Teacher Education at a Crossroads: Computer Science and Digital Education in a Blended Curriculum

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Keywords: Teacher Education, Curriculum Design, Digital Education, Computer Science Education, Educational Policy.

Abstract: In response to the growing need for digital literacy, the Austrian Ministry of Education introduced digital education as a stand-alone subject in 2022, prompting its integration into existing Computer Science teacher training programs. This study explores the effects of this significant curriculum reform on the preferences, perceptions, and preparedness of 70 students enrolled in either the traditional computer science or the newly combined computer science & digital education teacher training. Through a comprehensive survey, the research investigates whether students prefer the blended or the stand-alone computer science university curriculum and identifies the factors influencing their choice. The study also examines how effectively digital education has been integrated into the curriculum and its impact on students' perceptions of their teaching readiness. The findings reveal mixed reactions, with some students appreciating the broader skill set provided by the combined approach. In contrast, others express concern over the diminished focus on core computer science topics. This paper highlights the challenges and opportunities of implementing such curricular changes and offers insights for improving teacher education in the digital age.

1 INTRODUCTION

The rapid development of digital technologies influences almost every aspect of society, and education is no exception. In recognition of the growing need for digital literacy, there have been significant changes in Austrian schools in recent years, including introducing a new subject "Digital Education" (German: Digitale Grundbildung). Computer science (CS) has been incorporated into the Austrian school system since 1985. Nevertheless, despite the early integration of CS education, its scope has remained limited, constrained by time and resources, and it has a narrow focus on rudimentary computer skills.

Over the past few years, Austria's educational system has had a notable shift that emphasizes the integration of digital competencies across all educational levels. In 2018, Austria introduced a digitization strategy that includes the introduction of the new subject of digital education for lower secondary schools. In order to quickly equip teachers with the necessary skills, Austria first introduced in-service teacher training. It recently created a curriculum for a new degree program combining computer science and digital education. Still, many teachers in Austria face challenges in acquiring the necessary competencies to effectively teach digital education (Hörmann et al., 2023a; Hörmann et al., 2023b). However, Bocconi et al. (2022) stated that a lack of adequately prepared teachers is one of the main barriers to introducing computer science into curricula (Bocconi et al., 2022).

Using a comprehensive survey, this study explores students' perceptions of the new blended curriculum and how they rate it in terms of content and suitability for practical use. Section two presents the development of CS education and the major changes regarding digital education. It is followed by the outline of the study's methodology and the discussion of the sur-

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Hörmann, C., Unterweger, M., Schmidthaler, E., Kuka, L., Hinterplattner, S. and Sabitzer, B.
Teacher Education at a Crossroads: Computer Science and Digital Education in a Blended Curriculum.
DOI: 10.5220/0013326500003932

In *Proceedings of the 17th International Conference on Computer Supported Education (CSEDU 2025) - Volume 2*, pages 768-775
ISBN: 978-989-758-746-7; ISSN: 2184-5026

vey results, focusing on university students' views of the new curriculum. Finally, the conclusion summarizes the key findings, reflects on their impact, and provides suggestions for further research.

2 BACKGROUND

In 1985, Austria introduced computer science (CS) as a stand-alone subject in its school system. Currently, the curriculum allocates just two hours per week for CS in the 9th grade of academic secondary schools. Despite nearly four decades of CS education, significant changes have been minimal. As a new subject, it had to compete with established subjects and justify the high cost of infrastructure and space requirements. The rapid advancement of information and communication technologies has often led educators to focus more on specific technologies rather than fundamental concepts (Friedrich and Hartmann, 2010). Additionally, computer science lacks a long tradition and strong advocacy from professional associations (Friedrich and Hartmann, 2010; Döbeli, 2010; Hörmann et al., 2022).

Still, another ongoing debate concerns the curriculum content, which remains vague and open to interpretation. Academic secondary schools, which emphasize general education, must decide what constitutes essential knowledge. Often, teaching is limited to basic computer skills, such as those outlined in the European Computer Driving Licence (ECDL) curriculum, which can give students a narrow view of the field. To provide actual value, CS education should inspire students and demonstrate its broader educational benefits beyond technical skills, preparing them for a society where information is paramount (Mittermeir, 2010; Hörmann et al., 2022). In 2018, the Austrian government introduced a master plan for digitalization, comprising three key areas: revising existing curricula to integrate digital content, enhancing teacher training and education, and improving technical infrastructure and school administration (BMBWF, 2018; Hörmann et al., 2023c).

