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Teacher Trainees' Experiences of the Components of ICT Competencies and Key Factors in ICT Competence Development in Work-Based Vocational Teacher Training in Finland

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Abstract

Context: This research was conducted in the context of Finnish vocational education and training (VET) teacher training. The teacher training was work-based, meaning that each teacher trainee was already working as an unqualified VET teacher. Workplaces were comprehensively utilised as the learning environment, with teacher training support also being provided in the form of contact days, webinars, and online learning activities.

Approach: We aimed to explore the main components of information and communications technology (ICT) competencies among vocational teacher trainees within work-based training and also to reveal the supportive and challenging factors related to developing ICT competencies within the training. Overall, 44 vocational teacher trainees participated in our study. The data were analysed via qualitative content analysis.

Findings: Six main ICT competence components were identified during the work-based training: (1) The use and creation of digital learning materials, (2) the planning and use of digital learning environments, (3) synchronous digitally enhanced teaching, (4) general

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ICT competencies, (5) digital interaction, and (6) digital assessment. The development of teachers' ICT competencies was supported by their own active use of ICT and by experimenting with the ICT software and ideas presented by the teacher training staff. Challenging factors in ICT development included the continuous feeling of haste and the lack of time in the workplace, as well as the failure to recognise prior ICT competencies within the teacher training. This could limit the development of ICT competencies.

Conclusions: Work-based VET teacher training has the potential to develop teacher trainees' ICT competencies because it allows immediate implementation and experimentation with regard to new ICT ideas and tools. By aligning this research with prior research, it is possible to construct a comprehensive ICT competence framework to support VET teacher training and workplace development.

Keywords: Teacher Training, Work-Based Learning, Technological Change, Teacher ICT Competencies, Vocational Education and Training, VET

1 Introduction

The COVID-19 pandemic has resulted in a sudden burst of school closures at all levels of education and led to a massive demand for online teaching (Aditya, 2021; Carrillo & Flores, 2020; Thomas, 2020). To facilitate learning in digital environments, teachers must develop their own information and communications technology (ICT) competencies, thus preparing their students to cope with a digitalised working life. In addition to the challenges created by the pandemic, teachers face the demands caused by continuous technological, social, economic, and cultural changes in working life (Harteis et al., 2020), particularly those related to ICT. It should be noted that, in the industrial world, work and value chains have been shifting toward digitalisation in a process often referred to as *Industry 4.0* (Billett, 2021; Harteis, 2018). As a consequence of these changes, many jobs will be automated and digitalised. This phenomenon is setting new requirements for ICT competencies, including those within vocational education and training (VET) and its teaching (Teo et al., 2021).

Teachers' ICT competencies and their development have been widely examined (Almerich et al., 2016; Instefjord & Munthe, 2017; Koehler & Mishra, 2009; Roll & Ifenthaler, 2021). However, in-service VET teachers have been somewhat overlooked, despite the fact that this group of teachers plays a crucial role in preparing VET students for increasing digitalisation in working life.

In a meta-analysis, Tapani and Salonen (2019) found that vocational teacher competencies, including ICT competencies related to teaching, may be fragmented. Similarly, having studied vocational college teachers' technology adaptation, Bin et al. (2020) pointed out the need for more research into this complex phenomenon. Sylte (2020) suggested that, by ana-

lyzing VET teachers' work tasks, it will be possible to increase the coherence and relevance of educational programs in such a way as to better develop competencies in working life. All this implies that we must identify the components of VET teachers' main ICT competencies and determine the factors that support or challenge ICT competence development within work-based VET teacher training (Seufert et al., 2018). In this study, the term "components" refers to the single or partial competencies that exist as elements in VET teachers' overall ICT competencies. Our overall aim is to contribute to theory and research on VET teachers' ICT competencies and development, as well as to offer tools for practitioners, such as teacher training institutes and educational workplace developers.

2 Theoretical Framework

In this section, we first elaborate the components of teachers' ICT competencies, especially the technological and pedagogical components, while also taking into account the teaching context, content, and the demands of a changing society. Thereafter, we highlight the factors that support and challenge ICT competence development (both technological and pedagogical).

2.1 The Components of Teachers' ICT Competencies

Teachers' ICT competencies and competence development have been conceptualised in a variety of ways (e.g., Almerich et al., 2016; Ferrari, 2013; Koehler & Mishra, 2009; Roll & Ifenthaler, 2021). These ICT competencies encompass a set of ICT-related skills, knowledge, and attitudes (Hämäläinen et al., 2021). The competencies in question include technological and pedagogical components, with each of them being associated with the teaching context and content, as well as with a changing society (*Industry 4.0*: See also Ferrari, 2013; Koehler & Mishra, 2009; Teo et al., 2021). The *technological* component of the ICT competencies includes the skills needed to use computers, mobile devices, and applications (Almerich et al., 2016; Lindsay, 2016; see also Roll and Ifenthaler's (2021) multidisciplinary competence model for vocational teachers). Along similar lines, Guzman and Nussbaum (2009) highlight an instrumental/technological component within teachers' ICT competencies, arguing that teachers must develop ICT-handling abilities, including both software and hardware use. Lindsay (2016) notes that teachers must also master mobile ICT technologies, given that learning-teaching processes increasingly take place in informal contexts, where learning can happen anywhere and at any time, i.e., outside schools, classrooms, workplaces, and working hours. The technological component also includes the mastery of the technological resources needed for efficient ICT teaching practices and collaborating digitally (see Roll & Ifenthaler, 2021). Roll and Ifenthaler (2021) have further emphasised that vocational students and

