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Culturally Responsive Unplugged Integration of Computational Thinking Skills in Language/Literature and Arts Lessons: A Case Study in Greece

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Computational thinking skills are recognised as essential competencies for future citizens in an increasingly digital society, and such skills can be cultivated from the early stages of schooling through various pedagogical approaches. This article focuses on a culturally responsive, unplugged approach to teaching computational thinking skills, integrated within language/literature and arts lessons in primary education. The study examines the implementation of specially designed lesson plans for this purpose across multiple grade levels in Greek primary schools. It presents the methodology followed during the implementation of the lesson plans, emphasising the specific objectives related to linking computational thinking concepts with language/literature and arts curricula. Data drawn from the implementation process – including evidence of classroom practices and feedback collected from seven primary school teachers through questionnaires, focus group discussions and reflective journals – were analysed to address the research questions. The findings highlight effective elements of the educational design methodology, offer recommendations for teacher professional development, and underscore the potential of integrated, culturally responsive instruction in fostering computational thinking skills through unplugged activities in language/literature and arts education at the primary level.

Keywords: computational thinking, cultural responsiveness, educational design, integrated teaching, unplugged approach

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Kulturno odzivno vključevanje veščin računalniškega mišljenja v pouk jezika, književnosti in umetnosti s pristopom računalništva brez računalnika: študija primera v Grčiji

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Veščine računalniškega mišljenja so priznane kot bistvene kompetence za prihodnje državljane v vse bolj digitalni družbi, te veščine pa je mogoče razvijati že od zgodnjih stopenj šolanja z različnimi pedagoškimi pristopi. Ta članek se osredinja na kulturno odzivno vključevanje veščin računalniškega mišljenja v pouk jezika, književnosti in umetnosti v osnovni šoli, in sicer s pristopom računalništva brez računalnika. Študija preučuje izvajanje za ta namen oblikovanih učnih načrtov v več razredih grških osnovnih šol. Predstavlja metodologijo, ki se je uporabljala pri izvajanju učnih načrtov, s poudarkom na posebnih ciljih, ki povezujejo koncepte računalniškega mišljenja z učnimi načrti za jezik, književnost in za umetnost. Podatki, pridobljeni iz procesa izvajanja – vključno z dokazi o praksah v razredu in s povratnimi informacijami sedmih osnovnošolskih učiteljev, ki smo jih zbrali prek vprašalnikov, diskusij v fokusnih skupinah in refleksivnih dnevnikov –, so bili analizirani za obravnavo raziskovalnih vprašanj. Ugotovitve poudarjajo učinkovite elemente metodologije načrtovanja pouka, ponujajo priporočila za strokovni razvoj učiteljev ter poudarjajo potencial medpredmetnega, kulturno odzivnega poučevanja pri spodbujanju veščin računalniškega mišljenja prek pristopa računalništva brez računalnika pri pouku jezika, književnosti in umetnosti na osnovnošolski ravni.

Ključne besede: računalniško mišljenje, kulturna odzivnost, načrtovanje izobraževanja, medpredmetno poučevanje, pristop računalništvo brez računalnika

Introduction

The digital transformation of the economy and society influences every dimension of human activity, rendering the cultivation of citizens' digital competence through appropriate educational practices an urgent necessity. Future citizens must be adequately prepared to comprehend the complexities of the modern world and to engage actively in its ongoing digital evolution. In response to this demand, the European Union has established official policies aimed at enhancing digital competence (ECJRC, 2022) and promoting computer science education – referred to in this context as informatics education (ECDEAP, 2020) – to ensure that citizens are equipped to contribute meaningfully to the digital transformation of contemporary society.

The provision of equitable and high-quality computer science education varies significantly across education systems. Approaches range from the inclusion of discrete informatics subjects in basic education to international, large-scale initiatives involving voluntary participation, such as the *Hour of Code* and the *Bebras Challenge*, which seek to mitigate the absence of formal informatics courses at the primary and lower secondary levels (Fesakis et al., 2018). Given the constraints of available instructional time, increasing attention has been directed towards the integration of informatics concepts within the curricula of other subjects, both with and without the use of computers, through the unplugged approach. As well as optimising instructional time, such integration exploits the pedagogical benefits of the "integrated approach" (Neumann et al., 2021), fostering students' active engagement in meaningful learning, promoting deeper conceptual understanding, and encouraging interdisciplinary connections across diverse knowledge domains.

Computational thinking (CT) has been internationally recognised as a conceptual framework for integrating informatics within various school subjects (Fesakis et al., 2018; NRC, 2010; Wing, 2006, 2011). It is considered a cornerstone of digital competence, encompassing the ability to solve problems through the utilisation of informatics principles, methods and tools such as abstraction, generalisation, pattern recognition, algorithmic design, problem decomposition, data representation, simulation and automation, experimentation and play, debugging, persistence and continuation of work, collaboration-teamwork, etc. (Bocconi et al., 2022; Fesakis et al., 2018). CT can be effectively applied not only in disciplines closely related to informatics, such as mathematics and the natural sciences, but also in the humanities, social sciences and arts, reflecting the pervasive influence of digital technology across all fields. Moreover, as a fundamental practice of informatics that supports the solution

of real-world problems, CT can be integrated into nearly every school subject, both in plugged and unplugged forms. Successful implementation, however, largely depends on the preparation and professional development of teachers tasked with facilitating such integration (Fesakis & Prantsoudi, 2019).