2.1 Digitalization and 8-Point-Plan

The plan features an eight-point strategy to foster digital education across the school system. Notable initiatives include the Portal Digital School (PoDS), which consolidates various pedagogical and administrative applications intending to streamline school operations (BMBWF, 2020c). Furthermore, a Massive Open Online Course (MOOC) was launched to prepare teachers for blended and distance learning environments. By August 2020, the MOOC had recorded over 11,000 participating educators (BMBWF, 2020b). The plan also emphasizes the enhancement of digital teaching resources through Eduthek (BMBWF, 2024), an Austrian online repository of educational materials, and aims to provide digital devices to students. However, the roll-out of this initiative was delayed due to the COVID-19 pandemic (BMBWF, 2020a; Hörmann et al., 2022).

2.2 Introduction of the Subject "Digital Education"

After a pilot phase in 2017/18, the new subject digital education was implemented in September 2018 for grades 5 to 8, offering schools greater flexibility in the delivery of content. A survey revealed a mix of approaches: Twenty-six percent of schools opted for a stand-alone subject, while others chose to integrate it into existing curricula (Oppl et al., 2021). The curriculum addresses eight critical areas, such as the social implications of digitalization, data security, and computational thinking, all designed to prepare students for life in a digital society (BGBLA, 2018). In November 2021, the Austrian Minister of Education announced that digital education would become a compulsory subject with traditional grading starting in the 2022/23 school year. The revised curriculum will incorporate IT and media education across all grades, beginning in primary education. It places particular emphasis on the 4C's – critical thinking, creativity, collaboration, and communication – to equip students with essential skills for their future careers (Polaschek, 2022; Hörmann et al., 2022; Hörmann et al., 2023c). Computer science and digital education share essential competencies, such as critical thinking and problem-solving. However, their teaching approaches and application methods can diverge significantly (BMBWF, 2024; Informatikportal AHS Österreich, 2022). In computer science, problem-solving is typically tackled through programming tasks, computational exercises, and logical reasoning activities. Conversely, digital education often emphasizes scenarios involving digital ethics, online communication challenges, or media interpretation. These areas require educators to translate problem-solving skills into practical, relatable applications that resonate with students' everyday digital experiences.

2.3 Introduction of the In-Service Teacher Training and Double Degree at Universities

In the 2022/23 academic year, universities of education launched a 30 ECTS credit program designed for current in-service teachers to gain qualifications for teaching the new mandatory subject of digital education. The teacher training started with over 1,000 participants and aims to qualify teachers for teaching digital education (Der Standard, 2024). It focuses on education with, about, despite, and guided by digital media, aligning with curriculum requirements for secondary education. The program incorporates technological, socio-cultural, and application-based perspectives on education in a digitally connected world. Fundamental principles include "Design for All", promoting accessibility for individuals with diverse needs, and sustainability, emphasizing responsible resource use in digital media (BMBWF, 2028), (Gesellschaft für Informatik, 2016). The introduction of in-service teacher training bridges the gap until the students of the new subject have joined them.

In addition, digital education can now be studied in combination with computer science, and university students can teach both compulsory subjects after completing their studies (University of Vienna, 2024). The new structure serves both upper secondary and lower secondary education (University of Vienna, 2024), making it more attractive for new students. Still, few students study computer science (or computer science in combination with digital education), which eventually results in teacher shortages (Statistik Austria, 2024; European Commission and European Education and Culture Executive Agency, 2022).

3 STUDY

3.1 Methodology

The study's primary focus is on examining the perceptions of future (pre-service) teachers about integrating digital education with computer science studies, as well as the challenges and opportunities this blended approach presents within teacher training programs.

The following research question serves as the survey's foundation:

(RQ1) What are the preferences of teacher education students regarding the new blended curriculum of computer science and digital education compared to the previous curriculum?

(RQ2) What factors influence students' decisions to prefer either the standalone computer science program or the combined curriculum?

The underlying survey was conducted in the autumn of 2024 and was sent to all Austrian universities that provide "Computer Science" as a major. Data was gathered using the university-provided, free, 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).

In total, 70 university students currently studying "Teacher Training: Computer Science" or "Teacher Training: Computer Science & Digital Education" attended, but only 49 finished it. As numbers in this field of study are meager, so are the study's participants.

