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Digital education training for teachers—Learnings from Austria

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The rapid evolution of digital technology has necessitated a shift in educational paradigms, particularly in teacher training and continuous professional development. This paper presents a study that explores Austrian teachers' attitudes toward digital education training and their preferences for in-service training modalities. Data were collected from a comprehensive survey involving about 600 Austrian secondary public school teachers and analyzed using quantitative and qualitative methods to reveal preferences and constraints in digital education in-service training, including the preferred modalities, the support required, and the teachers' motivations for engaging with training. Key findings from the study indicate that Austrian teachers generally have a positive perception of their autonomy in teaching digital education. Additionally, the study reveals that teachers are willing to participate in in-service training under specific conditions. This willingness is influenced by factors such as the flexibility of the training schedule, the provision of support resources, and the balance between professional obligations and personal time. The study highlights a broader trend toward flexibility and efficiency in in-service teacher training, acknowledging teachers' time constraints and the importance of maintaining a work-life balance. The findings suggest that flexible and supportive training environments can enhance teachers' engagement with digital education, ultimately benefiting their teaching practices and student outcomes. Overall, this study underscores the importance of adapting in-service teacher training to meet the needs of teachers, promoting a more effective integration of digital education.

KEYWORDS

teacher training, teacher motivation, digital education, in-service, educator digital competency

1 Introduction

Education is evolving to incorporate digital approaches into teaching practices, equipping both students and teachers with the skills needed to thrive in the digital age (Redecker and Punie, 2017). Moreover, the COVID-19 pandemic has underscored the importance of digital education and highlighted the need for teachers to adapt their teaching methods to incorporate digital tools and platforms for effective distance learning (OECD, 2020).

The "Teaching and Learning International Survey" conducted in 2018 revealed that Austrian teachers had less professional IT education and attended fewer digital education training programs than teachers in other European countries. Additionally, compared to other states, Austrian teachers tend to participate in fewer digital education training programs, and information and communications technologies (ICT) are used less frequently for project work or customized education programs. Another problem with

international comparisons is the need for more enthusiasm among Austrian educators to use new technologies (Sturm, 2020). Nonetheless, it has been postulated that an important indicator of whether or not educators use digital technology in the classroom is their level of digital self-efficacy, which has been reported to rise with in-service training in digital skills (Saikkonen and Kaarakainen, 2021). Still, teachers' digital skills correlate more strongly with available resources than sociodemographic characteristics, according to research by Saikkonen and Kaarakainen (2021).

Following the introduction of Computer Science in the ninth grade in 1985, the subsequent significant development in Austria to meet the urgent need for digital education was the introduction of "digital education" as a stand-alone subject in other lower secondary schools. Since 2023, children from grades five to eight must take the course digital education, and teachers need to receive significant additional training. Moreover, the necessity for more professional IT education among Austrian teachers was identified as a barrier to effectively implementing digital education (Hörmann et al., 2023a,b). However, despite these challenges, the Austrian government has tried to address them and promote digital education.

The structure of this paper is outlined as follows: The introduction gives a brief overview of the subject matter, setting the stage for further exploration. Section two deals with the foundations and the current landscape of digital education by providing an overview of digital education in Europe and Austria and insights into the Austrian in-service teacher training landscape. The methodology employed in the underlying study and its findings are described in Sections 3.1 and 3.2, followed by a discussion of these results in Section 3.3. The paper closes with a conclusion in the last section.

2 Foundations and current landscape of digital education

2.1 Austrian context

The educational system in Austria offers a diverse range of possibilities for instruction and training tailored to the requirements and preferences of parents and students (see Figure 1).

In Austria, children must attend school for nine years, beginning at age six. There are public and private schools, whereas state institutions have no tuition. All students can attend Compulsory Secondary School after completing primary school, where they generally stay for four years. Children with good grades can also choose Academic Secondary School (Lower Cycle) from ten to 14. The Academic Secondary School aims to prepare students for university entrance, offering an in-depth general education. This school type consists of two levels: a lower cycle that lasts four years and an upper cycle that lasts four years and ends with the school-leaving examination (Matura). After completing four years of Academic Secondary School (Lower Cycle) or Compulsory Secondary School, students in Austria can advance to either Academic Secondary School (Upper Cycle) for university preparation or Colleges for Higher Vocational Education for practical career training. The latter provides a sound general education and specific vocational qualifications as part of a higher vocational training program and practical training. They end with the school-leaving and diploma examinations (BMBWF, 2022a).

2.2 Key elements of Austria's approach to digital education

As long ago as 1985, Austria introduced the subject "Computer Science" in grade nine. Traditional Computer Science (CS) education has historically concentrated on foundational principles such as programming, data structures, algorithms, and computational thinking. Its focus is on equipping students with a deep, technical understanding of computing systems and logical problem-solving skills, often intended for students pursuing further studies or careers in technology fields (BMBWF, 2024).

For a long time, there was only one year of compulsory CS education during the school career. Starting with the school year 2022/2023, the mandatory subject "digital education" aimed to implement one annual stand-alone hour per week for students in grades five to seven. The integration into grade eight followed the consecutive year. From the 2023/2024 school year onwards, the competence-oriented curriculum was implemented at primary and secondary levels I. Furthermore, this curriculum introduced compulsory topics of "CS Education" and "Media Education" from the first grade, which must be integrated into other subjects (Polaschek, 2022).

Concerning the curriculum at elementary school, digital education should be integrated into all subjects. The focus lies on media education, the reflective use of the internet, and a playful approach to technology and problem-solving. "Education Innovation Studios" have been set up at university colleges for teacher education in all federal states and 100 elementary schools. Here, students learn how to use robotics and coding playfully. Under the motto "Learning to think. Problem-Solving", projects and initiatives focus on developing digital skills among primary school students (BMBWF, 2023).

Using national and international competence models, a team of specialists from teacher training and universities developed a draft of the curriculum for digital education for secondary schools (Polaschek, 2022). The Austrian Ministry of Education introduced the new curriculum's concepts in March 2022, focusing on the four 21st-century competencies (4 C's) of critical thinking, creativity, collaboration, and communication. The curriculum is based on a two-dimensional competence model (BMBWF, 2022b). The topics included in the "Frankfurt Dreieck" are listed in the vertical classification under the corresponding subject headings: (T) technical-media—structures and features of digital, IT, and media systems; (G) social-cultural—social interactions through the use of digital technologies, and (I) interaction-related—interaction in the form of usage, action, and subjectification (Brinda et al., 2020). The following competencies compose the horizontal line: (1) orientation—analyzing and reflecting on social aspects of media change and digitization; (2) information—responsible handling of data, information, and information systems; (3) communication—communicating and cooperating using media systems, (4) production—creating and publishing digital content, designing algorithms, and creating

