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I Am not as Rich as Alexander the Great, but I Can Have my own AI-RISTOTLE

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Abstract
Human tutoring is one of the most effective methods to prevent school failure and reduce early school dropout. Due to their high cost and low scalability, digital technologies have been used to approach or complement human tutoring, although their relative efficacy remains low. This chapter delves into the role of digital technologies in the implementation of tutorials exploring how Artificial Intelligence (AI) may be used as a complement to human tutors to provide educational accompaniment to students who attend schools in areas of low socioeconomic level. In our contribution, we present the methods and main results of a workshop of experts in which, following a design-thinking

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approach, we developed AI-mediated propositions aimed at maximizing the efficacy and efficiency of educational accompaniment. The experts proposed the creation of an adaptive virtual learning environment (AI-RISTOTLE), based on local AI, that respects the ethical principles and integrates accompaniment functionalities. Moreover, the experts agreed that this environment should make use of the potential of AI to include tools that critically reflect personal and sociocultural identity, improve family participation, offer social and emotional support, provide adequate feedback including metacognitive elements, and develop the digital competence of the students.

Keywords: Artificial Intelligence, tutoring, Low-SES, Primary Education, experts, design thinking.

9.1. Introduction

In the last decades, we have witnessed an increase of socioeconomic inequalities worldwide (Blanchet & Martínez-Toledano, 2023; OECD, 2011; Seguino et al., 2013). In Spain, by the end of 2022, the risk of poverty reached a general rate of 20.4% (9.6 million people), which was 32.2% in the child and adolescent population (Canals et al., 2023). Currently, poverty and social exclusion derive from job insecurity, academic deficiency and the fragility of social and family networks (Subirats, 2004), as well as from more recent challenges, such as the housing crisis and the digital divide (Malgesini, 2021).

Early School Dropout (hereinafter, ESD) is interpreted as an indicator of the inefficacy of education systems (Bernardo et al., 2020), and it is an important predictor of the risk of youth poverty. Despite the improvement experienced in the last years, in Spain, the rate of ESD continues to be especially high, with 13.9% in the year 2022 (vs the average ESD of 9.6% in EU-27). Furthermore, the ESD rates are unequally distributed, being especially high among men (16.5%) and in some autonomous communities (above 19%) (Spanish Ministry of Education and Vocational Training, 2023). Likewise, this phenomenon is much more pronounced in the socioeconomically disadvantaged population and in areas with social transformation needs, where it generates adverse consequences at the individual level (e.g., illiteracy, unemployment, social insecurity, job insecurity, lack of hygiene and healthiness, etc.) and at the social level (e.g., econo-

my, sustainability, social cohesion, wellbeing, security, etc.), thus contributing to the reproduction of the extant inequalities in society (González-Rodríguez et al., 2019).

The European Commission and the Organization for Economic Co-operation and Development (OECD) specify that one of the weaknesses of education systems in their struggle against ESD is the absence of adequate counselling in the academic and professional career of students (European Commission, 2015; OECD, 2023). This counselling must offer personalized accompaniment (academic, professional and social) and aid the attainment of vital alternative projects. Therefore, addressing it requires rethinking the educational counselling that is carried out in schools, attending to the diversity of situations and complex trajectories of young people and fostering personal growth and empowerment (Rossier et al. 2020). Moreover, at the social level, situated learning and critical consciousness must be promoted to contribute to the social transformation and community development of the areas with the highest ESD rates (Romero-Rodríguez et al., 2022).

At the classroom level, educational counselling is specified in the tutorial function. School tutoring may be interpreted as a process of counselling and accompaniment for students (and other members of the educational community). Therefore, tutors must plan actions with the aim of improving the learning processes by attending to the specific needs of the tutees in dimensions such as attention to diversity, previous levels and knowledge, academic difficulties, and socioeconomic and cultural differences, at both the individual and community levels (Del Río & Codés, 2007).

