

## **Students' sense of self-efficacy in digital skills during teacher training: a pre- and post-coronavirus lockdown comparison**

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This present research project reproduces and, in so doing, completes an initial 2018-2020 study (*Digitalisation and training: student and teacher competencies*) undertaken at the University of Teacher Education - States of Bern, Jura and Neuchâtel - in Switzerland (HEP-BEJUNE) (Boéchat-Heer & Padiglia, 2020; Boéchat-Heer et al., 2022). The research aim is to identify potential changes in teacher training students' sense of self-efficacy in digital use, their digital representations, digital uses and coping strategies during both training and work placement periods since the initial study. Digital skill transfer from a training context to a practically applied, in-class context is also of particular interest. The change in results anticipated could be due to a 'before and after' effect generated by the Covid-19 pandemic. Data for the initial study was collected at the end of 2019, directly before the outbreak of Covid-19. To avoid conducting a redundant study, data was recollected using identical methodology, albeit different sampling, from December 2021 to January 2022 in order to obtain relevant, up-to-date post-lockdown results. The research team worked under the assumption that 'forced' digital use during the pandemic lockdowns engendered an evolution of students' digital representations, sense of self-efficacy and uses. This chapter focuses on the 2021-22 results which are analysed and then compared with the 2019 results in order to describe any evolutions in students' digital representations, sense of self-efficacy and uses within the just over two-year period.

Several observations led the research team to pursue these projects. Firstly, teacher training and professional development courses for information and communications technology (ICT) have been a European preoccupation for around twenty years. Lordache et al. (2017) highlight the differences between digital literacy, digital skills and digital competences - concepts that are often used interchangeably yet have distinct meanings. According to their literature review, literacy refers to "certain competences and knowledge" (p. 8), while competence itself concerns one's ability to apply knowledge. Citing van Deursen (2010), Lordache et al. (2017) list six practice-oriented skills: operational skills, formal skills, information skills, strategic skills, communication skills and content creation skills, summarising that "digital skills are consequently to be seen as the more practical and measurable outcomes of media, information or digital literacies" (ibid., p. 8). The European Commission's DigCompEduc report (Redecker & Punie, 2017) describes the digital skills that teachers must acquire in various domains such as professional engagement, digital resources, teaching and learning, assessment, empowering learners and facilitating learners' digital competence.

For context, numerous studies partially based on this report contribute further to defining digital skills and uses (Ferrari, 2012), analysing and describing related teacher practices (Güneş & Bahçivan, 2018) and identifying difficulties concerning ICT integration in teaching and learning practices in Switzerland (Boéchat-Heer & Padiglia, 2020). Secondly, research shows that teachers generally feel

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insufficiently trained to integrate digital tools into their teaching practice (Gudmundsdottir & Hatlevik, 2018; Røkenes & Krumsvik, 2014 ; Tondeur et al., 2017; Valtonen et al., 2015). Using models that integrate technologies in a cross-disciplinary way, and favouring prolonged exposure to these technologies during undergraduate or postgraduate training are strategies that allow not only an improvement in digital skills (Kay & Kanaak, 2005), but also an improved sense of self-efficacy (Boéchat-Heer, 2018). Moreover, faced with a problem, teachers activate certain coping mechanisms or strategies. Regarding this theme, Laugaa and Bruchon-Schweitzer's 2005 study demonstrates that a sense of self-efficacy is positively associated with problem-centred coping. In this context, 'coping strategies' are problem-centred "actions to address the origins of stress" including problem-solving and seeking adequate support (Labrague, 2022, p. 2708). Finally, several studies show a link between digital representations and practical uses (Abric, 2001; Ratinaud, 2003).

With all of the above in mind, a team at the HEP-BEJUNE submitted and received approval to conduct a research project from 2018 that would provide an overview of students' and teacher trainers' digital skills, digital uses, digital habits and digital representations. As aforementioned, factors favouring or inhibiting digital uses in training and the transfer of digital skills from training to class contexts also interested the research team. To clarify, by 'digital uses', the authors mean 'all the ways that a subject can use digital technology' in terms of tools and frequencies, in personal and/or professional contexts. 'Digital representations' is a term that represents a respondent's personal negative, neutral or positive perceptions of digital technologies and uses in a defined context.

This project had no particular corrective aim, but sought rather to gather information regarding these digital questions. If in doing so, possible improvements to current training practices were to emerge due to establishing links between training and professional practice contexts in the findings, this would be an unintended benefit. Moreover, digital skills and technology representation in teacher training obviously have a spillover effect on practice in schools, thus it would be judicious to assess the HEP-BEJUNE's institutional digital training situation in order to positively affect broader societal and educational implications in terms of future teachers' impact on our citizens of tomorrow.

An initial theoretical framework for the 2019 study on students' and teacher trainers' digital skills, digital uses, digital habits and digital representations (Boéchat-Heer & Padiglia, 2020; Boéchat-Heer et al., 2022) was elaborated based on the European Commission's DigCompEduc report (Redecker & Punie, 2017), Switzerland-specific educational domain strategies and reports (CDIP 2007, 2018; Boéchat-Heer, 2018) as well as an internationally sourced literature review around digital education in teacher training and teachers' phases of digital integration (Boéchat-Heer & Padiglia, 2020). Research on teachers' digital training highlights the importance of learner communities (Breuleux et al., 2002), reflexive practices (Deaudelin et al., 2002), a sense of self-efficacy (Carugati & Tomasetto, 2002), involvement on the part of management/direction (Isabelle et al., 2002) and cooperation and communication (Haeuw, 2002). Teachers pass through various phases of digital integration when they innovate their practice. Some authors show the importance of personal before professional and pedagogical practice (Raby, 2005) while others describe these phases as part of a gradual expertise-developing process going from appropriation to adopting routines (Depover & Strebelle, 1997; Morais, 2001). The literature consulted inspired the formulation of statements used to identify, then measure or demonstrate behaviour, knowledge or skills using scales to self-evaluate in the questionnaire distributed.

The results of the initial 2019 study (Boéchat-Heer et al., 2022) show that students have a strong feeling of digital competence in terms of digital tool use and information research, but they do not feel as confident in data development and digital identity security, moreover it seems that students' digital

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skills are largely self-taught. Additionally, students perceive digital technology for information research and for play positively, but perceptions of this same technology are less positive in terms of its pedagogical use in class for learning activities. Students use the internet, mobile phones and social media most in private, but in their training context they favour institutionally provided tools such as Moodle and Google Drive. During work placement, student teachers use digital technology mainly for information research and less frequently for discussions or explanations in class. Students with a higher usage of digital tools and software during their teacher training-related learning have a significantly higher usage of these same tools and software in class (in a training/work placement context or in employment). Finally, significant correlations exist between feelings of self-efficacy and coping strategies and between coping strategies and usage frequency of digital technologies in class.