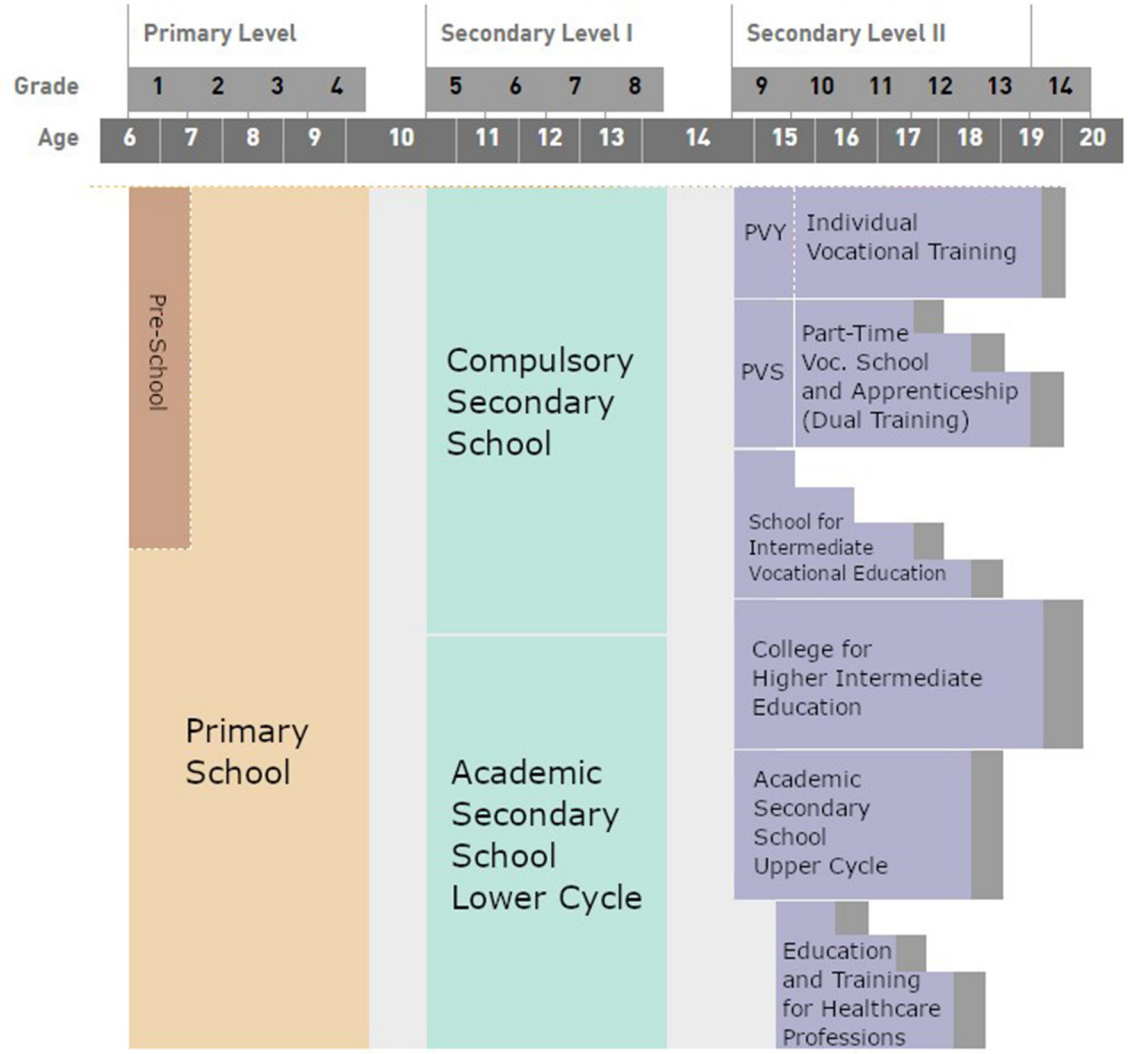

FIGURE 1
The Austrian education system (OeAD, 2024) (adapted by the authors).

software programs, (5) interaction—responsible use of offers and options of a digital world.

The content of the curriculum for secondary school has been split into the following four grades (Hörmann et al., 2023a; Informatikportal AHS Österreich, 2022):

5th grade:

(T) IPO model, search engines, personal data protection, algorithms, hardware.
(G) Understanding digital vs. analog, personalized searches, online teamwork, content presentation, media evolution.
(I) Evaluate personal internet use, research skills, source assessment, data management, basic data calculations, text processing, problem-solving with help systems.

6th grade:

(T) Tech accessibility, data management, internet basics, coding, hardware/software, networking.
(G) Media production, software selection, digital communication, opinion dynamics, copyright.
(I) Digital life balance, social media, content creation, digital health/ecology.

7th grade:

(T) Tech applications in society, AI, cloud systems, Computational Thinking, embedded computer systems.
(G) Media behavior, search routines, privacy vs. openness, digital culture, digitization's ecological impact.
(I) Everyday tech reflection, efficient information search, pattern recognition, crowd-sourcing, digital identity, adapting software, cybersecurity.

8th grade:

(T) AI's limits, data security, network protocols, software development, software/hardware differentiation, encryption.

(G) Digital attitudes, data privacy, manipulation, civil society digital participation.
(I) Digital norms, content management, ethical communication, programming, technical limitations awareness, digital autonomy.

The rapid introduction of digital education in Austria was implemented without adequate preparation for the teaching staff, leading to significant challenges (Hörmann et al., 2023a). The mandate for digital education, especially as a compulsory subject from grades five to eight starting in the 2023 school year, was a swift shift that did not allow for the development of fully trained educators to meet these new requirements. Austrian teachers were required to adopt a new curriculum with limited prior training, underscoring a notable gap in readiness (Hörmann et al., 2023a).

In Austria, every teacher usually studies two subjects and covers at least two subjects at a time. Because of a lack of teachers, the administration also deploys its staff to other field-related subjects. This is most often seen in middle school. Presently, the school administration decides who is teaching digital education, as there are currently no teachers with a certificate for digital education. However, this is a widespread procedure even for other subjects where there is a lack of teachers in "Mittelschule" but instead not in "AHS" [secondary school in Austria is divided into "Mittelschulen" (Compulsory Secondary School) and "Allgemeinbildende Höhere Schulen" (short AHS, Academic Secondary School)]. The first participants from the in-service teacher training at university colleges (described in the following section) will finish in consecutive years. Furthermore, Bachelor- and Master-Study Programs in "Computer Science & Digital Education" started at university and university colleges. Nevertheless, Austria appears to represent an unconventional approach when introducing a subject prior to the subsequent training of teachers.

2.3 In-service teacher training in Austria

Both subjects, computer science and digital education, share specific competencies, such as problem-solving and critical thinking, but the application and instructional methods vary significantly (BMBWF, 2024; Informatikportal AHS Österreich, 2022). In computer science, problem-solving is often approached through programming exercises, computational challenges, and logical reasoning tasks. Digital education, however, may approach problem-solving through scenarios in digital ethics, online communication challenges, or media interpretation, requiring teachers to adapt these skills to real-world applications that students can relate to in daily digital interactions. The overlapping yet distinct nature of competencies in the two subjects suggests the need for targeted teacher training.

In Austria, the 14 university teacher education colleges are responsible for continuing and further teacher training. Primarily, they offer teacher training at the primary level (elementary school), secondary level (general education), and secondary level (vocational education and training), and they enable career changers to obtain a teaching degree. At the secondary level (general education), they do this in a network (or cluster) with public universities.

Eleven of the 14 university colleges provide the in-service teacher training "digital education", which spans over four semesters, containing 30 ECTS (European Credit Transfer and Accumulation System) (BMBWF, 2018). This course offers the opportunity to study the specific topic of digital education theoretically and practically and provides insight into professional content and current didactic and pedagogical concepts. Moreover, the underlying framework curriculum was created with the participation of both universities and university colleges. The study program consists of 20 - 40% supervised study components, while the unsupervised self-study components in the individual modules exceed 50% of the total workload. The curriculum postulates that after completing the university course, graduates can, among other things (Pädagogische Hochschule NÖ, 2023):

- … enable students to independently and responsibly evaluate the fundamental ethical concerns and values brought up by digital media and technologies.
- … interact with the socially significant influences of the digital media and technologies that are currently relevant, allowing them to evaluate their importance for the world and the school environment.
- … master the fundamental concepts, techniques, and abilities to instruct programming and foster Computational Thinking.
- … provide knowledge that improves teamwork when working on projects.
- … develop practical abilities in network, communication, and digital data and information management.
- … employ hardware and software that has been didactically and pedagogically tailored for specific circumstances while keeping diversity and inclusion in mind.
- … organize, visualize, transform, and present collected data to demonstrate relationships and substantiate claims, making them more valuable and reliable.
- … engage in focused and creative interaction with the offered media and software programs.
- … to collaboratively create, adapt, analyze, and publish visual/audiovisual/audio content, considering the necessary legal framework.

