Digital Literacy in Lower Secondary Education – A First Evaluation of the Situation in Austria

Corinna Hörmann[1][0000−0002−4770−6217] and Barbara Sabitzer[2][0000−0002−1304−6863]

[1] Johannes Kepler University, Linz, Austria
corinna.hoermann@jku.at
[2] Johannes Kepler University, Linz, Austria
barbara.sabitzer@jku.at

Abstract. As long ago as 1988, Austria introduced the subject "Computer Science" in grade 9. Quite a long time there was solely this one year of mandatory IT-education during school career. In 2011, all European countries had digital education policies in place, either as standalone policies or as part of a national ICT strategy. The strategic weight of these policies remained on nurturing students' digital competences, justified by future economic benefits. For Austria, these changes have not resulted in further computer science education in school. When Austria implemented the new mandatory subject "Digital Education" in September 2018 for all students in lower secondary education, computer science education finally found its way into additional grades. The curriculum covers digital competences, media competences, as well as civic education. Schools can decide if they offer stand-alone subjects or if they implement the curriculum in an integrative way in several other subjects. However, schools still fight the problem who is teaching and how, because most schools just cannot install an extra subject, due to lack of teachers or lack of teaching hours available. This paper reports on the implementation of the subject "Digital Education" in Upper Austrian schools and takes a closer look at first experiences by evaluating a survey answered by 117 teachers approximately two years after the implementation of the new subject.

Keywords: STEM · Digital Literacy · Digital Education · Computational Thinking

1 Introduction

Computational thinking tools and methods found their way into multiple scientific fields, becoming widespread among scientists long ago [14]. Computational thinking covers solving problems, designing systems, and understanding human behavior by drawing on the concepts of computer science [16]. Furthermore, computational thinking can be understood as the connective tissue that combines computer science with many other disciplines [13]. However, there is still a lack of those concepts in educational context in Austria, even if the implementation

of computational thinking in schools is nothing new. In the 1960s, the American computer scientist and university professor Alan Perlis insisted on the introduction of "theory of computation" for all college students in the USA [9]. As long ago as 1988, Austria introduced the subject "Computer Science" in grade 9. The curriculum includes the topics "Computer Science, People, and Society", "IT Systems", "Applied Computer Science", "Computer Science in Practice". So, in this curriculum there is no digital literacy ar all.

Concerning the International Computer and Information Literacy Study (ICILS) 30% of the tested German students are "functional digital analphabets", henceforth they only show rudimentary skills in working with new technologies and digital devices (as Austria did not participate in the study, Germany was chosen because both countries start their computer science education by age 10) [17]. Consequently, educators have the responsibility to make computational thinking available to school students as well [9]. Furthermore, research shows that it is better to implement computational thinking in other subjects than to teach it as a stand-alone subject because it tends to be separated from real-world problems [15].

This paper describes related work as well as the implementation of the curriculum "Digital Education" in Austria. In section 4 the methodology and results of a study, conducted in secondary schools in Upper Austria, are characterized.

2 Related Work

Regarding a nationwide promotion of media literacy, both the EU and UNESCO act as driving institutions. Consequently, individual nations try to integrate those recommendations into their own educational reforms and curricula. European Union nations share lots of common characteristics in their implementation of digital literacy in educational context [2]. This can also be observed in computer science education world-wide. Australia, USA, and Great Britain introduced an early education in computer science, whereas both Germany and Austria can be found at the back of the field (see figure 1) [8].

Regarding a study from 2010 from the university in Dresden, 12 out of 16 states of Germany integrated media literacy or basic concepts of computer science in their curricula. But otherwise there is no nationwide directive for teaching computer science or digital education.

In Switzerland a project called "Lehrplan 21" has been developed to introduce the topic "Media and Computer Science" throughout the school career. The project focuses on "Understanding Media & Responsible Usage", "Basic Computer Science Concepts and problem Solving", as well as "Applied Computer Science".