For this second, replicated 2021-22 study, an extended theoretical framework is developed by reviewing articles published in English or in French from 2016 onwards, predominantly in 2020 and 2021. New insights into student and teacher digital competencies after the outbreak of Covid-19 emerge in this second literature review, particularly in terms of:

- the widespread dependency on distance learning and online learning technology for delivering education since Covid-19,
- digital skill development in teachers, or the modernisation of teaching methods using modern technologies,
- the extent of institutional support during the Covid-19 period, and lastly,
- teacher training for the digital educational space, using digital technologies and tools in the classroom.

An outline of the main points pertaining to these emergent themes follows.

### *Widespread dependency on distance learning and online learning technology for delivering education since Covid-19*

A temporary shift to online teaching has been the worldwide response to Covid-19 (Seufert et al., 2021). Findings from an open public consultation undertaken by the European Commission (June to September, 2020) establish that before Covid-19, almost 60% of participants had not used distance or online learning (Annette, 2021). This same publication states that the Covid-19 pandemic “has led to a much greater dependency on technology for providing the support needed to deliver education” (p. 2). This new dependency has led to an evolution from a ‘first level’ of ‘digital fracture’ (digital inequality linked to disparate information technology material access) (Bachy, 2021) to a ‘second level’ of digital fracture. This “fracture within a fracture “ (ibid., p. 19, author’s translation) creates divisions, not in terms of material access this time, but between digital users in terms of what they are able to do with the material (contextualised use in a rapidly evolving digital environment, resource assessment and management). For example, some students, at ease with social networks and sustained screen time, found themselves at a loss when needing to communicate via email using attachments, and teachers experienced reticence when faced with the obligation to organise distance learning (Collet, 2020). The imposed reality of embarking on a distance-teaching and/or learning experience because of Covid-19 has compelled many teachers to confront their relative inexperience in diverse didactic and pedagogical digital methods, and to use technology as a mediator for learning (González-Fernández, 2021, p. 17). Greenhow, Lewin and Staudt Willet (2021) mention that teachers were inadequately prepared for online learning despite recommendations to address this fragility over a decade ago. However, teachers have

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been able to adapt to online teaching during school closures because of their digital skills and/or teacher education opportunities to learn digital competencies (König et al., 2020, p. 608) although the Covid-19 situation has required confidence from teachers, not just knowledge and skills, to make online teaching a success (p. 611).

A study on initial teacher education in England and Covid-19 (La Velle et al., 2020) argues for a new digital pedagogy that considers “opportunities and affordances available as the post-Covid educational landscape emerges” (p. 596). Citing Guertin (2012) and Lenoir (2012), Dupuis (2020) postulates that circumstantial and temporary adjustments arising from the Covid-19 pandemic may possibly lead to changes in teaching practices that represent lasting, reflected, grounded and legitimate modifications (p. 3). However, the education system needs to take time to absorb this social change, as the initial reaction to widespread distance learning and online learning technology use is less significant than judicious, continuing pedagogical use for attaining the finalities of schooling (El Khalfi, 2021, p. 16). Following the Covid-19 experience, Toto and Limone (2021) claim that “teachers have a role of renewed authority because, now aware of their own abilities and limitations, they exploit the digital resources available to build a strong educational process” (p. 7), thus suggesting that didactic, not material considerations can now be at the forefront of digital tool use that has become so widespread after the lockdown periods.

### *Digital skill development in teachers, or the modernisation of teaching methods using modern technologies*

Langset et al. (2018) state that “digital competence, which comprises digital knowledge, skills, attitude and literacy, has become a key competence in education in most developed countries” (p. 25). Melash et al. (2020) present four dimensions to digital competencies necessary for future primary school teachers: familiarisation, use, integration and reorientation (p. 378). According to Nowak (2019), digital skills help people to “[...] be conscious recipients of content and creative creators in online communities, and enable a more efficient implementation of individual paths of educational and professional development” (p. 266). Reisoğlu and Çebi (2020), referencing Calvani et al. (2008), state that “digital competence is multidimensional, complex, related to 21st century skills and sensitive to socio-cultural issues” (p. 3), adding that for teachers, “digital competence includes supporting the learning process of the students and contributing to all the processes that lead to the configuration of information” (p. 3). Lafleur (2021) presents a recapitulative table of a study’s general observations of communities of practice (p. 24) with one axis comprising twelve dimensions of digital competence and the other presenting thirteen dimensions of professional competence observed in teachers from Quebec, the table clearly highlighting many points of interaction between digital and professional competencies.

König et al. (2020) point out that “contrary to our expectations, early career teachers’ status as belonging to the generation of ‘digital natives’ (Prensky 2001) does not guarantee that they have developed sophisticated digital skills in general” (p. 618), an argument also supported by Popa et al. (2020, p. 10). Seufert et al. (2021) point out that “we cannot expect prospective teachers to possess technology-related knowledge and skills simply because they grew up with digital technology” (p. 3).

Despite little research yet available on teachers’ self-perceptions of digital competence (Rubach & Lazarides, 2021, p. 1), results of a study by Garzon Artacho et al. (2020) show that teachers “use ICTs as a minimum support tool but do not have the self-efficacy to create their own digital content and share

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it with other peer users" (p. 9). In this new era, "teachers are therefore called to develop digital skills to update their teaching methods using modern technologies [that allow] them to prepare new incentives, provided with disciplinary and educational coherence in well-organised digital environments" (Barana et al., 2020, p. 1). Indeed, all teachers have had to update their techno-pedagogical practices in order to transform didactic material to suit distance learning situations, a process that "requires continuous professional self-improvement using a wide range of digital tools" (Budnyk et al., 2021, p. 19). One advantage to this is that ICT use allows for the integration of active and innovative methodologies, focussing on the student (García-Vandewalle García et al., 2021, p. 5). However, a generalised disconnect still exists between technological innovations and their practical, pedagogical integration by school teachers, according to El Khalfi (2021, p. 1).

### *Extent of institutional support during the Covid-19 period*

The lockdown periods imposed due to the pandemic involved consequential demands on teachers to continue to provide education despite a sudden lack of resources and scarce experience with using digital tools in the classroom, much less for remote teaching and distance learning (Rabaglietti et al., 2021). Citing several other studies, these authors highlight the stress felt differently by individual teachers who had to work harder, for longer, at a screen and using unfamiliar tools with little to no training. These stress levels depended on gender, pragmatic situational realities and variations in real and self-perceived professional and digital competencies (p. 2). As mentioned in the 2016 Rabaglietti et al. study, a link between perceived stress and an individual's sense of self-efficacy is confirmed, and people with greater self-efficacy are more motivated to seek out and utilise resources when stressed (p. 2). The results of this same study also suggest an effect "of [difficulties in organizing distance learning] on perceived stress, a relationship mediated by teachers' self-efficacy" (p. 5).