In-service teacher training in digital education is divided into five modules: (M1) Understanding and Shaping Your Own Media Use, (M2) Digitality and Society, (M3) Programming, (M4) Computer Systems, and (M5) Application. (M1) contains two classes, named *Understanding Media, Shaping Its Use 1* and *2*, with a total of eight ECTS. *Social Influences Through Digital Media* and *Project Work on Socially Relevant Influences of Digital Media* form module two, containing six ECTS. The part consisting of the most ECTS is (M3) with seven, consisting of four parts: *Programming—Basics 1*, *2*, *Programming—Didactics*, as well as *Programming—Project Work*. Module four deals with *Computer Systems—Basics* and *Specialization*, with a total of four ECTS. The last module includes the courses *Applied Computer Applications* and *Applied Media Design Including Project Work*, with a total of five ECTS (Pädagogische Hochschule NÖ, 2023).

In conclusion, the teacher training landscape in Austria, mainly through the lens of digital education, represents a forward-thinking and comprehensive approach to preparing educators for the modern classroom. The offer of this in-service teacher training at university colleges undermines Austria's commitment to integrating digital literacy and technological proficiency into its educational ethos. Austria is setting a high standard for teacher education with a curriculum that balances theoretical knowledge with practical application and spans critical areas from ethical considerations of digital technologies to hands-on programming and media design.

2.4 Digital education within the European framework

"Digital competence" is defined as follows by the Joint Research Center of the European Union (Ferrari, 2013):

> Digital Competence is the set of knowledge, skills, attitudes (thus including abilities, strategies, values and awareness) that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning, socializing, consuming, and empowerment.

The European Digital Competence Framework (DigCompEdu) has been developed to recognize the critical role of digital competence for citizens. It is a foundational tool for understanding and cultivating digital literacy, guiding policy development across European nations (Redecker and Punie, 2017).

In response to the global shift toward digitalization accelerated by the COVID-19 pandemic, the European Commission initiated the "Digital Education Action Plan (DEAP)" in September 2020. This plan outlines a dual strategy: firstly, to boost digital infrastructure and supply necessary equipment, and secondly, to enhance the digital educational content that includes mastering emerging technologies. The overarching aim is to ensure that educational systems are responsive to the rapid digital transformations of our time. However, a survey indicates significant disparities in digital readiness among EU member states. For instance, only a minority of primary schools have dependable digital infrastructure, while a more significant proportion of secondary schools are better equipped (Kask and Feller, 2021).

Most European school systems begin teaching digital competency to all students in primary school (ISCED level 1—International Standard Classification of Education). This occurs in 21 primary education educational systems as early as grade one. In comparison, in five other systems, it is conducted several years later in primary education (grade four in the Czech Republic and grade three in Bulgaria, Hungary, and Slovakia). Top-tier education authorities in the remaining five nations have set ISCED level 24 (general lower secondary education) as the required beginning grade. While digital competency education becomes mandatory in fifth grade in Croatia and Romania, it begins in Cyprus, Malta, and Albania in grade seven. However, there are various curricular approaches to teaching digital competence across Europe (see Figure 2). In the cross-curricular approach, digital competency is considered transversal and taught in all curriculum subjects. Henceforth, all educators must foster digital competency. Digital competence could also be taught in a stand-alone subject—compulsory or optional. The third possibility is integrating the topics into the curriculum of other subjects (EACEA, 2023).

In numerous European countries, in-service teacher training is considered an obligation for educators. While many countries, like the Czech Republic, Germany, Austria, Great Britain, and others, require continual improvement, others allow optional participation (like Greece and Italy). Furthermore, the numbers vary considering the amount of teacher training. For example, in Lithuania, Slovenia, and Finland, the law entitles up to five days of professional training, while the Czech Republic aims for twelve working days per year. However, only a few countries reward teachers with salary increases when they have undergone teacher training (European Commission et al., 2010). Upon closer inspection, Austrian educational staff has different obligations regarding teacher training depending on their contract, varying from zero to 15 hours per year (BKA, 2023). Nonetheless, the teachers make the final decisions regarding the content and extent, meaning their interests strongly influence their choices (Hartmann and Schratz, 2010).

Concerning Bocconi et al. (2022), inadequate training of teachers not only undermines instruction quality but also represents a significant obstacle to integrating Computer Science into the curriculum. Therefore, the availability of qualified educators is necessary for education systems to facilitate the imparting of Computer Science education (Bocconi et al., 2022). Attracting and retaining specialist Computer Science teachers presents a common challenge for countries newly incorporating the subject into their educational programs and those with a longstanding tradition of offering it. A primary factor contributing to the shortage of Computer Science teachers is the comparatively low number of students graduating with an academic degree in Computer Science relative to the demand in the labor market. To expand the number of Computer Science teachers in secondary education, over half of the education systems from the Eurydice report provide retraining programs that enable teachers to gain extra qualifications. Over a third offer alternative routes for people needing a teaching qualification. A third of the education systems offer both retraining options and alternative pathways (EACEA, 2023).

Teacher autonomy, defined as the capacity to make decisions about instructional practices and professional development choices, is crucial in adapting to educational innovations (Deci and Ryan, 2000). In digital education, teachers' autonomy affects their readiness to integrate digital tools and curricula effectively. Similarly, teachers' attitudes, which encompass their beliefs, perceptions, and motivations toward digital education, influence their engagement with professional development and classroom practices (Bandura, 1997).

Regarding the motivation before a teacher training that promotes participation in such a course, several findings indicate that teachers' interest in the particular training content or the

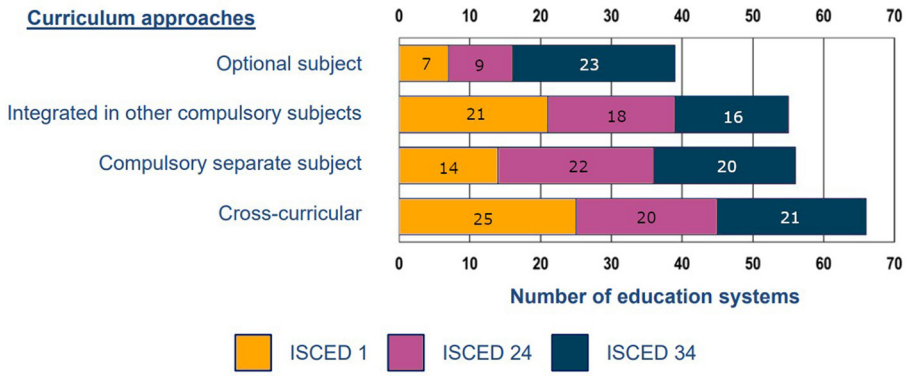

FIGURE 2
Curriculum approaches to teaching digital competence (EACEA, 2023) (adapted by the authors).

importance of intrinsic motivation of choice are significant influences. However, other motivations (such as a particular career benefit) may also be crucial (Andreitz, 2018; Müller et al., 2018). Nevertheless, Andreitz et al. (2017) suggest that, in addition to the content's subjectively assessed practical relevance, other factors that significantly influence intrinsic motivation include the trainers' strong expert orientation (i.e., their ability to solve problems through demonstration) and the participants' perception of high intellectual challenges during teacher training. Moreover, Zehetmeier (2017) describes four types of teachers which are participating in teacher training:

1. Omnivores: Teachers who constantly seek out new ideas, develop chances for training and education, start their own projects, or create and deliver their training programs.
2. Active Consumers: Teachers who, like omnivores, look for possibilities for in-service training inside their workplace but do not take the initiative to create their own courses.
3. Passive Consumers: Teachers who participate in in-service training only after being made aware of them and if they are organized in conjunction with their social surroundings.
4. Reticents: Teachers who are difficult to convince to participate in further training initiatives and can only be encouraged to participate with great difficulty (usually through financial or personal incentives).

However, according to an Austrian survey, more than 80% of teachers believe that teacher training is essential. Nevertheless, more than 38% also said that they do not think it will provide any novel ideas for teaching (Söllinger and Krumhofer, 2018; Müller et al., 2018).