Shortly after providing each and every student at age 11 and 12 with BBC micro:bit, England introduced a mandatory subject "Information and Communication Technology" in 2014. Educational and teaching objectives concentrate on "Computer Science", "Digital Literacy", and "Information Technology".

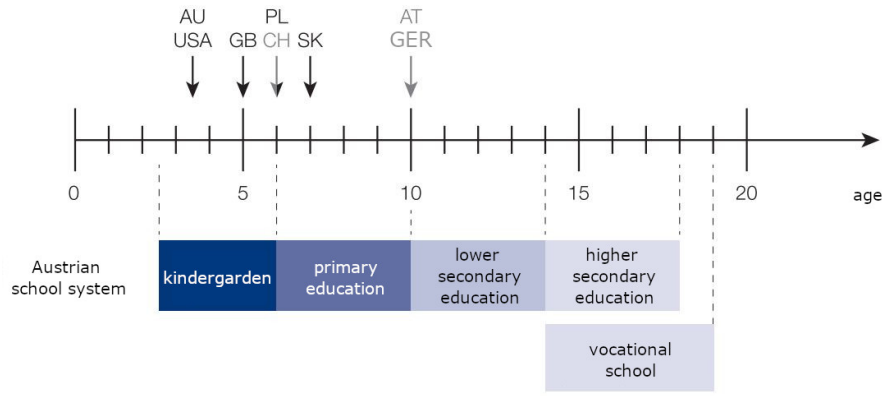

Fig. 1. Comparison of the starting age of computer science education between countries [8] (adapted by the authors) – AT: Austria; AU: Australia; CH: Switzerland; GER: Germany; GB: Great Britain; PL: Poland; SK: Slovakia; USA: United States of America

Slovakia installed the subject "Informatika" for all students from grade two to eleven by focusing on computational thinking. Poland integrated the topics "Understanding and Analysis of Problems" and "Programming and Problem Solving by Using Computers and other Digital Devices" in their curriculum.

As part of Barack Obama's "Computer Science for All" initiative in 2016, the USA enhanced computer science education from kindergarten until grade 12.

There has not been deeper research in the Austrian curriculum of "Digital Education" due to the fact that it was installed in 2018. Furthermore, the COVID-19 pandemic took other topics to the center of the stage, even if the home-schooling situation forced students and teachers to deal with digital devices.

Furthermore, there are no long time studies concerning digital literacy skills of students in Austria but Lazonder et al. [12] report on a three-year study that investigated the development of children's digital literacy skills in the Netherlands. One hundred fifty-one students have been tested three times in yearly intervals to gather information on how they collect, create, transform, and safely use digital information. The study suggested that there is a linear increase in all skills, but nonetheless natural development of digital literacy skills is slow. Furthermore, they found out that the investigated students gained the most in the competence "collecting information on the Internet", whereas the expertise in creating digital products from scratch improves the least. However, the growth of most skills seemed unrelated to socio-demographic characteristics [12].

Concerning teacher training at university level, a study of the Austrian Computer Society (OCG – Österreichische Computer Gesellschaft) shows that the suggested 8 to 12 ECTS of digital competences cannot be reached at Austrian

universities – they could merely be counted with 4.7 and are characterised by the usage of software applications [2]. Nonetheless, each teacher has to implement the "Digital Literacy" curriculum in Austria, even if there are few available teacher training courses or university support. Still, Bratengeyer et al. show that e-learning can be found at each Austrian university, though intensity and offers vary. Especially smaller institutions lack the necessary infrastructure as well as technical support [3].

3 Digital Education in Austria

In the last two decades the idea of life-long learning gained more and more importance. According to the EU key competences, "Digital Literacy" is one of those topics students should master when they finish school. In 2006 "digi.komp", a model for digital competences, was introduced in Austria. *Digi.komp4* describes the model until grade 4, *digi.komp8* states examples from grade 4 until grade 8, *digi.komp12* suggests competences for grades 9 - 12, and *digi.kompP* characterizes the model for teachers [5].