teachers require digital problem-solving skills, in addition to the skills needed to adequately access, analyse, and evaluate information (referred to as information literacy). There is also a need for self-reflecting on the digital environment, bearing in mind that, for digital development, one should be able to reflect on and understand one's actions within digital environments (Roll & Ifenthaler, 2021). The self-efficacy associated with these skills also forms part of the technological component of teachers' ICT competencies (Choi et al., 2018; Kreijns et al., 2013).

The *pedagogical* component of the teachers' ICT competencies includes knowledge about how they can implement technological resources in curricular designs, planning teaching-learning processes, and their professional development as teachers (Almerich et al., 2016; Guzman & Nussbaum, 2009; Koehler & Mishra, 2009). Wadmany and Kliachko (2014) noted that ICT could help teachers to create a supportive learning environment, demonstrate phenomena and processes, increase learning possibilities overall, and respond to the needs of a broad range of students. The pedagogical component also encompasses the skills needed to create and use digital learning materials, construct technology-rich learning environments, and use mobile and other technologies in teaching and learning (Almerich et al., 2016; Lindsay, 2016).

Guzman and Nussbaum (2009) have provided an overview of the pedagogical component of teachers' ICT competence. Pedagogical/curricular competence refers to the logic and optimised implementation of technology (in accordance with the teachers' institution, as well as its mission and curriculum), while didactic/methodological competence enriches learning experiences by applying ICT to other educational activities in a motivational manner. There is also an evaluative/investigative dimension to the pedagogical component of ICT competencies, with the focus on feedback and the development of both the students' learning processes and the general functioning of ICT in educational settings.

These different components of the ICT competencies are interrelated, and it may be challenging to distinguish the technological and pedagogical components of ICT-related work. For example, *digital security*, which includes the ethical and legal aspects of ICT use, as well as safely dealing with phenomena such as malware, identity theft, passwords, securing devices, and sharing information, encompasses both technological and pedagogical aspects (Almerich et al., 2016; Roll & Ifenthaler, 2021). Moreover, attitudes toward digitalisation include both technological and pedagogical components, and these attitudes must be positive if one is to work with digital devices. Additionally, there should be positive attitudes toward the idea that ICT can provide added value for teaching, its planning, and its assessment (Guzman & Nussbaum, 2009; Roll & Ifenthaler, 2021).

These interrelations are also visible in the TPACK (technological pedagogical content knowledge) framework of technology integration with teaching (Koehler & Mishra, 2009). The TPACK model builds on the interaction between three forms of teacher knowledge, i.e.,

technological, pedagogical, and content-based. If teachers wish to successfully integrate ICT in their teaching, they must integrate all three forms of knowledge in theory and practice. Koehler and Mishra (2009) also point out that there is no "one-size-fits-all" approach to ICT integration within teaching. They note that teaching with technology is not easy and requires a continuous appreciation of the connections between the *teaching context,* content knowledge, pedagogical approaches, and ICT possibilities. Thus, to support the development of teachers' ICT competencies, special attention should be paid, in teacher training, to the factors that support and challenge teachers in developing their ICT competencies (Rosenberg & Koehler, 2015).

2.2 Development of Teachers' ICT Competencies

Despite the complex nature of teachers' ICT competencies (e.g., Almerich et al., 2016; Ferrari, 2013; Koehler & Mishra, 2009; Roll & Ifenthaler, 2021), it has been pointed out that teachers' ICT competencies, in general, develop within a complex synergy of individual and contextual factors (Guzman & Nussbaum, 2009; Hämäläinen et al., 2019; Kreijns et al., 2013).

Individual factors are important in teachers' ICT competence development. Personal factors, such as age, gender, parental education, and native speaking skills, play a significant part in developing ICT competencies (Almerich et al., 2016; Choi et al., 2018; Hämäläinen et al., 2019; 2021). In addition, other individual factors, such as attitudes toward technology (in general and as a teacher) and ICT self-efficacy, may prompt teachers to develop the pedagogical component of ICT competence (Choi et al., 2018; Kreijns et al., 2013). Islam's (2016) technology adoption and gratification (TAG) model in higher education demonstrates how a set of individual factors may be associated with one another and with the development of teachers' ICT competencies. In this model, the teachers' use of ICT is constructed based on five factors: Computer self-efficacy, gratification, perceived usefulness, intention to use ICT, and perceived ease of use. Nevertheless, the model has been found to work differently in different contexts, such as in different cultural settings (Bin et al., 2020; Islam, 2016).

