The Integration of Digital Education Within an Ozobot Pilot Project: Austrian Teacher Perspectives and Practices

Sara Hinterplattner[1][a], Eva Schmidthaler[2][b], Michaela Schwinghammer[2][c], Jakob S. Skogø[2][d] and Corinna Hörmann[2][e]

[1]*Linz Institute of Technology, Dynatrace Austria, Linz, Austria*

[2]*Department of STEM Education, Johannes Kepler University, Linz, Austria*

sara.hinterplattner@dynatrace.com,{eva.schmidthaler, michaela.schwinghammer, jakob.skogoe, corinna.hoermann}@jku.at

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Abstract: This study explores the integration of STEM (Science, Technology, Engineering, and Mathematics) education in Austrian elementary and secondary schools, emphasizing teachers' experiences and challenges in delivering STEM content. Through a survey combining questionnaires and interviews, the study highlights significant disparities in STEM equipment and resources among schools, limited STEM-specific teacher training, and varying degrees of STEM curriculum integration. Additionally, while some schools offer student-focused initiatives to foster interest in STEM, others face constraints due to lack of resources and support. In response, a unique pilot project in Steyr (Upper Austria) was developed to address these gaps by providing the educational robots Ozobots, alongside extensive teacher training. Supported by the local government, a major industry partner, and a university, this collaborative effort aims to build teacher competency, promote digital literacy, and encourage interdisciplinary STEM learning in schools. Initial results of the project indicate improved teacher confidence in delivering STEM content and increased student engagement through hands-on learning with Ozobots. This project serves as a model for Austrian education policy, aiming to position Steyr as a leader in Digital Education and offering a scalable framework for addressing STEM and digital education needs across the region.

1 INTRODUCTION

One of the primary goals of education at all levels is to foster and reinforce a lifelong disposition for learning. While the innate desire to explore and understand the world is evident in young children, a well-designed curriculum is essential to cultivate their intellectual curiosity and guide their development. Research consistently demonstrates that infants and toddlers exhibit a remarkable capacity for learning, forming an astounding 700 neural connections per second during these formative years (Buchter et al., 2017). This biological phenomenon, coupled with their inherent inquisitiveness, makes early childhood an ideal window for introducing foundational scientific concepts.

Furthermore, early exposure to STEM (Science, Technology, Engineering, and Mathematics) education offers numerous benefits beyond content knowledge. STEM education not only equips learners with critical thinking, problem-solving abilities, and innovation but also prepares them to participate productively in scientific practices and discourse (DeJarnette, 2012; Duschl et al., 2007; Erdogan et al., 2017). Effective STEM instruction must go beyond rote memorization, embracing inquiry-based approaches, hands-on experiences, and opportunities for students to engage in authentic, developmentally appropriate scientific processes (Duschl et al., 2007; Inan, 2019). These approaches, such as active exploration, data collection, question formulation, and testing scientific ideas, allow students to connect prior knowledge to new experiences, fostering deeper understanding and engagement (Frances et al., 2009; Eshach and Fried, 2005). Moreover, the process of scientific inquiry in STEM education involves active exploration and participation, allowing students to engage in hands-on activities, interact with peers and mentors, and use the authentic tools of science (Duschl et al., 2007;

[a] https://orcid.org/0000-0002-9601-433X
[b] https://orcid.org/0000-0001-9633-8855
[c] https://orcid.org/0000-0002-7738-9953
[d] https://orcid.org/0000-0002-7311-7969
[e] https://orcid.org/0000-0002-4770-6217

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Inan, 2019). Such experiences are particularly impactful when they align with students' natural interests and curiosity, fostering excitement and deeper engagement with the subject matter (Inan, 2019).

Early STEM education also holds the potential to mitigate gender-based stereotypes and reduce barriers to participation in STEM fields (Davidson, 2011; Kazakoff et al., 2013). By providing engaging and inclusive learning experiences, educators can foster a love of STEM in all children, regardless of their gender or background.

However, despite the growing emphasis on STEM in primary education, many teachers face challenges in effectively integrating these concepts into their classrooms. Insufficient training and a lack of confidence often hinder their ability to deliver engaging and effective STEM instruction (Jamil et al., 2017; Hinterplattner et al., 2024). Research by Nugent et al. (2010) highlights the significance of effective professional development in enhancing teacher knowledge, attitudes, and self-efficacy in STEM education (Nugent et al., 2010).

Teachers who engage in inquiry-based professional development programs that are well-structured and hands-on tend to develop stronger abilities to present authentic STEM experiences in their classrooms (Snow-Renner and Lauer, 2005; Silverstein, 2017; Wenglinsky and Silverstein, 2006; Loucks-Horsley et al., 1998). These programs also help teachers interpret children's experiences with scientific phenomena, assess their understanding, and connect their observations to relevant concepts (Chalufour, 2010). Such training is particularly important given the growing emphasis on STEM in primary education, where many teachers remain apprehensive about their ability to engage students in meaningful STEM activities (Brenneman et al., 2009; Brenneman et al., 2018; Clements, 2021). Additionally, anxiety about STEM topics, especially mathematics, is prevalent among educators, and this anxiety can negatively influence student outcomes, particularly for girls (Beilock et al., 2010). To address these challenges, teacher training programs must focus on equipping educators with the skills to adapt STEM instruction to meet diverse student needs and interests while fostering positive attitudes toward STEM subjects (Hiebert, 1999; McClure et al., 2017).

