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INTEGRATING MOBILE TECHNOLOGY IN COMPUTER SCIENCE EDUCATION AT TERTIARY LEVEL

Abstract

This study addresses the imperative for contemporary computer science educators to integrate mobile technology into their pedagogy, with a particular focus on mobile gaming applications for educational content. Through a meticulous literature review and surveys, the research identifies crucial competencies required by computer science teachers, evaluates current assessment methods, and proposes integrative strategies for curricula. Key competencies such as coding, pedagogical integration of technology, and game design principles are spotlighted. The development of assessment tools aims to balance theoretical knowledge with practical application, ensuring educators' readiness for a digitally oriented classroom. Proposals for curriculum integration emphasize the harmonization of technical skills with effective teaching methods, aligning education with rapid technological advancements. The findings suggest the need for enhanced teacher training, practical application opportunities, and industry-academia collaboration. This research contributes a framework for updating computer science education, preparing educators to meet modern technological challenges and enrich student learning outcomes.

Keywords: computer science education, mobile technology integration, educational gaming applications, teacher competency assessment, curriculum development, pedagogical strategies, technology, industry-academia collaboration.

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УНИВЕРСИТЕТТЕРДЕ ИНФОРМАТИКА ПӘНІНДЕГІ ОҚЫТУДА МОБИЛЬДІ ҚОЛДАНБАЛАРДЫ ДАМЫТУ ТЕХНОЛОГИЯЛАРЫН ИНТЕГРАЦИЯЛАУ

Аңдатпа

Бұл зерттеу жоғары оқу орындарында білім беру бағдарламасында мобильді ойын қосымшаларын даярлау дағдыларын үйретуге ерекше назар аудара отырып, қазіргі информатика мұғалімдері үшін мобильді қосымшаларды әзірлеуді педагогикаға біріктіру қажеттілігін зерттейді. Әдебиеттерді шолу және сауалнамалар арқылы зерттеу информатика мұғалімдеріне қажет сыни құзыреттерді анықтайды, ағымдағы бағалау тәжірибесін бағалайды және оқу бағдарламасына интеграциялық стратегияларды ұсынады. Бағдарламалау, технологияны педагогикаға біріктіру және ойынды құрастыру принциптері сияқты негізгі құзыреттерге баса назар аударылады. Бағалау құралдарын әзірлеу білім берушілердің цифрлық сыныпқа дайын болуын қамтамасыз ете отырып, теориялық білімді практикалық қолданумен теңестіруге бағытталған. Оқу бағдарламаларын біріктіру бойынша ұсыныстар техникалық дағдыларды тиімді оқыту әдістерімен үйлестіруге, білім беруді жылдам технологиялық жетістіктерге сәйкестендіруге баса назар аударады. Нәтижелер мұғалімдердің біліктілігін арттырудың, тәжірибе мүмкіндіктерінің және өндіріс пен академия арасындағы ынтымақтастықтың қажеттілігін көрсетеді. Бұл зерттеу информатика білімін дамытуға, мұғалімдерді бүгінгі технологиялық мәселелерді шешудегі дағдыларын арттыруға және оқушылардың оқу нәтижелерін жақсартуға негіз береді.

Түйін сөздер: информатика бойынша білім, мобильді технологиялар интеграциясы, білім беру ойын қосымшалары, мұғалімнің құзыреттілігін бағалау, оқу жоспарын әзірлеу, педагогикалық стратегиялар, технология, сала-академияның ынтымақтастығы.

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ИНТЕГРАЦИЯ ТЕХНОЛОГИЙ РАЗРАБОТКИ МОБИЛЬНЫХ ПРИЛОЖЕНИЙ В ОБУЧЕНИИ ИНФОРМАТИКЕ В ВУЗАХ

Аннотация

В этом исследовании изучается интегрирование разработки мобильных приложений в педагогику для современных преподавателей информатики и дальнейшее, уделяя особое внимание мобильным игровым приложениям для образовательного контента, после чего делается вывод о необходимости такого подхода. Посредством обзора литературы и опросов исследование определяет важнейшие компетенции, необходимые учителям информатики, оценивает текущие методы оценки и предлагает интегративные стратегии для учебных программ. Особое внимание уделяется таким ключевым компетенциям, как программирование, интеграция технологий в педагогику и принципы игрового дизайна. Разработка инструментов оценки направлена на то, чтобы сбалансировать теоретические знания с практическим применением, обеспечивая готовность преподавателей к работе в цифровом классе. В предложениях по интеграции учебных программ делается упор на гармонизацию технических навыков с эффективными методами обучения, приведение образования в соответствие с быстрым технологическим прогрессом. Полученные результаты свидетельствуют о необходимости улучшения подготовки учителей, возможностей практического применения и сотрудничества между промышленностью и научными кругами. Это исследование создает основу для обновления образования в области информатики, подготовки преподавателей к решению современных технологических задач и улучшения результатов обучения учащихся.

Ключевые слова: образование в области информатики, интеграция мобильных технологий, образовательные игровые приложения, оценка компетентности учителей, разработка учебных программ, педагогические стратегии, технологии, сотрудничество между промышленностью и научными кругами.

Main provisions

This research focuses on the essential need for modern computer science educators to incorporate mobile technology, specifically emphasizing educational applications through mobile gaming.Through thorough examination of literature and surveys, the study identifies essential skills needed by computer science instructors, assesses existing assessment techniques, and suggests methods to integrate these skills into curricula effectively. Important skills like programming, integrating technology into teaching, and understanding game design principles are emphasized.

This study provides a framework for modernizing computer science education, equipping educators to address current technological challenges and enhance student learning results.

Introduction

The rapid proliferation of mobile technology has necessitated a reevaluation of competencies for computer science educators, especially in leveraging mobile gaming applications for educational purposes. This study is structured around three core research objectives aimed at addressing the evolving demands of computer science education in the context of mobile technologies. The relevance of the problem at hand lies in the urgent need to equip educators with the skills and knowledge to effectively integrate these technologies into their teaching practices, ensuring that students are well-prepared for a technology-driven future. By focusing on the pedagogical potential of mobile gaming, this research seeks to bridge the gap between current educational practices and the innovative tools that are increasingly shaping the digital landscape.