3 Study

3.1 Methodology

The study's primary focus is on understanding the landscape of Digital Education teaching in Austria from the perspective of secondary school teachers, including their training, needs, and preferences for in-service training and the broader context of their professional demographics and motivations.

The following research questions serve as the survey's foundation:

(1) What are the attitudes of teachers in Austria toward the autonomy of their decision to teach digital education as a subject?
(2) How do organizational factors, motivational elements, and preferred teaching modalities influence teachers' willingness to engage in multi-week professional teacher training?

Data was gathered using the university-provided, accessible, and General Data Protection Regulation (GDPR) compliant online application called "LimeSurvey". This platform has integrated data analysis tools and complete data export capabilities (Limesurvey, 2024). The survey was sent to all secondary public school teachers in Austria in the academic year 2023–2024. While 1,356 teachers consented to start the questionnaire, only 578 (42.63%) completed it.

The questionnaire used in this study was designed to capture Austrian teachers' attitudes, motivations, and perceptions regarding digital education training. Its items were developed based on expert feedback and prior studies from the research team. First, it was verified that the participants taught, teach, or will teach digital education. The following question wanted to find out if teachers had to join the course or if they did it voluntarily by rating the statement "It was my own decision to teach the subject digital education" using a five-point Likert scale with the options "totally agree, agree, neither agree nor disagree, disagree, totally disagree" (Joshi et al., 2015). The Likert scale was chosen as it is a widely accepted method for measuring attitudes and perceptions, particularly effective for quantifying subjective responses (Joshi et al., 2015; Edmondson, 2005; McLeod, 2023). This scale provided an appropriate structure for gathering nuanced insights into the participants' views on autonomy, organizational factors, and preferred modalities for in-service training. Furthermore, the median was selected as the primary measure of central tendency in analyzing these questions. As the Likert scale produces ordinal

data, the median offers a more robust representation of central tendency than the mean, as outliers and extreme values influence it less. The following section focused on the in-service teacher training and wanted to find out if participants were already enrolled in training. The teachers' individual perceptions and requirements were the focus of the following section. The last part of the survey concerned gender, age group, years in service, school type, subjects taught, and state. The complete questionnaire can be found in the Supplementary material.

Additionally, a chance to contribute one's perspective was given by asking, "I would also like to say the following." A content analysis was conducted on the collected qualitative data, following the seven-step model outlined by Kuckartz and Rädiker (2022). This standard provides a comprehensive approach to structured qualitative content analysis. The text is analyzed, organized, and summarized in the initial phase. The next step involves identifying key categories, leading to the first coding round based on these categories. If necessary, sub-categories are created, and a second coding round is performed. The following steps allow for additional analyses, while the final step entails documenting the process and results. This spiral process can be restarted at any point, allowing for iterative refinement (Kuckartz and Rädiker, 2022).

The analysis was done with the help of "MAXQDA" and AI tools. At first, ChatGPT helped translate the comments into English. Then, the comments on the most common words were investigated using MAXQDA. Furthermore, the statements have been categorized into topics, although one comment may be related to multiple categories. Four key codes were established to determine the primary topics teachers mentioned: "Training Quality", "Additional Training Burden", "Curriculum Issues", and "Equipment Shortages". Moreover, the statements were categorized into three codes, reflecting the attitude of the comment: "positive", "neutral", and "negative".

3.2 Results

3.2.1 Quantitative results—General information

In total, there were 1,356 participants, whereas 464 completed the questionnaire. Of these 464 participants, 142 (30.60%) identified as "male", 312 (67.24%) as "female", one (0.22%) as "diverse", and nine (1.94%) provided "no answer". The age group consisted of 79 (17.03%) teachers "under 30", 122 (26.29%) "between 30 and 39", 128 (27.59%) "between 40 and 49", 105 (22.63%) "between 50 and 59", 29 (6.25%) "over 60", and one (0.22%) person giving "no answer" at all. The arithmetic mean of the ages is approximately 42.09 years, and the median is 44.5 years. Concerning the years in service, 92 (19.83%) stated that they teach "less than 5 years", 114 (24.57%) "5 to 10 years", 100 (21.55%) "11 to 20 years", 91 (19.61%) "21 to 30 years", 66 (14.22%) "30 or more years", and one (0.22%) providing "no answer" (see Figure 3). The arithmetic mean of the years in service is approximately 15.69 years, and the median years in service is 15.5 years.

When looking at the subjects taught by participating teachers (see Figure 4), of course, "digital education" was the most common, with 288 mentions. "Mathematics" was picked by 206 participants, "German" by 147, "English" by 143, "Computer Science" by 137, "Sports" by 115, "Arts" by 99, "Music" by 86, "Handicraft" by 86, "Textile Crafts" by 70, "Physics" by 67, "History" by 66, "Geography" by 59, "Biology" by 57, "Chemistry" by 48, "Career Guidance" by 47, "(Descriptive) Geometry or Geometric Drawing" by 39, "Civic Education" by 29, "Nutrition and Household" by 23, "Religion" by 21, "Psychology & Philosophy" by 12, "French" by 11, "Italian" by six, as well as "Latin" by two. Other mentions included "Elementary School Teacher", "Management", "Vocational School", "Ethics", "Social Education", "Economics", and more.

Two-hundred-and-thirty-three (46.49%) stated that they teach in "Compulsory Secondary School (Mittelschule)", 126 (25.25%) in "Academic Secondary School (Lower Level AHS)", 17 in "Special or Inclusive Schools", and 124 chose "other". Those who picked the last option mentioned "Elementary School" and "Vocational School" amongst others.

When asked in which state they teach, 143 (30.89%) chose "Lower Austria", 82 (17.71%) "Styria", 71 (15.33%) "Vienna", 61 (13.17%) "the Tyrol", 45 (9.72%) "Carinthia", 28 (6.05%) "Upper Austria", 20 (4.32%) "Vorarlberg", eleven (2.38%) "Burgenland", and two (0.43%) "Salzburg".

3.2.2 Quantitative results—Preliminary information

This question explores whether teachers chose to teach digital education voluntarily or were required to do so, using a five-point Likert scale to measure their agreement with the decision being their own. Out of the 551 teachers who were willing to answer the question, "It was my own decision to teach the subject digital education." 254 (46.10%) "totally agreed", 114 (20.69%) "agreed", 91 (16.52%) "neither agreed nor disagreed", 63 (11.43%) "disagreed", and 29 (5.26%) "totally disagreed" (see Figure 5), whereas the median lies with "agree". This answers the first research question, which was stated the following: (RQ1) What are the attitudes of teachers in Austria toward the autonomy of their decision to teach digital education as a subject?

3.2.3 Quantitative results—In-service teacher training

This section investigates whether teachers are currently attending or planning to attend teacher training specifically designed for digital education in Secondary Schools. It further investigates their motivations or reasons for attending or not attending such training.

Concerning the question "Are you currently attending or planning to attend the teacher training for digital education for Secondary Schools?", 138 (25.60%) answered "yes", whereas 401 (74.40%) stated "no". Out of the 138 teachers that provided the answer "yes", a total of 56 (40.58%) "totally agreed" with the statement "It was my own decision to attend this teacher training.", ten (7.25%) "agreed", four (2.90%) "neither agreed nor disagreed", one (0.72%) "disagreed", two (1.45%) "totally disagreed", and 65 (47.10%) provided no answer (median = "totally agree", $n = 539$).