Unplugged activities mitigate concerns related to limited access to technological equipment by allowing learners to engage in kinesthetic, hands-on experiences that emphasise core informatics concepts without the distractions or technical demands associated with programming environments and software tools (Webb et al., 2017). When employed with younger students, unplugged activities have been found to enhance perceptual and conceptual understanding more effectively than plugged activities (Sung et al., 2017; Hu et al., 2024). Concurrently, the development of intercultural competence has also emerged as a critical educational objective, given the increasingly diverse and international composition of modern classrooms (Kavenuke & Kihwele, 2025; Portera, 2020).

The present study draws upon the outcomes of an international Erasmus+ project designed to advance the development of CT as a key twenty-first-century skill within primary education. The project involved the design and implementation of culturally responsive educational scenarios that integrate CT into language/literature and arts (visual arts and music) subjects without the use of digital technology – that is, through unplugged methods – drawing inspiration from the cultural heritage of the participating countries. The findings provide valuable insights into the educational potential of CT integration within a culturally responsive and interdisciplinary teaching framework.

The integrated approach to education

The integrated, or embedded, approach to education entails the combination of distinct scientific fields within the learning process to provide students with a more holistic, connected and contextually meaningful educational experience. This stands in contrast to the traditional, single-theme/single-discipline instructional model characterised by discrete and isolated teaching from each scientific field (Drake & Burns, 2004). Integration in education can take several forms, most notably interdisciplinary, multidisciplinary and transdisciplinary approaches (Choi & Pak, 2006). The interdisciplinary approach (Mulder, 2012) leverages conceptual and methodological connections between disciplines, the multidisciplinary approach involves examining a topic through the separate yet complementary perspectives of various fields, while the transdisciplinary approach dissolves the boundaries between scientific fields and often involves

knowledge co-creation with stakeholders outside academia (Klein, 2013). The integrated approach offers substantial educational benefits (Jones, 2010), as it supports deeper learning through the development of a holistic understanding of complex systems, while also facilitating the synthesis of knowledge across domains, enabling students to perceive relationships between diverse concepts and disciplines.

As a fundamental practice within informatics involving the application of computer science concepts to diverse problem-solving contexts, CT can be effectively incorporated into almost all areas of compulsory education (Neumann et al., 2021; Weintrop et al., 2016). Such integration may occur through interdisciplinary, multidisciplinary or transdisciplinary strategies, depending on the degree to which the involved disciplines maintain distinct conceptual boundaries (Drake & Burns, 2004). Within the framework of the present project, CT was integrated into language/literature and arts courses in primary education, mainly through multidisciplinary and interdisciplinary methods, while further extensions to additional subjects and grade levels were also proposed. Although the unplugged nature of the implementation posed additional pedagogical challenges, it also enriched the creative and experiential dimensions of the learning process.

The rationale for integrating CT across subject areas is particularly strong, as even in educational contexts where discrete informatics courses are available, integrated lessons promote a more cohesive understanding of knowledge, allowing students to develop more durable and transferable cognitive schemas. The cultivation of CT competence inherently aligns with the principles of integration, as CT itself embodies the capacity to creatively and effectively apply informatics concepts across multiple domains. This holistic perspective served as the guiding principle for the present study.

Culturally responsive education

Culturally responsive teaching situates academic knowledge and skill development within the lived experiences of students, thereby fostering personal relevance, increased engagement and more effective learning (Gay, 2018). It constitutes a pedagogical framework in which instruction is adapted to reflect teachers' understanding (Mazzuki, 2024) and students' diverse cultural identities, capabilities and resources, often referred to as asset-based pedagogies. Such approaches utilise students' cultural backgrounds, customs, perspectives and lived experiences as instructional tools, positioning knowledge at the core of the learning process while empowering students from all social groups to

become autonomous, critical and lifelong learners. Empirical studies demonstrate that culturally responsive pedagogies enhance students' active participation, motivation, conceptual understanding, self-efficacy and overall academic performance, both quantitatively and qualitatively (Will & Najarro, 2022).

In the context of the present project, culturally responsive lesson plans (LPs) were designed around fairy tales, myths, visual artworks and musical compositions, integrating elements of each participating country's cultural heritage. With respect to CT, the LPs were informed by the Computer Science Teachers Association (CSTA) Standards (2023), which emphasise equity and inclusion through pedagogical frameworks that align with the principles of culturally relevant/responsive pedagogy (CSTA, 2023).

A comprehensive account of culturally responsive CT educational design methodology developed and applied within the project is available at https://inctcorps.pau.edu.tr/.