Given the critical importance of providing high-quality STEM education from an early age to ensure that children are well-prepared for future success (Hapgood et al., 2020; Tytler, 2020), it is imperative that teachers possess the necessary skills and knowledge to effectively integrate STEM concepts into their classrooms. This research aims to assess the extent to which teachers are prepared to integrate STEM, particularly in the context of digital education, and to identify areas where additional support or training may be needed.

2 DIGITAL EDUCATION IN AUSTRIA'S SCHOOL SYSTEM

In Austria, formal education begins at age six and lasts four years of primary school. Following this, students attend four years of lower secondary school where they can pursue either a high or middle school education. Finally, students typically attend four or five years of higher secondary school, where they can choose from various school types that qualify for different jobs or university studies. In addition to regular schooling, children with special needs can attend a particular school starting from grade 1. Figure 1 gives an overview of the Austrian school system.

The subject "Digital Education" was introduced in Austria in the 2018/2019 school year (Swertz, 2018). However, in the first years schools could choose to integrate this "Digital Education" into other subjects like using a word processing program for writing essays. In 2022, the "Digital Education" was introduced as a compulsory subject in 5th grade, with one teaching lesson (50 minutes) per week from 5th to 8th grade (Hinterplattner et al., 2022; Hörmann et al., 2022). Before, computer science education was only compulsory in the 9th grade of upper secondary schools. However, in some vocational schools, computer science was offered as a specialization. Although the government has taken a further step towards early digital education with the subject "Digital Education" for lower secondary schools, Austria still tends to be trailing in global comparisons (Hinterplattner et al., 2022). Depending on the type of school, STEM education is covered with different intensities throughout the school career.

When looking at education before school starts, educational areas are defined for teaching in early childhood education centers. STEM and some basic digital education concepts are addressed within the "Nature and Technology" and "Language and Communication" educational areas, specifically within "Nature and Technology" where "Nature and Environment" and "Technology and Mathematics" are described (Hinterplattner et al., 2024). Examples in Nature and Environment include nature encounters, experiments, and computational thinking. In the Technology area, emphasis is placed on exploring large devices and machines, understanding physical-technical laws, and handling various tools. In the mathematics

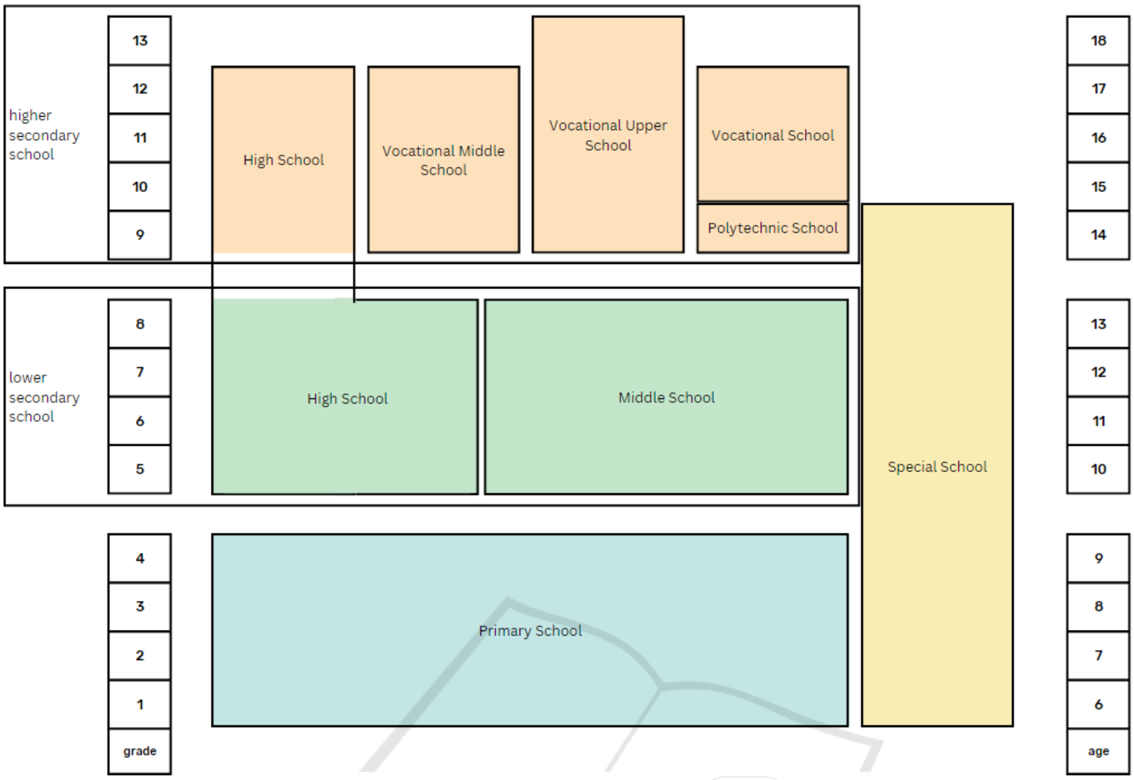

Figure 1: Overview of the Austrian school system.

domain, explicit mentions include recognizing patterns and sequences, quantities and sizes, geometric shapes and numbers, as well as mathematical precursor skills. Computer science is associated with the "Language and Communication" area, focusing on media literacy and explicitly mentioning independent and critical use and design of digital media. However, even though digital education in early childhood education centers is already intended, it will not be continued during primary school (Hinterplattner et al., 2022).