Recent studies have shown that *contextual factors* (e.g., the school ICT resources and environment, positive collegial pressure, and ICT support) also play a significant role in teachers' ICT development, especially among teachers beginning their careers (Ottenbreit-Leftwich et al., 2018). Hämäläinen and Cattaneo (2015) found that the ICT competencies used outside the workplace contribute to its technological component (i.e., problem-solving skills in technology-rich environments). Choi et al. (2018) refer to teachers as "digital citizens" – persons who must master ICT meta-competencies, such as the ethical and responsible use of the Internet and social media, alongside active and critical Internet practices. This also implies that the use of digital devices and software in everyday life would also support ICT competence development in one's work as a teacher. The contextual factors affecting teachers' ICT

competence development would include the frequency of using a computer at home and in everyday learning – in addition to one's own level of education and the amount of workplace-supported and work-related implementation of ICT (Almerich et al., 2016; Hämäläinen et al., 2019). Along similar lines, Kreijns et al. (2013) noted that positive social or collegial pressure and a shared interest in ICT in teaching encourage teachers to use ICT. Guzman and Nussbaum (2009) concluded that the communicational/relational aspect of teachers' ICT competencies is an essential element, encompassing the educational interaction and collaboration of actors in ICT environments.

It appears that, among teachers, the technological and pedagogical components of ICT competencies are intertwined and that both individual and contextual factors underlie ICT competence development. These considerations allowed us to frame our research questions, as described below.

3 Research Questions

We aimed to explore teacher trainees' ICT competencies and ICT competence development during a work-based VET teacher training program. The research questions were as follows:

1. What are the main components of ICT competencies that were identified by the VET teacher trainees in a work-based training process?

2. What kinds of supportive and challenging factors do the VET teacher trainees experience in their ICT competence development within a work-based training process?

4 Materials and Methods

4.1 Research Context

The context of this research was vocational teacher training in Finland. In Finland, a vocational teaching qualification is defined and required by legislation, and it consists of 60 credits of pedagogical studies. A higher education degree in the craft field (if there is one) and working life experience are also required. After the teacher training, most teachers will work in vocational schools or higher education. The data were gathered from five Finnish vocational teacher training groups from two universities of the applied sciences All the participants in the study were VET teacher trainees (n = 44) who were working full time as (non-qualified) vocational teachers. The training processes for all five groups were conducted in the same settings, adopting a work-based (competence-based) and ICT-rich approach. One group (n = 14, referred to as the "key" study group) also produced longitudinal data, while all the groups

participated in the graduation questionnaire. In this study, "work-based" means that the VET teacher trainees' workplaces were strongly utilised as a context of learning and assessment. The VET teacher trainees compiled personal plans, touching on how they would pursue new competencies as a VET teacher, including ICT competencies (using a competence framework from the VET teacher training curriculum as a tool for planning and assessing). For this purpose, they would seek to utilise their own work with assistance from their organisation and networks as required. In addition, a workplace mentor (an experienced colleague) was nominated for each participant from their own organisation.

An "ICT-rich" approach means that much use was made of ICT-related methods and content as the mainstay of the training processes. For example, ICT was used as a tool for planning, documenting, collaborating, and participating in the teacher training processes, which involved activities such as contact days, learning tasks, personal online meetings, webinars, online small group activities, and mobile fast messaging. Also, ICT was among the content of the pedagogical studies. Its possibilities were examined during the contact days and webinars, and a spectrum of pedagogical software/applications were demonstrated and tested during the training (notably online digital whiteboard/canvas applications, learning activation and assessment applications, online teaching applications, digital learning material, and video/interactive picture software). There was also a chance to achieve digital online learning badges for ICT-related content.

4.2 Participants

All five VET teacher training groups were multi-professional in nature, representing different fields of work. The strongest representation overall was from the fields of Technical Qualifications and Traffic (n = 21); Marketing and Services, including Languages (n = 8); and Social-, Healthcare, and Well-being (n = 5). Eleven of the participants were women, and 34 were men. They were all adults, with the largest age group (n = 33) being spread evenly between the ages of 41 and 55. All the participants had more than one year of teaching experience. One of the five VET teacher trainee groups formed a key group for a study, yielding longitudinal data (n = 14). Participation in this study was voluntary, and all participants and their organisations will remain anonymous in this report.

4.3 Data Collection

The data were gathered via three methods. The first author of this article worked as a teacher trainer of the key study group (n = 14), i.e., persons who produced deeper qualitative data on a longitudinal basis. In this group, the initial procedure was to collect written stories. Thus, before commencing training, every VET teacher trainee from the key study group

wrote a narrative about their "path to becoming a teacher". Subsequently, on graduation, they wrote a continuation to the earlier narrative. This was based on the initial story, but with the theme "me as a teacher, now and in the future". In these narratives, the participants were not instructed to ponder ICT-related content.

