T7	Secondary	Semi-private	11-15	40-49	b	76-100%
T8	Secondary	Semi-private	16-20	40-49	b	26-50%
T9	Secondary	Semi-private	>20	50-59	a	76-100%

** **a**: I am usually among the innovators who try out new technologies, **b**: I tend to be an early adopter where I see clear benefits; **c**: I tend to use digital technologies at the pace of the majority of my colleagues.*

SELFIE and WTMST questionnaires

To investigate teacher use of digital technologies for teaching an adapted version of SELFIE (EC, 2018) was created. Table 2 shows the questions used. Question Q3 was formulated by the authors as SELFIE does not include questions that elicit teacher concerns regarding the increased use of technology in education. Yet, there is an increasing focus in the research community on critical studies of technology use in education (Selwyn *et al.*, 2019). To study the situations both before and during the pandemic, participants were asked to mark two responses to each survey item considering two time periods. The first time period was "during the previous year before schools were forced to close" and the second "during the emergency remote teaching situation"). Most questions were answered using a five-point Likert scale. Questions Q1a-d used a confidence scale whereas Q2a-f and Q3a-c used an agreement scale.

Table 2. Questionnaire adapted from SELFIE (https://ec.europa.eu/education/schools-go-digital_en)

Q	Item Code	Question
Q1a	Preparing lessons	Preparing lessons by editing or creating a variety of digital resources (for instance slide show, images, audio or video).
Q2b	Class teaching	Class teaching using a variety of devices (such as interactive whiteboards, video projectors) and resources (for instance online quizzes, mind maps, simulations).
Q1c	Feedback and support	Assessing or providing personal feedback and support to students.
Q1d	Communication	Communicating with students and parents.
Q2a	Online educational resources	I search online for digital educational resources
Q2b	Creating digital resources	I create digital resources to support my teaching
Q2c	Using VLE	I use virtual learning environments (VLE) with students
Q2d	Communicating with the school community	I use digital technologies (DT) for school-related communication
Q2e	Keeping data secure	I keep school-related digital data secure
Q2f	Open educational resources	I use open educational resources
Q3a	Benefit student learning	Increasing the use of DT in education will benefit student learning.
Q3b	Benefit teaching profession	Increasing the use of DT in education will benefit the teaching profession.
Q3c	Overall concern	I am concerned about increasing the use of digital technologies in education.

To measure teacher motivation the WTMST questionnaire was used. Three out of the five motivational constructs offered by WTMST were measured: intrinsic motivation (behaviors are engaged in for the pleasure or the satisfaction derived from performing them), external regulation (behaviors are performed to obtain a reward or avoid a constraint) and identified regulation (behaviors are performed as they align with the individual's own values and goals) (Fernet. *et al*., 2008). The measures were made in relation to two work tasks: (1) Participation in continuous professional development (CPD) activities related to teaching with digital technologies such as discussing CPD needs with school leaders, participating in CPD for teaching and learning with digital technologies, and sharing experiences within the school about teaching with digital technologies; and (2) Usage of digital technologies in teaching practices such as to prepare and deliver lessons to students, assess and provide personal feedback and support to students, and to communicate with students and parents.

Both Catalan and Spanish versions of SELFIE were offered to participants. The surveys were administered online (see Figure 1 for the timeline). The first survey (*S1* in Figure 1) was the adapted SELFIE questionnaire and was available for 5 days in April. The second survey (*S2* in Figure 1) was only available to participants of the first survey and included the SELFIE and WTMST questionnaires. It was available from August 27 until September 13. Less than a third of respondents to the first survey completed the second survey. Our analysis focuses on the responses of the participants who completed both surveys (during lockdown and post-lockdown). Parametric and nonparametric statistical tests for comparing groupings of responses (before the pandemic, during the lockdown period, and after the lockdown period) were used as well as non-parametric correlations to explore associations among factors.

Interviews

To complement the quantitative results obtained from the surveys, we carried out nine semi-structured interviews with teachers who participated in the survey. The retrospective interviews were carried out between September 7 and 25 – a period when the new (face-to-face) academic course had started (see Figure 1). Interviews were audio-recorded, done online using Google Meet, and lasted 50 minutes on average. Data analysis was conducted by two researchers (first and second authors). The interviews were transcribed and translated from Catalan or Spanish into English. Identifiable information was anonymised, then all interview transcripts were imported into NVivo 11 (Richards, 2002) and coded using an inductive thematic analysis (Guest, MacQueen & Namey, 2011) driven by our research questions. Two researchers familiarized themselves with the data and open coding was used for identifying the main themes (Guest, MacQueen & Namey, 2011). Codes were iteratively discussed among the research team to reach inter-rater agreement. Finally, the codes were used for the reporting of results.