Carron and Veillette (2020) highlight the beneficial effects of work undertaken by members of their institution's institutional technical support department who made available certain digital tools and helped with their availability, conceptualisation and use. The specifically institutional nature of the technical support on offer meant that teacher trainers and students alike had free access to pertinent, targeted support particularly in terms of hardware, platforms and software availability and usage. This reduced the stress generated and time spent by all on finding quick and often suboptimal solutions to problems they were not qualified to solve. However, in an unrelated study at another institution, Budnyk et al. (2021) find that "a significant part of practitioner-teachers (53.8%) faced the problem of insufficient technical support" (p. 9) in terms of digital practices. With regard to the generally significantly increased workload for teachers during the pandemic lockdowns, they struggled to cope with the multiple challenges and time-consuming nature of sudden distance-teaching. One member of an institution said, "I've been staring at a computer for eight solid hours, my eyes are strained... and I have to keep reminding myself, all this is new... we are all learning, and it will get easier, I hope'" (Greenhow et al., 2021, p. 13). Students were of course concurrently dealing with similar challenges inherent to the pandemic-caused lockdown, learning to adapt to new learning environments and new learning rules and tools.

As might be expected, rapid digital evolution within institutions can present challenges. Langset et al. (2018) write that:

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“a fairly common and well-known approach to digitalization is individual, tool-focused and campus-based courses to implement tools already purchased by the organization. Typically, training relates to a certain digital infrastructure, such as an LMS [learning management system], that the institution expects faculties to use in their courses. [...] educators are also usually left with a limited degree of autonomy” (p. 26).

At Norwegian universities - the context of these authors' study - the focus is on “digital infrastructure, technical support and short ‘top down’ courses on how to use specific digital tools (p. 27). Pedagogical uses of new technology to enhance education in a long-term perspective are rarely evoked. Popa et al. (2020) citing Reeves and Reeves (2012), in turn point out that university professors, while specialists in their fields, are not necessarily competent to transform learning environments, certainly to create efficient, online educational approaches. Thus, teachers at this level “need to be open and search for institutional help among colleagues with more experience or developed competencies” (p. 10). The possibilities for this during the lockdown periods were however quite fraught.

#### *Teacher training for the digital educational space both online and offline: using digital technologies and tools in the classroom*

For Fernández-Batanero et al. (2020), complications come to light “when technological training acquired is mainly based on technical rather than pedagogical aspects [and] many tasks based on technology fail to culminate in meaningful learning for students” (p. 14). Howard et al. (2021) point out that preservice teachers need to have the skills necessary to develop digitally integrated learning, but that the mastery of existing technologies does not suffice. Teachers need to be able to confront a continually changing digital landscape, both today and in the future. According to these same authors, the best way for preservice teachers to integrate these skills is to have “experiences integrating digital technologies in learning as part of their training” (p. 2). Weiss et al. (2020) note that French universities have difficulty in developing virtual learning environments, and conclude that despite sufficient digital work space, users are not offered more complex or innovative training experiences (p. 181). Reisoğlu and Çebi (2020) highlight that “teacher educators do not share enough experiences, examples, or strategies that can potentially make them role models in teacher training programmes; and pre-service teachers experience passive, theoretical information about digital technologies” (p. 4). Indeed, student teachers need to recognise their educators as role models in the use of new technologies in education in order to be inspired to use technology in the classroom themselves (García-Vandewalle Garcá et al., 2021, p. 5; Reisoğlu & Çebi, 2020, p. 1). Supporting further these ideas, Romero-Tena et al. (2020) conclude that “deficiencies regarding the use of the technologies found in childrens' classrooms are determined by these major factors: study plans [training curriculum] and training of trainers” (p. 14). Continuing education of teacher trainers' training in the digital domain is thus vital (García-Vandewalle Garcá et al., 2021, p. 15).

Future teachers come into training with different backgrounds and “variables such as gender, previous ICT training, teacher qualifications, teaching experience and sociocultural context” can determine levels of digital competence (Garzon Artacho et al., 2020, p. 4). Providing adequate training to prepare students for appropriate and innovative use of digital tools in and out of the classroom is essential as a level of mastery of digital tools is not innate (Cabero-Almenara et al., 2020; González-Fernández, 2021). A study at the University of Seville (Romero-Tena et al., 2020) shows the importance

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of the training course for improving students' self-perception of digital competency, changes in measure before and after the training course shown to be statistically significant.

Future teachers' perceptions of their digital tool use do not highlight pedagogical use but personal use, and although more than 45% of future teachers describe themselves as at ease with PowerPoint software, for example, the extrapolation of foreseen assured integration of ICT in classrooms on this basis is erroneous (El Khalfi, 2021, p. 15). In terms of information-related digital skills, results from this same study reveal a lack of critical thinking in future teachers when faced with different ICT uses in education (for example, filtering and selecting different information to be found on the internet). El Khalfi's 2021 study also highlights how, in terms of techno-pedagogical skills, future primary and secondary teachers do not feel capable of planning, managing and evaluating learning by digital means, partly because the didactic potential of digital tools is not well understood (p. 16), and also highlights the importance of encouraging accompanied, self-evaluative practices in training in order to develop professional judgement (p. 17). Rodríguez et al. (2021) critique training programs, pointing out the lack of "tools to help [preservice teachers] self-evaluate their own competence and get instant feedback on how their TDC [Teacher Digital Competence] is developing" (p. 354). Teacher training courses are particularly lacking when it comes to digital security (García-Vandewalle Garcá et al., 2021, p. 1).

Some differences exist between Bachelor and Masters level students concerning their perceived digital competencies (García-Vandewalle Garcá, et al., 2021, p. 1). Masters students have more positive perceptions of their digital skills than Bachelor students (p. 16), and "as the number of years in higher education increases, teacher trainees' positive self-assessment of their digital competence also increases in all areas except [...] safety" (p. 16).

Concerning teachers' attitudes towards digital tools, a "teacher's favourable or unfavourable attitude toward the use of ICTs influences their use; if the teacher shows a negative attitude toward them even though he or she is provided with excellent facilities; he or she will not use them in his or her session" (Manco-Chavez et al., 2020, p. 13). Romero-Tena et al. (2020) state that teachers themselves are the reason why technologies "are not used, and are poorly integrated in the classroom" (p. 2), because of their personal choice and not a lack of technology in the classroom.

Receiving continuous feedback regarding performed practices is an important part of preservice teacher training (Reisoğlu & Çebi, 2020, p. 4) and continues to be a valuable part of the workplace experience after graduation. A study set in Barbados found that "the teacher community would need common meeting places", "time to work with peers" and even "encounters across school boundaries" (Rieble & Heinonen, 2021, p. 3). Seufert et al. (2021) cite a study that suggests "skilled teachers with a highly positive attitude towards technology could act as coaches or mentors to support their colleagues", creating "communities of practice that play an important role in [...] professional development" (p. 3). Finally, the inclusion of ICT in lifelong learning will become an "indispensable tool to thrive in the framework of digital competence" (Ponce Gea et al., 2021, p. 197).