Defining the objectives of the study involves three key components. The primary goal is to pinpoint the abilities required for educators, in computer science. It aims to highlight the expertise needed for developing and using mobile gaming applications. This involves not programming and game design concepts but incorporating teaching methods, with technological resources to enhance learning effectively.

The second goal involves creating assessment methods. This means developing accurate tools to assess the skills identified covering both the basis and real world use of mobile technology, in education. These tools are essential to help educators have the needed abilities to succeed in an environment enriched with technology.

The final objective revolves around proposals for curriculum integration. The study aims to provide recommendations on how to embed these competences in the training curricula of future computing teachers. It highlights the need to strike a balance between in-depth technical acumen and pedagogical finesse. The intended outcome is a curriculum that not only keeps pace with technological advances, but also promotes effective teaching methods.The culmination of this research will contribute to a comprehensive framework that empowers educators to effectively harness mobile technology, thereby enriching the computer science education paradigm and enhancing student learning experiences.

This review critically examines the evolving competencies required in computer science education, emphasizing the integration of mobile technologies and their pedagogical applications. It spans global research with a particular focus on how these developments pertain to Kazakhstan's educational context. The main problematic provisions have two different directions. Teachers in Kazakhstan may not be receiving the professional development and ongoing support needed to acquire and effectively utilize these developing competencies in their classrooms. Also there may not be enough emphasis on developing and implementing assessment tools to measure the effectiveness of mobile technology integration in computer science education in Kazakhstan.

In the realm of computer science education, a crucial aspect of pedagogical competency is striking a balance between theoretical knowledge and hands-on technological skills. Angeli and Giannakos [1] emphasize the importance of computational thinking as a fundamental competency for educators, particularly in the digital age. This skill extends beyond mere coding; it involves a problem-solving mindset that is essential for understanding and applying computer science principles.

However, a significant gap is evident in the literature regarding the integration of mobile technologies and gaming applications within computer science education. This gap is not just about the technical skills needed to use or develop these applications, but also about understanding their pedagogical implications. The rapid evolution of mobile technology and its widespread use in everyday life makes it a critical area for educational integration, yet current curricula seem to lag behind these technological advancements. This disconnect between educational practices and technological evolution suggests that educators might not be fully prepared to leverage these technologies effectively in their teaching practices.

To address this, there's a need for more research and curricular development focusing on the integration of mobile technologies in computer science education. This could include exploring the pedagogical potentials of mobile gaming applications, which offer an engaging and interactive way of learning complex computer science concepts. The current lack of emphasis on these areas in the literature points towards an urgent need for curriculum updates and professional development opportunities for educators, to equip them with the necessary skills and knowledge to navigate this rapidly changing technological landscape.

The integration of mobile technologies in education, particularly through mobile learning (m-Learning) and educational mobile gaming applications, represents a significant shift in teaching methodologies. Ally [2] highlights the evolving competency profiles required for educators in digital and online contexts, emphasizing the need for dynamic and adaptive skill sets. However, the potential of mobile gaming applications in enhancing learning outcomes remains underexplored in current literature, signaling a vital area for further research. This gap is especially noteworthy in the context of inquiry-based learning approaches and the individualization of educational experiences, where mobile technologies can play a transformative role. Studies like those by Onyema et al. [3] investigate the potentials of mobile technologies in improving inquiry-based learning methods, underscoring their effectiveness in engaging and interactive learning. Furthermore, the work of Tangirov and Sattarov [4] delves into the didactical possibilities of mobile applications, highlighting their role in

the individualization and informatization of education. This suggests a vast potential for mobile technologies to cater to diverse learning needs and styles, thereby enhancing the overall educational experience. The comparative analysis examines prominent game development platforms – Unity, Fusion, and Unreal Engine – in the context of their application in educational environments. This section highlights the unique attributes, advantages, and challenges of each platform, offering insights into their suitability for developing educational content (Table 1). The analysis serves as a guide for educators and developers in choosing the most appropriate platform to meet their specific educational application needs.

Table 1. Comparison of mobile programming languages

Unique attributes	*Unity*	*Unreal Engine*	*Fusion*
Accessibility	*User-friendly interface, suitable for beginners and experienced developers alike [5].*	*Advanced features presenting a steeper learning curve, more suitable for experienced developers [6].*	*Intuitive interface and easy to use, making it suitable for beginners and those without traditional programming experience.*
Cross-Platform Development	*Supports a wide range of platforms including mobile, PC, consoles, and web browsers [5].*	*Also supports multiple platforms, often preferred for PC and console development due to high-end graphics capabilities [5].*	*Fusion offers capabilities for developing games across various platforms, though it's more renowned for its 2D game development strengths.*
Graphics	*Improved graphics capabilities but may fall short compared to Unreal Engine for highly realistic visuals [6].*	*Renowned for photorealistic graphics, advanced rendering techniques, and high-quality visual effects [6].*	*While Fusion is powerful for 2D game development, it may not match the advanced 3D graphical capabilities of engines like Unreal.*
Scripting	*Uses C# for scripting, offering a balance of simplicity and power [6].*	*Utilizes a hybrid approach of Blueprint visual scripting and C++ programming, allowing for complex game logic creation [5].*	*Fusion allows for game and application development without traditional programming, utilizing a more visual and event-based programming language.*
Asset Store	*Extensive library with a variety of assets, including models, textures, and scripts [5].*	*Vast library of high-quality assets, particularly advanced graphical assets and tools [5].*	*It has a community-driven extensive object repository with a variety of game-building assets and extensions.*
Performance	*Suitable for mobile and less demanding projects, may require optimization for high-end projects [6].*	*Better suited for visually demanding and high-performance games, requires more powerful hardware [5].*	*Fusion is well-optimized, especially under high object numbers, making it suitable for PC and iOS development.*
VR/AR Support	*Offers straight-forward VR/AR development, making it accessible for beginners [5].*	*Provides advanced features for high-end VR/AR experiences [5].*	*Specific VR/AR support capabilities are not as prominent as in Unity or Unreal Engine.*
Community and Support	*Large community with ample resources and tutorials, especially beneficial for beginners [5].*	*Supportive community with expertise in advanced topics and AAA game development [6].*	*Fusion boasts a supportive and passionate community, with forums and events fostering a community spirit among its users.*

The comparative analysis of Unity, Fusion, and Unreal Engine reveals distinct differences in their approach to game development, particularly in educational settings. Unity and Unreal Engine emerge as strong contenders for high-end, graphically intensive projects, with Unity being more accessible to beginners and Unreal Engine offering advanced visual capabilities. Fusion, while less advanced in 3D graphics, provides an intuitive platform ideal for beginners and 2D game development.