Teachers' messages on social media (Twitter)

To perform the analysis of Twitter messages, a dataset of tweets was built that contained hashtags related to educators during the COVID-19 pandemic (see Table 1 in Annex). Next, a list of users who posted at least one message in this dataset was created. Users who had not selected Spain as their user location and did not have one of the following words in their user description field (all are variations on the word teacher in Catalan and Spanish): 'mestre', 'mestra', 'maestra', 'maestro', 'profesor', 'profesora', 'professor', 'professora', 'profe', 'docente' were removed. The remaining Twitter profiles were inspected to remove those who were not primary and secondary school teachers (i.e. teachers of universities or non academic institutions). A dataset containing tweets published between March and August 2020 from over 1000 teachers in Spain was then generated. From this dataset, the hashtags related to educators were sorted by the number of associated tweets (see Table 2 in Annex) for both the lockdown and post-lockdown periods. The hashtag #claustrovirtual (virtual faculty) was found to be the most popular hashtag in both periods and a new dataset was created with all tweets by teachers using the #claustrovirtual hashtag. Spanish media also reported that teachers were sharing and discussing ideas and concerns with other teachers about teaching in the lockdown using the claustrovirtual hashtag (e.g. García & Rubio, 2021; Mosquera, 2020). This dataset was manually inspected to identify tweets related to advice seeking and hence create a final dataset of advice seeking tweets for both the lockdown and post-lockdown periods. These tweets were ranked to identify the top 20 liked and top 20 retweeted tweets and then coded using an inductive thematic analysis (Guest, MacQueen & Namey, 2011) following the same approach as the analysis of interviews.

Results

Teachers' competencies and abilities

Results of the SELFIE survey are shown in Table 3 and indicate that the teacher confidence in using digital technologies for preparing lessons, class teaching, feedback and support, and communication (Q1a-d) increased in all categories since the onset of the pandemic (before, during and after the lockdown). Results related to the frequency of performing digital activities (SELFIE Q2a-f) show that the frequency of using virtual learning environments (Q2c), communicating with the school community (Q2d), and keeping data secure (Q2e) all increased over time.

Table 3. Teacher confidence in using digital technologies (Q1a-d) and teacher frequency of digital technology usage (Q2a-f)

Q	Item Code	Before lockdown *M* (*SD*)	During lockdown *M* (*SD*)	Post-lockdown *M* (*SD*)
Q1a	Preparing lessons	4.47 (1.07)	4.59 (1.00)	4.65 (0.49)
Q2b	Class teaching	4.24 (1.03)	4.35 (0.99)	4.41 (0.87)
Q1c	Feedback and support	4.00 (1.00)	4.24 (1.03)	4.35 (0.86)
Q1d	Communication	4.29 (1.16)	4.35 (1.17)	4.53 (0.62)
Q2a	Search Online educational resources	4.53 (0.51)	4.65 (0.49)	4.53 (0.51)
Q2b	Creating digital resources	4.24 (1.14)	4.35 (1.06)	4.35 (0.86)
Q2c	Using VLE	4.41 (1.06	4.59 (1.06)	4.71 (0.59)
Q2d	Communicating with the school community	4.35 (0.99)	4.65 (0.70)	4.71 (0.47)
Q2e	Keeping data secure	3.82 (1.07)	3.88 (1.11)	3.94 (0.74)
Q2f	Open educational resources	4.06 (0.93)	4.06 (0.93)	4.25 (0.86)

Table 4 shows Spearman and Kendall's Tau correlations (Puth, Neuhäuser & Ruxton, 2015) between teachers' confidence and frequency of performing digital activities during the pandemic. Significant positive correlations were found between the frequency of creating digital resources to support teaching and confidence in using digital technologies for class teaching, feedback and support, and for communication; between the frequency of using digital technologies for school-related communication and confidence in using digital technologies for feedback and support; and between the frequency of using virtual learning environments with students and confidence in using digital technologies for class teaching; feedback and support; and for communication.

Table 4. Relationship between teacher confidence and frequency of performing digital activities

	Creating digital resources to support teaching (f)		Using virtual learning environments with students (f)		Using DT for school-related communication (f)	
Confidence in using DT for...	Spearman	Kendall's Tau	Spearman	Kendall's Tau	Spearman	Kendall's Tau
Class teaching using a variety of devices and resources	$r_s(15) = .742$ $p = .001$	$r_\tau = 0.711$, $p < .01$	$r_s(15) = .527$ $p = .030$	$r_\tau = 0.509$ $p < .05$	---	---
Assessing or providing personal feedback/support	$r_s(15) = .827$ $p < .01$	$r_\tau = 0.800$ $p < .01$	$r_s(15) = .706$ $p = .002$	$r_\tau = 0.687$ $p < .01$	$r_s(15) = .747$ $p = .001$	$r_\tau = 0.714$ $p < .01$
Communicating with students and parents	$r_s(15) = .704$ $p = .002$	$r_\tau = 0.672$ $p < .01$	$r_s(15) = .716$ $p = .001$	$r_\tau = 0.711$ $p < .01$	---	---

Table 5 presents the themes and excerpts of the thematic analysis for the interview question *How would you describe your proficiency with digital technologies? How has this changed?* Results show that most of the interviewed teachers (7 of 9) think that their proficiency with digital technologies has improved since the onset of the pandemic. One did not respond to the question and another stated that their proficiency had not changed since they were highly proficient prior to the pandemic. Examples of improvements made by teachers include becoming more effective using common tools (3), improving pedagogical use of technology (3), and discovering new tools for teaching (2).