The key study group also compiled learning diaries during the training. There, the participants reflected on their processes of constructing different competencies and identity trajectories during simultaneous work and training. In these learning diaries, there was also no specific ICT-related instruction.

At the end of their training, all the graduating VET teacher trainees (n = 44) answered a qualitative web-based questionnaire. In the questionnaire, we asked participants about their experiences of developing technological and pedagogical ICT competencies during their training (these concepts were explained within the teacher training). We also asked about the factors that supported and challenged ICT development; this was done via open-ended questions. The questions were as follows:

1. How have your ICT competencies (technological and pedagogical) developed during the VET teacher training?

2. What kinds of factors have supported and/or challenged the development of your ICT competence during the VET teacher training, as observed in the workplace and the VET teacher training interventions?

4.4 Data Analysis

To identify the main components of ICT competencies (RQ1), we used all the datasets described above. These included the longitudinal data (learning diaries and written narratives) from the key study group, as well as the cross-sectional questionnaire data from the other groups. We applied qualitative content analysis to the data (Saldaña, 2013; Schreier, 2012), first extracting phrases containing ICT-related content. For example, in the first phase of analysis, the following three extracts were noted as exemplifying ICT-related content (p = participant):

"Started to use Drive-cloud more than before…" (Group 4, p5)

"I've learned to use new tools such as... cloud services more effectively." (Group 5, p5)

"Used OneDrive…" (Group 1, p7)

A minimum of one phrase or sentence was used for this purpose in order to preserve the context (Elo & Kyngäs, 2008; Vaismoradi et al., 2013). There were 127 extracts referring to ICT overall.

In the second phase of analysis, we inductively formed 19 subcategories (see Table 1) from these extracts. Extracts with the same kind of content were merged and given a common label, with each of these forming a subcategory, from which a smaller number of "main" categories could be formed; see Saldaña, 2013; Schreier, 2012). As an illustration, the three extracts presented above were merged and named as a single subcategory, *Use of cloud services*.

Eventually, all 19 subcategories were analysed and placed within a total of six "main" competence components: *The use and creation of digital learning materials, The planning and use of digital learning environments, Synchronous digitally enhanced teaching, General ICT competencies, Digital interaction, and Digital assessment*. For example, the *Use of cloud services* subcategory mentioned above was deemed to be one of four subcategories belonging to the main category *General ICT competencies*. All the subcategories and main categories can be seen in Table 1.

In Tables 1, 2, and 3, the frequency (*f*) is recorded with regard to the main categories and subcategories. This was done for the reader to see, how much each category and subcategory appeared within others and overall data. The frequency refers to the number of overall mentions in the qualitative data, not to the number of individual participants (Vaismoradi et al., 2013). In addition, we present the number of individual persons (*n*) for every main category, i.e., persons who contributed data to this particular main category.

Thereafter (for RQ2), we examined the supportive and challenging factors pertaining to VET teacher trainees' ICT development during the workplace-oriented training process. To answer this question, we used the graduation questionnaire ($n = 44$) data because this contained two open-ended questions specifically concerning the supportive and challenging factors affecting ICT-competence construction. The data thus obtained shed light on the factors present in VET teacher trainees' own work organisation and VET teacher training interventions. In RQ2, the approach was more theory-driven because questionnaire themes were derived from previous theory (e.g., *pedagogical and technological* ICT use; Almerich et al., 2016). The data were analysed via a qualitative content analysis procedure broadly similar to that applied in RQ1 (see above). In the first phase of the analysis, written extracts from the open-ended questions were placed within four main categories (chosen *a priori*, in line with the research question): *(1) Supportive factors in the VET teacher trainees' workplace, (2) Supportive factors in VET teacher training, (3) Challenging factors in the VET teacher trainees' workplace, and (4) Challenging factors in VET teacher training.* In the second phase of the analysis, the data in the four categories were re-analysed, grouping together data that appeared to exhibit common content, thus arriving at the subcategories (either three or four) for each main category. The subcategories within the four main categories can be seen in Tables 2 and 3.

The coding of the data was initially conducted by the first author of this article, and the reliability of the coding was checked by all the authors in common meetings.

5 Results

5.1 Components of ICT Competencies in a Work-Based VET Teacher Training Process

In order to capture and present the main components of ICT competencies identified by the VET teacher trainees in a work-based training process (RQ1), we synthesized six main components of VET teacher trainees' ICT competencies, which are presented in Table 1.