When the 401 teachers who were not participating in any training were asked "Why is a teacher training out of the question for you?", "not enough time" was chosen 168 times, "I am already

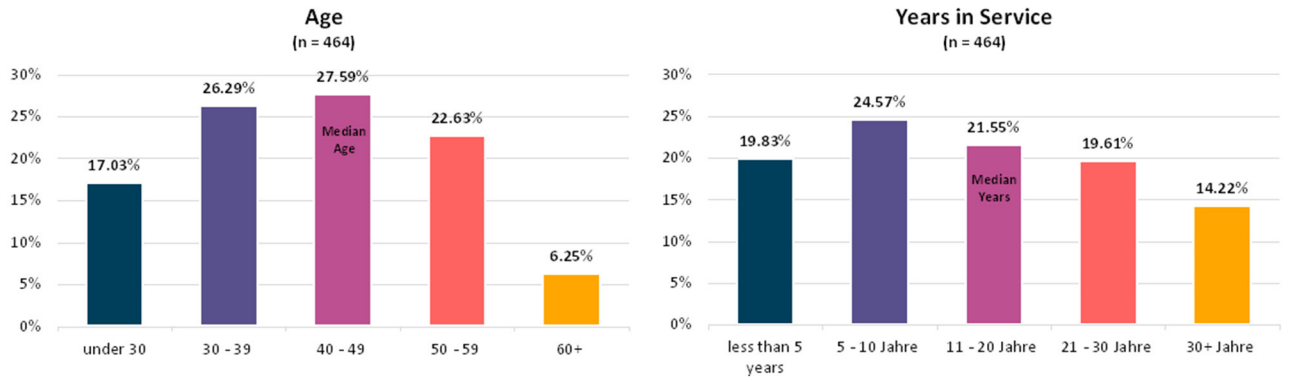

FIGURE 3
Age and years in service of participating teachers ($n = 464$).

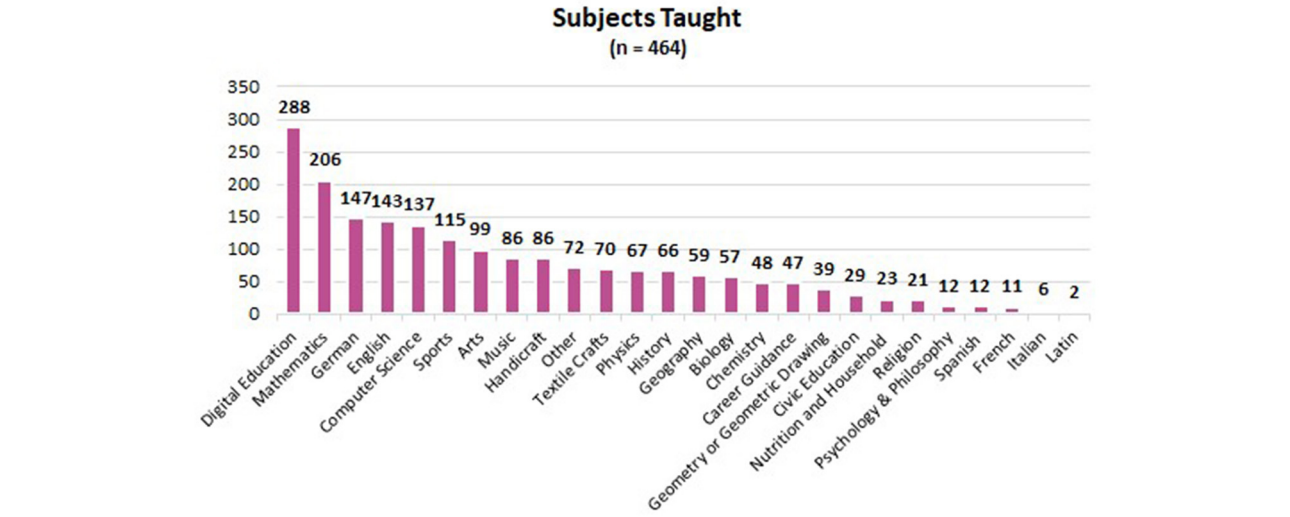

FIGURE 4
Subjects currently taught by participating teachers ($n = 464$).

very familiar with the topic" 124 times, "too time-consuming" 60 times, "too far away" 35 times, "I am not interested" 30 times, "other" 24 times, "not supported by my school" twelve times, and "no vacant spot" ten times. Among further mentions were, for example, "too many other mandatory further training courses", "interesting, but content not suitable for school", and "teaching degree in computer science".

3.2.4 Quantitative results—Perceptions and requirements

This part delves into the support teachers need in implementing the curriculum, their preferences for training modalities (online, on-site, hybrid, asynchronous), and their willingness to participate in training courses under various conditions (e.g., timing, workload adjustments, financial incentives).

Three-hundred-and-thirty-six (70.74%) teachers stated that they "would like to have more support in implementing the digital education curriculum", whereas 139 (29.26%) claimed that they do not need any support. When those 336 were asked "What offers would you use for this?", "online collections of material" was chosen 254 times, "online training (MOOCs, Moodle courses, etc.)" 213 times, "training at schools" 197 times, "further training at universities" 176 times, "Network of digital education teachers" 126 times, "books, professional journals" 79 times, "ARGE (workgroup) training (at own school)" 79 times, "attendance at conferences & educational congresses" 64 times, "newsletter" 47 times, and "other" six times. Among the further mentions were "practical implementation, best practice examples", "WiFi in the classroom and projector or whiteboard", "generally having extra teachers who come to the schools and work with the children", "Network stability for schools would be great", and "useful teaching units".

Taking a look at the teacher training modalities, 242 (49.29%) rated the statement "I prefer an online training course" with "totally agree", 105 (21.38%) with "agree", 93 (18.94%) with "neither

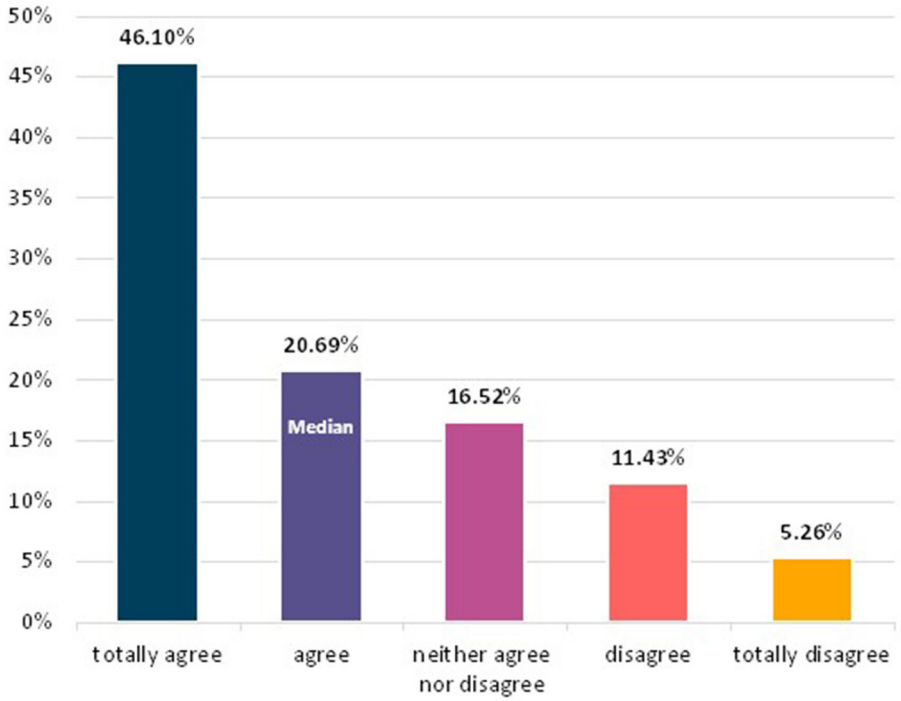

FIGURE 5
It was my own decision to teach the subject digital education ($n = 551$).