Table 5. Themes and excerpts from the thematic analysis of the interview question: *How would you describe your proficiency with digital technologies? How has this changed?*

Themes (freq.)	Examples of excerpts (Teacher ID) - Theme ID
A. Becoming more effective using common tools (3)	"Thanks to the pandemic, I learned more about the working of apps I already used such as Gmail, Calendar, or Google Classroom." (T3) - A1 "I have learned to use Microsoft Teams, which has many things. In fact, I use it much more now than before. [...] However, the fact of how to use them has not changed too much." (T5) - A2 "Before, we only used Moodle to upload a document, to do a task, and little else. Now, we use the forums, the bulletin board, we do different types of exams with different types of Moodle questions which allows you to get all the analysis of the grades. Moodle was a tool that we have always had but we were not using its full potential. Now we have improved that and we will continue using it." (T7) - A3
B. Improving pedagogical use of technology (3)	"... having to consider online evaluation approaches, I think, has made me improve. I did a lot of documentation. I expanded it because teaching online requires having a lot of material and one must be autonomous." (T7) - B1 "... elements are necessary to make people feel part of the group. [...] It is not the use of technology but it is the considerations that we must have in relation to educational pedagogy when we use these technologies." (T9) - B2 "I think what has changed is, above all, these collaborative spaces. Because it was something that was super important in the classroom, to do collaborative work, and that was being lost during the pandemic. And I had to figure it out. I didn't want to start doing tutorial actions and just talk and have them answer me. I wanted them to talk to each other [the students]. I think one of the big shortcomings that everyone has seen is the socialization between them [the students] maybe not in an educational context, maybe they talk about anything, but they talk to each other. And that has been the point I have had to improve on." (T1) - B3
C. Discovering new tools for teaching (2)	"...the fact of searching, or training and looking for these extra features makes you better. Even if you start from scratch, living the pandemic makes you better with the tools." (T6) - C1

Interviewees were asked to elaborate on the competencies (Table 2: Q1a-d) they felt would benefit them beyond emergency remote teaching. Figure 2 presents these competences and shows that 8 teachers felt they would benefit from improved abilities related to using digital technologies for preparing lessons; 6 related to teaching classes; 7 related to providing personalized feedback and support; and 8 related to communicating with students and parents. Table 3 in the Annex presents interviewee excerpts.

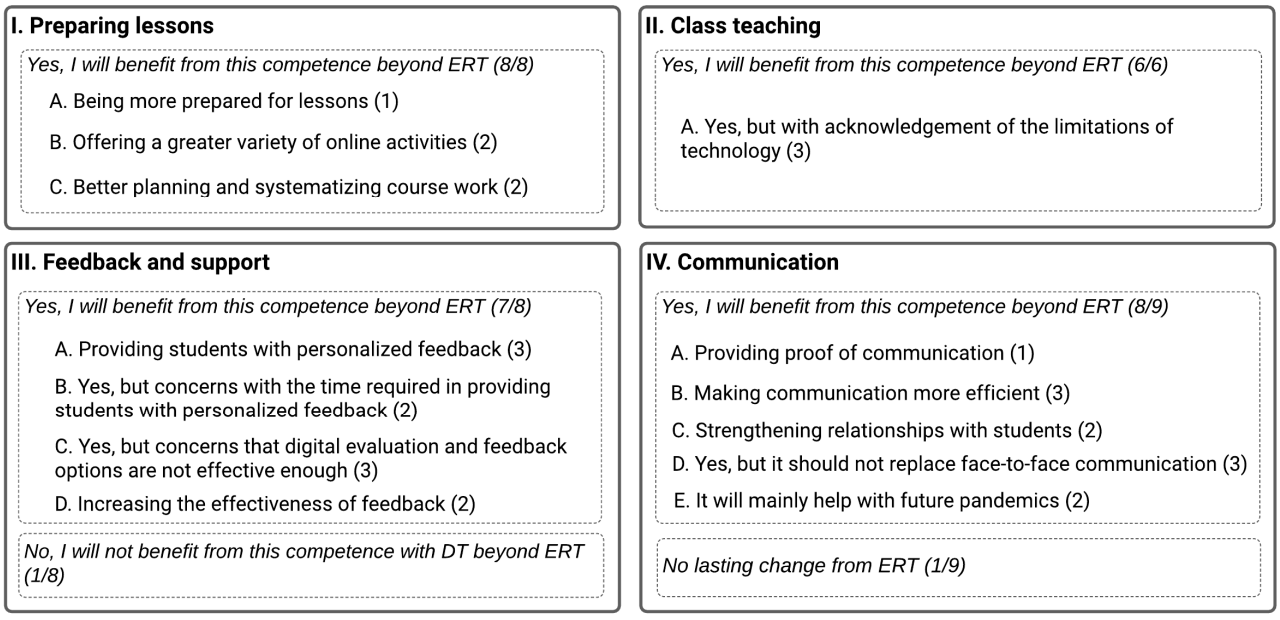

Figure 2. Thematic analysis of the interview question: *Competences that you feel will benefit you beyond emergency remote teaching (ERT).*

Teachers' motivation

Results from the WTMST questionnaire (Table 6) indicate that teacher motivation for participating in CPD activities (Task 1) related to teaching with digital technologies slightly increased during the period of remote teaching. Teacher motivation to use digital technologies in their teaching practice (Task 2) also increased during the same period with the largest increase found in the external regulation construct.

Table 6. Teacher motivation before and during the pandemic.

	Intrinsic Motivation		Identified regulation		External regulation		Overall Motivation	
	Before M (SD)	During M (SD)	Before M (SD)	During M (SD)	Before M (SD)	During M (SD)	Before M (SD)	During M (SD)
Task 1. I participate in CPD activities related to teaching with DT	4.84 (1.33)	4.94 (1.36)	5.37 (1.12)	5.41 (1.07)	2.45 (1.05)	2.55 (1.06)	4.22 (0.72)	4.30 (0.90)
Task 2. I use DT in my teaching practice	4.98 (1.31)	5.12 (1.21)	5.31 (1.27)	5.65 (1.16)	2.59 (0.98)*	3.29 (1.19)*	4.29 (0.96)**	4.68 (0.77)**

*Paired sign test, p=0.039; **Paired-sample T-test p=0.03, Cohen's d=0.574

In response to the interview question *Has your motivation related to learning about and using digital technologies for teaching changed? In what way?*, teachers elaborated on how the remote teaching experience affected their motivation in relation to adopting digital technologies for teaching. Results (see Table 7) show that most teachers (6 of 9) stated that their motivation had increased during the pandemic. Some (3) indicated that their motivation had not changed mainly because they were already highly motivated before the pandemic had started. Identified themes included an increased motivation to renew/upgrade their teaching practice with digital technologies (3) and to be better prepared for future pandemics (3).