3 DIGITALIZATION PROJECT IN STEYR

The city of Steyr has initiated a digitalization project to enhance the educational landscape across its 16 public schools: Nine primary schools, six middle schools, and one polytechnical school. This initiative comes with a dedicated budget for acquiring digital equipment to be used in the classrooms. Notably, the budget is conditioned upon the stipulation that it be allocated for digital tools that the city is not obligated to provide, such as projectors or PCs. This strategic approach ensures that the funds are directed toward innovative solutions that genuinely enhance the learning environment (Steyr News, 2024). To spearhead this project, the responsible authorities employed a STEM education researcher who has become the project leader. In this capacity, she formed a collaborative team that includes the global tech company Dynatrace and Johannes Kepler University Linz. Both project partners were chosen because they have initiated programs aimed at sparking interest in STEM subjects from an early age, promoting gender equality, and developing the digital skills essential for the future (Johannes Kepler University, 2024; Dynatrace, 2024). This collaboration makes this project unique in Austria and exemplifies how cities, private companies, and research institutions can work together to drive future-oriented education (Steyr News, 2024). As part of their commitment to the project, Dynatrace and the university calculated over 1,100 working hours that they will invest without any financial benefit, offering this support free of charge entirely. The partnership aims are multifaceted but primarily focus on enhancing digital education's role in fostering critical skills among students. Key objectives include: (1) Promoting Digital Literacy: Ensuring students acquire essential digital skills that are increasingly vital in the modern workforce. (2) Enhancing Engagement: Utilizing digital tools to create more interactive and engaging learning experiences that resonate with today's learners. (3) Fostering Collaboration: Encouraging collaborative learning through digital platforms prepares students for teamwork in professional settings. (4) Supporting Differentiated Learning: Leveraging technology to cater to diverse learning styles and needs, thus promoting inclusive education. (5) Ensuring Equal Accessibility for All Students: This project must reach all primary and secondary school students, including those who might otherwise miss out on these experiences due to their backgrounds or surroundings. By implementing the program across all compulsory schools, the project aims to provide equal access to digital resources and opportunities for every primary and secondary school student. A critical consideration for the scientific research team was ensuring that the allocated budget would be spent on something other than equipment that would ultimately go unused due to teachers' lack of implementation knowledge. To address this, it was decided that at least two teachers from each participating school must attend training focused on effectively integrating STEM and digital education into their teaching practices. Throughout the project, participating schools and their teachers must complete two modules. The first module (Module 1) presets the Ozobots and how they can be programmed using color codes. In the second module (Module 2), the focus is on block-based programming with Ozobots. In addition, after each module, further teacher training at the schools and student workshops are offered optionally to deepen the content further and strengthen teachers' competencies in integrating digital education. Furthermore, upon completion of Module 1, schools will receive their digital equipment and have the opportunity to invite the project team to conduct workshops with their students. These workshops are designed to facilitate the practical implementation of the newly acquired tools and provide firsthand experience of how these digital resources can enhance student learning. The workflow of the Steyr project (overview of the project stages can be found in Figure 2) aims to ensure the quality of instruction and to reinforce best practices in using technology and digital education effectively in the classroom.

Moreover, part of the project involves developing digital teaching materials tailored for all grades, which will be offered free of charge. This ensures that not only the schools participating in the project but also other schools can benefit from the materials, potentially spreading the impact of this initiative beyond Steyr. The collaboration in Steyr is a potential model for other cities across Austria. It should demonstrate how investing in education and technology today is an investment in the future and inspire other cities to commit to similar initiatives and expand the benefits of digital education.

The entire process will be accompanied by ongoing research, which will inform both the planning and implementation of the project. This initial research phase, focusing on teachers' training, is essential for assessing teachers' existing knowledge in STEM, evaluating how well-prepared schools are for STEM integration, and determining what training would be most effective. By understanding these foundational aspects, the project can be tailored to meet the specific needs of the educators and ultimately enhance the quality of STEM education in Steyr's schools.

Therefore, this paper highlights the necessity of quality teacher preparation as a foundational element in promoting strong STEM education from the start and investigates the following research questions:

- STEM Resources and Teacher Preparation (RQ1): How well-equipped are schools in terms of STEM resources, digital tools, and specialized spaces, and how adequately prepared are teachers in terms of their qualifications, professional development, and support structures for effective STEM instruction?
- Integration of STEM into the Curriculum and Student Engagement (RQ2): How is STEM integrated into the school curriculum, and how are individual student strengths and interests in STEM promoted through projects, competitions, and interdisciplinary teaching?
- Collaboration and Networking in STEM Education (RQ3): What partnerships exist between schools and external STEM organizations, and how do these collaborations contribute to interdisciplinary learning and the pursuit of STEM certifications?

4 METHODOLOGY

The study involved questionnaires to teachers across all 16 schools participating in the project, capturing a range of perspectives from educators in both primary and secondary settings. After completing the questionnaires, teachers participated in follow-up interviews where they were invited to discuss their responses in greater depth. These interviews provided an opportunity for teachers to elaborate on their experiences, clarify points from the survey, and offer additional context to their responses. This two-step