Table 1: Components of ICT Competencies in a Work-Based VET Teacher Training Process

MAIN CATEGORIES (6): Components of ICT Competencies	**SUBCATEGORIES (19) forming the Components of ICT Competencies:**
DIGITAL LEARNING MATERIALS - Use and creation (f = 41, n = 23)	- Video and other digital learning materials (f = 26) - Open online learning badges (f = 15)
DIGITAL LEARNING ENVIRONMENTS (*f* = 26, n = 14)	- Planning and using digital learning platform (f = 20) - Simulated teaching (f = 3) - Virtual learning environments (f = 2) - Blogs (f = 1)
SYNCHRONOUS DIGITALLY ENHANCED TEACHING (*f* = 22, n = 10)	- Digital tools for learning activation (f = 14) - Teaching online and webinars (f = 6) - Digital presentations (f = 2)
GENERAL ICT COMPETENCIES (*f* = 17, *n* = 13)	- Mastering holistic ICT-systems, e.g., 0365, Google (f = 7) - Basic handling of hardware and software, including mobile (f = 5) - Use of cloud services (f = 3) - Data protection and privacy (f = 2)
DIGITAL INTERACTION (*f* = 13, n = 8)	- Online coaching and meetings (f = 5) - Social media and fast messaging (f = 5) - Digital interaction tools (f = 3)
DIGITAL ASSESSMENT (*f* = 8, *n* = 6)	- Digital assessment tools and applications (f = 4) - Questionnaire and survey tools (f = 2) - e-Portfolio and digital CV (f = 2)

The most common ICT-related component was the use and creation of *digital learning materials*. As learning gradually shifts from classrooms to digital environments, VET teachers face new competence demands, notably the question of how to create, produce, and use pedagogically relevant digital learning materials (e.g., videos, interactive content) to promote their students' vocational learning. Open online learning badges were also included in this category (as an example of digital learning material) because the participants in this VET teacher training program had the chance to earn online learning badges as part of their teacher trai-

ning. Several participants reflected on current demands (due to digitalisation in general) to produce learning materials in digital form, as can be seen in following extracts. The extracts also reveal the individual needs and attitudes of teacher trainees. The same content can appear as either a challenge or a possibility:

> "Training has forced me to implement new digital methods. My challenge is to produce learning material, [learn] how to construct digital learning material in a new way." (Group 2, p4)

> "Thinglink and screencast-O-matic are new tools for me, which I can utilize in many ways when transforming my learning materials into a digital form." (Group 1, p8)

The teachers' new role in planning and using *digital learning environments* in their work and with their students (e.g., via Moodle and Google Classroom) emerged clearly from the data. It seemed that every degree program or vocational qualification used some kind of digital platform to support students; hence, this had become an everyday activity for VET teachers also. Indeed, many participants reflected on planning, constructing, using, and developing at least one digital learning platform. The participants clearly recognised this competence demand, but they were heterogeneous (ranging from "unsure" to "developer") in terms of their confidence regarding the use of digital platforms for learning and teaching:

> "I haven't previously used different digital learning platforms that much. I would very much like to learn how to create and use these platforms, since this seems to be a weak link in my teaching." (Group 1, p1)

> "I have managed to build my teaching modules into a digital learning platform and also participated in developing digital learning environments in our school community." (Group 1, p2)

The use of different digital tools for learning activation and participation in the classroom was reflected ($f = 23$), as was teaching via online webinars with digital presentations. The amount of teaching online and the number of organised webinars have increased in recent years, and this has placed new competence demands on VET teachers. There is a need for *synchronous digitally enhanced teaching*, meaning that learning activation and teaching (either in the classroom or online) occurs at the same time. Because learning now tends to be viewed as an interactive and participatory process, vocational teachers must also have digital tools for student activation and participation during online/classroom teaching. The participants in the study described how they had enriched their teaching via digital tools. They reflected on the successful implementation of these digital tools, with resulting positive attitudes toward ICT use in learning and teaching:

> "It has been great to familiarise myself with different digital learning applications. I have tried to implement these in my teaching in my current courses. I have used Thinglink to teach car parts and also used Flinga and Kahoot in tests and learning tasks." (Group 1, p6)

> "I have learned a lot about different digital teaching "toys" that can be found freely online and, of course, also how to use them properly in my teaching." (Group 1, p5)

Within their organisation, teacher trainees also required *general ICT competencies* to master holistic ICT systems (e.g., O365, Google) and thus communicate effectively with their students and professional networks. This category included the basic technological competencies pertaining to teachers' work-related hardware and software (such as adequate technological use of e-mail, calendar, video conferencing, cloud services and mobile devices), as well as data protection and privacy. Some participants ($f = 5$) also included basic knowledge about mobile devices and technologies. This general development can result in positive attitudes toward ICT, encouraging the further development of ICT competencies as a VET teacher:

> "My general ICT competencies have developed a lot, since I have used them so actively during this period of time. I have also gained a lot of confidence with regard to my ICT use… my fear of digitalisation has receded." (Group 1, p4)