In 2018 the Austrian government published a "master-plan for digitalization" where three main fields of action are described. Field one concerns curricula and their development, whereby digital content has to be integrated. Furthermore, infrastructure of schools has to be improved, as for example 24% of the primary schools have no WiFi installed in their building. Topic three covers teacher training and teacher education, concentrating on ideas for the implementation of digital literacy [6].

This master-plan also presented an 8-point-concept to foster digital education that is outlined as the following [6]:

1. "Portal Digital School": should be a single point of entry and should unify all necessary pedagogical and administrative applications.
2. Standardization of learning platforms
3. Teacher training concerning distance- and blended learning
4. Expansion of the platform "eduthek": this learning platform provides additional exercises and has been further developed since the COVID-19 pandemic.
5. Development of verified learning-apps
6. Upgrading IT infrastructure
7. Supplying students with digital devices
8. Supplying teachers with digital devices

Concerning this 8-point-plan, the Austrian government invested 200 million Euros until 2022, to guarantee a consistent development [6].

The new subject "Digital Education" was installed in September 2018 in lower secondary education (grades 5-8), implemented by two to four weekly lessons. If schools want to implement more than 4 hours per week, they have the finance it from the school budget – ministry will not pay for it. School administration can decide if they offer stand-alone subjects or if they implement the

curriculum in an integrative way in several other subjects. The Austrian government recommends the following implementation when "Digital Education" is taught as a stand-alone subject (see figure 2).

	grade 5	grade 6	grade 7	grade 8
digital education	0-2 hrs/wk	0-2 hrs/wk	0-2 hrs/wk	0-2 hrs/wk

Fig. 2. Implementation of the Curriculum of "Digital Education" [4] (adapted by the authors)

Of course it is also possible to introduce other concepts. For example it is possible to start with 1 hour per week stand-alone in grade 5, then switch to 1 hour per week integrated in other subjects in years six to eight. Of course, schools can also decide to install "Digital Education" in other subjects in year 5 using 1 hour per week and grades six and seven each with 0.5 hours per week stand-alone. Many other options are possible and common [4].

"Digital Education" covers digital competences, media competences, as well as civic education (see figure 3). According to the curriculum, those three topics should not be taught separately but must be connected to other subject-specific fields. The BGBL (Bundesgesetzblatt für die Republik Österreich — federal law gazette of Austria) states that the main aim is to develop students who deal with media and technology to be more responsible and well-briefed [1]. The subject-specific topics are described as the following [1]:

1. Social aspects of digitalization: reflecting the usage of digital devices in everyday life as well as benefits and ethical boundaries
2. Information, data, & media: queries, evaluating sources, sharing information
3. Operating systems & standard software: basic knowledge of operating systems, text processing, presentation software, calculations
4. Media design: adopting, producing, and adapting media
5. Communication & social media: different communication platforms, creating digital identities, cloud-sharing
6. Data security & privacy: securing devices as well as private data
7. Technical problem solving: solving basic IT problems
8. Computational thinking: working with algorithms, creative usage of programming languages

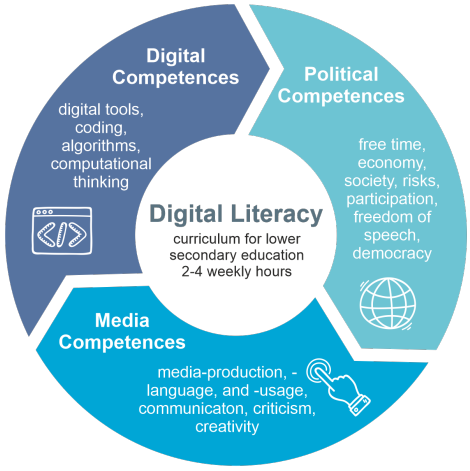

Fig. 3. Overview of the Curriculum of "Digital Education" combining different topics [10] (adapted by the authors)

4 Study

4.1 Methodology

The study concentrated on the implementation of the new curriculum "Digital Education" that was introduced in September 2018. The following research question lay out the basis for the survey: How do schools implement the new curriculum? Stand-alone or integrated in other subjects?