Table 7. Thematic analysis of the interview responses related to teacher motivation

Themes (frequency)	Examples of excerpts (Teacher ID)
It has increased (6)	
A. Increased motivation to renew/upgrade teaching practice with DT (3)	"You know about things that exist and that you think one day you will look at yourself, it forces you to go look at it now. [...] you don't have time, then, this pandemic has helped me a little for this, to give me note that the issue of learning new technologies should not be ignored." (T8) - A1 "... I am motivated to use digital tools. But digital tools that serve, that have a utility beyond teaching, that serve socially. I was already motivated before the pandemic but with the pandemic even more so." (T3) - A2 "Now I feel more like looking for different solutions online. Or different tools other than the typical ones." (T7) - A3
B. Increased motivation to be prepared for a future pandemic (3)	"I think that if we are confined again, technology can help me develop my teaching job much better. And I want to have the tools ready, I want to be ready." (T1) - B1 "Yes, it [motivation] has changed because you see that they are useful. I've seen it before but now I've realized that it's the future and that's where you have to go because adverse situations can occur and you have to be prepared. [...] Seeing that they help you to overcome difficulties makes you more motivated in the face of them." (T6) - B2 "I am more motivated to do so, but out of necessity." (T5) - B3
It has not changed (3)	
C. Continued motivation to improve teaching practice using DT (3)	"Since I was already motivated, I don't feel any more or less motivated. It is part of our reality and the use of technologies must be accepted because we are immersed in this constant change." (T9) - C1 "As I was already aware that they could be useful for me, and if it is useful for me it can also be useful for the students." (T2) - C2 "It has not changed. Because I'm curious and learning is good for me. Therefore, this path of having to know more tools to be able to arrive at this new way of teaching has fulfilled my satisfaction of learning more." (T4) - C3

Two interview questions explored teacher feelings related to the use of digital technologies. The first asked teachers whether there were any changes in relation to their enjoyment of using digital technologies for teaching. The second asked teachers about changes in feelings of dissatisfaction/stress related to using digital technologies. In relation to the former, a few teachers (3 of 9) stated that their enjoyment level had increased during the pandemic and the rest reported no change. A reason given for the increase in enjoyment was that digital technologies made life easier, "*Because they make my life easier. So yes, the truth is that they are quite useful. I use them more and I think I like them better*" (T5); and also the usefulness of the technologies became more obvious "*Yes, you feel more motivated as you see more of their usefulness. Internally you enjoy them, search for more, look for alternatives, and are more daring to try them*"

(T6). In relation to the latter question related to dissatisfaction, most teachers reported no change. However, some teachers (4 out of 9) reported feelings of dissatisfaction/stress caused by feeling overloaded by the number of digital technologies to consider for teaching, the time demands of providing personalized feedback, the lack of face-to-face interactions, the failure of institutional leaders to address teacher training needs, the blurring of home and work boundaries, and the lack of responsiveness and maturity of students needed to learn in a more autonomous manner online.

Concerns

Three level of agreement statements were included in the survey to gather teacher impressions on the increasing use of digital technologies in education. Table 8 presents the results and shows that during the lockdown teachers perceived an increased benefit to the use of digital technologies but by the post-lockdown period the gain had regressed. Moreover, teachers' concern about the increasing use of digital technologies was lower during the lockdown but had increased post-lockdown.

Table 8. Teacher concerns regarding the increased use of technology in education

Q	Item Code	Before lockdown *M* (*SD*)	During lockdown *M* (*SD*)	Post-lockdown *M* (*SD*)
Q3a	Benefit student learning	4.29 (0.69)	4.65 (0.61)	4.47 (0.72)
Q3b	Benefit teaching profession	4.35 (0.70)	4.71 (0.59)	4.47 (0.72)
Q3c	Overall concern	2.12 (1.22)	2.06 (1.34)	2.18 (1.24)

In the interviews with teachers, various concerns were raised and excerpts from the thematic analysis of teacher concerns are presented in Table 9. Recurrent themes included concerns about the time/health burden of digital technologies (4 of 9), general limitations of digital technologies in relation to teaching (3), and the limited effectiveness of digital technologies for evaluating students (2).