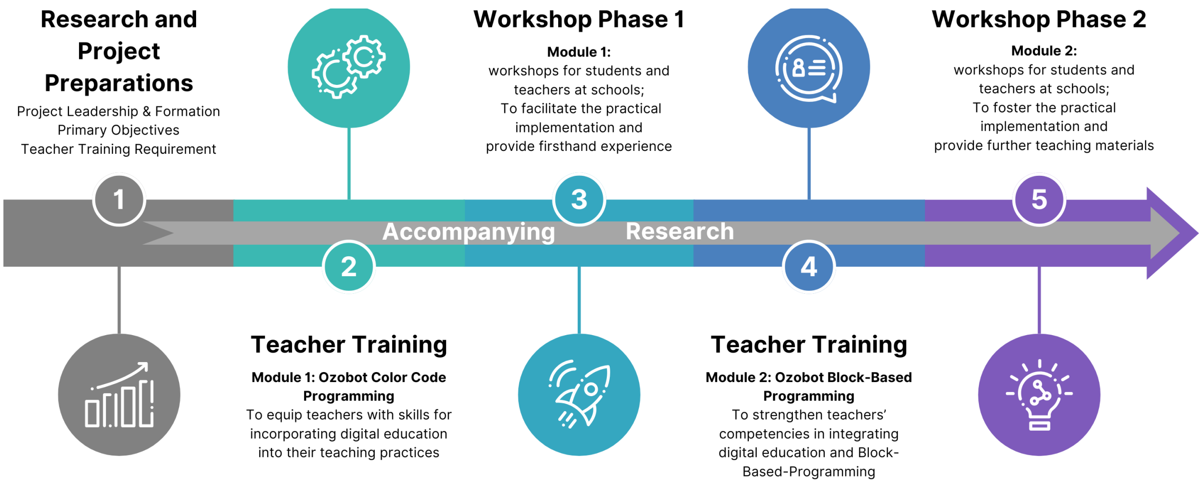

Figure 2: Overview of the project plan and its stages of the digitalization project in Steyr.

approach – using both questionnaires and follow-up interviews – allowed for a comprehensive understanding of the teachers' perspectives, ensuring that both quantitative data and qualitative insights contributed to the findings.

4.1 Participants

The survey involved a total of 36 participants, all of whom were teachers. The distribution of their teaching roles is as follows: Eighteen teachers work in primary schools; one teacher works in a special school; five teachers work in both primary and special schools; eleven teachers work in secondary schools; and one teacher works in both primary and secondary schools. This diverse group of educators represents a range of teaching environments, from primary and special education to secondary schools.

4.2 Study Design

The survey was designed to allow participants to provide open-ended responses to all questions. This approach enabled respondents to freely express their views without the constraints of predefined answer options, ensuring a more detailed and qualitative understanding of their opinions. The questions covered various topics relevant to the study, and participants were encouraged to elaborate on their answers when possible. The first section of the survey focused on STEM equipment in the schools and consisted of the following questions:

1. How would you describe the current STEM equipment at your school, and what resources and materials are available to teachers for STEM instruction?
2. What digital tools, devices, or software are used in STEM classes?
3. What special classrooms or laboratories for STEM subjects are at your school?

The second section focused on teachers' qualifications and support:

4. To what extent was STEM a topic in your education?
5. What STEM-related further education have you already attended/are you attending?
6. How would you rate your skills and knowledge in the STEM field?
7. Which support structures or resources for teachers to improve STEM teaching do you know?

The third section focused on the integration of STEM into the curriculum:

8. How is STEM incorporated into the existing curriculum?
9. Which STEM areas are particularly promoted? Are there areas that receive less attention?
10. What is your interest in integrating STEM into your teaching?
11. How do you connect different STEM subjects in your teaching?

The fourth section focused on the student participation and interest:

12. What special opportunities, projects, or competitions are offered at your school to spark and promote interest in STEM?
13. How are the individual strengths and interests of students in the STEM field considered and promoted?

The fifth section focused on cooperation and networking:

14. Which partnerships do you have with universities, research institutions, companies, or experts from the STEM field?
15. How is the cooperation between science subjects and other subjects promoted?
16. Does the school have STEM certificates, or is it aiming for them?

The follow-up interviews were structured following the survey questions, but participants were encouraged to elaborate and discuss additional relevant points.

4.3 Data Analysis

A mixed-methods approach was employed for the data analysis to ensure a comprehensive understanding of quantitative and qualitative insights from the survey and follow-up interviews. The analysis was conducted in two phases: first, the quantitative data from the survey was processed, and second, the qualitative data from the interviews was analyzed to contextualize and deepen the findings. The quantitative data, collected through structured survey questions, was analyzed using descriptive statistics. Frequencies, percentages, and arithmetic mean, where appropriate, are calculated to summarize the teachers' responses. The results were presented through various figures to represent trends and patterns in the responses visually. The qualitative data, gathered from open-ended survey questions and follow-up interviews, was analyzed using thematic analysis. Each response was reviewed, and recurring themes were identified, such as barriers to interdisciplinary teaching, challenges with STEM integration, or the lack of resources. Responses were coded manually to categorize these themes, and illustrative quotes from participants were selected to provide context to the quantitative findings. The integration of both data types allowed triangulate the findings, ensuring that quantitative trends were supported and enriched by the teachers' lived experiences and descriptions of their circumstances. However, this paper's primary focus is on the quantitative data analysis, with qualitative insights used mainly to provide additional context.

5 RESULTS

The results of the survey and the interviews are presented combined in the following subsections.

5.1 STEM Equipment in Schools

In the first section of the survey and follow-up interviews, we examined the availability of STEM equipment in schools. Two participants did not answer the question regarding the equipment available for students and teachers. The remaining participants could identify between four and eleven different types of equipment, with an arithmetic mean of 6.62 (N=34). The most commonly mentioned equipment included: different experiment boxes (n=31), projectors or TVs (n=22), laptops (n=22) ranging from 1 (n=10) to 20 (n=3), tablets (n=26) ranging from one per class (n=1) to all students (n=12), robots (n=22), additional tools for computational thinking (n=10), books (12), PCs (n=12), additional programming tools (n=6), and magnifying glasses (n=6). Additionally, many participants mentioned various apps used for learning across all subjects, highlighting the widespread use of digital tools among students.