Computational thinking with the integrated, unplugged approach

Across European education systems, CT is implemented through diverse instructional models, as a cross-curricular concept, as a distinct component of computer-related courses, or through the integration of informatics concepts into other subject areas such as science, literature and the arts (Bocconi et al., 2016, 2022). Consequently, pedagogical approaches to teaching CT vary according to how it is introduced, as well as the specific dimensions and practices emphasised in each educational context (Mannila et al., 2014). Previous research has highlighted the potential of the interdisciplinary integration of CT into subjects including mathematics and science (Weintrop et al., 2016), as well as arts and dance (Leonard et al., 2021). The pedagogical strategies and tools proposed for this purpose are equally diverse, encompassing methods that employ software and computer programming (Sengupta et al., 2013; Werner et al., 2012), technological devices (Atmatzidou & Demetriadis, 2015; Gardeli & Vosinakis, 2019; Leonard et al., 2016), or combinations of programming and traditional social or physical games (Lee et al., 2014).

Despite the range of digital tools proposed for CT instruction, the use of technology is not a prerequisite. CT can also be effectively taught through unplugged activities, which do not rely on computing devices (Bell, 2021). The unplugged approach facilitates the integration of CT across multiple subjects while promoting experiential, hands-on learning and conceptual understanding. In recent years, unplugged activities have been incorporated into official

informatics curricula (Caeli & Yadav, 2020), often within the framework of integrated educational scenarios. These scenarios, grounded in constructivist learning theory, aim to support the teaching and learning of foundational computer science and CT concepts without requiring digital technologies or programming skills.

The playful and kinesthetic nature of unplugged and embodied learning activities fosters dynamic engagement with CT concepts, enabling learners, especially young children, to internalise and express CT principles through physical and creative means (Hu et al., 2024). The overarching goal of unplugged teaching is to broaden students' perspectives on CT and to nurture their intrinsic motivation to apply computational strategies in addressing interdisciplinary, real-world problems relevant to their interests. This approach is rooted in the understanding that computer science, on its own, may not inherently attract students' interest; rather, engagement and meaningful learning occur when activities align with students' perceptions of enjoyment, creativity and personal relevance (Bell, 2021).

Furthermore, unplugged activities have proven valuable in teacher professional development, offering educators accessible, inclusive tools for introducing CT concepts without technological constraints (Bell & Vahrenhold, 2018). Within the present research, the LPs were designed following the unplugged approach to facilitate the interdisciplinary integration of CT into language/literature and arts education at the primary school level.

Research problem and research questions

A review of the existing literature revealed an absence of prior research that combines cultural responsiveness with the unplugged approach to the integration of CT into language/literature and arts lessons in primary education. The present article addresses this gap by examining the implementation of such an approach within the framework of an international educational project and analysing its application in the Greek primary education context. The study aims to provide insights and empirical evidence in response to the following research questions:

1. Are teachers willing and adequately prepared to integrate culturally responsive and computational thinking elements into their daily teaching practices?
2. Can the culturally responsive, unplugged integration of computational thinking into language/literature and arts lessons be both effective and engaging for students?

3, Which aspects of the educational design employed in this research contribute to the success of the proposed approach?

The subsequent sections present the methodology and results of the study, provide answers to the above research questions, discuss the key findings, and propose directions for future research and development.

Method

Participants and research material

The study was conducted within the framework of an Erasmus+ KA220 project, involving partners from Turkey, Slovenia, Greece and Romania. The project's overarching objective was to promote the culturally responsive integration of CT into language/literature and arts lessons through the unplugged approach.

The Greek component of the study involved seven primary school teachers (five general education and two music education teachers; six female and one male) from five public primary schools. Each participating teacher selected two or three LPs from a database of 52 LPs developed by the project consortium. In total, 17 distinct LPs were implemented –12 in language/literature and 5 in arts (visual arts and music) – across Grades 1 to 4, with class sizes ranging from 20 to 25 students. Each LP had a duration of one to three sessions of 45 minutes each. Overall, data were collected from 17 LP implementations, 7 teachers, 155 students aged 6–10 years, and approximately 30 hours of classroom implementations.

Instruments

All of the LPs were designed to promote the development of CT skills while incorporating cultural elements such as tales, stories, myths and legends, folk songs, paintings, recipes, musical instruments, local features (mosaics, labyrinths), or traditional skills (weaving or singing). Each LP supported cross-curricular, multidisciplinary or interdisciplinary approaches and addressed a wide range of CT concepts and practices, including algorithmic thinking, decomposition, pattern recognition, abstraction and debugging. Each LP initially introduces the cultural element and then draws from language/literature and arts national curricula goals. In light of the cultural element, students are engaged in relevant activities to cultivate CT.