The questionnaire type is a mixed-methods survey that combines quantitative closed-ended questions using a five-point Likert scale with qualitative open-ended questions to gain comprehensive insights into participants' perceptions and opinions. The Likert scale has been employed because it is a commonly used technique for measuring attitudes and perceptions, and it works exceptionally well for quantifying subjective answers (Joshi et al., 2015; Edmondson, 2005; McLeod, 2023). Additionally, when examining these items, the median was chosen as the primary indicator of central tendency. Because the Likert scale generates ordinal data, the median provides a more reliable representation of central tendency than the mean because outliers and extreme values less impact it. The first section of this survey focused on the study program the participants are currently enrolled in and whether they would prefer to switch to other curricula. The following section covers students' perceptions and how well they feel prepared. In the next section, students should declare their own opinion of the new combined field of study. The final substantive question deals with students' plans. Following this, demographic data were collected.

Questions (4), (5), and (6) were implemented by using a scale rating applying a five-point Likert scale (Joshi et al., 2015).

All but three questions could be analyzed quantitatively with statistical tools. The remaining three ((7), (8), and (14)) have been analyzed using a content analysis following the seven-step model outlined by Kuckartz and Rädiker (Kuckartz and Rädiker, 2022). This standard offers a thorough method for structured qualitative content analysis. The first step involves organizing, summarizing, and analyzing the text. The

first coding cycle is based on the major categories identified in the next stage. Subcategories are made if needed, and another coding round is carried out. Additional analyses are possible in the subsequent steps, and the process and outcomes must be documented in the final step. Iterative refining is possible since this spiral process can be restarted at any time (Kuckartz and Rädiker, 2022).

3.2 Quantitative Results

A total of 70 university students enrolled in the "Teacher training computer science" or "Teacher training computer science & digital education" programs participated in the online survey, but only 49 completed it. The gender distribution in this survey looks like the following: 36% (18) identified with "female", 60% (30) with "male", and four percent (two) chose not to answer (n = 50). Considering the age group, 22.45% (11) stated that they were "under 20" years old, 53.06% (26) "20 - 25", 16.33% (eight) "26 - 30", 8.16% (four) "older than 30" (n = 49).

3.2.1 Study Program

Concerning the field of study, 43.55% (27) participants enrolled "Teacher training computer science & digital education bachelor", 37.1% (23) in "Teacher training computer science (& computer science management) bachelor", 6.45% (four) in "Teacher training computer science (& computer science management) master", and 12.9 % (eight) in "Other" (n = 62).

Taking a look at the semesters they are in, 44.23% (23) answered "1st semester", 15.38% (eight) "2nd semester", 3.85% (two) "3rd semester", 7.69% (four) "4th semester", 5.77% (three) "6th semester", 11.54% (six) "8th semester", 1.92% (one) "9th semester", 3.85% (two) "10th semester", and 5.77% (three) "eleven or more semesters" (n = 52, arithmetic mean = 3.63, median = 2).

"Mathematics" was stated 22 times as a second subject, followed by "English" with 13 times, "German" with five times, "Geography" with five times, "Sports" with three times, "Biology" with two times, and "Geometry", "Household Economics and Nutrition", "Technical and Textile Design", "Latin", "Media Design", "Physics", "Polish", "Psychology & Philosophy", "Slovakian", "Slovenian", and "Hungarian" once each.

The majority (32.65%, 16) of the participants graduated from Grammar School, 18.37% (nine) from "Higher Federal Technical College", 16.33% (eight) from "Secondary College of Business Administration", 14.29% (seven) from "College for Social Profession", 10.2% (five) did the "General Higher Education Entrance Examination", 4.08% (two) from "Secondary School for Economic Professions", 2.04% (one) from "College for Early Childhood Pedagogy", and 2.04% (one) did the "Limited Higher Education Entrance Examination" (n = 49).

Furthermore, there were 58.49% (31) students studying in "Linz", 20.75% (11) in "Feldkirch", 11.32% (six) in "Graz", 3.77% (two) in "Salzburg", 1.89% (one) in "Vienna", and 3.77% (two) in "Other cities" (n = 53).

A total of 85.71% (42) of the students indicated that they currently "do not teach at a school", whereas 14.29% (seven) said they do (n = 49).