### *Research aims*

The objective of this second 2021-22 study is to identify a possible change in students' sense of self-efficacy in digital skills, their digital uses, digital habits and digital representations following the Covid-

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19 lockdown period, in the contexts of their studies, work placements and private use. Particular attention will be paid to the transfer of digital skills acquired during training to the classroom setting.

The general hypothesis expected to be confirmed by the 2021-22 data is that students now have more positive representations of digital use and a greater sense of self-efficacy concerning their digital skills.

Based on the 2019 results, two additional hypotheses are made:

1. Future teachers who make regular use of digital tools for their own learning will use digital tools more in the classroom when teaching.
2. Future teachers with a strong sense of self-efficacy in digital use will adopt coping strategies centred on the resolution of a problem.

### Method

For this longitudinal study, two almost identical questionnaires are administered to a mixed population of primary, secondary and special education teacher training students at the HEP-BEJUNE, one in November 2019 (initial research project) and the second from December 2021 to January 2022 (duplicated research project post-lockdown period). For the initial dataset from 2019, 277 students out of 646 link recipients filled out the questionnaire (43% survey response rate) and for the duplicated 2021-22 questionnaire, 218 students responded out of 656 link recipients (33% survey response rate). Further information concerning final respondents can be found in *Table 1*.

*Table 1 Questionnaire sampling*

	2019	2021-22
Number of recipient links	646	656
Number of responses	277	221
Response rate (%)	42.88	33.69
Female respondents (%)	76.53	72.85
Male respondents (%)	23.47	27.15
Respondents from primary training (%)	53.43	52.04
Respondents from secondary training (%)	28.88	31.67
Respondents from special needs education training (%)	17.69	16.29
Respondents under 25 years of age (%)	52.35	52.04

The questionnaire includes the following categories: student profile, equipment and tools, digital representations, frequency of digital technology use in the private sphere, digital tools in teacher training, sense of personal digital skill level, digital technology and learning, and digital technology in actual classroom practices. Perceived digital competencies can be measured or demonstrated using statements identifying behaviour, knowledge or skills and inducing the respondent to self-evaluate using a Likert scale, for example, included in a questionnaire (Bigatel et al., 2012; Liu et al., 2022).

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Formulations for questions relating to a sense of self-efficacy and to coping strategies were influenced by existing research on an individual's sense of self efficacy in the use of ICT (Déro & Heutte, 2008). Questions relating to digital use and its frequency were influenced by the ICILS<sup>1</sup>, MIKE<sup>2</sup> and JAMES<sup>3</sup> surveys.

Using the separate 2019 and 2021-22 datasets and then a merged 2019 and 2021-22 dataset, descriptive and inferential analyses are conducted then tested for statistical significance (test t, ANOVA, correlations) using IBM® SPSS® software.

### Results

Analyses of data reveal noteworthy and statistically significant results that concern students' positive and negative representations of digital technology, correlations between the usage frequency of digital tools and software during training and students' ensuing uses and practices in the classroom, remote communication, students' sense of self-efficacy in digital skills, problem-solving strategies and the pandemic-engendered lockdown teaching-learning situation itself.

For the reader's information, some differences in question numbering can be observed between the two versions of the questionnaire (2019 and 2021-22). *Table 2* below summarises the differences:

*Table 2 Differences in question numbering for 2019 and 2021-22 questionnaires*

Question Numbers for 2019 vs. 2021-22 Questionnaires	2019	2021-22
How often do you use the following resources and tools to remotely communicate in the context of your learning activities?	Q10	Q10
What tools do you use to share information, photos or videos in the context of your learning activities, and how often?	Q17	Q16
How often do you use the following tools or software during the school year?	Q18	Q17
Have the students in your class (in work placement or employment) done the following activities this year?	Q19	Q18
Have you used digital tools for the following practices during your lessons in class (in work placement or employment) this current school year?	Q20	Q19
Sum of two questions combined	Q19_20 total	Q18_19 total
New question added to the 2021-22 version of the study to question students on their experiences during the distance teaching/learning periods imposed by the sanitary crisis		Q20

<sup>1</sup> <https://nces.ed.gov/surveys/icils/questionnaires.asp>

<sup>2</sup> <https://www.zhaw.ch/de/psychologie/forschung/medienpsychologie/mediennutzung/mike/>

<sup>3</sup> <https://www.swisscom.ch/fr/about/durabilite/james.html>

### Students' representations of digital use

Digital representations are investigated in Question 8 (Q8) of the 2019 and 2021-22 questionnaires: "To what extent do you agree with the following statements concerning digital use at school?". Students reply using a Likert scale with four potential selection points (4 strongly agree; 3 agree; 2 disagree; 1 strongly disagree) for various representations such as "[digital use] allows students to consult better information sources" or "[digital use] leads to more limited writing skills". Results show that students' representations of digital use are generally positive.

Digital representations concerning sources, collaboration, information treatment or processing, organisation, interest in learning and students' individual needs have not changed significantly according to t-tests. 2021-22 data shows that students are significantly more (t-test, correlation, ANOVA) in agreement with seven positive representations of digital technology out of fifteen positive or negative representations proposed in random order than in 2019 (see Figure 1). There is no significant evolution for the negative representations of digital technology proposed. To further confirm this result, when merging data sets, the correlation between the year (Group 0: 2019 or Group 1: 2021-22) and the evolution of positive representations of digital use (Q8, items 1, 3, 5, 7, 9, 10, 12 and 14) is significant ( $r=-0,294^{**}$ ). However, there is no significant correlation or mean comparison between the year and the evolution of negative representations of digital use (Q8, items 2, 4, 6, 8, 11, 13 and 15). This data confirms the first part of the general hypothesis, that students now have more positive representations of digital use following the Covid-19 lockdown periods. This is perhaps, in part, due to the advantage identified by García-Vandewalle García et al. (2021), which is that the integration of innovative and active methods rendered possible by ICT use puts the focus on the students. This result is a positive outcome of the study because future teachers' positive representations of digital use are an important predictor for their actual use in class (Manco-Chavez et al., 2020; Romero-Tena et al., 2020).

