The role of teacher-AI collaboration in curriculum adaptivity: a case in primary school mathematics

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Abstract

Currently, AI is being introduced into education through adaptive learning technologies (ALTs) to support teachers. In this hybrid system, AI assists by suggesting lesson orchestration and personalizing curricula, thereby making them more adaptive. However, effective integration requires aligning AI functionality with teachers' pedagogical and didactical practices. Our research examined how teachers implement an AI tool for curriculum adaptivity. The tool suggests ways to optimize the number and sequence of lessons for different learning topics, determine the number of repetition lessons needed, and select the type of repetition activities for groups of students within the ALT. Over one school year, we studied 20 primary school teachers (grades 3 to 6) using interviews, diaries, think-aloud protocols, and log data. Initial findings revealed that teachers viewed AI-based recommendations positively and increasingly implemented the provided suggestions. However, teachers differed in their need to understand the AI functions and recommendations. Some required only initial reassurance about the recommendations' accuracy, while others sought a deeper understanding of the AI's workings. Over time, teachers reported increasing trust in the AI's functioning and a reduced workload in their daily practices. These results demonstrate that studying teacher-AI collaboration provides valuable insights into how AI functionality and teachers' pedagogical and didactical practices co-evolve. We also discuss whether the observed interaction patterns can be explained by factors such as teachers' trust, understanding of AI functionality, pedagogical-didactical knowledge, and AI literacy. These patterns can lead to insights into effective teacher practices working with AI-assisted curriculum adaptivity.

Keywords

Human-AI collaboration, adaptive learning technology, teacher, curriculum adaptivity

1. Introduction

Adaptive Learning Technologies (ALTs) have increasingly supported primary school arithmetic learning over the past decade [1], [2]. ALTs assist students by providing immediate feedback (step adaptivity) and selecting appropriately challenging tasks (task adaptivity) [3]. They can also offer broader support for curriculum adaptivity, enabling teachers to tailor the structure and content of the entire curriculum [4]. For instance, AI tools can recommend adjustments to the curriculum plan, identifying learning topics that require additional practice for specific students. As such, AI functions as a recommendation tool, advising teachers while they retain control over curriculum implementation.

However, AI-assisted humans do not always outperform the best-performing human or AI alone. A systematic review found this to be the case when both AI and human performance were assessed [5].

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Performance loss can occur when people overly depend on AI suggestions (overreliance), without critically analyzing them [6]. Conversely, underreliance occurs when humans place too little trust in AI suggestions, often due to adverse attitudes toward automation [7]. For most teachers, using AI to adapt the curriculum in their classrooms is a new experience. Therefore, it is important to examine how their collaboration and reliance on AI develop over time.

In a hybrid intelligence system, teachers and AI can augment each other by leveraging the strengths of both human and artificial intelligence in active collaboration [8]. The level of augmentation in teacher-AI collaboration depends on how AI functionality supports teachers' practices. We define pedagogical-didactic practices as the actions taken by the teacher to structure, recognize, and value learning (pedagogy), and the teaching method used by teachers to transfer knowledge and skills for learning (didactics). The collaboration can co-evolve into new practices, where AI may (partially) replace certain teacher pedagogical-didactical practices (replacement), complement teachers to support extending pedagogical-didactical practices (complementation), or enable new pedagogical-didactical practices previously unattainable without AI (augmentation) [9]. These interactions reshape teachers' practices, knowledge, and roles.

Simultaneously, teachers' characteristics, such as trust in technology, significantly influence their interactions with AI [10]. Additionally, teachers may face increased workload when lacking AI literacy or sufficient pedagogical-didactical knowledge in mathematics. These factors can impact the quality and nature of their interactions with the AI.

In this study, we investigated the start of a collaboration of teachers with an AI-recommendation tool for curriculum adaptivity within an existing ALT to map their interactions. Furthermore, we examined how this collaboration is associated with teacher characteristics such as trust in the AI and experienced workload. We aim to define the different forms of teacher-AI collaborations based on these interactions to ultimately investigate their effectiveness, in terms of sustainable load on the teacher and more learning growth for the students in the ALT.

2. Methodology

This study reports findings from the first of two data collection cycles in a three-year design-based research project within a school district. Within the context of the national education lab AI (NOLAI), we work together with a tech company and teachers to develop, research and co-implement the AI-recommendation tool for curriculum adaptivity.