The survey was sent to all 133 local public schools whereas 117 teachers were willing to complete the questionnaire. Basic questions formed the first part of the survey concerning gender, age group, years in service, school type and subjects taught. The next section focused on the implementation of "Digital Education" at schools where we concentrated on the following questions:

- How is "Digital Education" implemented at your school? (stand-alone subject/integrative in regular lessons/both)
- If "Digital Education" is implemented as a stand-alone subject: who teaches this subject? (computer science teachers/interested teachers/other)
- If "Digital Education" is implemented integrative in regular lessons: who is implementing the curriculum? (everyone has to implement the curriculum/only those who are interested implement the curriculum/other)
- If "Digital Education" is implemented integrative in regular lessons: How is it checked whether material from the curriculum has been taught? (comment in class register/with a list in the class/not at all/other)
- Is there any revision (test, quiz, ...) of the students knowledge of the topics of "Digital Education"? (yes/no/other)

– If so, in which form? (open question)

The third section was dedicated to the personal experiences of the teachers and wanted to find out if teachers have already been confronted with the new curriculum. Furthermore, an opportunity was provided to add personal opinion:

– Have you already given a lesson on the "Digital Education" curriculum? (yes/no/other)
– If yes: which content was covered? (open question)
– If so, did you have any difficulties implementing the content? (yes/no/other)
– Which sources do you use to create "Digital Education" lessons? (digicomp.at/saferinternet.at/easy4me.info/eeducation.at/book "Digitale Grundbildung für digi.komp8"/other)
– How useful do you consider the subject "Digital Education" on a scale from 1 (very useful) to 5 (not useful at all)?
– Further comments on the introduction of "Digital Education" (open question)

The question using a scale-rating was implemented applying a five-point Likert scale with the options "very useful, rather useful, partly useful, rather not useful, not useful at all" [11]. In this paper we concentrate on evaluating the quantitative data of the survey, whereas the qualitative data are analyzed in following papers.

4.2 Results

In total there were 117 answered questionnaires while 73 defined themselves as female, 43 as male, and 1 as diverse. Thirteen people were under 30 years old, 16 between 30 and 39 years, 12 between 40 and 49 years, 58 between 50 and 59, and 18 over 60 years old. Reflecting their years in school service 19 teachers stated under 5 years, 10 teachers 5-10 years, 11 teachers 11-20 years, 21 teachers 21-30 years, and 56 teachers 30 or more years in service.

The subjects taught are displayed in figure 4. Fifty-four stated they teach mathematics, 42 teach foreign languages (English, Italian, Spanish, French, Latin, Greek, or Russian), 36 computer science, 24 biology, 22 German, 21 physics, 21 physical education (PE), 17 history, 16 geography, 15 arts, 10 chemistry, 10 music, 7 religious education, 5 home economics, and 3 teach career guidance. Fourteen named other subjects like ethics, handicraft, natural sciences, accounting, nutrition, CAD, or else. Of course, it was also possible to choose more than one subject, as in Austria most of the teachers cover two fields of expertise. In total 117 teachers picked 317 subjects, so on average one teacher covers approximately 2.7 subjects.

The next section of the questionnaire concentrated on the realization of the curriculum. The first question explored how "Digital Education" is implemented at school with 4 different options, whereas it was only possible to pick one exclusively. 30 teachers (26%) said that a stand-alone subject was introduced,