Table 9. Thematic analysis of the interview responses related to teacher concerns

Themes (frequency)	Examples of excerpts (Teacher ID)
A. A time/health burden (4)	"The risk that I see with digital technologies is that we spend too much time on the screen both for work and for students. [...] Life should not be entirely virtual. [...] Life shouldn't be twenty hours or twenty-four with little screens. This is the risk that we face." (T3) - A1 "... if you have 34 students, it's hard to give very personalized feedback unless you give little homework. Otherwise you don't have the time to give proper feedback." (T1) - A2 "... to give feedback to students is costing me a lot because it takes up a lot of my time. I prefer to give feedback in a meeting with the student, I dedicate the necessary 10-15 minutes. But designing an activity that gives feedback that I like takes a lot of time and I don't quite make it profitable." (T9) - A3 "Of course, when you go to school and leave school, you physically see a certain order. When you are at home, you no longer have that border in mind. And there's some stress from that." (T2) - A4
B. Realizing the limitations of technology (3)	"… technological tools limit you to things you can do or not do. And once you have it then you have to know how to make it work." (T4) - B1 "The only thing that you see now is more applicable to certain things that I couldn't do in the classroom, or I'm not interested in doing because I already do other things when I teach in person." (T8) - B2 "Making sure that everyone [students] has had the opportunity to speak, that they feel that they have been asked [...] in a face-to-face classroom by simply looking a student in the eye they already know that you have paid attention to them, they already know that you took them into account. Not possible in a group video call." (T9) - B3
C. Limited effectiveness in evaluating students (2)	"... as for the evaluation, it is true that there are many tools that are used to evaluate, but it is not the same as doing a class evaluation, something in person." (T5) - C1 "Here, as a teacher you have to look for strategies so that they don't copy. [...] I have delved deeper into doing oral exams. [...] But notice that I'm talking about oral exams, I'm not talking about using tools. In some cases I did them individually. Every 10 minutes they went into Google Meet to take the oral exam." (T2) - C2

Social media analysis

Table 10 presents the themes identified from the advice seeking tweets written by teachers. Table 4 of the Annex presents examples of teacher tweets under each theme and theme subcategory. Figure 3 shows a comparison of codes generated from the most liked and most retweeted advice seeking tweets between the lockdown (Period 1) and post-lockdown (Period 2) periods.

Table 10. Themes identified from teacher advice seeking tweets

Themes	Description of the theme, type of advice seeking
Using VLE	How to do basic instructional tasks digitally. For example, tasks that are common in the classroom but teachers are now trying to replicate them online.
Sourcing digital edu. content or material	Requests for content/material related to teaching a subject.
Increasing engagement	Content and/or material related to teaching a subject.
Pedagogical advice	Pedagogical requests that are not technology-specific.

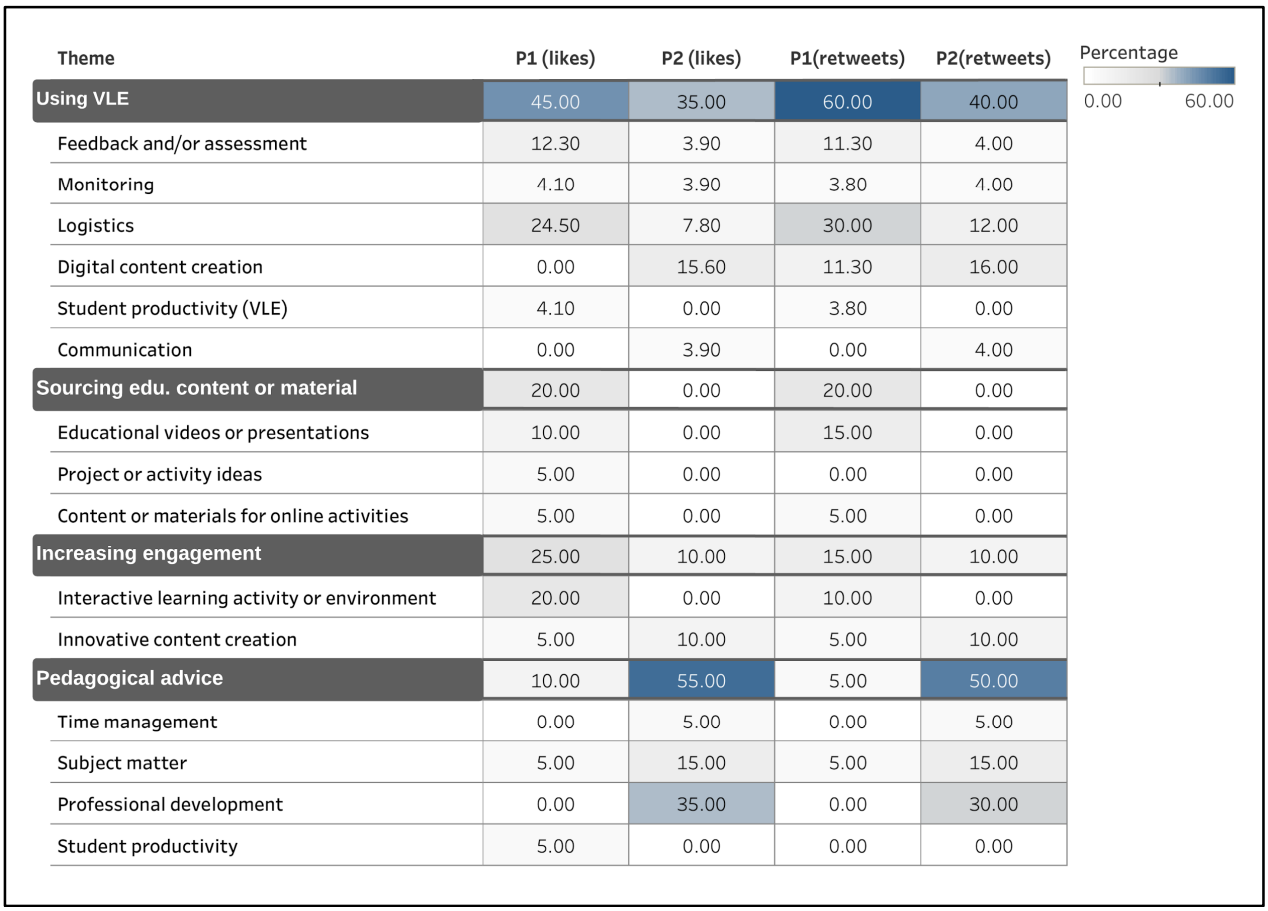

Figure 3. Thematic analysis of the 20 most liked and most retweeted tweets during lockdown (Period 1) and post-lockdown (Period 2)