Most teachers rated the availability of STEM equipment as "good" or "enough". However, many highlighted that the equipment needed to be updated to be used effectively in the classroom. In secondary schools, all students reportedly had their tablets or laptops. In contrast, in primary schools, the availability of these devices varied significantly—from none at all to sufficient numbers for a single class.

In secondary schools, each classroom was equipped with a fixed PC and either a projector or TV. In contrast, in primary schools, not all classrooms had projectors or TVs, and no fixed PCs were available. One participant described the challenging situation in their school, noting that there were only "2 PCs for 27 teachers". This illustrates the significant disparity in equipment availability between different schools and grade levels.

Five participants did not answer the question regarding special classrooms and laboratories. The others reported between zero and three specialized rooms, with an arithmetic mean of 1.03 (n=31). These included no specialized rooms at all, computer rooms, physics rooms, combined chemistry and physics rooms, handicraft rooms, talent rooms, and material storage rooms. No primary schools reported having dedicated computer rooms. This data indicates significant variation in the provision of specialized STEM facilities, with some schools needing more dedicated spaces for hands-on STEM learning entirely.

5.2 Teachers' Qualifications

The second section of the survey and follow-up interviews examined teachers' qualifications for STEM education. When asked about their initial teacher studies to become educators, all participants answered this question, and the most common response was that they did not receive any formal STEM training (n=14). An additional ten participants indicated they had only minimal exposure to STEM during their teacher studies. In contrast, seven teachers reported receiving full STEM training, and five participants mentioned completing specialized digital education training. Figure 3 shows an overview of these responses.

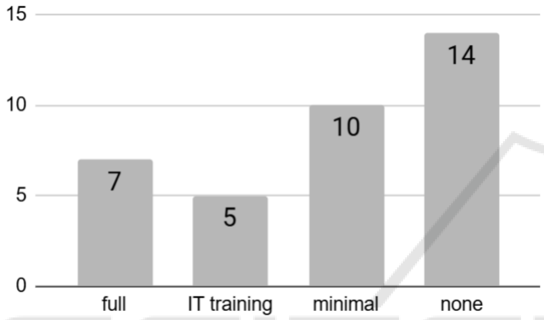

Figure 3: Overview of the teachers' training in STEM.

Ten participants reported not pursuing any further education in STEM after their teacher training, while another ten completed longer, more comprehensive training. The remaining 16 teachers participated in smaller, shorter workshops focused on STEM topics. All the participants answered this question. Figure 4 shows a breakdown of these responses.

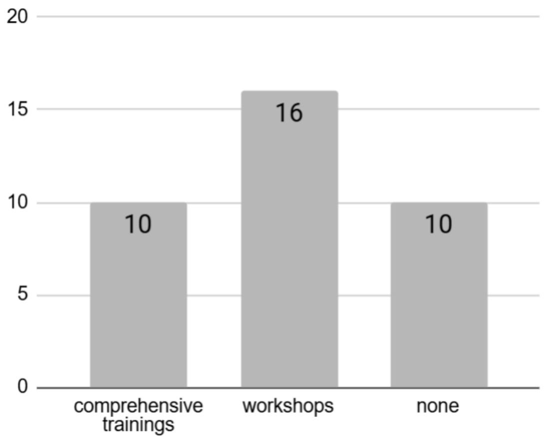

Figure 4: Overview of teachers' further education in STEM.

Teachers were also asked to rate their knowledge and skills in STEM. Again, all of the participants answered the question. The results were as follows: Eleven teachers rated themselves as having medium knowledge and skills in STEM, eight reported good knowledge and skills, eight noted that they had less knowledge, adding that their knowledge and skills could be improved, with one teacher stating, "There is still potential for growth." Five indicated no knowledge and skills, and four described themselves as having very good knowledge and skills. These ratings provide insight into the varied levels of confidence among the teachers in their STEM knowledge. Figure 5 shows an overview of this data.

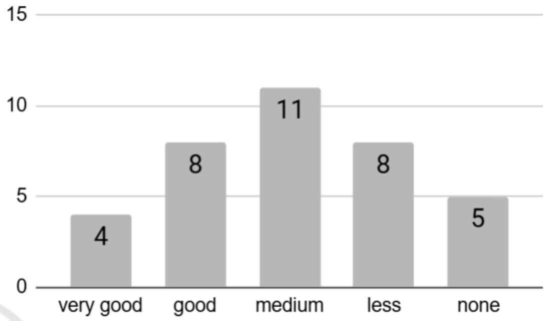

Figure 5: Perceived teachers' knowledge and skills in STEM.

When asked about the availability of support structures or resources to help improve their STEM teaching, 22 teachers reported that no support was available in their school, with one, for example, stating, "There is no money for this". Eleven teachers said that further education opportunities were available, two mentioned they could seek help from colleagues within the school, and one participant noted that their school had an IT team available to assist them. Again, no participants answered the question. Figure 6 shows an overview of these responses.