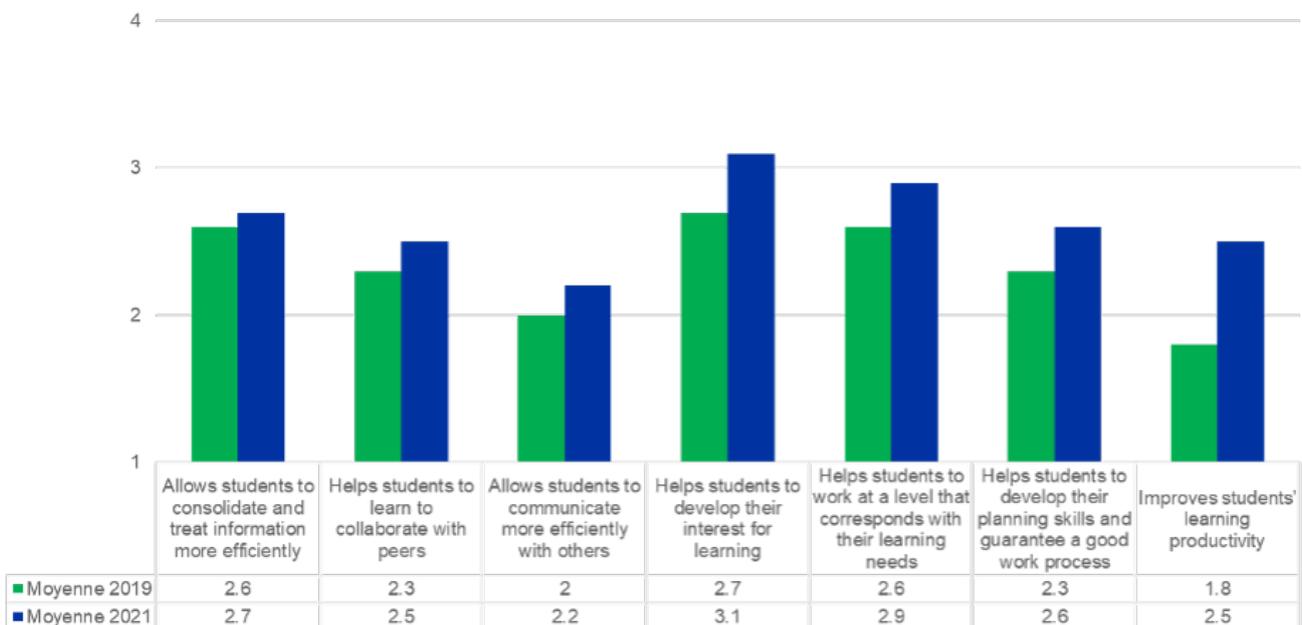


Figure 1 Significant evolution of seven positive representations of digital use (4 strongly agree; 3 agree; 2 disagree; 1 strongly disagree)

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### *Nature of students' in-course digital use*

Questions were asked about students' in-course uses of different digital tools (peer-to-peer distance communication, communications with teacher-trainers, brainstorming, platforms ...) and this usage frequency using a Likert scale with five potential selection points (1, I use it almost every day; 2, I often use it; 3, I rarely use it; 4, I never use it; 5 I, don't know of it).

2019 results show that 63% of students use e-mail most often to remotely communicate 'almost every day', followed by chat or instant messaging (36% 'almost every day') and social media (26% 'almost every day'). E-mail is also most used for sharing information (78% 'almost every day'). Students make almost daily use of tools made available by the institution: Moodle (85%), Google Drive (78%) and e-portfolio (26%).

2021-22 results equal and sometimes surpass these tendencies identified: 72% of students use email 'almost every day' (augmentation of almost 10%), 53% use chat or instant messaging 'almost every day' (augmentation of 17%), however 26% of students use social media 'almost every day' as in 2019. E-mail remains the most utilised means of sharing information. Students continue to use tools made available by the institution: Moodle (88%), Google Drive (99%) and e-portfolio (47%).

A comparison of means for Question 10 shows a significant evolution in usage of five resources and tools (see *Table 3*). Dropbox is used significantly less in 2021-22 than in 2019, but usage frequency of e-mail, chat and messaging, Google Docs and video-conferencing software (Google Meet, Skype, Zoom, ...) has significantly increased.

School desktop computer and personal laptop computer use 'for every or almost every lesson' both increased respectively from 9.7% to 17.5% (t-test not significant) and from 28.4% to 40.0% (t-test sign.  $p=0.030^*$ ) between the two questionnaires.

These results are aligned with previous findings that call attention to the increased dependency on technology in teaching during and since the Covid-19 lockdown period (Annette, 2021; González-Fernández, 2021).

### *Influence of digital use during the teacher training course on students' own classroom practice*

The significant correlations revealed in 2019 between, firstly, the usage frequency of digital tools and software during training, and students' ensuing pedagogical activities and practices using digital technology and secondly, the use of digital tools and platforms for sharing information during training and similar use in the classroom, are repeated in the 2021-22 dataset and the merged dataset.

Usage frequency was looked at through Question 9 (Q9): "At what frequency do you use the following resources and tools?" which itemised a list of activities such as "play video games", "make digital videos" or "use a tablet" and proposed a Likert scale with seven potential selection points (1 every day; 2 several times a week; 3 once a week; 4 once a fortnight; 5 once a month; 6 rarely; 7 never). Results show that students are avid internet users (94.2% 'every day' in 2019 vs. 90.1% in 2021-22), laptop users (97.8% 'everyday' in 2019 vs. 94.5% in 2021-22) and social media users (65.7% 'everyday' in 2019 vs. 68.0% in 2021-22). The lowest usage frequencies concerned "watching DVDs" (0.45% in 2019 vs. 0.00% in 2021-22, significant based on t-test,  $p=0.025$ ) and "making digital videos" (1.1% in 2019 vs. 0.1% in 2021-22, not significant based on t-test).

A strong correlation was found in the 2019 data (around  $r=0.38$ ,  $p<0.001^{***}$ ) between the computed variable for teacher-training students' in-course usage frequency of digital tools and software (Q18) and computed variables for the number of digital use-related activities (Q19) and pedagogical practices (Q20) carried out in class. The correlation between these variables is just as significant in 2021-22 ( $r=0.33$ ,  $p<0.01^{**}$ ), as well as for the analysis of merged data (2019 and 2021-22) ( $r=0.36$ ,  $p<0.01^{**}$ ). A similar significant correlation is found using a computed variable for Q10, which focuses on resource and tool usage-frequency in the context of students' in-course learning activities and distance communication. This strong correlation ( $r=-0.342$ ,  $p<0.001^{***}$ ) is between the use of tools and software for one's own learning at the HEP-BEJUNE (Q10) and their real usage in class during work placement or employment (computed variable for Q18 2019 / Q17 2021-22). This correlation is weaker but still significant in 2021-22 data ( $r=-0.200$ ,  $p=0.018^*$ ) and for merged data sets ( $r=-0.179$ ,  $p=0.034^*$ ).

These results are further confirmation of an argument made by Howard et al. (2021), where preservice teachers must have the opportunity of integrating digital skills and use during training in order to be best prepared for their profession.

A significant correlation was also found in 2019 between teacher-training students' in-course use of digital tools and platforms for information sharing and their actual use of similar tools and platforms in the classroom ( $r=0.188$ ,  $p<0.05$ ). These same correlations are also found in the 2021-22 data but with different levels of significance ( $r=0.224$ ,  $p=0.010^{**}$ ).

Support of teacher trainers is therefore vital as if the lack of digital technology in the classroom is due to training curriculum and training of teacher educators (Romero-Tena et al., 2020), and teacher educators are not themselves equipped to digitally transform learning environments (Langset et al., 2018; Garcia-Vanderwalle Garcá et al., 2021) arguing for teacher trainers' professional development in the digital domain is most pertinent and would surely benefit all actors going forward (trainee teachers, becoming qualified teachers, in direct contact with school students, ...). We can, however, confirm the first hypothesis based on 2019 data that future teachers who make regular use of digital tools for their own learning will use digital tools more in the classroom when teaching.