The LPs were developed following a standardised five-section template: Section A reports the LP's identity data (title, authors, country of origin, target group, duration, and school subject); Section B describes the aim and the intended learning outcomes, divided into subject-specific, CT-related and culturally responsive (CR) learning goals;

Section C describes in detail the teaching and learning process, including teaching, reinforcement and assessment activities; Section D provides additional information for teachers and proposed extensions; and Section E provides the educational materials. The complete collection of LPs is publicly available on the project's website: https://inctcorps.pau.edu.tr/.

Data collection involved multiple instruments such as a pre-implementation questionnaire completed by teachers to record their initial perspectives and readiness. Reflection and feedback reports were submitted by teachers after implementing each LP. Student feedback forms and completed worksheets provided additional qualitative data. A two-hour focus group discussion was held with all of the participating teachers following the implementation.

Research design

Prior to implementation, all of the teachers participated in a five-hour online training seminar conducted by the research team. The seminar introduced the project's theoretical foundations, familiarised the participants with the educational materials, and provided guidelines for implementation and data collection. Following the training, the teachers were given two weeks to review the theoretical background and select LPs for implementation.

During the implementation phase, the teachers implemented the LPs in their classrooms, collected student work, and documented their experiences through written reflection and feedback reports. Upon completion, all of the teachers participated in a comprehensive focus group session to discuss the process, challenges and perceived outcomes.

The researchers conducted a mixed-methods analysis, integrating qualitative and quantitative data from the various instruments to examine the implementation process, evaluate the teacher and student responses, and address the study's research questions.

The following sections present an analysis of the results, the answers to the research questions, and a discussion of the findings in light of the existing literature.

Results

Teachers' readiness to integrate CR and CT in their teaching

Most of the participants (5/7; 71.43%) reported having previously received some form of preparation related to cultural sensitivity or multicultural education. However, they emphasised that this preparation did not originate from their pre-service teacher training but rather stemmed from personal initiatives and professional interests. Examples included participation in seminars focused on teaching students with refugee or immigrant backgrounds, and attendance at specialised courses during postgraduate studies.

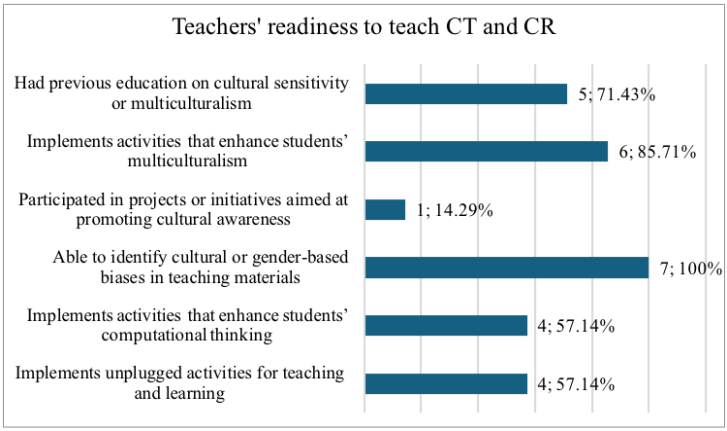
In only one case (1; 14.28%) did a teacher have prior involvement in projects or initiatives specifically designed to promote cultural awareness. Despite this limited formal experience, nearly all of the teachers (6/7; 85.71%) stated that they actively integrate multicultural awareness activities into their everyday teaching practice. Furthermore, all of the participants (7/7; 100%) expressed confidence in their ability to identify cultural or gender-based biases within educational materials, indicating a strong awareness of issues related to diversity and inclusion.

Regarding CT, more than half of the teachers (4/7; 57.14%) reported prior experience teaching CT-related concepts. When asked about their methods for developing problem-solving skills, the teachers described a variety of active learning strategies, including work in groups, case studies, projects, puzzles, treasure hunt, handmade constructions, games, STEM and web tools. They also mentioned fostering critical thinking, creativity and initiative, emphasising the importance of teaching students to follow structured problem-solving steps. Activities such as quizzes, role-playing, concept mapping, observation-comparison games and cooperative learning were cited as effective tools for cultivating analytical and empathetic thinking. The teachers further noted that discussion and guided reflection play key roles in achieving meaningful educational outcomes.

Approximately half of the participants (4/7; 57.14%) had prior experience in integrated lesson plans or unplugged activities that combine multiple subject areas for CT instruction, primarily within physics, mathematics and environmental education.

Figure 1

Teachers' readiness to teach CT and CR



Prior to the implementation phase, the teachers were asked to assess their familiarity with the main concepts underpinning the project. The results indicated that the participants perceived themselves as less familiar with CT and unplugged CT methodologies, while expressing greater familiarity with CR education and integrated curricular approaches.

Following their participation in the five-hour training seminar on CT, CR education, and the use of the LPs, the teachers provided highly positive evaluations of the experience. They described the training using terms such as "helpful", "accurate", "direct", "interesting", "clear", "specific", "enabling" and "supportive". These responses suggest that the training effectively addressed the teachers' knowledge gaps and initial concerns, particularly by helping them recognise CT-related elements already present in their existing instructional practices. The teachers emphasised that the training materials were "clear and easy to use", "interesting" and "understandable". This clarity allowed them to connect theoretical principles with practical applications, thus increasing their confidence in adopting new teaching methods.