Comparatively, other engines like Godot, CryEngine, Lumberyard, and Construct also offer unique features. Godot is known for being open-source and user-friendly, CryEngine for its advanced graphics, Lumberyard for its integration with Amazon's AWS services, and Construct for its simplicity and focus on non-programmers. Each of these alternatives presents its own set of advantages, catering to different needs and expertise levels in the realm of educational game development.

Existing methods and tools for assessing teacher competencies in technology often include a mix of self-assessment questionnaires, performance-based evaluations, and peer reviews. Self-assessment tools typically involve teachers reflecting on their own skills and knowledge in using technology in the classroom. Performance-based evaluations observe teachers in real or simulated teaching scenarios to assess their practical application of technology. Peer reviews involve colleagues or experts reviewing and providing feedback on a teacher's use of technology, offering a collaborative approach to competency assessment. These methods aim to gauge both theoretical understanding and practical application of educational technology.

The discussion on competency assessment methods in teacher technology education integrates insights from several key studies. Miranda et al. [7] suggest that with the advent of Education 4.0, assessment methods are increasingly leaning towards evaluating the application of technology in realistic settings, rather than just theoretical knowledge. This is echoed in the work of Bahodirovich and Romilovich [8], who advocate for project-based assessments that reflect real-world challenges teachers might face.

Ally [2] contributes to this discussion by highlighting the unique competencies required for digital and online teaching. The assessment of these competencies, therefore, demands tools that can evaluate not just technical skills but also the ability to engage and educate in a virtual environment. Fernández-Batanero et al. [9] further reinforce the need for continuous and systematic assessment methods that evolve alongside digital advancements in education.

These studies collectively underline a shift in assessment paradigms - from traditional, knowledge-based evaluations to dynamic, skill-and-application-oriented approaches. This shift reflects the broader changes in educational technology and underscores the necessity for assessment methods that are adaptable (Figure 1), practical, and aligned with the digital competencies required in contemporary education.

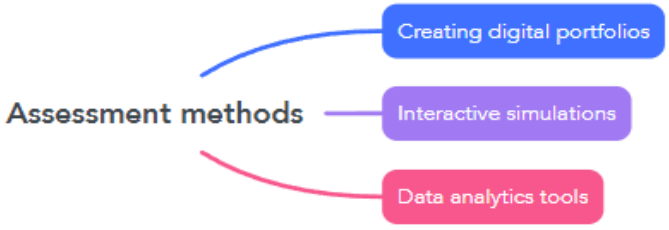

Figure 1. Assessment methods for evaluating teacher competencies

Emerging assessment methods for evaluating teacher competencies in technology include digital portfolios, interactive simulations, and data analytics tools. Digital portfolios allow teachers to showcase their integration of technology in teaching through a collection of digital artifacts. Interactive simulations provide an immersive environment where teachers can demonstrate their technological skills in a controlled, yet dynamic setting. Data analytics tools use data gathered from

various digital platforms to assess teachers' engagement with and effective use of educational technologies. These innovative approaches provide a more comprehensive and practical assessment of teachers' technological competencies. The assessment methods, such as digital portfolios, interactive simulations, and data analytics tools, not only evaluate teachers' skills but also reflect the kind of technological integration that modern curricula aim to achieve.

Understanding how teachers are assessed for their technological proficiency provides insight into what is valued and prioritized in educational technology, thus informing the curricular models and case studies explored in the context of integrating technology into computer science education. This connection highlights a reciprocal relationship where effective assessment drives curriculum development, and innovative curricular models, in turn, shape the focus of competency assessments.

In the realm of curriculum design, several models (Figure 2) have emerged that effectively integrate technology competencies, especially in computer science education. A prominent model is the TPACK (Technological Pedagogical Content Knowledge) framework, which emphasizes the intersection of technology, pedagogy, and content knowledge. This model advocates for a holistic approach where educators are not only proficient in their subject matter but also skilled in pedagogical strategies enhanced by technology.

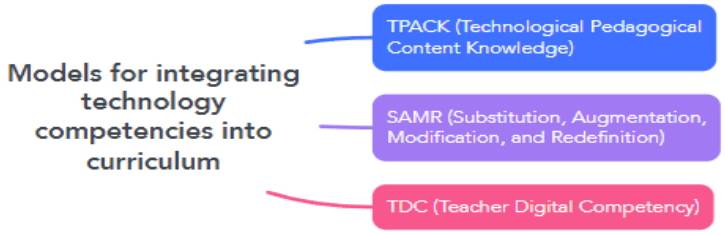

Figure 2. Models for integrating technology competencies into curriculum

Another significant model is the SAMR (Substitution, Augmentation, Modification, and Redefinition) model, which provides a method for moving through degrees of technology integration in teaching. The model challenges educators to progress from merely substituting traditional methods with technology (Substitution) to transforming learning experiences in ways that were previously inconceivable without technology (Redefinition).

Third framework, TDC (Teacher Digital Competency) framework, by Falloon [10] presents a comprehensive conceptual framework that expands the view of teacher digital competence. The TDC framework moves beyond traditional technical skills and literacy conceptualizations and advocates for a more holistic and broad-based understanding of the knowledge and skills needed in diverse and digitally-mediated environments. This framework is significant for its interdisciplinary nature, emphasizing the need for comprehensive digital capabilities in educational settings. It also offers practical suggestions for faculty on implementing this framework, underlining its applicability in contemporary education.

In computer science education, specifically, the incorporation of project-based learning (PBL) and flipped classroom models, supported by digital tools and resources, has shown significant promise. These approaches encourage active learning and hands-on experience with technology, crucial for developing practical skills in computer science.