5.3 Integration of STEM

The integration of STEM into the curriculum was explored through several questions in the survey and follow-up interviews. All participants responded when asked how STEM is incorporated into the existing curriculum. The majority (n=20) indicated that they follow the respective curriculum, with one elaborating on their school's new digital focus and others highlighting that STEM is part of their school's development and quality measures. However, nine participants stated that they do not incorporate STEM at all, with one noting, "I am not doing this at all; we do not have enough equipment or rooms for that". Additionally, seven teachers said they rarely incorporate STEM.

When asked which STEM areas are mainly promoted and which areas receive less attention, 16 par-

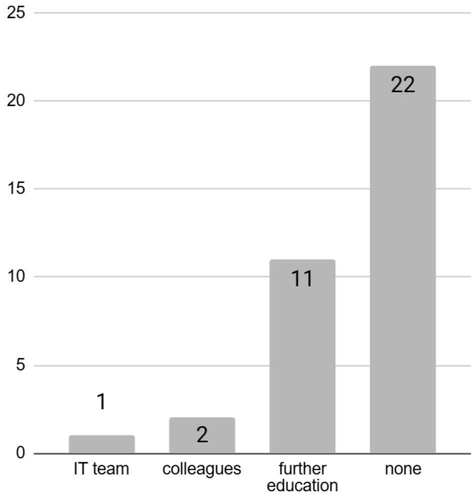

Figure 6: Availability of support structures in participants' schools.

ticipants reported that no specific STEM area was emphasized. Among those who did specify a focus, mathematics was the most frequently mentioned (n=13), followed by IT (n=6), biology (n=1), general science (n=1), and technics (n=1). Several respondents commented that promoting STEM is challenging due to a lack of resources, such as laptops and teaching staff. One participant pointed out that teachers are often required to teach subjects they have not specialized in, a common issue in Austria because they lack qualified teachers. There was also a call for more focus on digital education. Figure 7 provides an overview of these results. Twenty-one participants stated that all STEM areas receive too little attention, with particular emphasis on IT (n=7), with one person noting that "You only learn the basics". Other responses indicated that Natural Sciences (n=4), Geometric Drawing (n=2), and Handicrafts (n=2) are also neglected.

In response to the question about their interest in integrating STEM into their teaching, 14 participants indicated they were interested. At the same time, 13 reported being very interested, leading to a total of 75% expressing interest or strong interest. Eight teachers said they were not interested at all, and one reported only a slight interest. Several participants expressed the desire to integrate more STEM but cited barriers such as lack of time, support, or equipment. For instance, one participant said, "For the children, it is exciting. I would like to do it, but we do not even have a laptop for every child; how should I do this?" Another teacher mentioned, "I know too little about this and don't know how to integrate it." Figure 8 provides an overview of these responses.

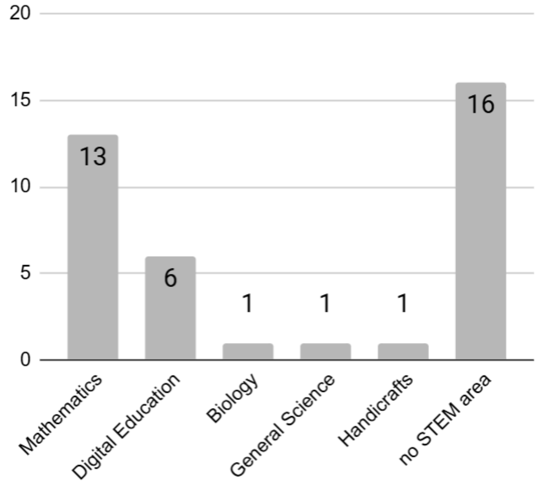

Figure 7: Promoted STEM areas in participants' schools.

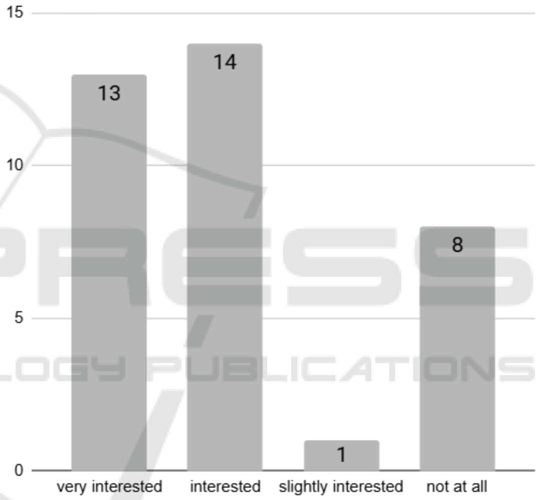

Figure 8: Interest in integrating STEM into teaching.

When asked how they connect different STEM subjects in their teaching, the most common answer (n=16) was that they do not do so. Twelve participants indicated that they regularly combine STEM subjects, citing examples such as integrating digital education with English, General Science, German, Mathematics, and Social Learning. Others noted that teaching interdisciplinary is a requirement in primary school, particularly in subjects like Handicrafts and General Science. Six participants reported they sometimes make these connections, while two said they rarely do so. Examples provided included using tablets in multiple subjects. Once again, it was mentioned that the lack of adequate devices is a barrier in schools. An overview of responses can be found in Figure 9.

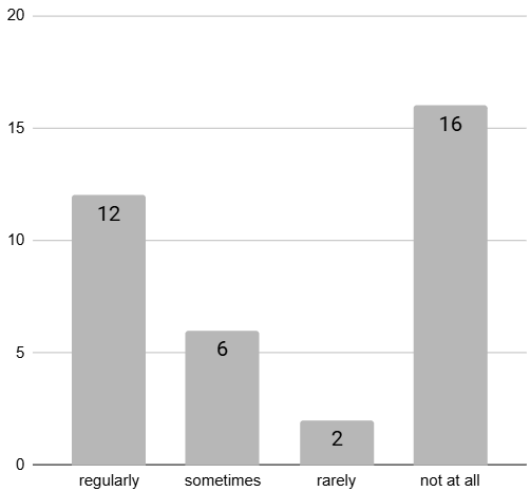

Figure 9: Connecting different STEM subjects.