After the training, the teachers self-assessed their confidence in implementing integrated, culturally responsive, unplugged CT lesson plans at an average level of 3.3 out of 5 on a Likert scale (1 = not confident to 5 = very confident). This moderate-to-high level of confidence indicates a positive shift in self-efficacy, suggesting that the professional development session contributed meaningfully to their readiness for implementation.

The teachers also expressed optimism about the training's potential to enhance creativity in their lessons and to broaden students' perspectives. One participant notably remarked that the training could serve as "a field of inspiration for new goals, and a basis for further development of existing ones", reflecting an emergent sense of professional growth and innovation. Table 1 presents the teachers' answers to questions before the training, on a 5-point Likert scale (1 = not familiar to 5 = very familiar).

Table 1

Teachers' readiness assessment.

	Means (*N* = 7)
Familiarity with the projects' concepts:	
Computational Thinking	2.7
Unplugged CT Activities	2.6
Culturally Responsive Education	3.6
Integrated Lesson Planning	3.4
Overall effectiveness of teacher training	4
Confidence about implementing the LPs	3.3

Following the implementation of the LPs, the teachers expressed a strong interest in receiving additional training on both CT and CR education. While they evaluated the educational approach employed in the project positively, they emphasised the importance of more extensive theoretical grounding and continuous professional support to enhance their capacity to integrate these concepts effectively into their everyday teaching practice. Some excerpts from the questionnaires and focus group discussions reflect the teachers' perspectives and evolving attitudes after their participation in the project:

T1: *"The LPs really make sense when one understands the theoretical framework, and I suggest that other colleagues who would like to do something similar should study it also."*

T2: *"Participating in this project has helped me to get more familiar with CT concepts."*

T3: *"I am looking forward to read and learn more about integrated CT and I feel there is a lot more that I have to learn."*

T4: *"I really liked it as an idea and educational practice. However, I wish to further cultivate this new method, so that I can be more informed and transmit it more correctly to my students."*

T5: *"I find teaching integrated computational thinking to be an extremely interesting and productive field. I would like to deal much more with the theoretical framework."*

T6: *"It surprised me how much computational thinking is present in many things we do in our daily lives. Also, that computational thinking is taught through school lessons without us realizing it."*

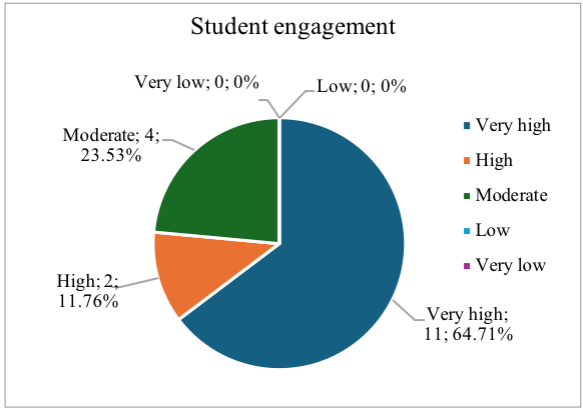
T7: *"…but mainly it made me realize that computational thinking existed in my teaching to a greater extent than I thought."*

Effectiveness of the CR unplugged approach to CT integration

According to the teachers' responses (Figure 2), student engagement during the implementation of the LPs was consistently high. No cases of "low" or "very low" engagement were reported, and the teachers unanimously noted that the students participated with enthusiasm and excitement. In a few instances where engagement during the initial tale or myth introduction phase was moderate, the teachers observed a significant increase in interest once the students began participating in hands-on, unplugged activities.

Figure 2

Students' level of engagement during the implementation of the LPs



The teachers' qualitative comments and interview excerpts provide further evidence of this high level of engagement and its underlying causes (Table 2). The integration of myths, folktales and cultural elements from different countries played a key role in capturing the students' attention and fostering cultural responsiveness. These culturally embedded components not only made

the lessons more appealing but also enhanced the students' cultural awareness and appreciation of diversity.

Table 2

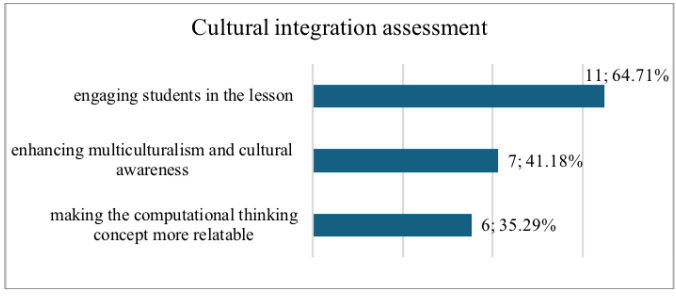
Student engagement evidence

Concept	Evidence
Student engagement	T6: *"Students were listening carefully to the teacher reading the story... answered questions... they collaborated within their groups to complete the activities..."* T1: *"The students were asking questions and they all participated with excitement in the activities."* T5: *"Children's participation in the analysis of the fairy tale was moderate. Then, with the introduction of the worksheet and the presentation of the rhythms, the children's participation increased."*
Reasons for student engagement	T4: *"The students were familiar with the fairytale as they knew it but in the Greek version which has a few differences and similarities."* T7: *"The activities were connected to the heroes, and they increased students' interest."*

The teachers highlighted the fact that the inclusion of cultural content contributed to student engagement in 11 LP implementations (11/17; 64.71%), partially promoted multiculturalism and cultural awareness in 7 cases (7/17; 41.18%), and made CT concepts more relatable in 6 cases (6/17; 35.29%), as illustrated in Figure 3.