3.2.2 Students from Computer Science Only

The following results concern the participants who chose the option "Teacher training computer science (& computer science management) bachelor" or "Teacher training computer science (& computer science management) master":

The question "If you had the opportunity, would you choose the pure computer teaching degree again, or would you prefer to study the combined computer science & digital education teaching degree?" was answered by 80.77% (21) with "combined computer science & digital education teaching degree", and by 19.23% (five) with "computer science only" (n = 26) (see Figure 1). This shows a general preference for the blended curriculum among students who have experienced the traditional approach, which provides answers to (RQ1).

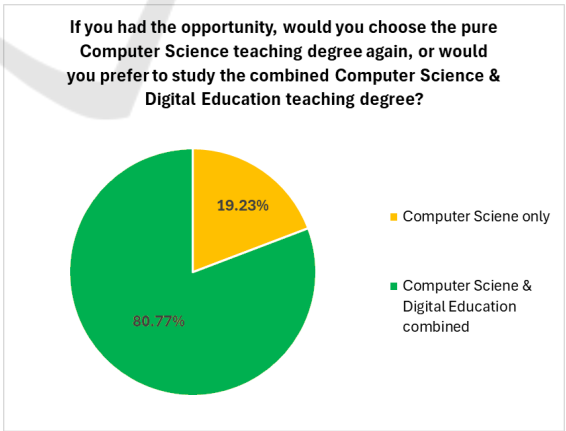

Figure 1: If you had the opportunity, would you choose the pure computer science teaching degree again, or would you prefer to study the combined computer science & digital education teaching degree? (n = 26).

Moreover, 53.85% (14) don't see any "disadvantages in their career prospects because they study computer science only", whereas 46.15% (twelve) do

so (n = 26). When asked if the students think about switching the curriculum, 57.69% (15) stated "Yes", and 42.31% stated "No" (n = 26).

3.2.3 Students from Combined Subject

Subsequent results pertain to participants who selected the "Teacher training in computer science & digital education Bachelor" option:

"Would you have preferred to study only computer science or only digital education instead of the combined subject?" was answered by 11.54% (three) participants with "Yes, only Computer Science", by 23.08% (six) with "Yes, only digital education", and by 65.38% (17) with "No, I like the combination of computer science and digital education" (n = 26) (see Figure 2). This provides a direct comparison of preferences between those exposed to the new and traditional curricula and helps to answer (RQ1).

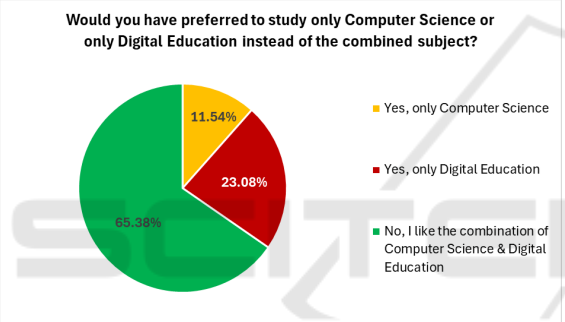

Figure 2: Would you have preferred to study only computer science or only digital education instead of the combined subject? (n = 26).

Of those 3 students, that ticked the option "Yes, only computer science", "Digital Education not that important for me" was chosen two times and one "Digital education does not interest me" once (multiple responses possible).

Taking a closer look at the six participants that would prefer to study digital education solely, the statements "computer science does not interest me" and "computer science is too difficult" were chosen thrice each, and "I assume it requires more effort" twice.

3.2.4 Perceptions of Preparation

The question "How well do you feel prepared for teaching computer science or computer science & digital education?" was assessed by 7.69% (four) with "Very well prepared", by 21.15% (11) with "well prepared", by 34.62% (18) with "Neither well nor poorly prepared", by 21.15% (11) with "not very well prepared", and by 15.38% (eight) with "Not well prepared at all" (n = 52). Since the question uses an ordinal scale, each category can be represented by a number. The response "Very well prepared" is assigned a value of five, indicating the highest level of preparedness. "Well prepared" is assigned a value of four, while "Neither well nor poorly prepared" receives a value of three, representing a neutral level of preparedness. "Not very well prepared" is given a value of two, and the lowest level, "Not well prepared at all" is assigned a value of one. This numerical scale allows to quantify the ordinal data and proceed with the mean calculation. Therefore, the arithmetic mean is approximately 2.85, and the median is "Neither well nor poorly prepared".