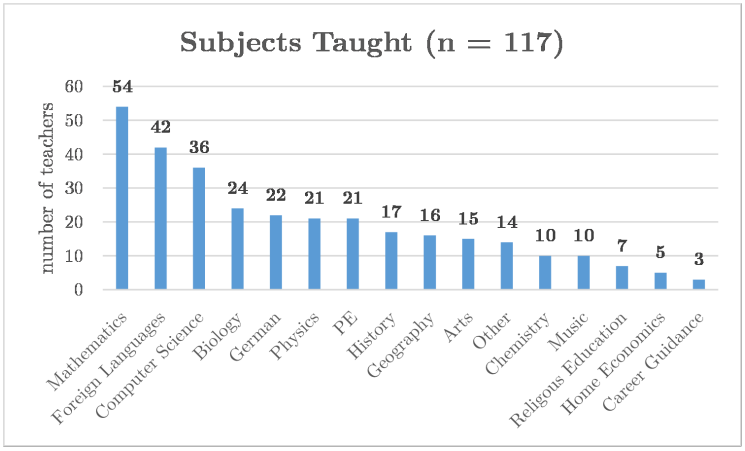

Fig. 4. Different subjects taught (n = 117)

25 (21%) stated they integrate the curriculum in other subjects, 53 (45%) choose "mixed", and 9 (8%) picked "other"(see figure 5).

51% stated that if the curriculum is implemented as a stand-alone subject, it is taught by computer science teachers, whereas 37% said it is taught by interested ones, and 11% stated both. Nine teachers (8%) described different approaches and therefore picked the category "other". One possible alternative was stated as doing workshops or blocked courses, whereas one teacher stated that he/she does not even know if "Digital Education" is taught at school.

When integrated in other subjects, 59% specified that each teacher has to implement the new curriculum, while 41% said that only interested teachers do that. To verify whether the curriculum has been taught in an integrative way, 40 people stated that they use comments in the class register, 18 said that they work with checklists of the topics of the curriculum or the like in the classroom, and 30 claimed that there is no verification at all. Three teachers picked "other", while they added the answers "competence catalogue", "checklist in teachers office", and "teacher conferences". When looking at assessment, 47 teachers (40%) reported that there is some kind of verification of the topics of the curriculum of "Digital Education", and 70 (60%) claimed that there is no test at all. 42% out of these 47 teachers who said that there is a verification, stated that they use tests, quizzes, or the like. The governmental tool "digicheck" [7] was chosen by 15%, 23% reported they use the ECDL ("European Certificate of Digital Literacy')', 8% picked the option "mixed", and 12% named other forms of assessment.

The following part concentrated on personal experience of teachers with the implementation of "Digital Education". Concerning the question if teachers have already held a lesson implementing the curriculum, 66 people (56%) answered "yes", 46 (39%) "no", and 5 (4%) picked "other". Only 11% claimed that they

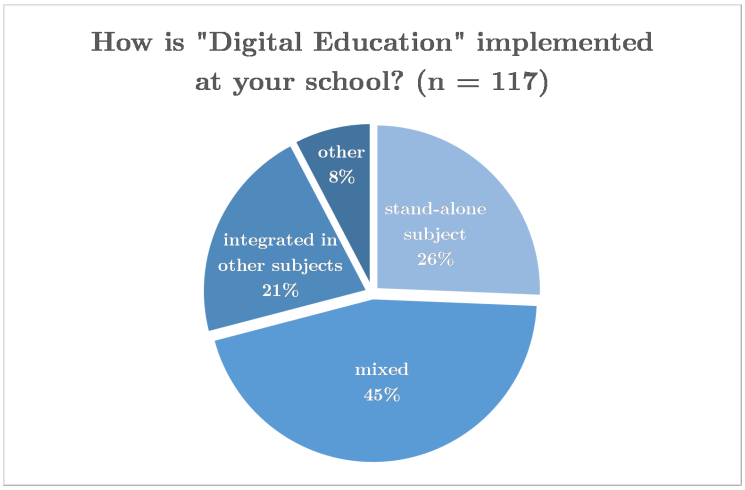

Fig. 5. Implementation of "Digital Education" at school (n = 117)

had problems teaching the new content, whereas 80% experienced no complications at all (8% chose "other"). Regarding educational resources, the questionnaire listed the most popular ones known of the field in Austria. 25% use the website "digicomp.at", 24% "saferinternet.at", 19% "easy4me.info", 17% "eeducation.at", 12% the book "Digitale Grundbildung", and 4% other sources.