Figure 3

Assessment of cultural integration



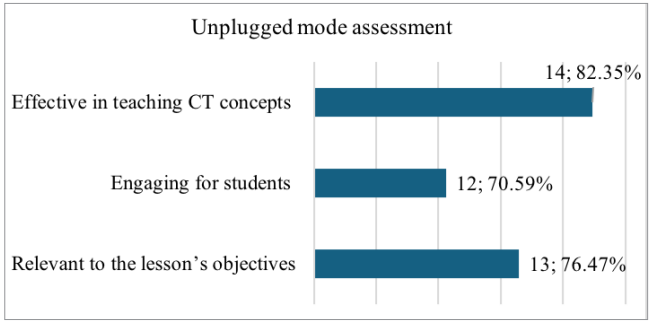
In order to explain student engagement, the teachers mentioned the students' familiarity with the topic, and the engaging and culturally appropriate activities. The students were reported to have enjoyed the fairy tale and connected with the heroes, while their engagement was reinforced by clear instructions

and interesting activities promoting collaboration. However, multiculturalism and cultural awareness were low rated and should be further investigated.

The unplugged mode of the activities was also highly rated as effective in teaching CT concepts (14/17; 82.35%), engaging for students (12/17; 70.59%) and relevant to the lesson's objectives (13/17; 76.47%), as shown in Figure 4.

Figure 4

Assessment of the unplugged mode of the activities



The students were reported to have enjoyed working in pairs or teams through unplugged activities, discovering CT concepts and practices such as perseverance and collaboration. Language and arts lessons offered a new and distinctive context in which students were encouraged to think computationally. At the same time, the teachers indicated that learning objectives related to the arts and language were achieved in 14 cases (14/17; 82.35%), while CT learning goals were met in 16 cases (16/17; 94.12%), demonstrating the strong effectiveness of the LPs. The implementation process was described as highly successful, with no significant difficulties reported by the teachers. Any necessary adaptations, such as adjustments to the duration or the format of the activities (oral or written), were managed effectively according to the needs of each class. Overall, the students appeared to integrate unplugged CT activities smoothly through fairy tales and myths. They were able to partially associate CT with the narratives and, with teacher guidance, identify other situations in which they apply CT unknowingly, such as "following recipes, playing videogames, dressing, brushing teeth, making origami, assembling objects, or choosing a route from home to school", as noted by their teachers. The students also expressed enjoyment in creating and executing pseudocode and exploring how music boxes are programmed. Some of the students were particularly enthusiastic about this new way of thinking and showed eagerness to continue working on

it, while others were initially more sceptical and only recognised the connection between technology and CT after teacher intervention, at which point they became more engaged and interested in learning more about CT and its applications. Selected excerpts from the students' reflective writings capture their evolving understanding and excitement:

S6: *"Helped me discover ways to solve my differences with my classmates when arguing during the school break."*

S5: *"… I created a small musical instrument with the help of my teacher."*

S3: *"I used computational thinking when I tried to compose my own piece of music with the metallophone. I used the code with the table and dots."*

S4: *"In my daily life there are many aspects of what we learned in class – repetitive situations (loops), problem solving, etc."*

S5: *"I use CT sometimes when difficult situations happen to me. In such cases I try to be calm, analyse the situation, think about similar cases in the past and try to find a solution."*

S6: *"… I liked that we talked about music boxes and programming. I wish I could build something like this in the future."*

Educational design of the CR unplugged approach of CT integration

The overall experience was positive and appeared to engage both students and teachers. The integration of multicultural elements within the LPs enhanced student involvement, while the inclusion of tales and myths provided a safe and meaningful context in which learners could emotionally connect with the heroes. Moreover, the unplugged approach not only increased interest and motivation among participants but also facilitated the implementation process by eliminating potential barriers related to technological equipment and digital literacy.

T3: " *An Italian student, who usually did not participate, started participating voluntarily because of the connection he found with the myth of Jason. Familiar educational material activates students."*

T5: *"I am excited by the connection of CT with music. I want to work more on this field."*

Cultural elements such as traditional recipes and folk songs, along with tangible educational materials like Lego and tangrams, were identified by the teachers as particularly effective components of the LPs. They noted that these elements contributed to enhancing student engagement and facilitating conceptual

understanding. The integration of myths was also regarded as highly interesting and pedagogically valuable, as it provided a meaningful narrative framework for linking cultural content with learning objectives, although CT objectives were not highly connected to cultural awareness by the teachers. The reasons for this need to be investigated. However, the teachers emphasised the necessity of language adaptation and editorial adjustments to ensure that the myths correspond appropriately to the students' age level and linguistic competence.

