

# ***The transformative potential of Artificial Intelligence for Education***

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## **Abstract**

Education today faces a range of challenges, but also unique opportunities, vis-à-vis the evolution of digital technologies. Traditional teaching methods struggle to meet the diverse needs of students, as classrooms comprise learners at different levels. The Education AI project represents an initiative aimed at integrating Artificial Intelligence (AI) into the classroom to address the diversity of students and the challenges faced by traditional teaching methods. The project's core objective is to enhance student learning outcomes by providing an adaptive and personalised learning experience, thereby making education more equitable and effective. This paper evaluates the project's impact on student learning, teacher workload, and its broader applicability in education.

The study's methodology combines quantitative and qualitative data, employing a mixed-methods approach to provide a comprehensive analysis of the Education AI system's effectiveness. Preliminary findings indicate a notable improvement in student performance, particularly among low and medium-performing students, with quantitative data revealing an average improvement of 23% in assessments for low-performing students. The system's user-friendly interface, gamified elements, and immediate feedback mechanisms have been well-received, with a majority of students reporting enhanced engagement and understanding of mathematical concepts. Teachers have also reported positive experiences, highlighting the system's role in reducing their workload and facilitating personalised and adaptive teaching and learning. Qualitative feedback from interviews with teachers and students provides further insights into the system's impact, emphasising its varied and engaging question types, adaptivity, and the shift from paper-based to digital learning. The feedback also reveals a desire for expansion to other subjects and enhancements in the system's analytics for more targeted support.

The Education AI project demonstrates the transformative potential of AI in the classroom, with significant improvements in student performance and positive reception from both students and teachers. The study highlights the importance of addressing technical challenges and expanding the system's capabilities for broader application. The project offers valuable insights into the future of education, where technology and human expertise converge to create a more personalised, adaptive, engaging, and effective learning experience for all students. This initiative, underpinned by the transformative potential of AI for education, aims at informing and guiding future innovations in educational technology.

## **Keywords**

Artificial intelligence, education, adaptivity, personalisation

## **Introduction**

Education today faces a range of challenges, but also unique opportunities, vis-à-vis the evolution of digital technologies (Kizilkaya et al., 2021). Traditional teaching methods struggle to meet the diverse needs of students (Anthony, 2019). Teachers find it difficult to give each student the pedagogical attention they deserve, which can leave some students behind and others unchallenged (Ford et al., 2019). Additionally, the engaging world of digital technology can make traditional classroom resources seem dull in comparison.

The Education AI project aims to tackle these issues by introducing Artificial Intelligence (AI) into the classroom. In doing so, it strives to align with the principles of networked learning through its underpinning connectivism, where technology fosters connections beyond the immediate academic content (Networked Learning Editorial Collective, 2021a). In fact, the system is designed to support students in understanding themselves as learners, their preferences and needs (Networked Learning Editorial Collective, 2021b), and in turn, assist teachers in providing these students with an adaptive and personalised learning experience. This paper will evaluate the

Education AI project, examining its effects on student learning, teacher workload, and the potential for its application in education more broadly.

## **Aims and Objectives**

The primary objective of this short paper is to evaluate the effectiveness of the Education AI system in enhancing student learning outcomes. In particular the research question guiding this study is “To what extent does the Education AI system contribute to improvements in students’ academic performance?” This involves assessing improvements in academic performance, with a particular focus on how these vary across different student proficiency levels.

Another key aim is to assess the impact of the Education AI system on teacher workload and pedagogical practices. In this case, the research question is “In what ways does the Education AI system impact teacher workload and pedagogical practices?”. This includes exploring how the system's automation of certain tasks might reduce the burden on educators and allow for more adaptive and personalised learning paths for students. Additionally, the study will examine any shifts in teaching methods, through user perceptions and satisfaction, and the dynamics of teacher-student interactions resulting from the use of the Education AI system.

## **Conceptual Framework**

The conceptual framework underpinning the Education AI project is rooted in the principles of personalised and adaptive learning, supported by the capabilities of AI (Chen et al., 2020). At the heart of this framework is the belief that education should be tailored to meet the unique needs and abilities of each student, moving away from the one-size-fits-all approach that has dominated traditional educational models (Pallitt et al., 2021). AI serves as the cornerstone of this framework, providing the technological means to achieve adaptivity and personalisation at scale, AI algorithms are designed to analyse student performance data in real-time, adapting the difficulty and content of educational materials to match individual learning trajectories (Luan et al., 2020). This dynamic approach not only caters to the diverse abilities within a classroom but also fosters a more engaging and effective learning environment. By providing personalised learning paths, the Education AI system aligns with these theories, allowing students to build upon their existing knowledge and skills at their own pace (Murtaza et al., 2022). Furthermore, the framework incorporates elements of continuous assessment and feedback, recognising the importance of timely interventions in the learning process (Wisniewski et al., 2020).

## **Research Context**

The research context for evaluating the Education AI project encompasses a diverse educational landscape, involving multiple Primary schools, teachers, and students in Malta. The project was implemented in a variety of school settings, each with its unique demographic and academic characteristics. This diversity provides a rich backdrop for understanding the system's impact across different educational environments. Participants in the study included a broad demographic of 500 students from the final three years of primary education, along with 38 teachers from 8 different schools. This wide-ranging participant base allows for a comprehensive analysis of the Education AI system's effectiveness across varying age groups, academic abilities, and teaching styles.