Personalized tutoring has been considered the most effective method in the educational scope, due to its great impact on academic performance (Nickow et al., 2020; Sirinides et al., 2018). Furthermore, it also improves the confidence, expectations, motivation, self-concept and psychological wellbeing of the students (Partington, 2020; Prowse, et al., 2021; Turnbull, 2022). Thus, tutoring is presented as an adequate tool to mitigate some common problems in educational contexts of special vulnerability, such as lack of confidence, motivation and interest in academic work during non-school hours, as well as to effectively promote equity (Carlana & La Ferrara, 2021; Nickow et al.,

2020) and reduce academic failure. One of the main limitations of personalized tutoring is its high cost in human resources, since it is based on one-to-one interactions for relatively long periods of time. Consequently, personalized tutoring has been traditionally reserved for people of medium-high social status with economic resources to cover the cost (e.g., private schools or private tutors). Therefore, attaining more efficient, scalable and inclusive personalized tutoring is a key challenge in the struggle against inequality in education systems.

Information and Communication Technologies (ICTs) have been considered an option to improve the provision of tutorials. An example of this is the implementation of Computer-aided Instruction (CAI). These systems automatically provide feedback and suggestions based on the answers of the students to a set of questions (usually multiple-choice tests), and they often automatically adapt the next steps of the teaching to the students' level. Another approach is represented by Intelligent Tutoring Systems (ITS), which pose a further level, since they analyze not only the answers but also the methods and processes used by the students, providing more detailed feedback about each step (VanLehn, 2011). Lastly, technologies have also been used to improve and flexibilize human tutoring by conducting them online, as was experienced during the COVID-19 lockdown (Carlana & La Ferrara, 2021; Gortazar et al., 2023). Although the costs have been reduced, and both CAI and ITS show positive effects on the learning of students, the use of these systems for tutoring has not attained the efficacy of one-to-one human tutoring in any of their versions (VanLehn, 2011).

Recent developments in AI systems are also presented as an opportunity to improve the efficacy of technology-supported personalized tutoring (Chen et al., 2020). Darvishi et al. (2024) highlighted the potential of AI as a personal assistant for students, offering personalized reminders, real-time feedback to improve writing, and recommendations on when and what to study. The scientific literature shows that these systems can emulate aspects of personalized teaching, such as human conversations (specifically using large language models), or even surpass them, as in the case of the analysis of data about the behavior, activities and learning of students (Lin et al., 2023). Moreover, for students at risk of social exclusion, personalized tutoring

based on AI elements could be especially beneficial. Firstly, it could allow expanding tutorials of higher quality to a population that has never received it. Secondly, personalization (content, pace and methods) and specific support could be key elements for academic success in a context with a great disparity of performance levels, cultural practices, etc. Thirdly, the recent advances in AI could provide tools to improve the development of metacognitive skills (compared, for instance, to ITS, which do not incorporate this technology). Fourthly, it would allow using AI, especially generative AI, enabling the exploration of contributions of technology to the improvement of psychosocial aspects (e.g., motivation, self-concept, expectations, etc.) and relational aspects. Lastly, it could contribute to the development of the digital competence of students and to the use of ICTs for productive purposes.

The aim with AI is to improve the efficacy of technology-mediated tutoring, for example, integrating it in ITS (Lin et al., 2023), rather than replacing the human element, which is fundamental in disadvantaged contexts, complementing it in a way that it offers an improved and more affordable experience of guided and personalized learning at the reach of any individual, regardless of their socioeconomic condition. This chapter explores how AI can contribute to this goal by presenting the prototype of a proposal of AI-based virtual learning environment (VLE), which aims to improve the accompaniment of students in areas with social transformation needs (ASTN). Specifically, we present the results of a participatory workshop conducted with AI experts using the design thinking methodology. Next, we describe the methodology followed in the workshop, discuss the obtained results, and finally present the conclusions drawn from the findings.

9.2. Research Context

In the framework of the research project entitled *The digitization of Andalusian schools with greater presence of students with low socioeconomic level* (project 2022/00000398 of the 6th Research Plan of the University of Seville), the process of digital transformation was analyzed in eight schools located in ASTN in Andalusia

(Spain). Through a qualitative research design, interviews were carried out with principals, teachers and students of each of the participating schools during the first semester of the year 2023. Then, a specific content analysis of the transcriptions was performed to extract the main challenges faced by these schools. By triangulating the view of principals, teachers and students, eleven coinciding challenges were identified: (1) Information, (2) Educational accompaniment outside of the classroom, (3) Personalization of learning, (4) Attention to diversity, (5) Evaluation of learning, (6) Counselling, (7) Digital competence, (8) Families, (9) Absenteeism, (10) Educational innovation, and (11) Evaluation of the school. After rethinking each of these challenges, we considered that AI systems could be a powerful resource in their total or partial overcoming. Therefore, an expert workshop with researchers and professionals specialized in AI was organized, where the experts imagined and proposed AI-mediated solutions to the main challenges.