T7: *"In the Romanian scenario, an activity of comparing the fairy tale with the corresponding Greek one emerged and the children's participation became very active and essential."*

T6: *"In the LP with the magical pipe, the use of metallophones and the composition with their own notation activated children."*

Interdisciplinary elements were employed by the teachers to support the implementation of the LPs in the classroom. In relation to the individual subjects, the teachers noted that the combination of myths and CT contributed to the enhancement of the students' language learning, as it encouraged comprehension, sequencing and narrative reasoning. They also emphasised the inherent connection between music and CT, observing that musical structure, rhythm and pattern recognition align naturally with key computational concepts and practices.

T1: "*We worked on the recognition of structural elements of texts.*"

T7: *"They found it quite interesting as this interdisciplinarity in teaching helped them develop their critical thinking."*

T5: *"The playing of music and the creation of music involve elements of CT so it is a normal relationship. If we highlight it, it helps in learning music. If interdisciplinary commonalities are emphasized in LPs, then the cause is served."*

The teachers recognised the cultural responsiveness of the LPs and their capacity to include students from diverse backgrounds. Learners from different cultural and social groups, such as Roma students or those of various religious affiliations, were reported to have participated equally and actively in the implementation of the LPs. According to the teachers' observations, all of the students found the activities engaging and relevant, indicating that the culturally responsive design successfully promoted inclusion and equal participation in the learning process.

T6: *"Contact with the different helped students broaden their horizons and acquire critical skills."*

T1: *"Through fairy tales, they met other cultures and learned about the value of respecting diversity."*

T7: " *Maybe we could bring information from their group, e.g., Roma myths."*

The students' levels of enthusiasm and understanding were observed to evolve during and after the implementation of the LPs. While one student disengaged after facing difficulties, most found the lessons engaging and showed positive behavioural shifts towards collaboration, persistence and active participation.

T6: *"A student with dyslexia gave up on the Pixelart LP. Another student who usually does not work in groups liked the princess who saved the prince and actively participated."*

T4: *"When they had to construct something themselves, they were more excited than answering by writing on the worksheets."*

T1: *"Moreover, they were excited by the idea of an algorithm, an important idea for solving problems."*

The teachers emphasised challenges related to time management and recommended that the LPs be made more flexible to allow easier adaptation. Drawing on their experience, they proposed adjustments such as strengthening the connection between CT and myths, selecting or modifying activities, and replacing written tasks with oral ones. They also advised avoiding direct instruction of CT and suggested including additional cultural groups (e.g., Roma, immigrant communities).

Overall, the teachers noted that only long-term implementations can reveal the true impact of this approach on students' CT skills and cultural awareness. They found it difficult to assess measurable CT skill development but agreed on the importance of continued engagement in such activities to foster CT growth.

T7: "*… the effect is long-term evaluable. If there is continuation, CT will be developed. Cultural diversity requires a combination of many parameters to have a definitive result. The LPs are a positive contribution but what we need is continuity in the interventions."*

Discussion

The results indicate a generally positive experience and reveal important insights regarding teacher preparation, student engagement and the educational impact of the culturally responsive, unplugged integration of CT in subject

fields. The findings highlight both the potential of the approach and the continuing need for systematic teacher training in CT and cultural responsiveness.

Evidence suggests that teachers lack adequate pre-service preparation in cultural awareness, which contributes to cautious attitudes and uncertainty towards inclusive education, an issue similarly noted by Mazzuki (2024). Their readiness to teach cultural responsiveness appears to derive primarily from personal motivation and professional experience rather than formal education. Participation in initiatives promoting cultural awareness was minimal, and the teachers' sense of readiness may be attributed to instinct and accumulated teaching experience. Nevertheless, the importance of strengthening intercultural knowledge to prepare teachers for culturally diverse classrooms has been emphasised in prior research (Kavenuke & Kihwele, 2025), and policies supporting this direction remain essential.

Following the implementation of the LPs, the participating teachers expressed a strong demand for further training, as well as for structured educational materials and curricula. Although they reported familiarity with concepts such as culturally responsive education and integrated lesson planning, their confidence in implementing culturally responsive unplugged CT lessons was moderate. They rated the training they attended highly, reflecting both its effectiveness and above all their need for additional support in this area (Will & Najarro, 2022).

The teachers' responses demonstrated limited confidence and cautiousness regarding CT concepts and practices, which is consistent with earlier findings (Fesakis & Prantsoudi, 2019). While many of the teachers already used practices associated with CT, such as problem decomposition or algorithmic thinking, they often did so unconsciously. The realisation that such practices were already part of their teaching seemed to raise their awareness, but it also highlighted their insecurity and the need for further professional development.