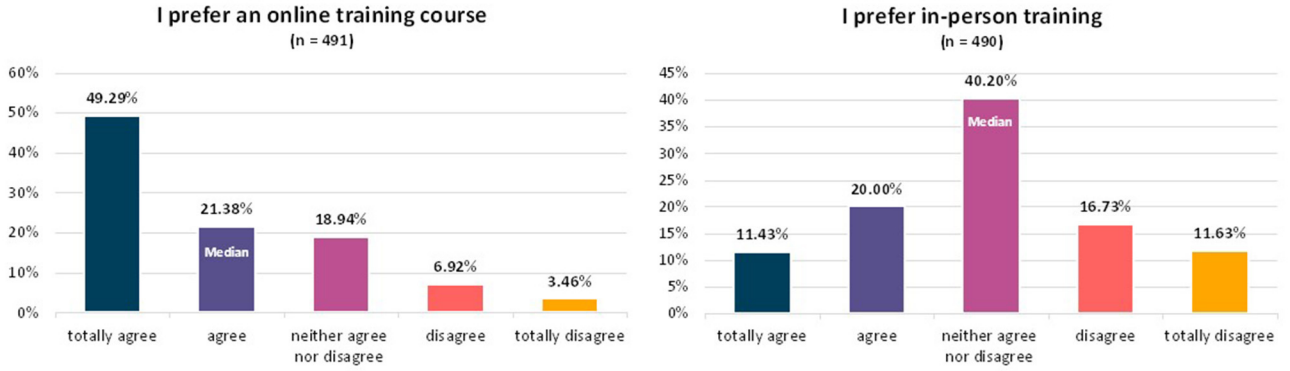

FIGURE 6
I prefer online training vs. I prefer in-person training ($n = 490$).

disagree nor agree", 34 (6.92%) with "disagree", and 17 (3.46%) with "totally disagree" (median = "agree", $n = 491$), see Figure 6.

Moreover, 56 (11.43%) gave the statement "I prefer in-person training" a rating of "totally agree", 98 (20.00%) gave it a rating of "agree", 197 (40.20%) gave it a rating of "neither disagree nor agree", 82 (16.73%) gave it a rating of "disagree", and 57 (11.63%) gave it a rating of "totally disagree" (median = "neither disagree nor agree", $n = 490$).

Concerning mixed versions of teacher training, 101 (20.61%) rated the statement "I prefer hybrid training (online & in person)" with "totally agree", 110 (22.45%) with "agree", 146 (29.80%) with "neither agree nor disagree", 56 (11.43%) with "disagree", and 77 (15.71%) with "disagree" (median = "neither agree nor disagree", $n = 490$). One-hundred-and-fifty-nine (32.58%) "totally agreed" with "I would like asynchronous further training that I can do independently and autonomously", 134 (27.46%) "agreed", 84 (17.21%) "neither agreed nor disagreed", 58 (11.89%) "disagreed", and 53 (10.86%) "totally disagreed" (median = "agree", $n = 488$).

When rating the statement, "I would take part in a training course lasting several weeks if it would take place during my teaching time." 128 (26.23%) "totally agreed", 108 (22.13%) "agreed", 74 (15.16%) "neither agreed nor disagreed", 82 (16.80%) "disagreed", and 96 (19.67%) "totally disagreed" (median = "neither agreed nor disagreed", $n = 488$).

Regarding Figure 7, 17% (3.49%) "totally agreed" to the statement "I would take part in a training course lasting several weeks if it would take place on weekends.", 72 (14.78%) "agreed", 65 (13.35%) "neither agreed nor disagreed", 124 (25.46%) "disagreed", whereas 209 (42.92%) "totally disagreed" (median = "disagree", n = 487).

Moreover, "I would take part in a training course lasting several weeks if it would take place during holidays." was rated by 33 (6.78%) of the teachers with "totally agree", 102 (20.94%) with "agree", 94 (19.30%) with "neither agree nor disagree", by 82 (16.84%) with "disagree", and 176 (36.14%) with "totally disagree" (median = "disagree", n = 487).

A total of 95 (19.51%) "totally agreed" to the comment "I would take part in a training course lasting several weeks if my readiness to substitute for colleagues would be reduced.", 119 (24.44%) "agreed", 118 (24.23%) "neither agreed nor disagreed", 55 (11.29%) "disagreed", and 100 (20.53%) "totally disagreed" (median = "neither agree nor disagree", n = 487).

When rating the statement "I would take part in a training course lasting several weeks if my corridor supervision/break supervision would be dropped.", 74 (15.20%) "totally agreed", 60 (12.32%) "agreed", 118 (24.23%) "neither agreed nor disagreed", 92 (18.89%) "disagreed", whereas 143 (29.36%) "totally disagreed" (median = "neither agree nor disagree", n = 487).

"I would take part in a training course lasting several weeks if hours of my teaching obligation would be reduced" was rated by 91 (18.69%) with "totally agree", 98 (20.12%) with "agree", 107 (21.97%) with "neither agree nor disagree", 73 (14.99%) with "disagree", and 118 (24.23%) with "totally disagree" (median = "neither agree nor disagree", n = 487).

Moreover, Figure 8 shows that 194 (39.75%) rated the statement "I would take part in a training course lasting several weeks if hours of my teaching obligation would be reduced while my pay would remain the same." with "totally agree", 124 (25.41%) with "agree", 74 (15.16%) with "neither agree nor disagree", 41 (8.40%) with "disagree', and 55 (11.27%) with "totally disagree" (median = "agree", n = 488).

Two-hundred-and-eighteen (44.67%) "totally agreed" to the comment "I would take part in a training course lasting several weeks if I would receive additional payments in return.", 151 (30.94%) "agreed", 58 (11.89%) "neither agreed nor disagreed", 24 (4.92%) "disagreed", whereas 37 (7.58%) "totally disagreed" (median = "agree", n = 488).

Taking a look at (RQ2), which was expressed as follows, "How do organizational factors, motivational elements, and preferred teaching modalities influence teachers' willingness to engage in multi-week professional teacher training?", that teachers prefer an online or mixed version of teacher training over on-site appointments. Moreover, participants disagreed with attending teacher training on weekends or holidays. The concepts of "reducing substitution hours", "dropping corridor/break supervision", or "reducing hours of teaching obligation" were neither agreed nor disagreed with. However, teachers liked the idea of joining a teacher training in digital education if their "hours of teaching obligation would be reduced while the pay remains the same" and if they would "receive additional payment".

3.2.5 Qualitative results

Although this paper primarily focuses on analyzing quantitative data, it is essential to summarize the qualitative results from Hörmann et al. (2024). Seventy-three people completed the voluntary comment section. The most extended text was 224 words long, the shortest comment was only six words long, and the average character count in the text box was roughly 278.

As shown in Figure 9 (left), "Training Quality" was the most discussed, with 26 comments (48.1%) highlighting both positive and negative aspects. Teachers expressed dissatisfaction with training effectiveness, citing inadequate preparation, lack of practical relevance, and issues with course structure and speaker preparedness. Some appreciated applicable content but noted a lack of depth in didactic approaches and organizational chaos. The "Additional Training Burdens" category, with 21 comments (38.9%), emphasized the strain of training on teachers' time, with feedback on inconvenient schedules, added stress, and inadequate support for extra efforts, which conflicted with personal time and teaching duties. For the "Curriculum Issues" category, 16 comments (29.6%) noted that the curriculum was often complex, vague, or disconnected from practical teaching needs. Teachers suggested content revisions to improve clarity and relevance. Lastly, "Equipment Shortages" were mentioned in 8 comments (14.8%), pointing to insufficient digital infrastructure in schools, such as a lack of Wi-Fi and essential classroom tools, limiting effective implementation of digital education.

In terms of sentiment, the comments were largely negative (60.3%), with fewer neutral (26%) and positive (13.7%) responses (see Figure 9 right).

3.3 Discussion

3.3.1 Instrument validity and limitations

While the questionnaire was carefully constructed to align with the study's objectives, a formal pilot test was not conducted. This presents a limitation, as pilot testing could further validate the instrument's clarity and reliability. Future research could benefit from a preliminary test of the questionnaire with a smaller sample to refine items and assess any potential issues in interpretation.

3.3.2 Participant selection and demographic representativeness

Invitations to participate in the survey were distributed through official channels to ensure comprehensive coverage across various secondary school types, including compulsory and academic secondary schools. By reaching out to all eligible teachers, the study aimed to gather a representative sample of educators currently involved in delivering the digital education curriculum across Austria's secondary public school system.