Selection of participants for the expert workshop

For the selection of participants, we firstly performed a study of the most outstanding profiles in the application of AI in the Spanish educational scope. Then, to reduce the list and send invitations for participation, a set of inclusion criteria were established: (1) being a researcher in a Spanish university with a renowned scientific production in this specific scope, (2) being a practitioner with a renowned professional career in this specific scope, (3) being specialized in AI and in at least one of the eleven challenges identified in the previous section, and (4) having research or professional experience in ASTN. In order to be included in the study, the experts had to meet at least 2 of the 4 inclusion criteria. Additionally, gender parity in the group was ensured.

Prioritization and selection of challenges

Prior to the realization of the workshop, the experts were contacted through an online form, where they were asked, in a ranking format, about the eleven challenges identified during the course of the investigation. To this end, they had to attend to

two criteria: 1) viability of AI to solve or aid in said problem, and 2) level of importance of the challenge in relation to ASTN. The four challenges with the greatest score, and therefore considered most relevant, were: information, personalization, families, and accompaniment.

Development of the workshop: design thinking

The workshop was carried out in November 2023 in the Faculty of Education at the University of Seville. To solve the four challenges cited in the previous section, the design thinking methodology was followed, as it was considered an optimal option for the generation of innovative and practical ideas/solutions, and based on its collaborative and negotiated character. The experts worked for five hours on the resolution of the challenges. They were organized in pairs, and they were assigned a challenge based on their specialization. Although each pair was in charge of their challenge, all experts worked on all challenges to provide original ideas that contributed to their resolution. The development of the workshop was focused on three of the five phases of design thinking: think, design and evaluate.

9.3. Results

The results presented in this chapter refer to the prototype proposed by the experts for the resolution of *Challenge 1: Educational accompaniment*. The resolution of this challenge was led by a researcher specialized in counselling processes and AI, and a practitioner (teacher and teaching counsellor) with experience in schools located in ASTN and the use of AI in education. Their proposition to improve educational accompaniment was the creation of an adaptive virtual learning environment (VLE) improved through AI systems (hereinafter, AI-RISTOTLE) that includes elements aimed at educational accompaniment. Figure 9.1 shows the cross-sectional criteria that were initially defined by the experts and which guided every stage of the design of their prototype:

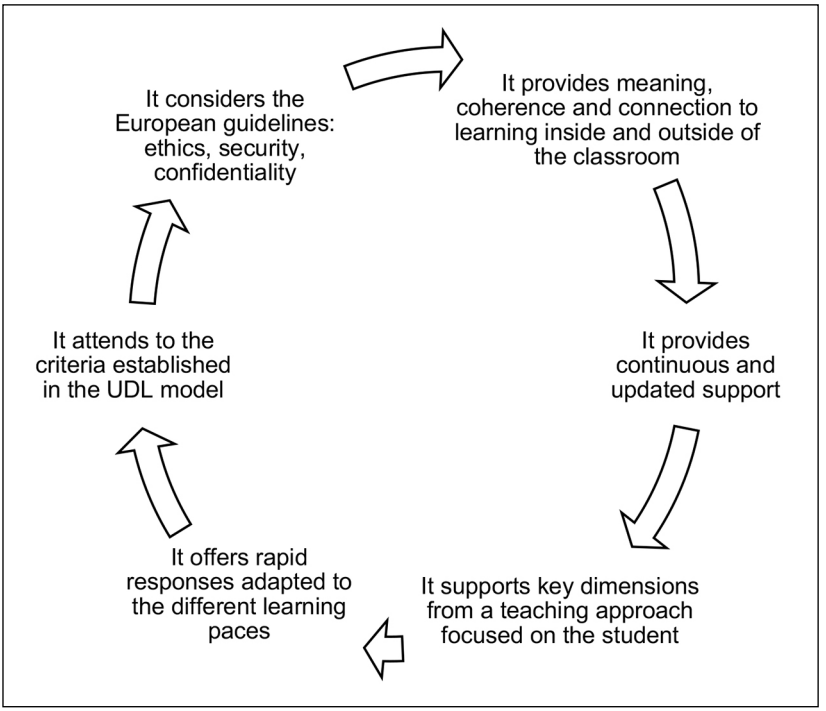

Figure 9.1. Criteria considered in the virtual learning environment. Source: developed by authors.