When asked "How well do you feel digital education has been integrated into your current studies", 5.88% (three) chose "Very well integrated", 29.41% (15) "Well integrated", 35.29% (18) "Neither well nor poorly integrated", 21.57% (11) "Not very well integrated", and 7.84% (four) "Not well integrated at all" (n = 51, arithmetic mean = 3.04, median = "Neither well nor poorly integrated").

3.2.5 Students' Opinion on Combined Subject

As shown in Figure 3, "How do you rate the decision to introduce computer science & digital education as a combined subject at universities?" was assessed by 29.41% (15) with "Very good", by 37.25% (19) with "Good", by 13.73% (seven) with "Neither good nor bad", by 7.84% (four) "Bad", by 11.76% (six) with "Very bad" (n = 51, arithmetic mean = 3.65, median = "Good").

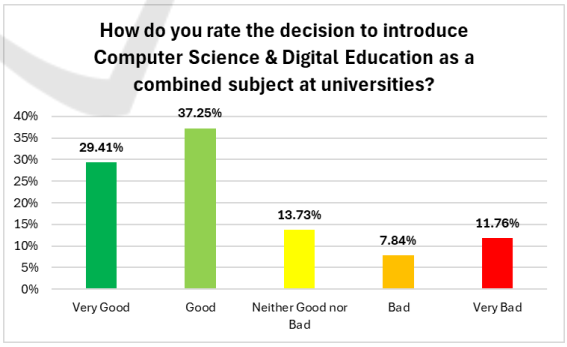

Figure 3: How do you rate the decision to introduce computer science & digital education as a combined subject at universities? (n = 51).

3.2.6 Future Plans

The question "Do you plan to work in the field of education/teaching after graduation?" was answered by 82.35% (42) with "Yes", 3.92% (two) with "No", and 13.73% (seven) with "Unsure" (n = 51).

3.3 Qualitative Results

The following three questions were analyzed qualitatively:

(4) What advantages do you see in integrating digital education into computer science studies? (open question)

(5) What disadvantages do you see in integrating digital education into computer science studies? (open question)

(6) Do you have any other comments or suggestions you would like to share with us? (open question)

Twenty-eight participants answered the question (4). Similar ideas of those comments have been grouped into key themes (see Figure 4):

- Broader career opportunities (six responses)
- Overlap between computer science and digital education (six responses)
- Practical application and relevance in education (five responses)
- Enhanced skill set and versatility for teachers (four responses)
- Criticism or opposition (four responses)
- Pedagogical advantages (three responses)

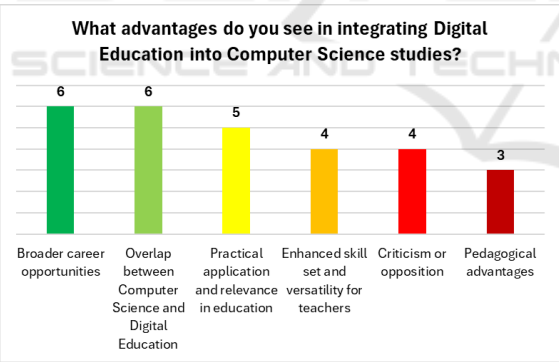

Figure 4: What advantages do you see in integrating digital education into computer science studies?

Furthermore, 28 students commented on the question (5), where the following common themes could be identified (see Figure 5):

- Loss of focus on core computer science (five comments)
- Overloaded curriculum (four comments)
- Loss of advanced computer science skills (three comments)
- Uncertainty about outcomes (three comments)
- Devaluation of computer science degree (three comments)
- Unfair transition for current students (two comments)
- Impact on future career (one comment)

Seven comments were not categorized, as they mostly stated "None", "No idea" or similar responses.

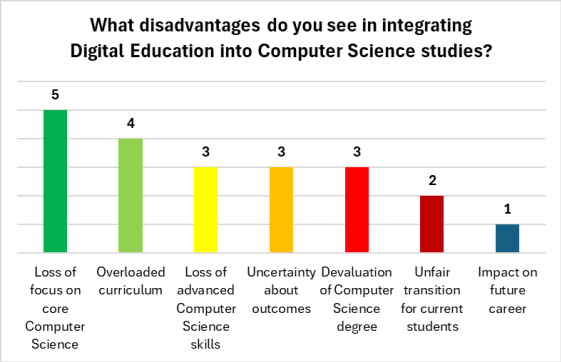

Figure 5: What disadvantages do you see in integrating digital education into computer science studies?