At the start of cycle 1, before the AI-recommendation tool was introduced to the teachers, a baseline questionnaire was distributed to the district's grade 2-6 teachers (N = 133) to assess their expectations of the AI tool. During cycle 1, four expert teachers began using AI-recommendation tool and documented their experiences in weekly diaries, where they reported on their workload increase during the implementation (7-point Likert scale from much less workload to much more workload) and trust in the AI recommendations (10-point Likert scale from 1= no trust to 10 = complete trust). Two interviews and think-aloud sessions per teacher provided insights into the evolving teacher-AI collaboration, focusing on teachers' pedagogical didactical practices and functioning of the AI. In think-aloud sessions teachers made their thinking explicit while using the tool for lesson planning. In the coming months, log data of the ALT will be analysed to follow which AI suggestions teachers incorporated into their curriculum. In the second cycle, starting from January 2025, more teachers (~20) will participate.

3. Results

Before implementation, the baseline questionnaire revealed that most teachers had positive expectations about working with the AI tool. Specifically, 78.2% saw potential opportunities, and 70%

anticipated greater flexibility in lesson planning. However, opinions about the expected workload varied: 28.9% predicted an increase, 28% anticipated a decrease, and 43.2% remained neutral.

Weekly diaries recorded during implementation showed that the perceived workload associated with the AI tool varied among teachers. Some reported fluctuations in workload, ranging from significantly less to more workload within a two-week period, while others reported consistently