The following cases showcase the successful integration of the programming into the curriculum.

-MIT’s Introduction to Computer Science and Programming: This course, widely popular on platforms like edX, successfully integrates technology by using an online learning platform, enabling interactive learning experiences. It combines video lectures, interactive problem sets, and a community forum, thereby enhancing engagement and practical application of computer science principles.

-The Flipped Classroom Model in High Schools: A case study in a high school showed that flipping the classroom – where students engage with lecture content at home and work on problem-solving in class – significantly improved students' practical skills in computer science. The use of technology for accessing content outside the classroom and for collaborative projects inside the classroom proved effective.

Despite all the opportunities, there are distinctive challenges in integration technology, especially, creating mobile applications into the curriculum such as limited access to internet in some locations and teacher preparedness. The second is the central issue of the present article, and the object that the present article aims to investigate. Rural schools face challenges in integrating technology in computer science education due to limited access to high-speed internet and modern computing resources. This limited the effectiveness of technology-dependent curricular models.

Moreover, in some instances, despite having the technological tools, the lack of adequately trained teachers to integrate these tools into the computer science curriculum posed a significant challenge. This underscores the need for professional development focused on technological competencies. These curricular models and case studies demonstrate the varying degrees of success and challenges in integrating technology into computer science education, highlighting the importance of access, teacher preparedness, and innovative teaching strategies.

In conclusion, the review of literature on teacher competencies in technology, innovative assessment methods, and integration into curricula reveals several key findings.

There is a clear emphasis on developing comprehensive technological skills among educators, moving beyond basic digital literacy to encompass a more integrated, practical application of technology in pedagogy. Moreover, Innovative assessment methods, such as digital portfolios and interactive simulations, are increasingly recognized for their effectiveness in evaluating technological competencies. These methods offer a more holistic and authentic measure of teachers' abilities to integrate technology in educational settings.

Finally, models like TPACK and SAMR, along with project-based and flipped classroom approaches, are pivotal in embedding technology into curricula. Successful case studies highlight the transformative potential of these models in enhancing computer science education, while challenges point to issues like access and teacher preparedness.

Despite these insights, several gaps remain in the existing literature, which this research aims to address. There is a need for more longitudinal studies to understand the long-term effects of technology integration in education, particularly how it influences teaching practices and student outcomes over time. Much of the current research is centered on specific educational contexts or regions. More studies are needed to explore how technology integration and teacher competencies vary across different educational settings, including under-resourced or rural areas. Furthermore, while the importance of teacher competencies in technology is well-recognized, there is a gap in literature on effective teacher training and professional development models that specifically cater to these technological competencies. The majority of research focuses on technology integration in STEM education, particularly computer science. There is a gap in exploring how technology can be effectively integrated into non-STEM subjects. By addressing these gaps, the research aims to contribute a more comprehensive understanding of technology integration in education, offering insights that can inform policy, curriculum design, and teacher training programs.

Research methodology

The methodology of this study is designed to comprehensively evaluate the competencies required for computer science teachers in the context of mobile technologies. Initially, a literature review analyzeв existing research on relevant competencies and educational platforms like Unity, Fusion, and Unreal Engine. This phase aims to consolidate theoretical frameworks and existing knowledge in the field. Subsequently, the study employed surveys and interviews to gather insights from a practicing computer science teachers and mobile application developers. The insights gained from two groups that allowed to understand the gaps between the industry demand and current

competencies of the teachers. This approach ensures a practical perspective on the competencies currently in use and those needed for future development.

This examination aims to identify gaps and areas for enhancement, particularly focusing on how mobile technology competencies are integrated into existing educational frameworks.

After analyzing the collected data, a two-pronged approach were adopted. Quantitative analysis processed statistical data from surveys to identify trends and commonalities. Complementing this, qualitative analysis was delved into the data obtained from interviews, aiming to interpret and understand the nuances and contextual applications of the competencies identified.

The expected outcomes of this research include the development of a detailed list of essential competencies for computer science teachers in the field of mobile technology. Additionally, the study aims to propose reliable and valid tools for the assessment of these competencies. Furthermore, actionable suggestions for integrating these competencies into computer science education curricula developed. The study, while comprehensive, acknowledges potential limitations. Rapid technological changes may quickly render some findings outdated. Additionally, the limited availability of experts and the subjective nature of some assessments could pose challenges to the comprehensiveness and objectivity of the study. These limitations carefully considered throughout the research process to ensure the validity and relevance of the findings.

Results of the study

In the findings section, an analysis of the survey responses from computer science teachers and mobile application developers reveals insightful trends and specific needs in the realm of integrating mobile technology into computer science education. In the beginning the insights gained from practicing computer science teachers will be illustrated. 30 practicing teachers were surveyed to reveal the following trends. Figure 3 shows the spectrum of confidence levels among computer science teachers in integrating mobile technologies.

THE SPECTRUM OF CONFIDENCE LEVELS AMONG COMPUTER SCIENCE TEACHERS IN INTEGRATING MOBILE TECHNOLOGIES

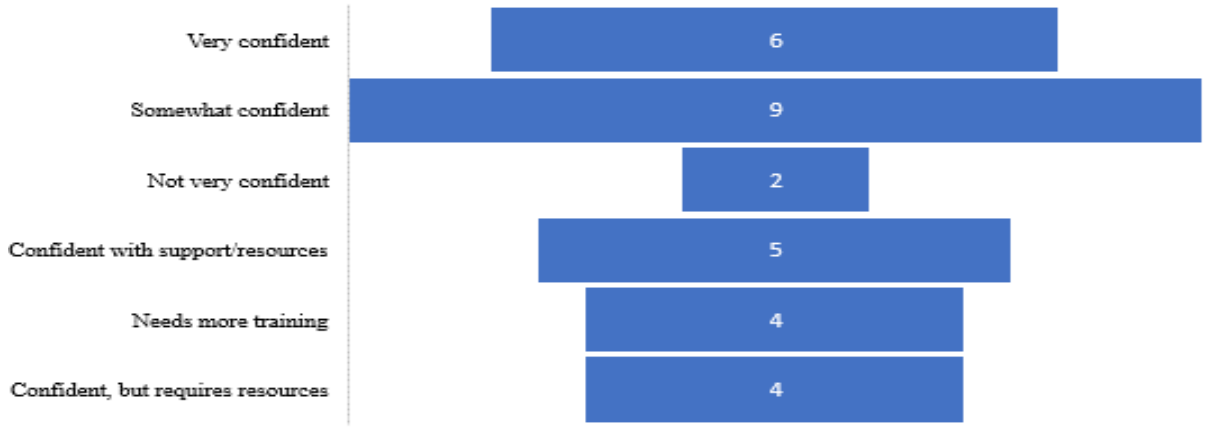

Figure 3. Confidence in Integrating Mobile Technologies

While some teachers expressed high confidence (6), a significant portion indicated a need for more training and resources. This implies that there is a significant room for improvement.