Results of the Twitter analysis indicate that during the lockdown, in comparison to after the lockdown, teacher advice seeking related more toward tracking down content for online teaching (Sourcing digital educational content or material), performing basic classroom tasks online (Using VLE: logistics), and finding applications that could make online learning interactive (Increasing engagement). On the other hand, during the post-lockdown period, teacher advice seeking related more toward supporting their own professional development (Pedagogical advice) and creating their own educational content and materials (Using VLE: Digital content creation, Increasing engagement: Innovative content creation).

Discussion

The objective of this study was to explore how teacher motivation and abilities related to the use of digital technologies for teaching have changed since the onset of the COVID-19 pandemic. Five research questions were used to guide the study and are discussed below. In relation to RQ1, survey results show that since the onset of the pandemic the frequency of using digital technologies for teaching increased and interviewed teachers believed that their proficiency in using digital technologies for teaching had improved. The increased use of digital technologies tended to address practical problems such as facilitating communication with students/parents, and sharing personalized feedback. Although, there is evidence from the interview excerpts of some teachers striving to go beyond addressing practical problems and working toward improving their pedagogical uses of technology with efforts to better support learner motivation and autonomy, improving their lesson preparedness, and systematizing their lessons/teaching. Correspondingly, teacher advice seeking on Twitter seemed to shift from serving immediate instructional needs (e.g.

sourcing materials and performing basic tasks) during the lockdown period to focussing on professional development and the creation of their own digital content (e.g. innovative content creation and digital content creation) during the post-lockdown period. Moreover, results of our previous study (Albó *et al.*, 2020) showed that teachers' had more access to CPD activities during the lockdown period and that time was no longer a major constraint preventing teachers from learning how to use digital technologies. In relation to RQ2, teacher confidence in using technology for preparing lessons, class teaching, assessing and providing feedback and for communicating with students and families increased. Interview excerpts suggest that this increase in confidence has carried over into the post-lockdown school year as one teacher said, "The fact of searching, training and looking for these extra features makes you better. Even if you start from scratch, living the pandemic makes you better with the tools" (T6). In relation to RQ3 and RQ4, teacher motivation to improve their digital skills and use digital technologies in their practices increased across the three motivational constructs. The largest increase was found in relation to external regulation to use digital technologies for teaching which is understandable as the pandemic required teachers to use technology to teach remotely. However, external regulation (M=3.29) was rated much lower than both intrinsic motivation (M=5.12) and identified regulation (M=5.65) suggesting that teachers may have felt external pressure but their efforts to use digital technologies for teaching were more likely to be propelled by internal drives. In relation to RQ5, teachers expressed concerns related to meeting students' social needs, evaluating their learning effectively, and giving personalized feedback in an efficient manner when teaching remotely. Some teachers noted that automatic evaluation systems can both speed up evaluation and facilitate the tracking of student performance remotely but the evaluations are limited, do not adequately address possible student cheating, and that providing feedback online was overly time consuming. Teacher struggles to efficiently and effectively provide feedback and evaluate students remotely suggests they lacked pedagogical knowledge about how to use digital technologies for such purposes.

There are a number of limitations to our study. The sample size is small, self-selected, and geographically narrow which hinders the generalization of the results despite our use of a mix-methods approach. Survey and interview participants were from Catalonia which is an autonomous community in Spain that has certain rights to adapt parts of its curriculum (e.g., affecting the teaching practices related to digital skills and digitalization). Hence, the reality in other parts of Spain may differ. Moreover, Spain ranks 11th out of 28 EU Member States in the Digital Economy and Society Index (DESI) (EC, 2019). Thus, the realities in other countries are likely to differ. Finally, study participants were teachers who volunteered to complete the online surveys and/or interviews and most of them likely had a higher than average proficiency with or high interest in digital technologies. Future investigations could include the creation of a quantitative follow up study to explore whether the results apply to a larger sample. Results regarding the relationship between teachers' abilities and motivation could be contextualized with a future analysis on teacher support and training received during the pandemic in order to identify effective training practices. Moreover, our methodology, based on surveys, interviews and Twitter analysis, can open a window to future opportunities to study the professional development of teachers in times of crisis.

Conclusion

Framed within the FBM, we conducted a study to assess how teacher motivation and abilities related to the use of digital technologies for teaching have changed since the onset of the pandemic. We made use of validated research instruments (SELFIE, WTMST) and had the same participants complete surveys during two separate time periods (4 months apart). To contextualize teacher responses, interviews were conducted and a Twitter analysis carried out. Results indicate that teachers believe their proficiency in using digital technologies for teaching has improved since the onset of the pandemic. Also, teacher frequency of using digital technologies for teaching increased as did their confidence in using technology for preparing lessons, class teaching, assessing and providing feedback and for communicating with students and families. Teacher motivation to improve their digital skills and use digital technologies in their practices also increased and teacher advice seeking on Twitter seemed to shift from serving immediate instructional needs to focussing on professional development and the creation of their own digital content. In sum, these findings contribute to our understanding of teacher abilities and motivation to use digital technologies have been affected by the remote teaching response to COVID-19.