5.4 Student Participation and Interest

In the fourth part of the survey, focusing on student participation and interest in STEM, the first question asked teachers what exceptional opportunities, projects, or competitions are offered at their schools to spark and promote interest in STEM. Ten respondents stated that no such initiatives are currently offered. However, the remaining 26 teachers reported various opportunities, including special classes designed for talented and interested children (mentioned by 18 participants), experiments in regular classes (n=7), digital education (n=7), robotics activities (n=5), and the use of learning apps (n=2). Despite these offerings, some teachers highlighted a lack of available staff in this field, with one remarking, “We have too few teachers who know these things; how should we do this?” There were also mentions of a desire for more training and workshops similar to those offered in the project at the center of this research. An overview of these findings can be seen in Figure 10.

The second question explored how individual strengths and interests of students in STEM are considered and promoted. Fourteen respondents mentioned special classes for talented and interested students, while nine reported using various learning and teaching strategies to foster these interests. These strategies included collaborative learning (n=1), experimental learning (n=1), interdisciplinary teaching (n=1), inquiry-based learning (1), project-based learning (n=1), and self-directed learning (n=5). Additionally, two teachers referenced programs after or outside regular school hours.

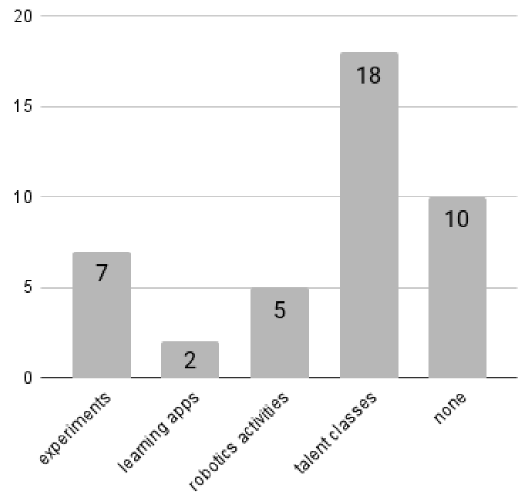

Figure 10: Special opportunities, projects, or competitions offered at participants’ schools.

5.5 Collaborations and Networking

The survey and follow-up interviews regarding collaborations and networking revealed the following insights.

When participants were asked about partnerships with universities, research institutions, companies, or experts from the STEM field, 21 teachers reported that there are no partnerships at all. The remaining participants listed partnerships with a total of eleven different organizations, including the Austrian Economic Chambers, the Austrian Federal Ministry for Education, Science, and Research (BMBWF), centers for education, high schools, local farmers, the police, and universities. These partnerships show a range of connections beyond STEM-specific institutions, though the majority lack such collaborations. An overview of these responses is provided in Figure 11 and 12.

The second question addressed promoting cooperation between science subjects and other disciplines. Twenty participants stated that interdisciplinary cooperation is not promoted in their schools. The remaining 16 participants mentioned various interdisciplinary projects, although many noted that these projects depend heavily on the initiative of individual teachers. One respondent stated, “There is no common practice in our school about interdisciplinary teaching”, while another added, “Sadly, this is happening rarely, because it just takes way too much time”.

The third question focused on whether schools have STEM certificates or are aiming to achieve them. Ten teachers reported that their schools neither have STEM certificates nor plan to pursue them. The re-

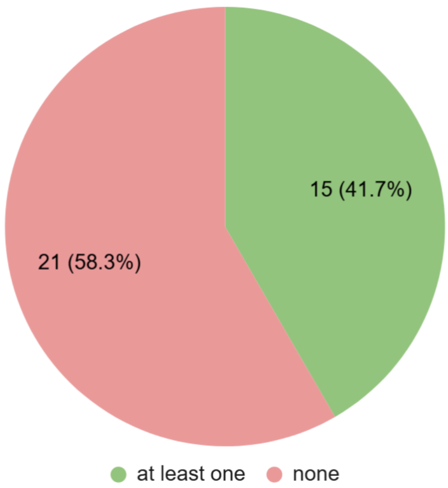

Figure 11: Partnerships between teachers' schools and universities, research institutions, companies, or experts from the STEM field.

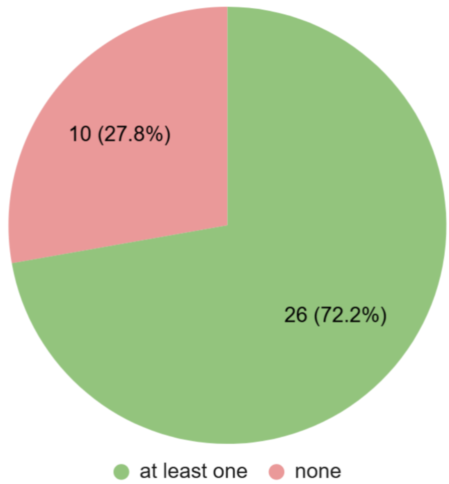

Figure 13: Existence of STEM certificates.