Moreover, to the question asking for challenges in using platforms like Unity, Fusion, Unreal Engine, teachers answered in the following manner (Figure 4).

Figure 4 highlights the challenges teachers face with platforms like Unity, Fusion, and Unreal Engine. Complex interfaces and lack of training were frequently mentioned, suggesting a disconnect between the teachers' current skills and the demands of these platforms.

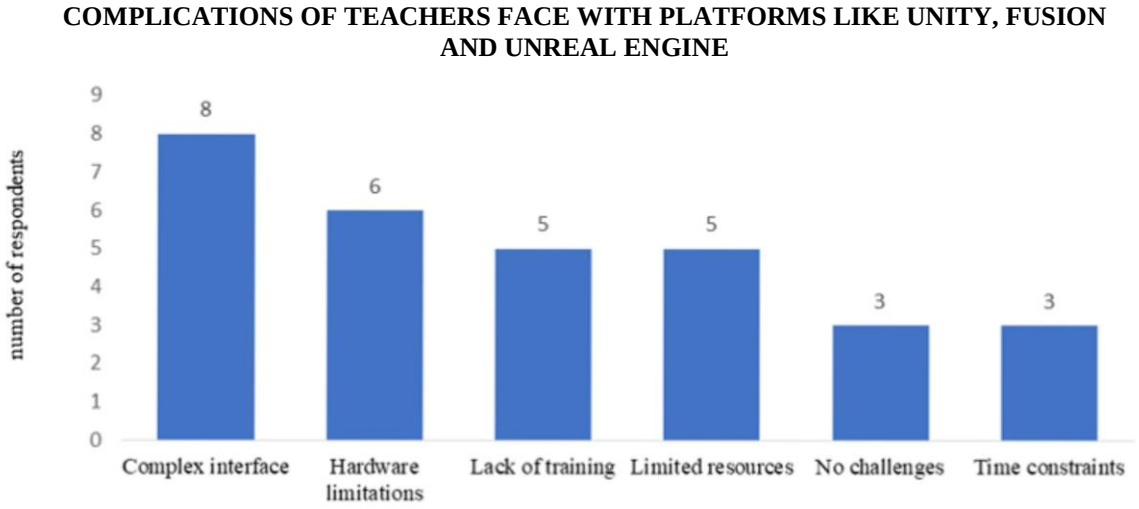

Figure 4. Challenges in Using Platforms like Unity, Fusion, Unreal Engine

Figure 5 illustrates the diverse range of curriculum integration examples provided by teachers, ranging from basic coding projects to advanced app design courses. This diversity indicates varied approaches to integrating technology into the curriculum, catering to the unique learning needs and interests of students across different levels of proficiency and engagement.

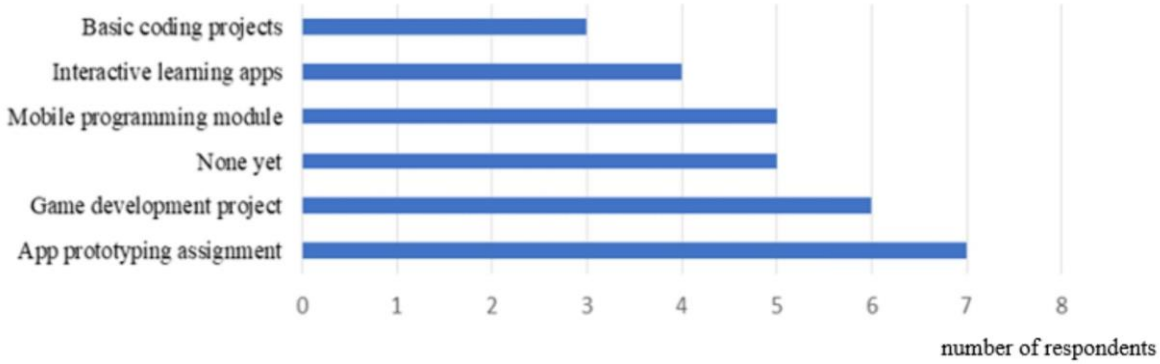

Figure 5. Examples of Mobile App Development in Curriculum

Finally, the fourth question of the survey, which aimed to identify the teacher perspective on which additional training or resources were needed, revealed that the most requested resource was hardware upgrades (7 responses), followed by advanced workshops (6 responses) and online courses (5 responses). Peer collaboration and more software licenses are equally needed (5 responses each), with in-depth training sessions being the least mentioned (3 responses). This table highlights the key areas where teachers seek additional support to effectively integrate mobile technology into their teaching. To sum up, this reveals the demand for additional training and resources, such as advanced workshops, online courses, and updated software tools. These needs highlight areas for improvement in current educational practices and resources.

The data from survey questions collectively point to a nuanced landscape in computer science education regarding mobile technology. The variance in confidence levels (Figure 3) suggests that while some teachers are adapting well to technological integration, others may feel left behind due to a lack of proper training or resources. Challenges cited in Figure 4, such as complex interfaces of popular development platforms and a lack of hands-on projects, further highlight the need for curricula that are more aligned with practical industry standards and teacher competencies. The range of curriculum integration examples (Figure 5) underscores the creativity and effort of some educators

but also hints at inconsistencies in approach and resource availability. Finally, the expressed need for more in-depth training and modern tools (4th question responses) underscores the gap between existing educational practices and the rapidly evolving field of mobile technology.