Digital interaction takes place between VET teachers, students, and workplace networks in groups or individually. In order to carry out online guidance, coaching, and negotiations, a VET teacher must use video-conferencing tools and social media, including rapid messaging applications. Along with workplace network negotiations, digital interaction involves digital spaces and tools organised by the teacher, within which students can discuss ICT topics, ask for help or guidance, and engage in other study-related dialogue with teachers individually or in groups. Within this theme, participants reflected on their developing positive attitudes and also on pedagogical factors, for example, the importance of dialogue in digital interaction:

> "I'm glad that I've got past my bad attitudes toward social media in teaching and that I've taken quite a leap toward using these with students." (Group 1, p7)

> "In digital learning situations, you have to remember and embrace dialogue…how to involve and listen also to the silent students." (Group 1, p9)

Finally, ICT tools are needed for assessment and evaluation. Assessment processes are shifting to digital form, and VET teachers must have the tools and competencies needed to conduct digital assessment. In addition, assessment materials and concepts such as ePortfolio and digital CV received brief mentions. However, within the current data, participants ($f = 8$) mainly reflected on assessment in terms of how they analysed and implemented new digital assessment tools and software in their own teaching:

> On the contact day, there were good new aspects and implementations of assessment. I also learned some good applications for constructing quizzes and tests in order to assess students. (Group 1, p7)

> "I tried out some nice assessment stuff on the contact days. I have already started to use Forms quizzes with my students…" (Group 1, p1)

5.2 ICT Development in Work-Based VET Teacher Training: Supportive and Challenging Factors

In relation to the supportive and challenging factors that VET teacher trainees experience in their ICT competence development within a work-based training process (RQ2), the results of the qualitative content analysis of the graduation questionnaire (n = 44) are presented in Tables 2 and 3. In Table 2, we present the *supportive* factors in VET teacher trainees' ICT development from the point of view of (1) the teachers' workplace and (2) their VET teacher training. In Table 3, we present the corresponding *challenging* factors (numbered 3 and 4). The categories show the numbers of overall extracts (f) and actual individuals (n) exhibiting the relevant content.

Table 2: VET Teacher Trainees' ICT Competence Development – Supportive Factors in the Workplace and Teacher Training

(1) SUPPORTIVE FACTORS IN THE WORKPLACE (f = 28, n = 21)	**(2) SUPPORTIVE FACTORS IN TEACHER TRAINING (f = 56, n = 36)**
1. Own active and supported use of ICT (f = 14)	1. Active use, trying out, and implementing various ICT tools (f = 29)
2. Organisations' leadership, as well as own ICT training and workshops (f = 8)	2. Teacher trainers' and peers' support for and examples of ICT use (f = 15)
3. Relevant and good ICT equipment and environment in the workplace (f = 6)	3. Open online learning badges (ICT-related content) (f = 12)

The main aspect related to ICT competence development in the workplace involved the teacher trainees' own active actions related to ICT implementation. It appeared that ICT development in the workplace depended mainly on individual efforts, involving a positive and active approach to new technologies in teaching, as seen in the following citation:

> "Mostly, my own activity has affected my ICT competencies as a teacher, since I have actively searched for information about different applications and have started to try them out and implement them in my work." (Group 4, p1)

However, it was also important to have ICT support in the workplace. The organisation's own ICT training and workshops, including leadership toward an ICT culture, were also

found to be relevant. The same was true of valid and up-to-date hardware and software in the workplace.

In VET teacher training, by far, the most important factor was presentation, familiarisation, and practice with various teaching-related ICT tools and applications. Many participants reported that they had developed a positive ICT attitude and good competence by trying various tools within their teacher training. According to the participants' experiences, the examples of ICT use in education enhance positive attitudes and encourage individuals to experiment with and implement ICT in their own workplace settings:

> "My development has been remarkable because these ICT learning applications have really been tried out and implemented in various situations. I no longer fear digital teaching tools." (Group 2, p3)

In addition, the supportive and encouraging atmosphere regarding ICT was significant to many participants. The encouragement came from peer teacher trainees and teacher trainers – persons who provided examples of ICT use in teaching. Finally, the chance to earn open online learning badges with ICT content, including social media for teaching and digital assessment, motivated many teacher trainees to develop their ICT competencies and gain the relevant documentation.

Alongside the supportive factors, challenging factors were encountered during the work-based training. However, it is notable that the overall frequencies of challenge-related codes ($f = 29$) were significantly lower than those associated with the supportive factors ($f = 84$).

Table 3: VET Teacher Trainees' ICT Competence Development – Challenging Factors in Workplace and VET Teacher Training

(3) CHALLENGING FACTORS IN THE WORKPLACE *(f = 17, n = 13)*	**(4) CHALLENGING FACTORS IN TEACHER TRAINING** *(f = 12, n = 10)*
1. Continuous hurry, no time to learn new ICT *(f = 7)*	1. Failure to develop ICT competencies at all *(f = 7)*
2. Disorganized or out-of-date ICT systems in the organisation *(f = 6)*	2. Failure to integrate ICT competencies with one's work as a VET teacher *(f = 3)*
3. Non-participatory and conservative organisational ICT culture *(f = 2)*	3. Teacher trainees' lack of time for or interest in ICT *(f = 2)*
4. Lack of economic and staff resources *(f = 2)*	

In the workplace, the most demanding challenge seemed to be the continuous feeling of haste, which led to shortcomings in learning and implementing new ICT. Some of the student teachers were so tied up with their work that there was no time to develop new digital competencies. There were also some other challenges, mostly related to the organisational level. These involved disorganised or old ICT systems, a conservative ICT organisational culture, and an overall lack of ICT-related resources.