Both the teachers and the students responded positively to the overall learning experience. The teachers described creative and enjoyable teaching moments, while the students were reported to have been highly engaged and actively involved throughout both the storytelling and activity phases. The students recalled their favourite heroes and activities, emphasising how the cultural context created a sense of connection and emotional engagement. Moreover, with teacher guidance, the students were able to relate CT to real-life experiences such as following recipes, playing games or organising daily routines, thus demonstrating the potential for transferring CT concepts beyond the classroom.

The teachers acknowledged the added value of cultural integration, noting that multicultural elements enhanced student participation and engagement

(Gay, 2018). However, while they recognised the motivational role of cultural elements, they did not always perceive a strong conceptual link between these and CT learning outcomes, probably due to their limited understanding of CT. Cultural responsiveness was seen primarily as a means of fostering inclusion rather than as an integral component of computational learning. The unplugged approach further contributed to student engagement by removing technological barriers and reducing the need for specialised skills or infrastructure.

Several aspects of the educational design emerged as critical to the project's success. Activities connected to familiar situations and well-known heroes sustained the students' interest, while cultural references from different countries promoted multicultural awareness and made CT concepts more relatable (Bocconi et al., 2022; Mannila et al., 2014). The use of tangible educational materials and the unplugged format increased accessibility and equity (Hu et al., 2024; Sung et al., 2017). Moreover, the interdisciplinary nature of the approach linked CT with language/literature and the arts, offering a creative and cognitively stimulating context that fostered engagement and learning in both academic and cultural domains (Žnidaršič, 2022).

The participating teachers suggested improvements concerning time management, activity format (oral, written or visual), inclusion of more cultural groups (e.g., immigrants, refugees, Roma), and longer intervention periods, emphasising that sustained application is necessary in order to observe measurable progress in CT skills and cultural awareness.

Overall, the results demonstrate that student engagement was the most immediate and pronounced outcome of the intervention, clearly surpassing observable gains in CT skills or cultural awareness. The students' enthusiasm and participation were strong indicators of the approach's motivational power and inclusiveness. While CT skills and cultural understanding were fostered to some degree, their development was less evident and harder to assess within the short implementation period. The teachers appear eager yet insufficiently prepared to integrate CT and cultural responsiveness fully, underscoring the need for ongoing professional development. Nonetheless, the overall effectiveness of the LPs and the positive feedback from both students and teachers affirm the potential of the integrated, culturally responsive, unplugged approach as a sustainable model for fostering engagement, inclusivity and the gradual cultivation of CT competence in primary education.

Conclusions

Based on the findings of this research, the culturally responsive, unplugged integration of CT into language/literature and arts lessons proved to be both effective and engaging for students and teachers. The results demonstrate that this educational design can be feasibly implemented in real classroom settings to support the cultivation of CT skills while simultaneously promoting cultural awareness and inclusion. Teachers appeared willing and able to adopt the proposed approach in their daily practice; however, they also expressed a need for further support and training to acquire a deeper understanding of CT concepts and pedagogical applications. Such support could be systematically provided through pre-service and in-service professional development programmes, as well as through the development of relevant curricula and instructional materials designed to scaffold CT integration. Future research should therefore explore teachers' specific training needs, focusing on effective strategies for developing their CT competence and confidence in implementing integrated, culturally responsive approaches.

The study also concludes that the culturally responsive unplugged approach constitutes an appealing and effective pedagogical model for cultivating CT skills in primary education. By combining cultural narratives with hands-on, technology-free activities, this approach successfully enhanced students' engagement, motivation and sense of connection to the learning content. These findings suggest that a methodology of this kind can serve as a powerful vehicle for promoting CT integration across disciplines. Future studies could expand on this work by increasing the sample size, involving a broader range of teachers, students and lesson plans, and conducting long-term interventions to assess the sustained effects of this method. Additionally, the use of validated assessment instruments would enable more precise evaluation of CT skill development and its potential influence on students' future academic, social and professional orientations.

Key educational design features contributing to the success of the approach include the interdisciplinary integration of CT across multiple subjects and the use of the unplugged methodology. This combination enabled the achievement of diverse learning objectives while optimising instructional time and resources and reducing inequities related to technological access or prior knowledge. Building on these strengths, future research could focus on reviewing, designing and evaluating curricula and learning materials that incorporate CT skills into other subject areas, leveraging cultural content and the unplugged format to ensure inclusivity and engagement.

Finally, it is recognised that computational thinking is a complex and multi-dimensional construct, requiring systematic, long-term and well-designed interventions to be meaningfully developed. This study represents a contribution towards that broader goal by offering empirical evidence and pedagogical insights that support the integration of CT, cultural responsiveness and unplugged learning as complementary dimensions of effective, equitable and future-oriented education.

Ethical statement

The research study was carried out following ethical standards for pedagogical research and was approved by the University of the Aegean Research Committee, Greece.

Disclosure statement

The authors have no conflict of interest to declare.

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