These insights suggest that while strides have been made in integrating mobile technologies into computer science education, there remains significant room for improvement, particularly in terms of teacher training, resource allocation, and curriculum development. Addressing these areas could lead to more consistent and effective integration of mobile technology into educational settings.

The findings from the survey responses of computer science teachers and mobile application developers reveal distinct yet interconnected perspectives on the integration of mobile technology in education. From the developers' side, the emphasis is on the competencies that teachers should possess, such as proficiency in the latest coding languages and practical app development experience. The developers highlight gaps in current educational approaches, notably the lack of real-world problem-solving and an interdisciplinary approach, which are critical for students to thrive in the modern tech landscape. Furthermore, industry trends such as the need for rapid adaptation to new technologies and the growing importance of mobile security skills underline the necessity for curricula that are not only current but also predictive of future technological directions.

The findings from the survey data (Figure 6) indicate that mobile application developers place a high value on a range of competencies for computer science teachers specializing in mobile technology.

HIGH VALUE ON A RANGE OF COMPETENCIES FOR COMPUTER SCIENCE TEACHERS

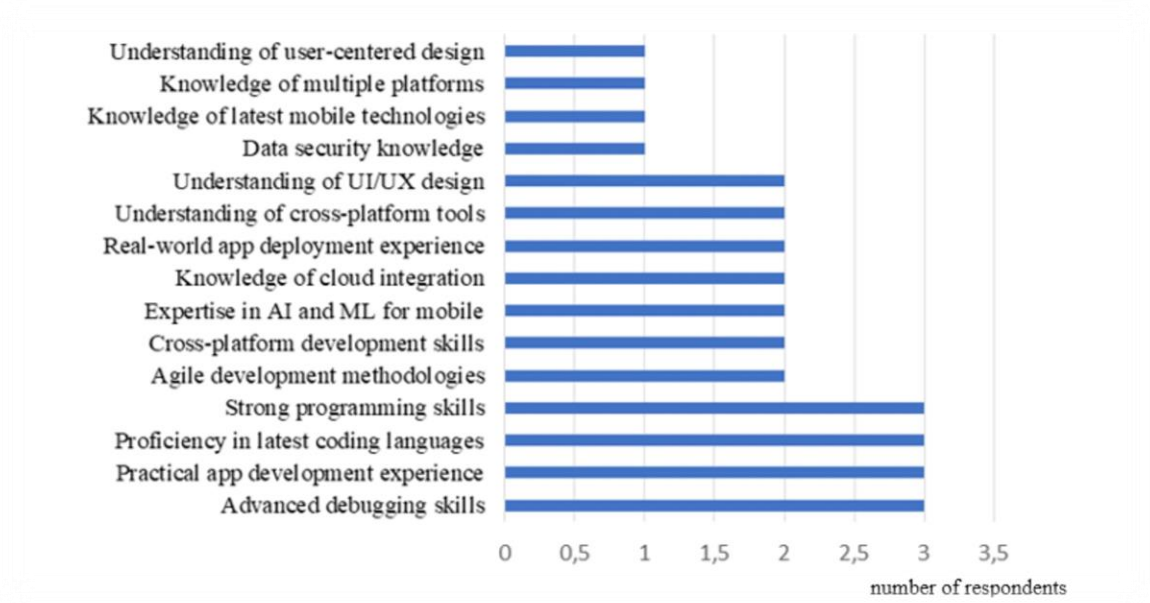

Figure 6. Key Competencies for Teaching Mobile App Development

Core programming skills are evidently at the forefront, with 'Strong programming skills', 'Proficiency in latest coding languages', and 'Advanced debugging skills' each garnering three mentions, suggesting a consensus on the importance of fundamental coding abilities in education. Practical application is also highlighted, with 'Practical app development experience' being emphasized by three developers, indicating the importance of hands-on, experiential learning.

Agility and adaptability in skills are considered significant but to a lesser degree, with 'Agile development methodologies', 'Cross-platform development skills', and 'Understanding of cross-platform tools' receiving two mentions each. These responses reflect the industry's appreciation for versatility in working across different platforms and methodologies.

Emerging technologies like 'AI and ML for mobile' and 'Cloud integration' are also recognized as important areas of expertise, though they are not as heavily emphasized, with two developers

mentioning each. This suggests a growing trend in the need for integrating advanced technological trends into the curriculum. Notably, 'Data security knowledge', 'Knowledge of latest mobile technologies', 'Knowledge of multiple platforms', and 'Understanding of user-centered design' were identified by a single developer each, which may indicate these areas are seen as more specialized or assumed to be encompassed within broader skill sets.

Overall, the diversity of responses underscores the need for a comprehensive approach to teacher competencies in computer science, blending foundational programming skills with an adaptable, practical, and forward-looking educational framework that reflects the multi-faceted nature of mobile application development.

The synthesis of the findings of Figure 7 suggests that while computer science teachers are eager to enhance their technical competencies and integrate mobile technology into their curricula, they require more structured support to meet industry standards. Developers, on the other hand, see vast room for improvement in educational practices and advocate for active collaboration between the tech industry and educational institutions. This collaboration could lead to a more dynamic educational framework that is responsive to the rapid evolution of mobile technology and prepares students for the challenges and opportunities of the digital world.