Based on the demographic data collected, the sample includes a range of age groups, years of teaching experience, subject specializations, and geographical locations, which provides a diverse cross-section of secondary public school teachers in Austria. The age distribution is well-balanced, with representation from teachers under 30 to those over 60, suggesting that the sample

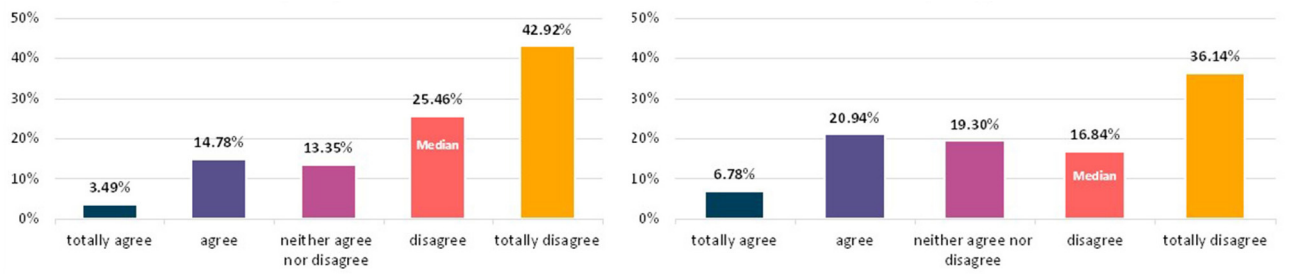

FIGURE 7
I would take part in a training course lasting several weeks if it would take place on weekends, I would take part in a training course lasting several weeks if it would take place during holidays ($n = 487$).

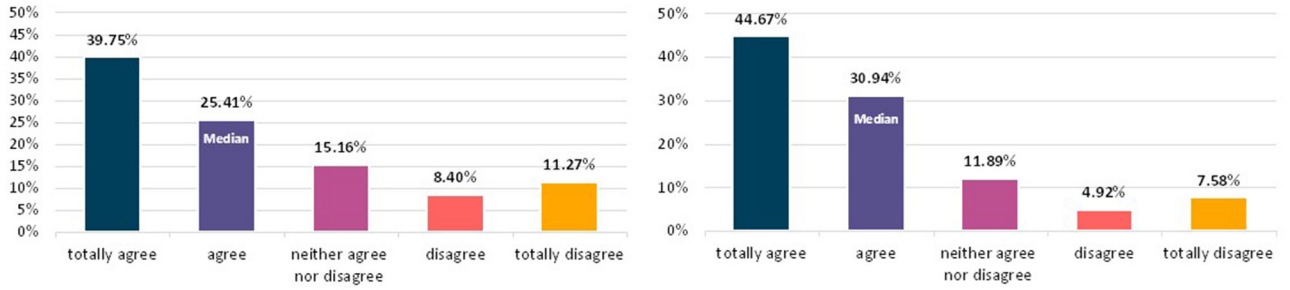

FIGURE 8
I would take part in a training course lasting several weeks if my hours would be reduced while my pay would remain the same, I would take part in a training course lasting several weeks if I would receive additional payments in return ($n = 487$).

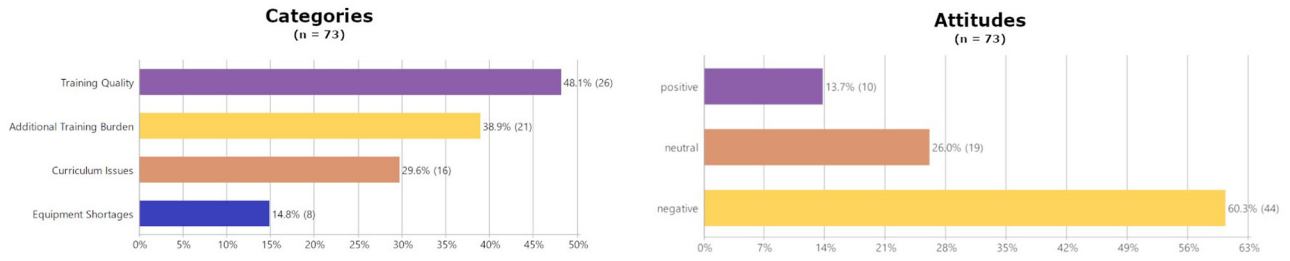

FIGURE 9
Left: category-based analysis of comments ($n = 73$), **right**: assigned attitude of the comments ($n = 73$).

captures a variety of perspectives across career stages. Similarly, the range of teaching experience ensures insights from both newer and more seasoned educators, which is valuable for understanding varying attitudes toward digital education training. However, some demographic biases may have emerged. For example, teachers from specific subject areas, such as mathematics and languages like German and English, were likelier to participate in the survey than teachers from less commonly taught subjects like Latin or French. This could introduce a subject-area bias, as the attitudes and needs of teachers in high-demand subjects may differ from those in niche or elective areas.

A high percentage of elementary school teachers filled in the questionnaire, likely motivated by the recent introduction of digital education at the primary level in autumn 2023. This may have occurred if the survey link was shared within broader educational networks or platforms accessed by both primary and secondary educators.

3.3.3 Subject-specific insights on digital education training engagement

When examining the subjects taught by the participating teachers, it is noticeable that "Mathematics" was selected most often. This could mean that mathematics teachers are also interested in digital education. Mathematics and digital education both require and develop logical reasoning, problem-solving, and abstract thinking skills. Teachers with a background in mathematics may find it easier to adopt digital education content,

as both fields reinforce these cognitive competencies. Moreover, mathematics educators often have higher familiarity with technical tools and software used in teaching, such as graphing calculators or statistical software, which may translate into greater ease in adopting digital tools for education.

On the other hand, "German" and "English" have been picked second, and neither of these subjects touches on technology topics. Still, it has to be mentioned that media pedagogy, media use, and other related topics appear in language curricula. Still "French", "Italian", and "Latin" are at the bottom of the list. However, there are generally more German and English teachers than teachers of other foreign languages. Therefore, even if all language teachers were equally inclined to participate in digital education, the higher number of German and English teachers would naturally lead to higher participation rates.

3.3.4 Teacher motivations and preferences for digital education training

Taking into account (RQ1), which wanted to find out if teachers chose to teach digital education voluntarily or were required to do so, only about half of the participants (254 out of 551) wanted to provide an answer. This limited response could reflect hesitation among teachers who may have been required to teach digital education without actively choosing it.

As many teachers chose the item "not enough time" when asked why they do not attend teacher training, it can be assumed that teaching is time-consuming. Not only do teachers have to be at school, but they also check homework exercises and tests and prepare lesson plans. Therefore, it also makes sense that participants stated that the in-service training for digital education is too time-consuming. As the on-site classes for teacher training take place in the capital or larger cities, it is evident that participants also opted for the item "too far away", as teachers from rural areas have to travel to access university colleges.

As depicted in Figure 6 (Section "Results"), nearly half of the participants preferred online training over on-site one. This could be because online sessions are more locally flexible, as it is harder to reach on-site training from rural areas. Furthermore, approximately half of the teachers favored asynchronous training, as it is deemed to be the most flexible and the one with the least effort.

Taking a closer look at the section concerning participating in training programs under different circumstances (e.g., timing, workload adjustments, financial incentives), the median of the answers to the question "I would take part in a training course lasting several weeks if it would take place during my teaching time" lies with "neither agree nor disagree". This might result in teachers fearing more workload during already packed weeks. Still, according to a report from 2018, 41% of all teacher training in the school year 2014/15 took place between 8 AM and 2 PM (Müller et al., 2018; Rechnungshof, 2017). However, the median of the statements concerning weekends can be found even worse with "disagree", even though many teacher training now takes place on Saturdays. The two statements that the participants agreed with were "I would take part in a training course lasting several weeks if my hours would be reduced while my pay would remain the same" and "I would take part in a training course lasting several weeks if I would receive additional payment". This is standard practice in most companies but not in schools, even if (higher) school administration should be interested in training their staff, too.