> "My ICT competence development in the workplace has been negatively affected, mostly by continuous feelings of rush." (Group 2, p14)

Within the work-based VET teacher training, there were not so many challenges to ICT development (overall f =12). The largest challenge concerned the perceived non-development of ICT competencies during the training. Because the student teachers were a highly multiprofessional group, their initial ICT competencies were also heterogeneous. For example, some of the VET teacher trainees were aiming to be ICT teachers, and they already had a deep understanding of ICT and extensive practical competence in the field.

> "I didn't learn many ICT competencies during this training, because I'd had a lot of previous studies on ICT." (Group 3, p1)

Some teacher trainees had difficulties transferring their ICT competencies from VET teacher training to actual workplace learning situations. In addition, a small number of challenges (f = 2) were reported concerning a lack of time for or interest in ICT in teaching.

6 Summary of the Results

The main results of our study are shown in Figure 1. We found six main components of ICT competencies among VET teachers, as experienced by teacher trainees who were already working as vocational teachers. In our study, the ICT competencies involved (1) *the use and creation of digital learning materials*, (2) *the planning and use of digital learning environments*, (3) *synchronous digitally enhanced teaching*, (4) *general ICT competencies*, (5) *digital interaction*, and (6) *digital assessment*.

During the work-based training process, both workplace and teacher training can support or challenge the ICT development of the trainee. The workplace offers potential affordances to the development of ICT competencies, including direct possibilities to explore and implement ICT-related teaching practices. There are also supportive resources in the workplace (e.g., ICT training and staff, relevant hardware and software, and leadership) that can support the ICT competence development of a VET teacher. However, the continuous feeling of rush and a heavy workload represent major challenges to ICT competence development. In Figure 1, we highlight the most relevant themes (regarding f within this data) of the supportive and challenging factors.

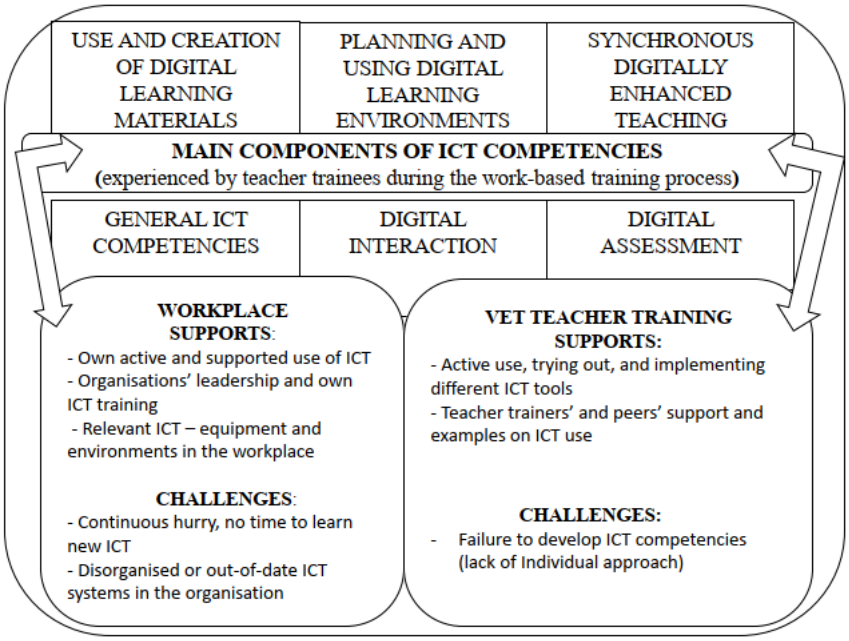

Figure 1: The Main Components of ICT Competencies and Supportive/Challenging Factors for ICT Development Within Work-Based VET Teacher Training

7 Discussion and Conclusions

The study explored the components of ICT competencies as experienced by VET teacher trainees in a work-based training process. It also explored the factors supporting and challenging ICT competence development in the work-based training (see Figure 1).