### *Students' sense of self-efficacy in digital skills*

Students' sense of self-efficacy in digital skills is looked at in Question 12 (Q12) of the 2019 and 2021-22 questionnaires with students' responses situated on a Likert scale with four potential selection points (1 very good level; 2 good level; 3 average level; 4 weak level). Data comparison for Q12 between the 2019 and 2021-22 versions of the study is limited to items 1 to 13, excluding items 14 to 19. These last six items are aligned with the second literature review (post-lockdown theoretical framework), therefore absent in the 2019 questionnaire and not able to be compared.

Their digital skill self-evaluation has not significantly changed since 2019, with students generally positively evaluating their competencies with digital tools and for seeking information (see *Figure 2*). Students feel less confident in their skills for digital content development and for managing and protecting their digital identities. Digital security and data protection remain skills evaluated as comparatively weaker (see *Figure 2*), reinforcing the claims of Garcá-Vandewalle Garcá et al. (2021) that training courses are inadequate concerning these matters.

The second part of the general hypothesis made is therefore unexpectedly disproved, as students do not have a significantly greater sense of self-efficacy concerning their digital skills

A mean comparison (ANOVA) between the self-evaluation of digital skills (computed variable for Q12) and the three training courses (Q3: primary teacher training, secondary teacher training or special education teacher training) produces significant results in 2019 ( $p=0.009^{**}$ ), for 2021-22 ( $p=0.018^{*}$ ) and for the merged datasets (2019 and 2021-22,  $p<0.001^{***}$ ). Students in special needs education training and primary training courses obtain above mean values and secondary training students obtain a below mean value, meaning that secondary training students have a greater sense of self-efficacy in digital skills than the students of the other two training courses. This result is similar to that of the García-Vandewalle García et al. study (2021) where Masters students evaluated their digital skills more positively than Bachelors students. This result is coherent with the number of years of education and training that a student may have received and the extent to which autonomous coping strategies and problem-solving skills may have needed to be developed over time.

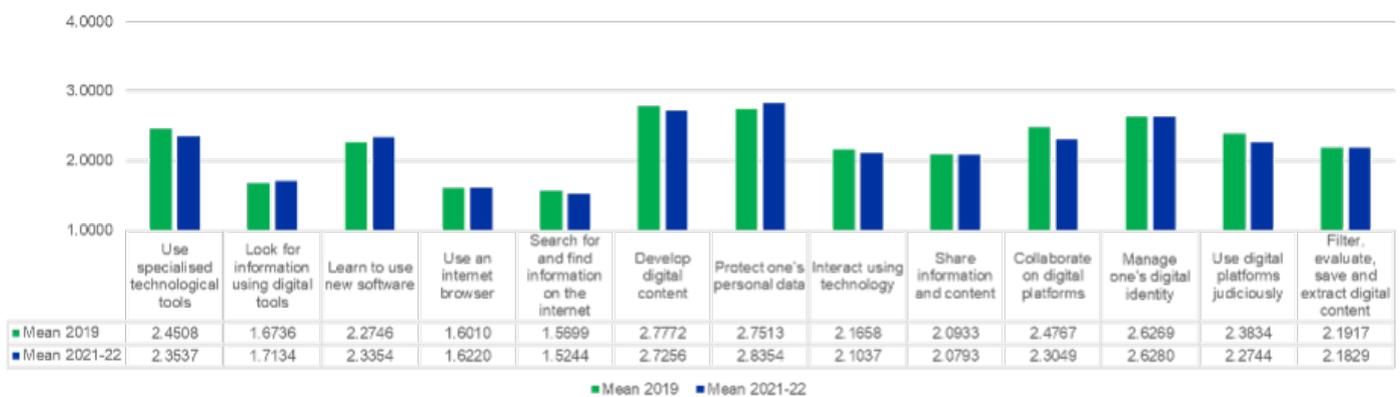


Figure 2 Students' sense of self-efficacy in digital skills: a 2019 and 2021-22 comparison (1, 'very good level'; 4, 'weak level')

A correlation between students' sense of self-efficacy (Q12) and sex (Q1) is found in the 2019 data ( $p<0.001^{***}$ ), the 2021-22 data ( $p=0.008^{**}$ ), and the merged datasets (2019 and 2021-22,  $p<0.001^{***}$ ). Female students (N=144) obtain an above-mean value and male students (N=49) a below-mean value, meaning that male students have a greater sense of self-efficacy in digital skills than female students.

Correlating age (Q2) and students' sense of self-efficacy (Q12) is almost statistically significant in 2019 ( $p=0.066$ ), with students less than 25 years old obtaining a below-mean value. No significant correlation emerges in the 2021-22 questionnaire. The merged data sets reveal a significant correlation between these two questions ( $p=0.015^{*}$ ), with the 25 to 29-year-old students emerging as having the greatest sense of self-efficacy in digital skills (below-mean value).

Interestingly, no correlation is found between students' sense of self-efficacy (Q12) and the quantity of digital training provided by the HEP-BEJUNE to future teachers over the period of data collection (whether or not students had classes or workshops on digital use - Q4) in 2019, 2021-22 and for the merged datasets.

Six 'new' skills were added to the questionnaire for evaluation in 2021-22 according to the extended post-lockdown theoretical framework (Q12, items 14 to 19, 4-point Likert scale: 1 weak level, 2 average level, 3 good level, 4 very good level) (see Figure 3). The majority of students feel equipped to remotely communicate (90.3% 'very good' or 'good' level), to share (75% 'very good' or 'good' level) and create (53.1% 'very good' or 'good' level) digital content or to critically evaluate ICT use in education (62.2%

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'very good' or 'good' level), but relatively few students feel equipped to teach remotely (34.2% 'very good' or 'good' level), to plan, accompany or evaluate learning via digital means (40.3% 'very good' or 'good' level).