The experts justified the design of their prototype from the following general objective: "Create contexts, propose processes and provide learning resources with the aid of AI for a comprehensive and adaptive accompaniment, according to the paces and personal and sociocultural situations (UDL)". Moreover, they highlighted four guiding principles for the design of AI-RISTOTLE:

- Continuous learning of AI-RISTOTLE based on Machine Learning.
- Local AI, that is, trained from specific data of the school and its context.
- Emotional AI adapted to the age and psychosocial profile of the students.
- AI tools that facilitate collaborative and situated learning.

These four elements are considered key elements to offer each student the academic-personal support they need, from the place where it is provided, and attending to the characteristics of their culture. Next subsections describe the characteristics of AI-RISTOTLE proposed in the expert workshop:

Reflect (critically) the personal and sociocultural identities of the students

The experts suggested that AI-RISTOTLE should use the potential of AI to adapt the academic materials and contents to the interests and culture of the students of ASTN to improve their attention and motivation. They also stated that the incorporation of characteristic elements of students' culture must be combined and compared, in some cases, with cultural elements of other social strata (and even from other places of the world), with the aim of facilitating the development of a critical consciousness about their own culture (an example mentioned in the workshop was to rethink the meaning of forced marriage by cultural "appropriation" at 14 years of age). Moreover, the incorporation of other cultural elements could help to expand and break social and information bubbles, which would result in the creation of new horizons and future expectations. The practitioner who participated in the design of this prototype described the success of a similar experience in a school located in a marginal neighborhood of Seville, where "after carrying out initiatives of this sort, there was a decrease in the dropout rate and an increase in the students' academic performance. In the end, adolescents who thought that school were not for them ended up in vocational training".

Create bonds between the families and the school (third space)

In the development of AI-RISTOTLE, it is important to stress the aim of transforming it into an intersection point between the families and the school. Having the support and interest of the families is key for the academic (and socio-personal) success of the students. AI-RISTOTLE must become a space recognised and positively valued by both the families and the students. The social, collaborative and adaptive character of this environment

could be key to attain the creation of a "third space" that goes beyond the sum of interests and practices of the families and the school itself. AI-RISTOTLE must be sensitive to the inclusion of the families and promote the creation of learning communities to contribute to their literacy and empowerment. In this sense, AI is more than an educational tool; it is a catalyst for social transformation and cultural enrichment. Through Machine Learning (ML) techniques, AI can gradually analyze the interests and concerns expressed by the families in documents and discussions with the school. The latter can use this information to further involve the families and create virtual spaces within the VLE related to these topics to attain a first approximation of the families to the use of VLE, in order to expand its use in other scopes. Additionally, this analysis of school documents that are used to communicate with the families may also allow improving said documents within the school context. In this sense, it is very important for the communication between the families and the school to be fluid. The use of AI to adapt the school communications to the socioeconomic language and context of the families in disadvantaged environments can contribute to strengthening the communication bond. This would have a positive impact on the involvement of the family in the educational process.

Offer emotional and social support for the learning of the students

The social and emotional aspects play a very important role in information processing and the acquisition of learning. Thus, they stand out for the fact that AI-RISTOTLE must include elements to work on the socioemotional skills of the students (e.g., empathy, active listening, teamwork, resilience, interpersonal communication, etc.).

Moreover, all the experts agreed that the incorporation of emotionally sensitive AI systems in AI-RISTOTLE (e.g., affective computing) is a key element of special importance in ASTN. These systems can gather, process, identify and respond to the emotional states of the students. Therefore, they optimize the emotional support, adapting the loads, paces and educational resources to the individual, emotional and cognitive needs of each moment.

Lastly, the experts also pointed out the importance of using AI systems to strengthen the social learning and connections of students. They proposed to employ AI to facilitate social learning by identifying and connecting the students with their peers with similar interests or complementary skills (e.g., through the content analysis of academic works or other documents). Similarly, this idea can be extended to connect students from disadvantaged environments with students from other environments, with the aim of sharing and expanding cultural views and mutually breaking the cultural information bubbles, or even with more suitable/adequate teachers and educators.