COMPUTER SCIENCE TEACHERS REQUIRE MORE STRUCTURED SUPPORT TO MEET INDUSTRY STANDARDS

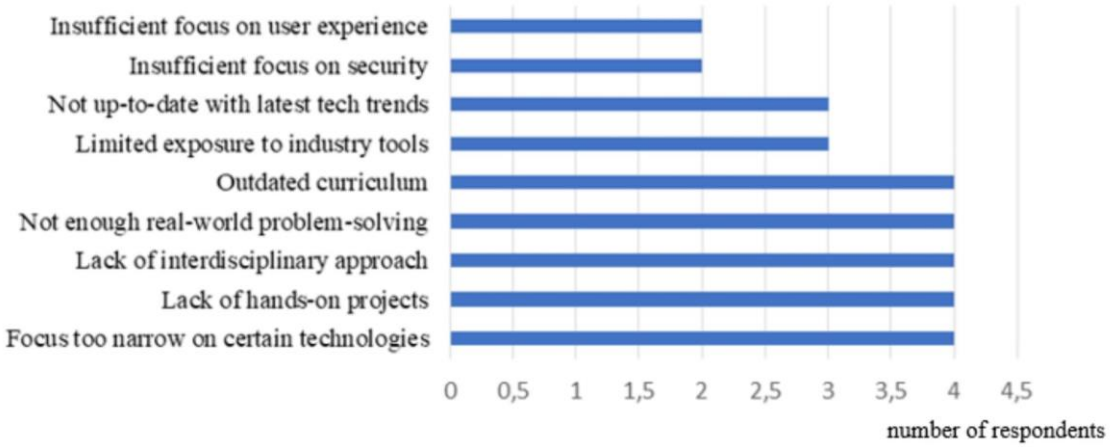

Figure 7. Gaps in Current Educational Approaches

The data presented indicates in Figure 8, a clear recognition among mobile application developers of the key impacts of industry trends on education. Security and privacy concerns are uniformly emphasized, with equal importance given to the need for mobile security skills, data privacy, and ethics, which each received four mentions. This uniformity suggests that the industry sees these areas as increasingly critical in the educational preparation of future professionals.

Equally noted is the 'Need for updated content' and 'Rapid adaptation to new technologies required', also with four responses, highlighting the dynamic nature of the tech industry and the expectation that educational content should be timely and evolve at pace with technological advancements. The 'Shift towards hybrid apps' is another trend with four responses, reflecting the industry's move towards more versatile and platform-agnostic applications.

Slightly less emphasized, but still noted by developers, are the 'Greater focus on user experience' and 'Shift towards AI-driven development', each with three responses. This suggests that while these areas are indeed considered important, they might be viewed as emerging trends that supplement the core skills and knowledge areas.

The survey data of Figure 9 regarding collaboration opportunities reveal that mobile application developers see a variety of ways to engage with educational institutions.

THE PRINCIPAL INFLUENCES OF INDUSTRY TRENDS ON EDUCATIONAL PRACTICE

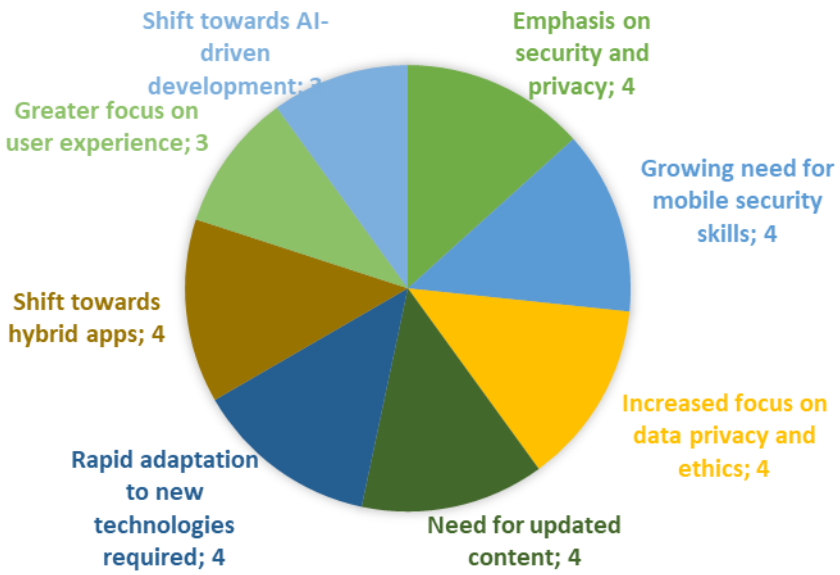

Figure 8. Impact of Industry Trends on Education

VARIETY OF WAYS TO ENGAGE WITH EDUCATIONAL INSTITUTIONS BY COLLABORATION OPPORTUNITIES

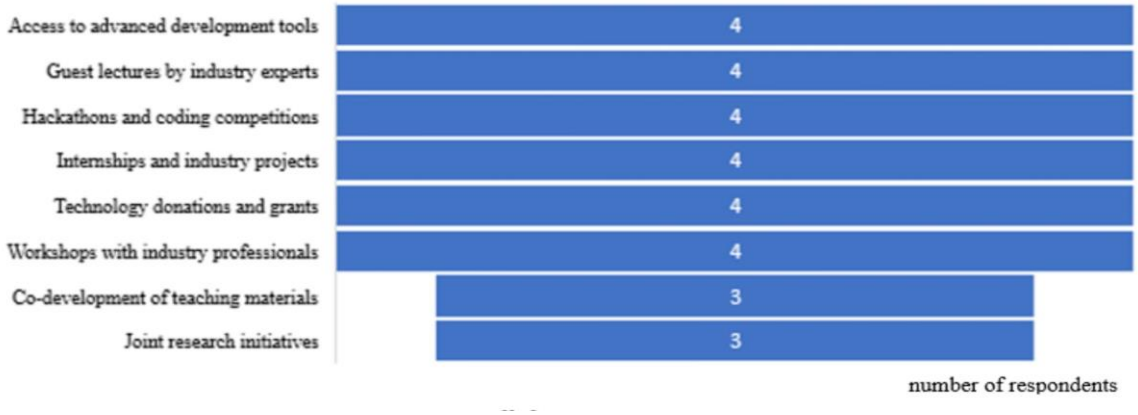

Figure 9. Collaboration Opportunities

The leading areas for potential collaboration, each with four mentions, include providing access to advanced development tools, guest lectures by industry experts, hackathons and coding competitions, internships and industry projects, technology donations and grants, and workshops with industry professionals. This indicates a strong desire for a hands-on, practical approach to education that aligns closely with current industry practices and tools.

Slightly less emphasized but still regarded as significant are co-development of teaching materials and joint research initiatives, each noted by three respondents. These areas suggest an interest in more deeply integrated partnerships that extend beyond immediate educational experiences into collaborative content creation and exploratory research, potentially blurring the lines between academic learning and industry practice. In sum, there's a consensus among developers that meaningful engagement with the tech industry can significantly enrich the educational landscape. They advocate for a multi-faceted collaboration that not only enhances the practical skills of students but also contributes to the resources and curriculum offered by educational institutions, ensuring that the training provided is relevant and up-to-date.