Statements on open data, ethics and conflict of interest

The ethics procedure followed the guidelines of the ethics committee of Universitat Pompeu Fabra Barcelona. Consent was obtained from participants. Results from the thematic analysis and data excerpts are available in supplementary files.

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Annex

Table 1. Twitter hashtags related to education during the COVID-19 pandemic

Hashtags (Original)	Hashtags (Translated)
#mestresconfinats	(confined teachers)
#profesconfinats	confined educators
#seguimeducant	we continue educating
#centreseducatiusenlinia	educational centers online
#claustrovirtual	translation
#claustreobert	open faculty
#sosdigitaldocente	digital-educational SOS
#profesqueayudan	teachers who help
#docentesencasa	educators at home
#maestrosdesdecasa	teachers from home

Table 2. Educational hashtags ordered based on the number of associated tweets.

Period 1 (14 Mar - 19 Jun)		Period 2 (20 Jun - 10 Aug)	
Hashtag	**Occurrences**	**Hashtag**	**Occurrences**
#claustrovirtual	2446	#claustrovirtual	828
#profesqueayudan	993	#vueltasegura	385
#elearning	895	#elearning	341
#edufis	691	#bachillerato	288
#fp	665	#learning	233
#educacion	610	#universidad	221
#learning	557	#aprendizaje	211
#aprendizaje	509	#fp	203
#educación	504	#educacion	196
#edtech	496	#edtech	194
#recursosmusicales	450	#educación	189
#universidad	417	#vueltasinriesgo	163
#charlaseducativas	359	#edufis	157
#educaciondisruptiva	310	#spanishteachers	122
#elcolesigue	305		
#bachillerato	304		
#mestreacasa	240		
#centreseducatiusenlínia	197		
#tecnologías	194		

Table 3. Excerpts from the thematic analysis of the interview question: *Competences that you feel will benefit you beyond emergency remote teaching (ERT)*.

Theme	Excerpt (Teacher ID)
I. Preparing lessons by editing or creating a variety of digital resources (for instance slide show, images, audio or video)	
Yes, I will benefit from this competence beyond ERT (8)	
A. Being more prepared for lessons (1)	"With a presentation in which you have already prepared what you mean, that you do not get lost in the speech, and that they reaffirm themselves visually and aurally is fantastic. Technology helps you be prepared." (T4)
B. Offering a greater variety of online activities (2)	"It prepares me to do activities online that until now I had not so much contemplated." (T6) "And what I have practiced the most has been the use / skill with virtual tools and simulations and also Moodle. We used to only use Moodle to upload a document, to do a task and little else. And now, we use the forums, the bulletin board, do different types of exams with different types of questions, from there you get all the analysis of the grades, and so on. All that is Moodle is a tool that we have always had and we were not using its full potential and now we will continue to use it. Even if I have face-to-face classes I will use it." (T7)
C. Better planning and systematizing course work (2)	"For example, creating videos to make explanations so that they can see it at home, is now much more useful because I have hours that they have to do online and I have to do something, maybe recording a class then they can watch it at home, saving time in the classroom." (T5) "Before, I explained the work orally, all this part of systematization… Now I am designing much more the guidelines that students must follow. I think this planning is very necessary to set goals as well, what I do expect from the students. This allows students to develop more autonomy. (T1)
II. Class teaching using a variety of devices (such as interactive whiteboards, video projectors) and resources (for instance online quizzes, mind maps, simulations)	
Yes, I will benefit from this competence beyond ERT (6)	"Because they are focused on making students more autonomous" (T6)
A. Yes, but with acknowledgement of limitations (3)	"But there will be a time when we will have to assess what works, what doesn't work, what's good and what's not good, for learning, for teaching, for everything." (T3) "Technological tools limit you to things you can do or not do. And once you have it then you have to know how to make it work." (T4) "Resources yes, I have learned it and I think it will help me, but not so much about devices. It can be useful but it depends on the subjects." (T5)
III. Assessing or providing personal feedback and support to students	
Yes, I will benefit from this competence beyond ERT (7)	
A. Providing students with personalized feedback (3)	"Because I used a lot of paper and pen. And there are many resources that allow you to take work off your shoulders. [...] what often happens with paper and pen is that you correct, you put the note and that's it. But the fact of being able to leave it posted online and being able to discuss it with them individually, I think it has favored individual evaluation. Both at the level of facilitating the evaluation, as well as the communication of this evaluation." (T8) - A2, D1
B. Yes, but concerns with the time required in providing students with personalized feedback (3)	"To give feedback to students is costing me a lot because it takes up a lot of my time. And I prefer to give feedback with a meeting with the student, I dedicate the necessary 10-15 minutes. Because designing an activity that gives feedback that I like I spend a lot of time on and I don't quite make it profitable. I can prepare a test and then give feedback for each question but it doesn't just give what I want the student to have. And I often prefer to review the exam, or how the assessment goes, directly with the student. Not to design a methodology for him to receive it automatically." (T9)
C. Yes, but concerns that digital evaluation and	"But as for the evaluation, it is true that there are many tools that are used to evaluate, but it is not the same as doing a class evaluation, something in person. They may be using the computer and

