Engaging Math Teachers as Co-designers of a Classroom Analytics Dashboard

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Abstract

The adoption of AI in education often falls short due to, among other factors, a lack of pedagogical grounding and teachers' unfamiliarity with AI technologies. To address these challenges, prior research has proposed participatory approaches to better understand teachers' perceptions of AI, as well as their practical needs and concerns. This paper adopts a human-centered approach to actively engage Dutch primary school teachers in the co-design of a dashboard intended to support mathematics instruction. As an initial step, the current work presents the preliminary findings on teachers' challenges, needs, and concerns regarding the use of AI in the classroom.

Keywords

Human-Centred Design, Artificial Intelligence (AI), Primary School Teachers, Mathematics

1. Introduction

The attention of Artificial Intelligence (AI) in education lies in its potential to enhance personalized learning, automate administrative tasks, alleviate teachers' workload, and boost learning outcomes [1]. However, despite its potential, the actual adoption of AI in the education sector remains slow. Among the challenges of hindering the AI integration is considered the lack of contextualization of many AI solutions under the course objectives or the pedagogical theories, the lack of teachers' background knowledge and skills in using the AI tools and the lack of trust on AI [2, 3].

To achieve careful consideration of pedagogical and teaching needs and increase teacher trust, prior research highlighted the adoption of human-centered design (HCD) through active positioning of the teachers in the creation of the technological solutions to ensure synergy between the needs of stakeholders and the tools. However, prior systematic reviews on HCD in learning analytics and AI noted that the adoption of HCD in AI is still scarce [4, 5]. Among the studies that employ HCD in AI, there are the ones by Holstein, McLaren, and Aleven [6, 7] who co-designed with teachers a real-time, wearable AI tool with the aim of increasing student monitoring in AI-enhanced K-12 classrooms. Likewise, Long, Aman and Avelen [8] employed a participatory approach to co-create with students the key characteristics of an intelligent tutoring system fostering students' motivation. Moreover, Lister et al. [9] in the context of distance learning followed a participatory approach to co-design with students a virtual agent for a learning management system (LMS) assisting its students with visual impairments.

The above studies underlined the added value of developing AI-driven solutions as desired and envisioned by the participants that address their actual needs that otherwise might not have been detected. Building on the above context, our study aims to create a common ground with K-6 teachers and their perceptions and needs respecting the use of AI when teaching mathematics in the Netherlands.

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2. Methodology

The present study is a part of a broader Design-based Research (DBR) project aiming to develop a dashboard to support Math teachers in monitoring their students and in providing them with AI-generated recommendations to enhance their teaching practices. The current study concerns the first DBR phase, i.e., analysis of practical problems with close collaboration with the teachers [10].

Teachers often face difficulties in connecting the course learning design and their teaching needs with the desired data-driven information from the student [11]. Thus, to better guide teachers in their role as co-designers and support them during this process, we employed a set of different sessions (see Figure 1). The current paper discusses the preliminary results of the initial interviews aimed at addressing the following questions (RQ), [RQ1] *"What are the challenges of Dutch K-6 educators with respect to their teaching practices in Mathematics?"* and [RQ2] *"What are the AI-related needs of Dutch K-6 educators to address the identified teaching challenges and what factors could hinder the adoption of AI?"*.

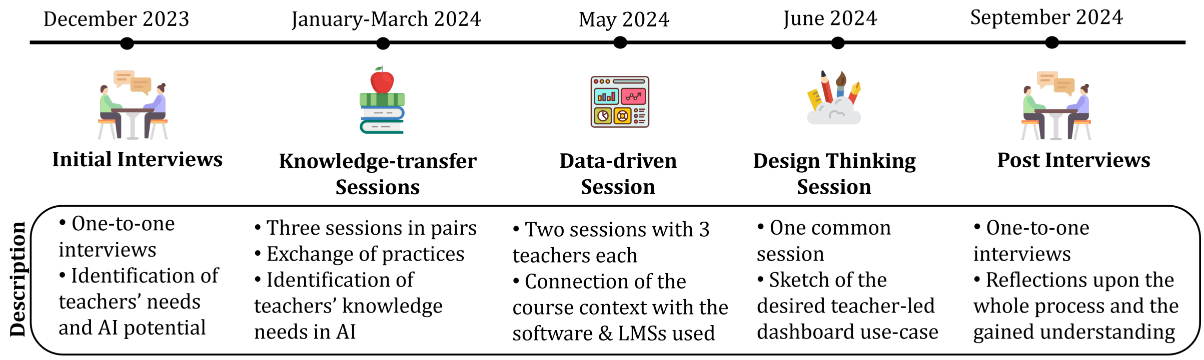

Figure 1: Co-design process employed during DBR first phase.