Discussion

The discussion addresses the initial research objectives, which sought to determine key competencies for computer science teachers, develop methods for assessing these competencies, and form recommendations for integrating them into curricula.

Teachers' varied confidence levels in integrating mobile technologies underscore a pressing need for targeted professional development, aligning with the objective to assess and enhance teacher competencies. The challenges they face, notably the complex interfaces of advanced development platforms and a scarcity of practical application opportunities, reflect the necessity for curricular reform. The educators' call for updated tools, advanced workshops, and peer collaboration resonates with the objective to not only identify but also resource these competencies effectively.

Developers' perspectives complement these findings by delineating specific competencies such as proficiency in coding and real-world application experience. Their emphasis on the growing need for mobile security skills and updated content reflects the rapid evolution of the mobile tech industry, which educational curricula must match. The responses further suggest an industry expectation for educational institutions to produce graduates who are not only technically adept but also capable of navigating the ethical and practical challenges of the tech landscape.

The shared advocacy from both teachers and developers for collaboration points to a collective recognition that the integration of industry expertise into educational frameworks is vital. Developers identify concrete collaborative opportunities, such as internships and workshops, which could serve as real-world platforms for competency development, addressing another research objective.

Moreover, it is evident that a strategic approach is necessary – one that considers teacher development, curricular updates, and industry-academia partnerships. By focusing on these areas, the research aligns educational practices with industry requirements, ensuring that future computer science educators are equipped to deliver a relevant and robust mobile technology education.

Conclusion

Based on the findings and discussions outlined, the following recommendations can be made for the development of curriculum in computer science education, particularly for integrating mobile technology competencies:

- Incorporate real-world tools and practices by updating the curriculum to include hands-on experience with industry-standard development platforms. Ensure that teachers and students have access to the latest tools and are familiar with current industry practices.
- Provide ongoing professional development opportunities focused on the latest mobile technology trends, programming languages, and application development practices. Encourage participation in advanced workshops, online courses, and peer collaboration sessions.
- Integrate project-based learning and capstone projects that require students to develop and deploy mobile applications, fostering practical skills and real-world problem-solving abilities.
- Given the industry emphasis on security and privacy, embed comprehensive modules on data security, privacy, and ethics in mobile technology into the curriculum.
- Embrace interdisciplinary learning by encouraging interdisciplinary approaches by combining computer science education with other subjects such as design thinking, user experience (UX), and business strategies to provide a holistic understanding of mobile application development.
- Strengthen industry collaboration and develop partnerships with tech companies to facilitate guest lectures, internships, technology donations, and collaborative projects that can provide students with insights into the mobile tech industry.
- Curriculum co-development by involving industry professionals in the curriculum design process to ensure that the content is aligned with current and future industry needs.
- Create a flexible curriculum framework that can be rapidly adapted to accommodate new technologies and industry trends.
- Secure necessary resources, such as advanced development tools and hardware, to support an up-to-date learning environment.

- Encourage and support joint research initiatives between academia and industry to explore innovative mobile technology applications and pedagogical strategies.

By implementing these recommendations, educational institutions can ensure that their computer science curriculum remains relevant, comprehensive, and responsive to the fast-paced changes in mobile technology, thereby preparing students for successful careers in the field.

References

[1] Angeli C., Giannakos M. (2020) Computational thinking education: Issues and challenges // Computers in Human Behavior. No. 105, P. 106185. https://doi.org/10.1016/j.chb.2019.106185

[2] Ally M. (2019) Competency profile of the digital and online teacher in future education // International Review of Research in Open and Distributed Learning. Vol. 20, No. 2. https://doi.org/10.19173/irrodl.v20i2.4206

[3] Onyema E. M., Ogechukwu U., Anthonia E. C. D., Deborah E. (2019) Potentials of mobile technologies in enhancing the effectiveness of inquiry-based learning approach // International Journal of Education (IJE). Vol. 2, No. 01, Pp. 1-22. DOI:10.5121/IJE.2019.1421

[4] Tangirov K. E., Sattarov A. R. (2020) Didactical possibilities of mobile applications in individualization and informatization of education // Mental Enlightenment Scientific-Methodological Journal. Pp. 76-84. URL:https://api.scienceweb.uz/storage/publication_files/3800/11035/647c4c2184308 Tangirov_Sattarov_Mamatqulova_MESMJ.pdf

[5] Papa K. (2023) Unity 3D VS Unreal Engine: The Ultimate game development showdown. MarketSplash [Electronic resource]. URL: https://marketsplash.com/tutorials/unity-3d/unity-3d-vs-unreal-engine/ (date of access: 09.12.2023).

[6] Azsan F. (2023) Best Game Engines The best Option to choose in 2023. Polydin [Electronic resource]. URL: https://.com/best-game-engines/ (date of access: 26.09.2023).

[7] Miranda J., Navarrete C., Noguez J., Molina-Espinosa J. M., Ramírez-Montoya M. S., Navarro-Tuch S. A., Molina A. (2021) The core components of education 4.0 in higher education: Three case studies in engineering education // Computers & Electrical Engineering. No. 93, P. 107278. https://doi.org/10.1016/j.compeleceng.2021.107278

[8] Bahodirovich O. J., Romilovich B. R. (2021) Project for training professional skills for future teachers of technological education // Mental Enlightenment Scientific-Methodological Journal. Pp. 139-150. DOI:10.51348/tziuj2021216

[9] Fernández-Batanero J. M., Montenegro-Rueda M., Fernández-Cerero J., García-Martínez I. (2022) Digital competences for teacher professional development. Systematic review // European Journal of Teacher Education. Vol. 45, No. 4, Pp. 513-531. DOI:10.1080/02619768.2020.1827389

[10] Falloon G. (2020) From digital literacy to digital competence: the teacher digital competency (TDC) framework // Educational Technology Research and Development. Vol. 68, Pp. 2449-2472. https://doi.org/10.1007/s11423-020-09767-4