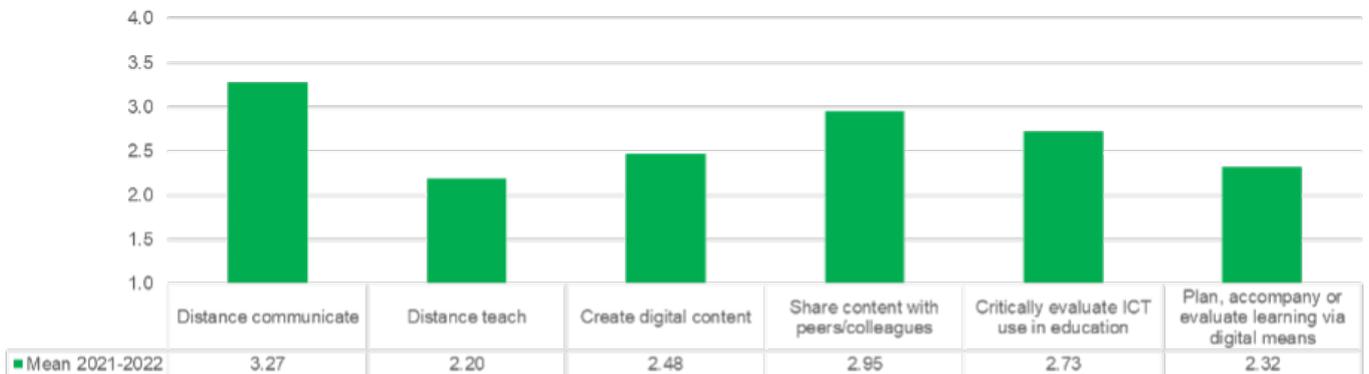


Figure 3 Students' sense of self-efficacy for new digital skills (cf. post-lockdown literature review) (1, 'weak level'; 4, 'very good level')

These results echo previous findings from research conducted during and since the Covid-19 lockdown periods that describes difficulties faced by teachers when obliged to use digital tools for diverse didactic and pedagogical aims (González-Fernández, 2021) while being woefully unprepared (Greenhow et al., 2021). The mean of 2.48 for 'create digital content' echoes the results of Garzon Artacho et al. (2020) where teachers used ICTs in a minimal support role without feeling capable to create and share digital content. Students' perception of their skills for critically evaluating ICT use in education is hearteningly, tentatively positive (m= 2.73) in comparison with the El Khalfi study cited (2021).

### Problem-solving or coping strategies

In 2019, when students were confronted with a digital technology-related problem, 20% of them stated they would cease all efforts (abandon), 38% stated that they would ask their students for help, 18% thought they would ask a professional for help and 14% would ask somebody they knew. In 2021-22, students were more likely to ask a colleague for help when confronted with such a problem (75% vs. 69.4% in 2019, not significant in t-test).

A significant evolution is seen in items 3/16 ("I stay calm when confronted difficulties linked to digital technology use because I have confidence in my ability to resolve problems") and 12/16 ("I ask my students for help when confronted with a digital technology-related problem") of Q13 between the 2019 and 2021-22 datasets. Students keep their calm more in 2019 than in 2021-22 when they are confronted with digital technology-related difficulties, and can rely less on their abilities to resolve problems in 2021-22 (sign. 0.041\*) as former capacities for overcoming problems are not necessarily pertinent to new and unforeseen pandemic circumstances. However, teacher-training students ask their own students more for help in 2021-22 than in 2019 when confronted with digital technology-related problems (sign. 0.030\*). These findings highlight the stress felt by students, also in their capacity as trainee teachers, as in other studies (Rabaglietti et al., 2021). A summary of all significant evolutions for Q13 is found in Figure 4 below.

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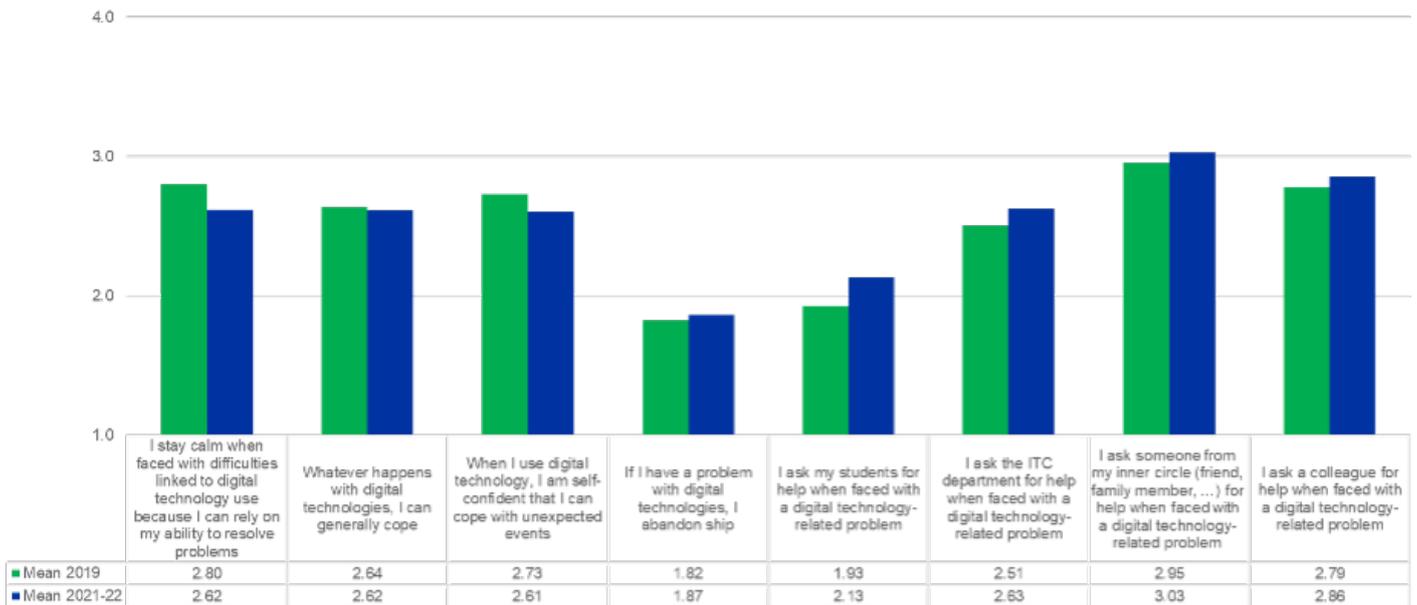


Figure 4 Significant evolutions in problem-solving or coping strategies (Q13) between 2019 and 2021-22 data (1, strongly disagree; 2, disagree; 3, agree; 4, strongly agree)

When correlating Q13 (problem solving strategies, sum of all variables) with Q12 (students' sense of self-efficacy in digital skills) in 2019 or in 2021-22 datasets, no significant result emerges at first. Significant correlations emerge after separating Q13 variables into three thematic computed variables (*confidence*-related adaptation strategies, *abandon*-related adaptation strategies and *asking for help*-related adaptation strategies) in both 2019 and 2021-22 datasets ( $p < 0.01^{**}$ ). These correlations ( $p < 0.01^{**}$ ) are found for all three thematic computed variables of Q13 and with items 1-13 and 1-19 for Q12. As in the Rabaglietti et al. study (2021), the relationship between the difficulties encountered during the distance teaching period, stress and the adoption and implementation of successful adaptation strategies was liaised by students' sense of self-efficacy in digital skills.

A significant correlation is equally found between students' *asking for help*-related adaptation strategies (Q13, computed variable `q13_sentiment_autoeffic_strategies_appel_a_laide`) and their digital use during work placement or employment with their own students in 2021-22 (Q18) ( $p = 0.010^*$ ). Correlating Q13 (all variables combined) and Q18 for the merged datasets (2019 and 2021-22) is also significant ( $p = 0.028^*$ ).