Each interview lasted approximately 1:30h and included a brainstorming approach to understand teachers' needs in terms of technological tools. During the interviews, we followed the approach proposed by Holstein et al. [6], who inquired teachers about the *'superpowers'* they would like to have, to understand teacher challenges, desired AI support, and fears of AI integration into classrooms. The data gathering sources used regarded responses to a profile questionnaire [Quest], teachers' artifacts [Art] (that is, perceived challenges, superpowers and desired use of the dashboard and aspects, such as intervention or alerting options, as derived by the storyboard technique) and observations of the researcher [Obs]. The next sessions were informed from the initial teacher insights and included *Knowledge-transfer Sessions* to enhance teachers' AI and dashboard knowledge, *Data-driven Sessions* to detect -together with the teachers- the key aspects of the current technological tools they use within classrooms, *Design Thinking Sessions* that employed the storyboard technique to place teachers as designers of their ideal use of an AI-trained dashboard and Post Interviews where teachers reflected on the whole co-design process. Figure 2 depicts an example of a storyboard created during the Design Thinking Sessions where we asked teachers to display their existing teaching challenges in mathematics and to draw an ideal AI use to overcome such challenges.

Six Dutch primary school teachers served as study informants. Briefly, most of the participants are female (N=4), hold a bachelor's degree (N=5) and have more than 10 years of teaching experience (N=4).

3. Preliminary Results

RQ1 explored the teacher challenges faced in terms of teaching mathematics, where AI technology could potentially contribute. Many teachers (N=4) mentioned the **lack of insights on students' progress**, e.g., *"I face difficulties on monitoring how far and how well students are progressing and what concepts they*

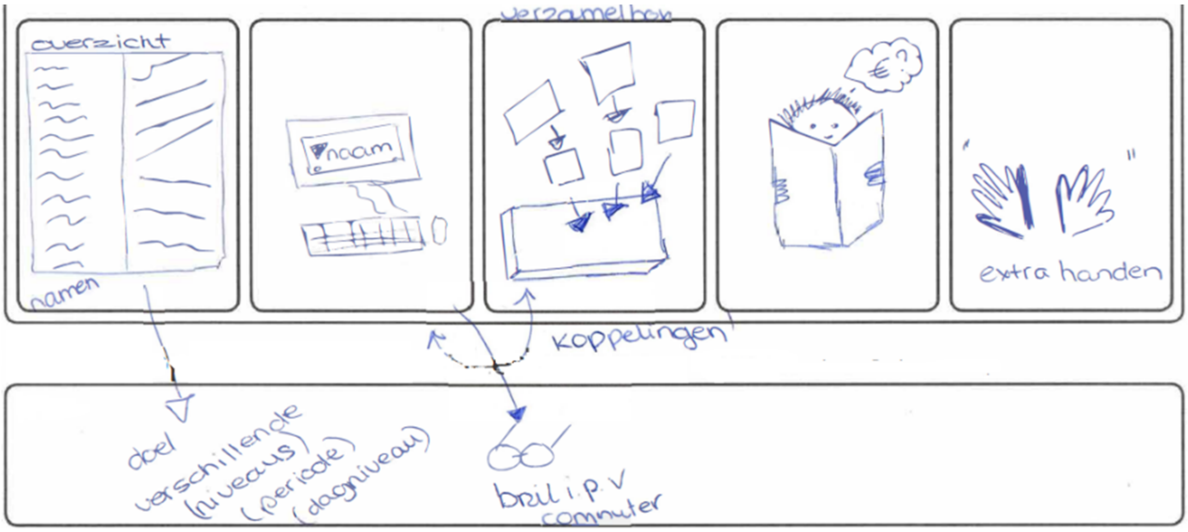

Figure 2: Example of a created storyboard depicting a desired use of an AI-trained dashboard. The AI system is expected to have an overview of each student (1st sketched square) and when it detects critical student behaviors to alert the teacher (2nd sketched square) and to provide a diagnose by linking all the different data sources (3rd sketched square). The AI is expected to act as 'glasses' that will help the teachers to grasp the students' difficulties (4th sketched square) acting as invisible student 'raised hands' (5th sketched square).