The last question wanted to find out how teachers would assess the new subject concerning usefulness and was implemented using a five-point Likert-Scale. Seventy-one teachers (61%) rated the subject "very useful", 31 (26%) "rather useful", 11 (9%) "partly useful", 2 (2%) "rather not useful", and 2 (2%) "not useful at all" (see figure 6). The rating is in the upper section with an arithmetic mean of approximately 1.57.

4.3 Discussion

Remarkably, the age group of 50-59 years appears most often in this survey (49%). This mirrors the current situation in Austria, as the majority of teachers are close to retirement (64% of the participants are 50 years or older). Henceforth, approximately half of the teachers stated that they have 30 or more years in service.

An interesting fact is that most often computer science teachers are deployed if "Digital Education" is taught as a stand-alone subject. That could be due to the fact that the new curriculum has a close connection to the computer science curriculum in Austria. Still, it would also be possible that teachers with other subjects get involved.

If taught in an integrative way in other subjects, 59% claimed that each teacher has to implement the new curriculum, while 41% said that only interested

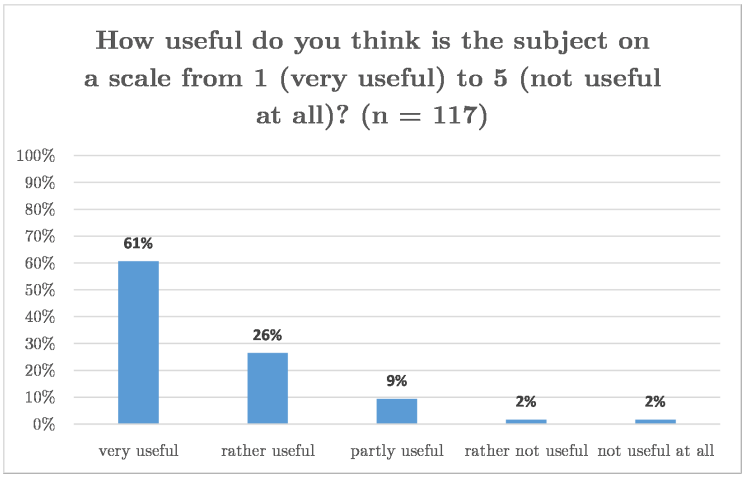

Fig. 6. Rating of usefulness applying a five-point Likert-scale (n = 117)

teachers do so. This is a very interesting finding because legally every teacher has to implement the new curriculum. Still, approximately half of the teachers do not know or at least do not consider that fact.

Another interesting discovery is shown in the answers of the question "Did you have any difficulties implementing the content?". 80% of the respondents claimed that they had no problems at all. This is the exact opposite of the tenor in teacher society because most teachers state that they do not know how to implement the curriculum and need further materials. However, when the survey was conducted only 56% already held a lesson in "Digital Education". Maybe those were the ones that had no difficulties from the start and the rest still deals with lack of teaching materials and sparse knowledge in the field.

5 Conclusion and Outlook

This paper focused on the implementation of the subject "Digital Education" that was introduced in 2018 in Austria. A study was conducted to investigate how schools cope with the launch of the new curriculum. Summarizing, the research question could be answered. It was investigated how schools implement the new curriculum – stand-alone or integrated in other subjects. 26% claimed that they introduced a stand-alone subject, 21% said they integrate the curriculum in other subjects, 45% picked "mixed", and 9 (8%) chose "other".
In summary, further development-steps are:

- analyzing the qualitative data of the study
- expanding the study nationwide to get broader insight

– development of an online teacher training course to support and encourage teachers to install "Digital Education" in their daily lessons at school by concentrating on integrative implementation with computational thinking
– evaluating the implemented teacher training course

Henceforth, there is still a lot of effort that has to be put into the implementation of the curriculum to gain further motivation of the teachers. Especially, due to the COVID-19 pandemic, it would be interesting to find out if the rating of usefulness of the subject "Digital Education" increased.

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