Considering the preceding results, we can confirm the second hypothesis made, based on 2019 results, that future teachers with a strong sense of self-efficacy in digital use will adopt coping strategies centred on the resolution of a problem.

### *Emergency distance teaching measures imposed by sanitary crisis from March 2020*

This theme concerns only the 2021-22 questionnaire. Students were asked to select appreciations for four statements that best described their personal experience, as a teacher or as a student, of emergency distance teaching measures imposed by the Covid-19 lockdowns (Q20) using a Likert scale (1 strongly disagree, 2 disagree, 3 agree and 4 strongly agree; the sum of positions 3 and 4 generates the percentages in the following text). 72.4% 'agree' or 'strongly agree' that they had access to necessary resources ( $m = 2.82$ ). 56.7% of students claim to have received satisfactory accompaniment

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( $m=2.52$ ), 55.3% of them feel sufficiently trained to transfer their acquired digital skills into their teaching practice ( $m=2.50$ ), and 48.2% consider their digital skills acquired in training as corresponding to what is really required of them as teachers at school ( $m=2.35$ ).

These results are thought-provoking, as they indicate that while students felt they had the necessary resources at hand, they didn't necessarily feel able to exploit them in a didactically and pedagogically satisfactory manner, previous experience and training being based on technical aspects less pertinent for constructing meaningful learning pathways (Fernández-Batanero et al., 2020). As Howard et al. (2021) write, fluency in technical use of material is not enough. However, a majority of students felt adequately supported by the institution during this time, which would give further credence to Carron and Veillette's results (2020) from data gathered at the same institution. A minority of students consider their skills built in training to be consistent with actual needs in schools, highlighting a somewhat slow digital evolution within the institution itself. This is in accordance with results from the Langset et al. study (2018) and the Popa et al. study (2020) where the difficulties for teacher trainers to meaningfully, digitally innovate are plain to see, and the need for institutional support is acute. In the 'satisfactory accompaniment' category, the role and/or proportional quantity of feed-back is not articulated, but remains an important factor to explore (Reisoğlu & Çebi, 2020; Rieble & Heinonen, 2021).

A significant correlation is found between students' sense of self-efficacy (Q12, items 1-19) and their appreciations of their personal experiences of the emergency distance teaching measures (Q20) ( $r=-0.270$ ,  $p=0.001^{**}$ ). This correlation is only slightly weaker when comparing Q12 pandemic-related variables (items 14-19) ( $r=-0.255$ ,  $p=0.002^{**}$ ). This finding mirrors the König et al. (2020) statement that teachers' successful adaptation to the pandemic-induced distance teaching situation is partly due to digital skill, a key competence in education (Langset et al., 2018).

A final correlation is found between problem-solving strategies (Q13) and students' appreciations of their personal experiences of the emergency distance teaching measures (Q20) ( $r=0.171$ ,  $p=0.043^{*}$ ). Yet stronger correlations are found using the two of the three thematic computed variables for Q13: Q13 *confidence*-related adaptation strategies correlated with Q20 ( $r=0.334^{**}$ ), and Q13 *abandon*-related adaptation strategies correlated with Q20 ( $r=-0.222^{**}$ ).

## Conclusions

Concerning the first hypothesis based on 2019 data, the results show a strong and significant correlation ( $r=-0.342$ ,  $p<0.001^{***}$ ) between the use of tools and software for one's own learning in training and their real use in classrooms during workplaces. Another correlation pertinent to this hypothesis is between the usage frequency of tools and software in training and the number of activities and pedagogical practices carried out in classroom with digital technology ( $r=0.300$ ,  $p<0.001^{***}$ ).

These results align with those of El Khalfi (2021) who highlights that teacher trainees' "perceptions of their digital tool use do not highlight pedagogical use but personal use, and [...] the extrapolation of foreseen assured integration of ICT in classrooms on this basis is erroneous" (p. 15). Trainee teachers actually need to be introduced to and to use digital resources and tools in training to have the confidence and skills to use them in class (König et al., 2020), otherwise the disconnect between available technology and its integration in the classroom will persist (El Khalfi, 2021).

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The importance of teacher trainers and students using digital tools during training courses is thus manifest. The use of digital tools and software during training courses makes possible and strengthens the transfer of these skills into the classroom. It would be interesting to further investigate to what extent personal learning environments bringing together different tools, services and resources to support student learning, could, depending on the offer, reinforce the transfer of skills acquired in training to enduring classroom practice (Dupuis, 2020). Trainer modelling for students in conjunction with feedback during ICT integration in training and in work placement are also important elements. Collaboration between trainee teachers, teacher trainers and work placement supervisors is essential to develop the attitudes and skills necessary for the effective use of digital tools.

These results also show that students have a relatively high sense of self-efficacy related to information processing (identifying, locating, retrieving, storing, organising and analysing digital information, judging its relevance and purpose) and a relatively low sense of self-efficacy in managing its security (personal protection, data protection, digital identity protection, security measures, safe and sustainable use).

In relation to the second hypothesis, results indicate a strong and significant correlation ( $p < 0.01^{**}$ ) between a sense of self-efficacy in digital skills and coping strategies used when students are faced with a problem. Indeed, it seems important to help future teachers to manage difficulties, find solutions, solve problems and acquire coping strategies that will allow them to project themselves in new teaching modalities that integrate digital technology. The more students are confronted with digital use and the resolution of its inevitable problems, the more they will be able to consolidate their expertise and deal with problems autonomously, unafraid to introduce new tools into their courses.

A noteworthy limitation of this research project is the narrow representative sample of the study. The methodology was applied to one teacher training institution alone. This research needs to be pursued on a greater scale in order to stabilise and generalise the results. Another limitation to this study is found in the methodological approach whereby the two populations (2019 and 2021-22) are not identical as the student population changes each year. The evolutions observed are therefore of the student body in general and not of an identical population. Indeed, the second post-Covid study was obviously entirely unanticipated during the initial project conceptualisation phase, and thus we were unable to follow the same students longitudinally.

Having analysed and reported the results obtained, we can recommend that teacher-training institutions reinforce students' sense of self-efficacy in digital skills during training by encouraging the use of pertinent digital tools and encouraging students to reflect on their personal learning environments. Opportunities to consolidate and improve resource sharing options and facilitate collaborations within communities of practice should be created, and students should be actively assisted in developing their coping strategies when faced with stressful situations via accompaniment during work placements (filming lessons and participating in self-confrontation interviews). Digital security and the development of digital content are also areas needing particular attention during teacher training. In a future research project around reflexive digital accompaniment, it will be interesting to follow students or new graduates in their classroom practice over a sustained time period to observe how they manage difficulties when implementing digital tools in the classroom.

The findings of this study relate to broader trends in education which recommend handling digital education in a more evolved way than former 'information technology' class models. If teacher-training institutions can incorporate digital training in a cross-disciplinary way, and if individual didactics can be attentive to the impact of including or excluding digital content, requirements and tools into their classes, students will likely use digital resources and teach digital knowledge and skills more effectively.

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