The question containing teacher support was asked in the current survey, but also in a survey from the authors in autumn 2022 with a similar target audience ($n = 673$). In 2022, 69.4% of the teachers stated that they "would like to have more support in implementing the digital education curriculum", whereas 24.9% claimed that they do not need any support. However, one year later, approximately the same percentage of teachers claimed to need help (see Figure 10). The 2022 survey likely captured teachers' initial reactions and expectations before they had practical experience teaching the subject, as digital education was newly introduced in the 2022/23 school year. In contrast, the 2023 survey reflects teachers' experiences after having taught digital education for at least one academic year, providing insights into the challenges and adjustments made during its first full year of implementation.

3.3.5 Alignment with European trends in digital education

Furthermore, our findings also reflect broader challenges documented in European studies on digital education. For instance, the European Commission's Digital Education Action Plan (2020) highlights disparities in digital readiness and infrastructure across EU member states, an issue that resonates with Austrian teachers' concerns about resource limitations and support for implementing digital education. Moreover, studies across Europe point to common barriers, such as time constraints, logistical challenges, and the need for personalized training, which were also frequently mentioned by Austrian teachers in our survey.

Similar to our findings, research by Bocconi et al. (2022) highlights that a shortage of trained educators and the rapid pace of digital curriculum changes have created considerable challenges for teachers across Europe. Studies like those by Bocconi et al. (2022) advocate for sustained digital skill-building, and our findings reinforce this view, as teachers clearly preferred training models that integrate easily into their professional lives, such as online and hybrid formats. Additionally, this demand for flexible and accessible training options underscores the importance of supporting remote and hybrid training formats, which could increase participation rates and reduce barriers for teachers in rural areas or those with heavy workloads. This preference also aligns with the European Commission's Digital Education Action Plan (DEAP) emphasis on leveraging digital solutions to make professional development more accessible and adaptable to educators' schedules and geographical constraints (Kask and Feller, 2021).

3.3.6 Alignment with Zehetmeier's typology of teacher engagement

Our study's findings align with several of Zehetmeier (2017) typologies of teacher engagement in professional development, particularly the Omnivores, Passive Consumers, and Reticents, but do not clearly represent the Active Consumers category. In this typology, "Omnivores" are teachers who actively seek out

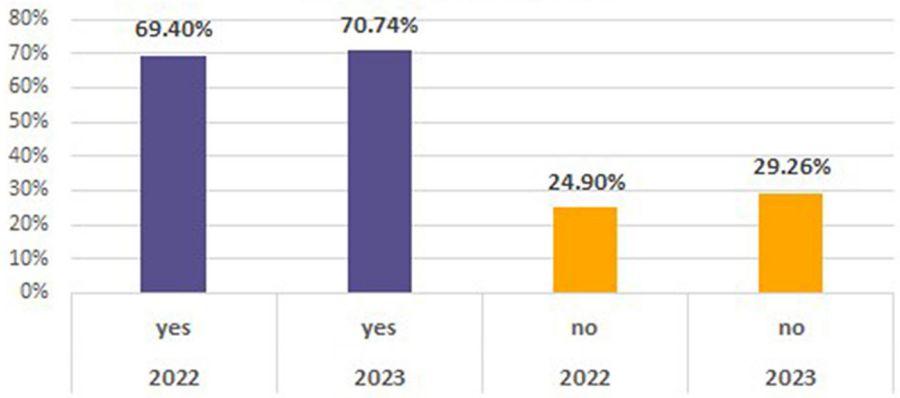

FIGURE 10
"I would like to have more support in implementing the digital education curriculum"—comparison 2022 ($n = 673$) and 2023 ($n = 475$).

new training opportunities and engage in ongoing professional development with enthusiasm. In our study, these teachers likely correspond to the group that reported high interest in digital education and voluntarily engaged in additional training to expand their skills. The "Passive Consumers" in our study attended digital education training when it was convenient or explicitly recommended by their school administration. Survey responses indicated a preference for accessible, time-efficient training options, such as online or hybrid formats that fit their existing schedules. "Reticents" are those who opted out of digital education training, often citing barriers like time constraints, lack of relevance, or insufficient school support. In survey responses, this group may be defined by participants who expressed concerns about the potential workload associated with training and skepticism about its practical benefits. Interestingly, "Active Consumers", typically defined as teachers who participate in training but do not proactively seek new opportunities, were not identifiable in our study. This absence may be due to limitations in the survey design or the sample characteristics, which could have favored participants with more substantial, more polarized attitudes toward digital education training.

3.3.7 Implications for generalization and future research

The findings of this study are particularly relevant for understanding current trends among Austrian secondary teachers in digital education. They offer valuable insights into teachers' motivations, challenges, and preferences regarding digital education training within the unique context of Austria's recent curricular reforms. However, these findings should be interpreted cautiously when considering other contexts, as the specific conditions of Austria's education system, including its rapid implementation of digital education as a compulsory subject and the structure of in-service teacher training, may differ from those in other countries or educational systems.

Further studies with broader or more targeted sampling would enhance the generalization of these insights. Future research could focus on comparing results across different school types or including a more diverse range of regions and subject specializations.

4 Conclusion

This work evaluated a study conducted from September to November 2023 concentrating on understanding the landscape of digital education teaching in Austria from the view of secondary school teachers, including their training, requirements, and priorities for professional growth. A significant portion of teachers viewed the decision to teach digital education as their own, with 46.10% totally agreeing and 20.69% agreeing with the statement "It was my own decision to teach the subject digital education". This indicates a generally positive perception of their autonomy in teaching this subject. Moreover, teachers are willing to participate in teacher training lasting several weeks under specific conditions. They prefer training that is offered online or in a hybrid format, as well as asynchronous training. Additionally, they show interest in training designed to ensure that participation does not detract from their leisure time or that time invested outside working hours is duly compensated. This could reflect a broader trend toward flexibility and efficiency in in-service training, acknowledging teachers' time constraints and the importance of work-life balance.

In conclusion, the study reveals a significant tendency among secondary public school teachers in Austria to teach digital education, mainly driven by personal decisions. Teachers' willingness to participate in extended in-service training is contingent upon providing flexible, convenient training modalities that respect their personal time and professional commitments. This underscores the necessity for educational policies and training programs to adapt teachers' preferences and constraints, enabling effective digital education instruction. Furthermore, the study emphasizes the importance of flexible, convenient training modalities that respect teachers' time. Teacher colleges might use these insights to refine their course offerings, ensuring they align with educators' needs and preferences, particularly regarding

flexibility and relevance. However, the results may also inform policy-makers about allocating resources toward teacher training.

The determination of outcomes for current digital education teachers who opt not to undergo further training—given its voluntary nature—or are deemed already qualified due to other factors remains pending. Additionally, an unresolved issue exists regarding educators possessing *solely* a "Computer Science" degree without the supplementary digital education qualification. It is unclear whether such individuals will be permitted to teach the subject in the future.

While this study provides valuable insights into Austrian teachers' attitudes and preferences regarding digital education training, further research is necessary to deepen our understanding and address existing gaps. Specifically, longitudinal studies could assess the long-term impact of digital education training on teaching practices and student outcomes, providing a more comprehensive view of the effectiveness of current training programs.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

CH: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing. LK: Writing – original draft, Writing – review & editing. ES: Writing – original draft, Writing – review & editing. BS: Writing – original draft, Writing – review & editing.

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In this paper, various AI tools were utilized to enhance the quality and structure. ChatGPT was employed to assist in generating ideas, structuring sections, and refining language. DeepL was used for translations to ensure linguistic accuracy. Additionally, Grammarly supported grammatical correctness, clarity, and stylistic consistency across sections. Each of these tools contributed to improving the paper's readability, coherence, and overall presentation, adhering to ethical AI usage in academic writing and maintaining the authors' intellectual ownership of content and arguments.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2024.1490123/full#supplementary-material

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