are missing" [Teacher#2]. Several teachers (N=3) mentioned as challenge the **fragmented nature of student data across the multiple adaptive learning technologies** employed to teach mathematics, e.g., *"There is not an overview per student across the different tools, so that you can see what a student has mastered"* [Teacher#5]. Two teachers highlighted the difficulty of **personalizing the learning process** according to student progress, e.g., *"There is a difficulty of tailoring the learning to the students. In case we could do it, we could teach mathematics more effectively"* [Teacher#6].

Moreover, we asked the teachers about AI-supported superpowers to overcome the above challenges (RQ2). Most teachers (N=5) stressed the need to **uncover key moments of the students' progress**. For instance, *"I would like to detect the exact moment that the confusion has started"* [Teacher#1]. Three teachers mentioned that they would like to have **assistance in understanding the data and in decision-making**, e.g., *"I would like to have a superpower overview, that is, to knows how to interpret everything in the data and use it in the lesson"* [Teacher#1], *"I would need action recommendations for the teacher, like suggestions per student to keep the learning efficiency as high as possible"* [Teacher#3]. Another common proposal (N = 3) regarded **the need to promptly address concrete student cohorts**, for example, *"I would like at the push of a button to have data about a specific student group"* [Teacher#1]. Finally, two teachers mentioned as potential superpower the **possibility to predict students' mistakes**, e.g., *"I would like to know in advance specific mistakes or thinking errors of my pupils"* [Teacher#6].

Respecting the perceived obstacles to AI adoption (RQ2), half of the teachers (N=3) expressed concerns about their **own expertise and autonomy**, e.g., *"Getting the feeling that you are losing some control, because part of your work is being taken over by AI"* [Teacher#2]. Two teachers questioned the **accuracy of AI-generated results**, i.e., *"I am worried about the reliability of the AI advice"* [Teacher#5], *"Many times we assume that the information coming from AI is always correct, but how do we know?"* [Teacher#4].

4. Conclusions

The current paper presents our preliminary results towards a co-design approach with the aim to actively position K-6 Math teachers in the design of a classroom analytics dashboard. To understand their needs, we asked teachers to reflect on potential AI-supported superpowers. These reported superpowers included the ability to uncover key moments of student progress (83.33%), assistance in interpreting data and in decision-making (50%), targeting concrete student cohorts (50%) and predictive capabilities to anticipate student mistakes (33.33%). Our results agree with the ones by Holstein et al. [6] who also detected as desired superpowers the teachers' need to track students' progress and uncover their misconceptions.

At the same time, participants expressed concerns about the adoption of AI in education, such as the fear of losing their teaching control (50%) and the accuracy of the AI-generated results (33.33%). These concerns have been acknowledged as well by Renz and Hilbig [12] and Qin, Li and Yan [13]. The authors explored the factors that influence negatively the educators' trust regarding the use of AI and they detected as barriers the lack of teachers' skills and technological competences and the potential danger of losing their teaching autonomy and their agentic role within the learning process. One critical aspect of AI-informed interventions is, for instance, its timing and contingency, since interventions triggered by AI in pedagogically 'wrong' moments (e.g., too early during the learning process) and in 'wrong' depth (e.g., providing directly the correct answers without examining the effort and progress of the students) could disrupt their learning progress. In this regard, Giannakos et al. [14] discussed the importance of teacher presence and control of the learning process within the AI era to ensure the adequate use of AI according to the pedagogical and didactical objectives.

The current study is an ongoing research. Further analysis is needed to contextualize our data with participants' reported practices and actual strategies considering the evidence as well from the rest of the sessions. Our future work for example aims to attend as well how to balance AI's capabilities with teachers' expertise, studying the proper timing and feedback contingency of the AI-driven interventions. We anticipate that the evidence gathered will help the design of a system aiming to correspond to teacher actual needs and that we will uncover the challenges faced by the stakeholders when being involved in co-design sessions.

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6. Declaration on Generative AI

I declare that no generative artificial intelligence (GenAI) tools were used in the writing, editing, or production of this paper.

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