Moreover, the Education AI system itself is central to the research context. It is an AI-driven platform preloaded with over 600 learning outcomes from the Primary Mathematics syllabus, which can automatically generate and correct exercises based on the teacher’s input. Furthermore, these exercises are personalised for the individual students and autonomously adapt in real-time to the current level of mastery of the student. This enables students to act within their current level. The system offers a range of other features, including immediate feedback, and predictive analytics to flag students who may require additional support. Its capabilities extend to both classroom and home settings, providing a continuous and integrated learning experience. This innovative platform was studied in the participating schools for a period of four months.

## Methodology

The evaluation of the Education AI project employs a mixed-methods approach, integrating both quantitative and qualitative data to construct a comprehensive analysis (Ramírez-Montoya & Lugo-Ocando, 2020). This approach was chosen to leverage the strengths of both quantitative and qualitative research, providing a more complete understanding of the Education AI system's impact (Creswell & Plano Clark, 2017). Quantitative methods allow for the measurement of changes in student performance and engagement through objective data, offering a broad overview of the system's effectiveness. This data was derived from pre- and post-intervention tests, system usage analytics, and continuous assessment scores (Trochim, 2001). Specifically, AI-generated tests were administered via the platform itself to assess student performance, while system usage analytics and continuous assessment scores were tracked through the platform's built-in monitoring tools. The quantitative data was analysed using statistical methods such as the Wilcoxon Signed Rank test to ascertain the significance of observed improvements in student performance.

On the other hand, qualitative methods provide depth and context to these findings, capturing the nuanced experiences and perceptions of students and teachers that numbers alone cannot convey. Qualitative data was gathered through structured questionnaires and semi-structured interviews, offering rich insights into the subjective impact of the Education AI system. Questionnaires were designed to capture a range of responses on user satisfaction and perceived effectiveness, while interviews allowed for more in-depth exploration of participants' experiences and attitudes. The qualitative data was analysed using thematic analysis, a method that involves identifying, analysing, and reporting patterns (themes) within the data (Peel, 2020). This process involves coding the data and grouping similar codes into themes that capture the essence of the participants' experiences and perceptions. The integration of these methods enables a more holistic evaluation, ensuring that both the measurable outcomes and the lived experiences of participants are considered in the analysis (Tashakkori & Teddlie, 2021).

## Preliminary Findings

The evaluation of the Education AI project revealed significant impacts on student academic performance and teacher experiences. In order to enable a more focussed analysis in terms of students' performance, the following criteria were used to define the student performance groups: low-performing students were those in the bottom 25th percentile, medium-performing students ranged from the 25th to the 75th percentile, and high-performing students were above the 75th percentile.

Statistical analysis of quantitative data demonstrated notable improvements in assessment scores, in particular among low-performing students (23% average increase) and medium-performing students (8% average increase). This enhancement was statistically significant, as per the Wilcoxon Signed-Rank Test ( $Z = -9.451, p < 0.0001$  for the low-performing group and  $Z = -13.71, p < 0.0001$  for the medium-performing group), which was chosen due to the non-normal distribution of the assessment scores among these groups (Shapiro-Wilk test,  $p < 0.05$ ). High-performing students maintained their levels, with a negligible decrease in scores. This change was determined as not statistically significant ( $t(124) = 0.907, p > 0.05$ ) by a paired t-test (due to the normal distribution of data), which can be attributed to their already high baseline performance.

Questionnaire results show that 93% of students found the app enjoyable and are willing to use it again. The user-friendly interface and gamified elements like rewards were praised by 78% and 88% of students, respectively. Furthermore, 83% reported enhanced understanding of mathematical concepts. Teachers also reported positive experiences, recognising the app's benefits in reducing workload and enabling personalised teaching. The system's adaptability was particularly valued for allowing students to progress at their own pace. Despite the successes, areas for improvement were identified, such as internet connectivity issues and re-login requirements on tablet reorientation.

The qualitative feedback from interviews with three teachers and three students offers a nuanced perspective on the Education AI system's classroom impact. Teachers enjoyed the system's diverse and engaging question types, a departure from traditional exercises, potentially enhancing student enjoyment and engagement. One Year 6

educator remarked, "Students are enjoying using the system as the questions are varied and different than the usual way we do it, with lots of same question types in the same exercise". The transition from paper-based to digital learning was also mentioned, as a potential positive shift in the learning experience. An Assistant Head of School noted, "It is very engaging for the students who up till now were always accustomed to paper and pencil." Personalised learning emerged as a key advantage, with educators able to tailor work to individual student needs. "Its adaptivity will allow students to work within their comfort zone and not feel pressured and disheartened as the questions are too difficult or sometimes too easy!" stated another Year 6 educator. Students particularly enjoyed the system's interactive elements and immediate feedback, which allowed for real-time correction of mistakes. They also appreciated the system's adaptivity to their own learning pace. Lastly, educators suggested enhancements in analytics for more targeted support. A Year 4 educator suggested, "It would be good to have the possibility to see more granular details where students are failing, so as to target those needs". This qualitative feedback underscores the system's potential and provides constructive insights for its continued development.

## Conclusion

The Education AI project represents a step forward towards the transformative role of AI in education, signalling a shift towards more personalised and engaging learning experiences. Its potential in enhancing student academic performance, reducing teacher workload and support classroom pedagogies, exemplifies the prospective of technology to augment educational processes. However, this innovation also underscores the need for robust infrastructure and user-centric design to ensure seamless integration into classroom dynamics. The findings from the AI project can potentially have meaningful implications for educational policy, potentially supporting the inclusion of AI tools in curricula and teacher training programmes. They also call for strategies ensuring equitable access to quality education for all, whilst establishing common knowledge, for example in the ethical underpinnings of AI in education. Future research should explore the long-term effects of AI integration on educational outcomes and the scalability of such systems across diverse educational settings (including subjects and year groups).

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