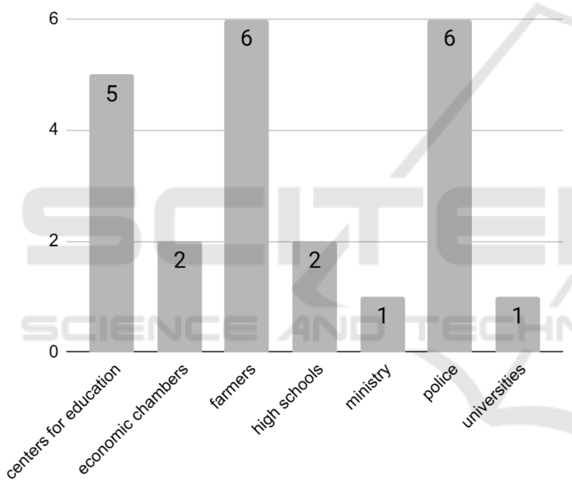

Figure 12: Types of partnerships between teachers' schools and universities, research institutions, companies, or experts from the STEM field.

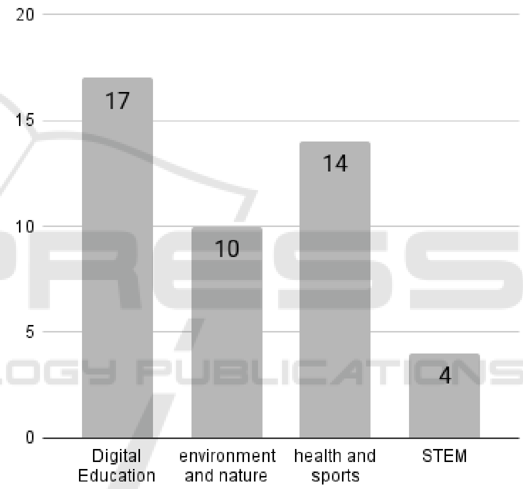

Figure 14: Overview of the fields of certificates of the teachers' schools.

maining participants reported between one and three STEM-related certificates that their schools have been awarded, with an arithmetic mean of 1.25 certificates per school. Eight different certificates were mentioned, including those related to Digital Education, environment, health, nature, sports, and general STEM. These certifications highlight a broader approach to recognition beyond STEM alone. Moreover, teachers from these schools were also interested in achieving more certificates. Figure 13 and 14 provide an overview of these results.

6 CONCLUSION

In conclusion, the findings of this study reveal several insights regarding the state of STEM education in Austrian schools and inform potential areas for improvement in line with the three research questions.

STEM Resources and Teacher Preparation (RQ1): Schools show significant variability in terms of STEM resources, digital tools, and specialized spaces, with some schools adequately equipped while others face limitations due to outdated or insufficient equipment. Teacher preparedness also varies widely; while some educators have received STEM-focused training, others have had limited or no exposure, resulting in a range of comfort and competency levels. Many teachers expressed a desire for more professional development and support structures to effectively incorporate STEM into their instruction.

Integration of STEM into the Curriculum and Student Engagement (RQ2): STEM integration into the curriculum varies across schools. While some schools promote STEM through projects and special classes, others lack the resources or infrastructure to fully engage students. Nevertheless, many teachers display a strong interest in STEM instruction and recognize the importance of fostering student strengths and interests through project-based learning and competitions. However, resource constraints and limited interdisciplinary opportunities sometimes hinder these efforts.

Collaboration and Networking in STEM Education (RQ3): Partnerships with external STEM organizations are limited, with only a few schools reporting active collaborations. Where partnerships exist, they can support interdisciplinary learning and facilitate pathways to STEM certifications. Nevertheless, the lack of a standardized approach to collaboration presents challenges to the consistent implementation of these partnerships across schools.

Overall, the study highlights both the potential and the challenges of enhancing STEM education within Austrian schools. Strengthening teacher training, ensuring consistent access to resources, and fostering partnerships with external STEM organizations will be critical for advancing STEM education and addressing current disparities.

7 DISCUSSION

Findings reveal that teachers' self-perceptions of their STEM skills and qualifications vary widely, with many lacking formal teacher training or ongoing professional development. Similar research with STEM teachers in Austria about the use of technology also shows a lack of knowledge about the efficient use of the latest technologies in the classroom, their utilization in general, and the participants' desire for professional teacher training (Schmidthaler et al., 2023a; Schmidthaler et al., 2023b; Hörmann et al., 2023). Furthermore, this research indicates that interdisciplinary collaboration is largely unsupported as a systematic practice in the participating Austrian compulsory schools, relying instead on the voluntary efforts of individual teachers. Despite some existing projects, a lack of institutional promotion limits regular cooperation across subjects. This inconsistency challenges effective curriculum integration and student engagement in STEM subjects. Like Hörmann et al. 2023, the data highlights a pressing need for better resources and facilities, particularly in Austrian primary schools, where disparities in equipment availability can significantly hinder the implementation of hands-on STEM activities. The pilot project in Steyr represents a proactive step toward addressing these gaps. However, its success will depend on sustained collaboration between local governments, educational institutions, and industry partners (Steyr News, 2024). As teachers express interest in integrating more STEM into their classrooms, creating an environment that fosters interdisciplinary teaching and supports teachers in developing innovative curricula that can engage students effectively (Hörmann et al., 2023) is crucial. Moreover, the lack of partnerships with universities and research institutions can limit the opportunities for primary and secondary school students to engage with real-world applications of their learning. Strengthening these collaborations can enhance the relevance of STEM education and provide students with valuable experiences that prepare them for future STEM careers.

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