3.4 Discussion

3.4.1 Instrument Validity & Limitations

Although the questionnaire was carefully designed to align with the study's goals, it lacked a formal pilot test. This absence is a limitation, as conducting a pilot test could have enhanced the validation of the instrument's clarity and reliability. Future research should consider implementing a preliminary test with a smaller group to refine questionnaire items and identify potential interpretation issues.

According to Statistik Austria (2024), there were a total of 211 students enrolled in teacher training programs for computer science across Austria in winter term 2023/24, with 51 students enrolled in master's programs (Statistik Austria, 2024). These figures underscore the relatively small size of the cohort specializing in computer science education within the country. Such numbers reflect the niche nature of the field, which impacts the availability of participants for research and studies focused on teacher training in computer science.

3.4.2 Participant Selection & Demographic Representativeness

Participants were drawn from various Austrian universities, enhancing the diversity of the sample concerning educational experiences. However, it is essential to acknowledge that the higher concentration

of responses from certain universities, such as Linz (58.49%), could introduce regional biases. The sample's gender imbalance, although typical of Computer Science programs (Castro Núñez and Santero-Sánchez, 2023), may limit the generalizability of findings when considering broader teacher education or interdisciplinary contexts that might have more balanced gender representation.

One potential bias in this study arises from the composition of the participant pool. A significant portion of the sample comprises students in their first semester of the computer science teacher training program. This demographic skew could introduce bias, as these students may have needed more exposure to the full scope of the curriculum compared to those in more advanced semesters. Consequently, their perspectives might only partially reflect the experiences or opinions of students who have progressed further in their studies and engaged more deeply with the combined curriculum's challenges and opportunities.

3.4.3 Analysis of Research Questions

The survey results indicate a general preference among students for the combined Computer Science and Digital Education curriculum, which directly addresses (RQ1). Approximately 81% of students enrolled in the traditional computer science program expressed a willingness to switch to or preferred the blended curriculum, suggesting a substantial inclination toward the new format. Moreover, students already enrolled in the blended curriculum reported higher satisfaction levels, with around 65% expressing contentment with the combination of subjects.

Concerning (RQ2), one primary influencing factor was the blended curriculum's perceived breadth. Many students who favored the combined program cited the advantage of acquiring diverse teaching skills, which could improve employability and adaptability in the education sector. Approximately 46% of respondents indicated concerns about career prospects influenced their preferences. Some felt that while the blended approach offered a well-rounded education, it might need to be revised in the depth of core computer science content. However, those who preferred the pure computer science curriculum often expressed lower interest in digital education content, viewing it as less relevant to their career aspiration.

3.4.4 Alignment with European Trends in Teacher Education

By mandating digital education in lower secondary schools, Austria complements broader European trends that advocate for embedding digital competencies into formal education. While some countries take a cross-curricular approach, Austria established digital education as a stand-alone subject (European Commission and European Education and Culture Executive Agency, 2022). However, Austria's educational system aligns with the objectives of the European Digital Education Action Plan (DEAP), which emphasizes the development of digital competencies among teachers and students across EU member states (European Commission and Directorate-General for Education, Youth, Sport and Culture, 2023).

4 CONCLUSION & OUTLOOK

The study reveals a complex landscape regarding integrating digital education in computer science teacher training in Austria. Despite a strong preference for the blended curriculum among students, concerns about its potential impact on core computer science education, particularly for those aiming for careers beyond teaching, are significant. However, challenges such as the shortage of trained teachers and the need for in-service teacher training highlight the importance of ongoing investment in teacher education.

Future research should investigate this integration's long-term effects on educational outcomes and career paths. Additionally, areas for further research could include conducting longitudinal studies to track how student preferences and perceptions evolve as they progress through the curriculum and exploring the motivations behind students' decisions to pursue either the standalone or combined programs, particularly in light of the evolving educational demands in the digital age.

ACKNOWLEDGMENTS

This paper employed various AI tools to enhance quality and structure. ChatGPT assisted with idea generation, section organization, and language refinement. DeepL ensured translation accuracy, while Grammarly maintained grammatical correctness, clarity, and style.

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