Provide automatic and personalized feedback as support to learning

According to the experts, the lack of family accompaniment outside the classroom for the realization of school assignments has a great impact on student performance in the most disadvantaged environments. AI may help in this regard by providing automatic and highly adaptive feedback that surpasses that of CAI systems, adapting to the pace and level of each student. Furthermore, generative AI may provide examples adapted to the interests of the students and adjust the language of the generated feedback. This results in a cycle of constructive feedback that prevents the frustration and discouragement derived from feedback that is not in line with the individual needs of the students. One of the experts stated that: "In these contexts, where the variety of paces and levels is so wide, automatic feedback helps students to advance at their own pace and provides a feeling of control and confidence in their learning process [...]. With automatic feedback, students are greatly empowered, by overcoming this limitation of non-accompaniment in the family context". Additionally, AI-generated feedback may contribute to the development of metacognitive strategies, helping students to establish realistic goals and self-evaluate their understanding (including processes and results) in a more efficient manner compared to non-AI-based ITS, granting more autonomy to the students and allowing them to develop their learning capacity.

Promote the development of safe digital and practical competences in technology

The experts stated that the introduction of digital training in disadvantaged areas using AI-RISTOTLE is an opportunity for the development of student digital competence. The design of AI-RISTOTLE must contribute to developing a positive relationship with digital technologies, overcoming the most common practices of the students (mediated by mobile phones and aimed at leisure). The need to implement digital practices and to use tools for studying can help to promote habits of digital wellbeing and safety, which, in some cases, are not fully developed in the family environment. Moreover, the introduction of AI-based elements brings students closer to the adequate use of emerging technologies. AI could be used to detect inadequate uses of technology in AI-RISTOTLE and provide recommendations on how to improve them. One of the experts underlined that "contemplating this aspect is key, since it could have an important impact on the development of adequate practices regarding the correct and safe use of technology [...]. Furthermore, this usually motivates the students; they always want to learn new concepts".

9.4. Conclusions and Practical Implications

The reflections presented in this chapter highlight the transforming role of AI in educational accompaniment, especially in disadvantaged contexts. In the search for methods that approach the ideal of efficacy of personalized human tutoring (Bloom, 1984), AI emerges as a promising technology that overcomes some limitations of other technologies that have previously attempted to improve educational accompaniment.

AI offers unique characteristics to work on educational accompaniment in disadvantaged environments. According to our study, if AI is continuously trained, with local data and respecting ethical criteria, the integration of this technology in a VLE has great potential. Firstly, it can facilitate the adaptation of materials and activities to the cultural context of the students, while inducing the latter to reflect critically on said context. Secondly,

it may help to create communication bonds between the families and the school. Thirdly, it would allow identifying and analyzing the emotional states of the students, even outside of the classroom, and consequently adapting education. Fourthly, it can provide elements to facilitate social learning and connections among students. Fifthly, this study highlights the potential of AI to provide a more adapted feedback compared to other technologies, even offering personalized scaffolding to develop metacognitive competences. Lastly, it can also contribute to the development of productive digital competences and practices.

However, it must be taken into account that this chapter only presented the design phase of AI-RISTOTLE through design thinking. This allowed us to identify its target design characteristics, although it needs to be implemented and tested in real environments. Therefore, despite the promising possibilities, we are still in the initial stages of understanding how AI can effectively transform education in disadvantaged schools.

The implementation of an AI-mediated VLE like the one proposed in this chapter (AI-RISTOTLE) is not exempt from challenges. The difficulties of implementing this technology include its effective integration in schools, the guarantee of access to an adequate technological infrastructure, and the need for continuous and specialized teacher training. Moreover, for AI-RISTOTLE to be successful, it is essential to change the mentality of all the parties involved in the educational process: teachers, students and families. This requires promoting motivation, adapting approaches and creating a suitable environment for AI-assisted learning that expands beyond the classroom. These challenges pose the critical question of how to attain the effective use of this technology in the mentioned disadvantaged contexts. In this sense, further research is required to delve into the factors that facilitate the adoption of educational technologies in these environments.

To sum up, although the literature is beginning to demonstrate that AI can offer functionalities for the improvement of tutoring, in order to achieve a significant impact, it is fundamental to address the practical and human challenges associated with the implementation of specific developments (such as AI-RISTOTLE) and carry out exhaustive tests to guarantee that these tools effectively adapt to the specific needs and contexts of the

students. Furthermore, we must be realistic and remember that, for the time being, the human element is key, and that AI systems offer better results when they support (not replace) humans (Darvishi et al., 2024).

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