Both *technological* and *pedagogical* components (Almerich et al., 2016; Koehler & Mishra, 2009) were strongly present because almost all the main ICT-related components of our findings included both these aspects. For example, the use and creation of digital learning materials clearly involves technological components (e.g., using cameras, video software, and editing /publishing tools) and also a pedagogical component because one must consider what makes good video material and also how it contributes to student learning. Moreover, the participants placed greater emphasis on the technological and pedagogical components of ICT competencies specific to the teaching profession than on general ICT competencies, such as *information literacy, digital problem-solving, and digital self-reflecting* (see Table 1; Roll & Ifenthaler, 2021). This finding may relate to our work-based approach, which was oriented toward the hands-on aspects of a vocational teacher's work. In sum, our results

may help in developing an ICT competence framework for VET teachers in the future. The framework should include general ICT competencies, such as information literacy, digital problem-solving, and self-reflecting, along with the components specific to the teaching profession, such as synchronous digitally enhanced teaching, as presented in Figure 1.

In fact, ICT competence development can be seen partly as an individual process that includes ICT self-efficacy and the intention to use ICT as a teacher (e.g., Bin et al., 2020). On an individual level, a positive and active experimental attitude, as well as a willingness to implement it, seemed to serve ICT competence development. Also, in our findings, teacher trainees' own active experimenting with ICT tools was the most important supportive factor for ICT competence development. On the other hand, competence development also occurs as a member of an organization (i.e., within a given context). This has been found to have a strong impact on teachers' ICT competencies, especially at the start of a teaching career (Ottenbreit-Leftwich et al., 2018). Quite similarly, our participants reported that contextual factors (e.g., ICT support staff, peer support, and organisations leadership) play a significant role in supporting their ICT competence development.

Overall, according to our results, the VET teacher trainees perceived the work-based training process to be beneficial in developing their ICT competencies. Individual and contextual factors seemed to intertwine within the process of work-based training; hence, contextual support encouraged individual ICT implementation in teaching, leading to positive attitudes toward ICT use. This, in turn, reflected upon attitudes toward the development of an ICT-enhanced teaching culture, and so forth. In our study, the supportive and challenging factors in the teacher trainees' ICT competence development related both to the trainees' workplace training and their VET teacher training. Our results suggest that organisations should support teachers' active experimentation with adequate resources, including time, ICT support personnel, ICT training, and relevant hardware and software. In addition, VET teacher training was seen both as an example of and inspiration regarding ICT use. It also provided an encouraging source of new ideas, with possibilities of using ICT in teaching and learning.

Several practical implications emerged from our findings. The work-based training process seemed to be a practical way to develop the ICT competencies of a VET teacher. The developed framework (Figure 1) can be used in planning and executing pre-service and in-service VET teacher training. In addition, vocational schools could benefit from this framework when seeking to assess their ICT-related culture, infrastructure, and other contextual factors that are associated with the development of teachers' ICT competence, in addition to individual factors. The framework also offers suggestions that can aid various organisations' own ICT training and workshops. Because all VET teachers may not be interested in ICT implementation in their teaching, well-structured, individualised and supportive ICT training could also motivate them to develop as a VET teacher in today's digitalised environments.

In terms of credibility and generalisation, this study has certain potential limitations: (i) The first author worked closely with the participants as a group teacher (in the key study group) during the training process. This could represent a benefit, leading to a deeper understanding in the research (Denzin & Lincoln 1994), but it could also lead to subjectivity bias. This was addressed by working closely with other authors, i.e., persons who did not work with the student teacher groups or in these teacher training organisations. (ii) Using our questionnaire, we also gathered data from four (non-key) teacher training groups. These had different trainers and were in different organisations. The training processes of the five participant groups were not identical; nevertheless, there was a common pedagogical curriculum, one involving a work-based, personalised, and competence-based approach. Furthermore, collaborative planning and follow-ups took place during the process among the group teachers. (iii) The sample size was small, and the qualitative and inductive data analysis (with an emphasis on participants' experiences) set limits to the transferability of the findings. In the future, it would be beneficial to study VET teachers' ICT competencies in different contexts, using larger samples, and with quantitative approaches. (iv) In our study, we obtained results by analysing the experiences of individual teacher trainees. It has been pointed out that personal experiences may not serve as a reliable measure in comparison with large-scale external evaluations (Hämäläinen et al., 2021). The method in the present study was chosen to focus closely on our research questions and capture the grassroots level of the VET teachers' work and workplace.

Research on teachers' ICT competencies has seemed to emphasise 'horizontal' aspects. This is also the case in the present study, in which we focused on a broad range of components pertaining to teachers' ICT competencies (Figure 1). In the future, "vertical" approaches could be adopted, in line with Mulder (2017), who emphasises the need to pursue depth in competence-related discussion. We must thus ask questions such as: *How profound are the ICT competencies that one must possess as a teacher? How can we identify and address the different levels and components of teachers' ICT competencies?* In the future, there will also be a need to better recognise the individual nature of the VET teachers' ICT competence development. One size does not fit all; hence, we should seek the kinds of theory and practice that will support the development of every VET teacher's ICT competencies at the deepest possible level, even among those who have already mastered the basics. Furthermore, it will be necessary to explore ICT competencies applicable to the teaching contexts surrounding specific VET craft fields, such as construction technology, logistics, and hairdressing.

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