feedback options are not effective enough (3)	taking a multiple choice test, I don't know if you mean this. But it is not the same that they have a paper and a pen. Maybe I look old-fashioned but I think an exam should be to put and think and not have a computer." (T5)
D. Increasing the effectiveness of feedback (2)	"This will be very important for teachers, so that it speeds up the evaluation of tasks [...] many platforms include self-assessment mechanisms, for example, a tool that I really liked this course was that I made them read some notes and made them do a questionnaire with Moodle and you know right away from the students, where had failed and feedback, for example [...] And you can see when they did it, when they failed, how many attempts they needed [...] we will have a single place where we will have all the books from different publishers and the activities of these books will be linked on this platform called clickedu and we were taught that you can link the activities to the notebook of the platform. That you can have the notes instantly was a big waste of time before. In this way, it will help to deepen the teaching with other aspects." (T3)
IV. Communicating with students and parents	
Yes, I will benefit from this competence beyond ERT (8)	
A. Providing proof of communication (1)	"Yes, because in face-to-face class you can say "Exercise 2 for tomorrow" and this is lost… but if you leave it in writing, no one can tell you that you have not asked. The email that has been sent and the day / time is recorded. [...] So really, at a communication level, we have communicated a lot with students and families. All in excess." (T8)
B. Making communication more efficient (3)	"Video conferencing [...] tutoring meetings with parents we did them in person, and now it's a lot easier and faster, in a moment, to schedule a 10-minute video conference with parents and students, communication is now much faster. (T7)
C. Strengthening relationships with students (2)	"The tools I have used to have closer contact with students I will continue to use. I should not be afraid to get to know the student better and to improve this role as a tutor to get to know the students, to know about their situation, and from there to be more inclusive taking into account their needs." (T6) "Email is very important [...] now everything happens by email, and often by Whatsapp. Many times I send an email and it doesn't reach the whole group, and sometimes an interesting strategy is to send the email and the student you have as a delegate or class representative and ask him to spread it through the Whatsapp group of the class.[...] We never say they should have a Whatsapp group but they always have it. So legally there is no problem. Then we take advantage of this technological structure that they have to communicate because we already know that many of them do not check email. They don't have this habit and the mail gets parked and doesn't arrive.[...] the Google Meet for a meeting with the family or with a student is very powerful. We conduct individual interviews with new students arriving at the center. The tutor talks to each student to see what expectations he has, because he has chosen these studies… what is his professional vocation, etc." (T9) - B3, C2
D. Yes, but it should not replace face-to-face communication (3)	"It's not the same to talk on screen [...] For example, with an app you can know who has done its homework or not. Or if the student did well or not so well with the grades. But what is the exchange of impressions, communication… I think the interviews should be done in person. [...] The pandemic has opened a window into the digital world.[...]For example in cases where the parents are divorced, who do not agree, and you can do a virtual interview with both of them there… but as a resource, as a support, never as a substitute for the face-to-face. [...] Simulations are not enough." (T3) "For one-to-one communication, I don't like it, I prefer it in person." (T5)
E. It will mainly help with future pandemics (2)	" How to use Google Meet [..]I hope to be able to do tutorials in person in a short time." (T1)

Table 4. Themes and excerpts of the thematic analysis of Tweets seeking advice.

Themes	**Description of the theme, type of advice seeking**
Using VLE	How to do basic instructional tasks digitally. For example, tasks that are common in the classroom but teachers are now trying to replicate them online.
Subcategory	*Example of tweet*
Feedback and/or assessment	*Do you know of any tool that allows you to design multiple choice and development-type exams that guarantee that the student has done it autonomously from their computer? Apps like Google Forms don't work for me.*
Monitoring	*Has anyone found / created / used a good rubric to evaluate student participation during video conferences? Thanks!*
Logistics	*Help! Is there an app that you recommend for making class schedules?*
Digital content creation	*What tool do you recommend for a newbie who wants to learn how to record videos for students?*
Student productivity	*Hello,#ClaustroVirtual ! Can someone recommend a tool to design a nice to-do list for the students, as a reminder, in which they can cross out items; or failing that, how to do it? Thanks a thousand !!*
Communication	*We are looking for a platform that serves as a record of information, monitoring - evaluation and that allows interaction with families. Primary stage. Any recommendations?*
Sourcing digital edu. content or material	Content and/or material related to teaching a subject.
Educational videos or presentations	*These days I want to recommend videos like #documental or #reportaje related to #EF and the #deporte to my students from the #ESO Y #Bachillerato to later be able to comment with them. Any recommendations?*
Project or activity ideas	*Hello #claustrovirtual Any online activity you recommend to close the 2nd grade course?*
Content or materials for online activities	*I'm trying to make a @vocaroo padlet on "short jokes" with my students. And I'm already running out of resources. Can you help us, can you tell us a joke?*
Increasing engagement	How to make online learning more engaging.
Interactive learning activity or environment	*Do you know alternatives to Kahoot that allow videos?*
Innovative content creation	*After seeing the success of gamification with my 1st ESO boys, I want to prepare a more complete project. I am planning a trailer based on Harry Potter. Can someone who "makes" movie trailers enlighten me a bit?*
Pedagogical advice	Pedagogical requests that are not technology-specific.
Time management	*[...] The idea is that in some classes, we analyze scenes from the TV series [La casa de papel]... and from there, we will work on Physics and Chemistry content. The fact is that I would like to have the video fragments already prepared so as not to depend on the center's internet and to amortize time, but I am concerned about the legal aspects [...]*
Subject matter	*In class there is a 14-year-old student, repeater. In bio and geo, when his classmates don't know an answer, he raises his hand and answers it. He has very little will and is unaware of his potential. I want to give him a book for the summer. Which one do you suggest?*
Professional development	*I am researching educational innovation. I would like you to recommend essential authors that I should cite.*