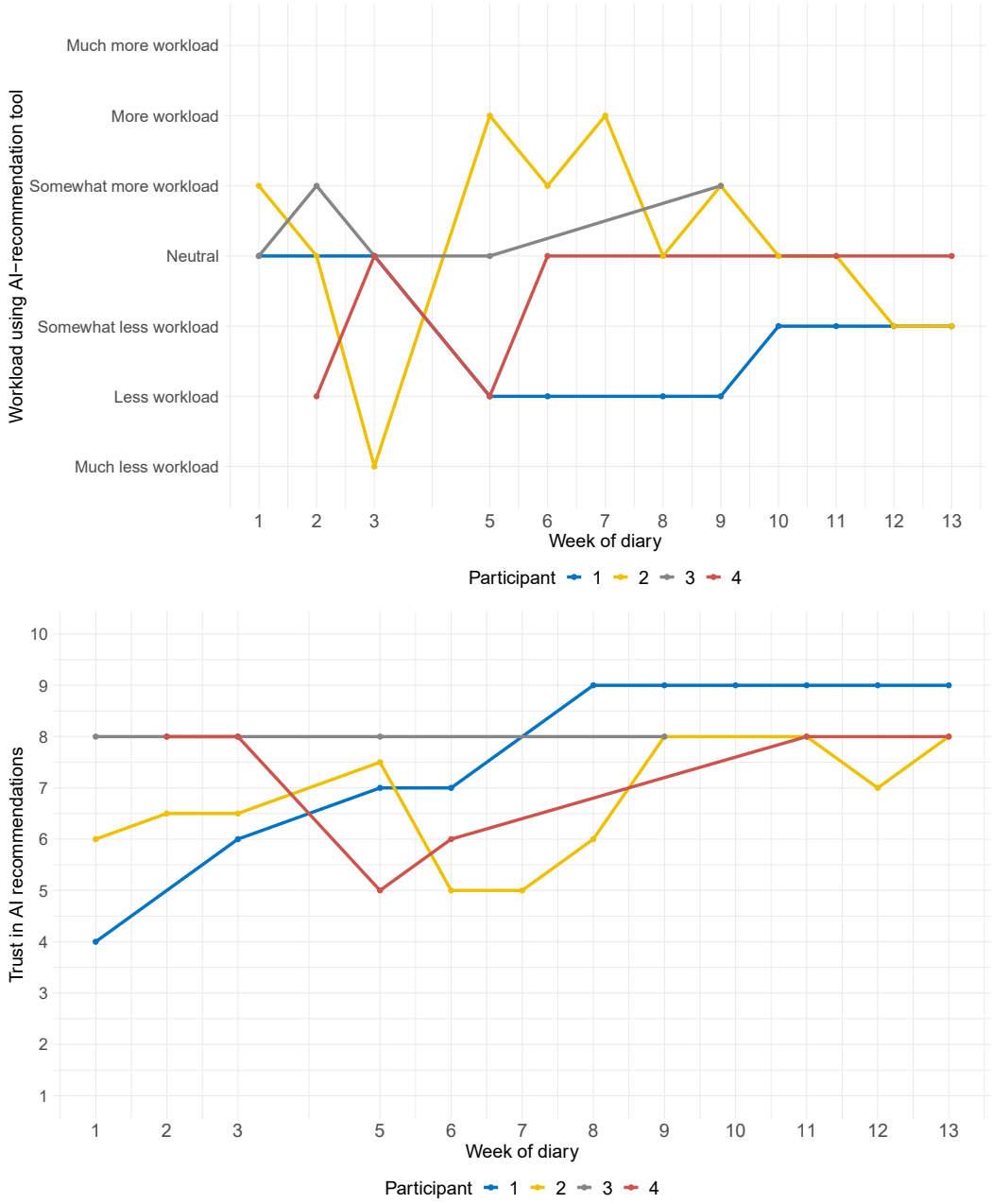

Figure 1: Top: Experienced workload of the teachers working with the AI-recommendation tool (7-point Likert scale from much less workload to much more workload). Bottom: Experienced trust of the teachers in the AI-recommendations (10-point Likert scale from 1= no trust to 10 = complete trust). Collected in weekly diaries of four teachers in cycle 1 (week 4 was a school holiday).

neutral experiences (Top, Figure 1). Over time, working with the AI tool led to a stabilization in workload, with most teachers reporting a slight decrease in workload during lesson preparation.

In terms of trust in the AI's suggestions, an overall increase was observed across the implementation period. Notably, the largest gains in trust were seen among teachers who initially reported low trust in the system (Bottom, Figure 1).

Interviews revealed varying teacher interactions with the AI-recommendation tool. Although all teachers sought greater insight into its decision-making, particularly regarding student-topic assignments, some teachers anticipated reduced need for monitoring as trust in the tool grew, exemplifying how parts of the pedagogical-didactical practices can be replaced by AI as confidence in its functionality increases. Other teachers preferred continuous insight into the AI tool's suggestion process – e.g., teacher 1 stated, "*In the end, I'm responsible for their learning process*" - using it to complement their analysis of students' needs and adapt the curriculum. For example, teacher 4 mentions how the AI allows them to aid individual students with their specific learning needs, rather than having students work randomly on learning goals they might not yet have completed. Teachers 1 and 2 explain that the AI has taken over the selection of students who need to rehearse lessons to achieve a learning goal. Yet they still experience that they need to check these suggestions to see whether the AI's selection of students matches their own. As such, these teachers are differentiating students by combining their own knowledge of students and the knowledge of the AI of their students. This illustrates AI complementing and augmenting teachers' pedagogical-didactical insights.

Teachers experience the AI tool to support curriculum adaptive teaching. They all mention how the AI creates space to think ahead about planning the curriculum for their students, based on what their class needs in terms of instruction, repeating lessons, and extra instruction. In short, it facilitated lesson planning (replacement) and enabled fine-tuning of instruction based on student needs (complementation). Additionally, evaluating AI recommendations introduced new responsibilities for teachers to interpret and manage these insights.

4. Conclusion and discussion

AI recommendation tools for curriculum adaptivity can support teachers in implementing adaptive learning in their classrooms by suggesting curriculum adjustments on an individual student level. Teachers assess these AI-driven insights based on their own pedagogical-didactical knowledge and actions. Our findings indicate that teachers' need to understand the functioning of AI differs. This is in line with literature, which shows that some teachers potentially over-rely on the AI, showing no need for analytical information [5]. Others mention the need for control and may under-rely on the AI. These discrepancies arise in interaction with the AI over time. For example, when AI suggests students for repetition lessons that do not align with teachers' observations, some teachers are prompted to more closely monitor the tool's recommendations. Importantly, the documented workload and trust levels suggest that teacher-AI collaboration is a dynamic process that evolves over time [10]. This process highlights how AI influences and sometimes transforms teachers' pedagogical-didactical practices.

These differences in teacher-AI collaboration can be understood in terms of teacher autonomy and AI automation. They can be mapped onto Molenaar's [11] six levels of automation model. Some teachers engage in continuous monitoring and use the tool at the level of teacher assistance whereas others monitor only incidentally and work at the level of partial automation.

For future directions, we will focus on scaling to include more teachers and diverse classroom settings with teachers who have less expertise in the ALT. We also plan to analyze any differences in students' mathematical knowledge trajectories in the ALT of the teachers involved, to understand the impact of their teacher-AI collaboration. This can hopefully also lead to interventions for effective pedagogical-didactical practices working with an AI-assistant.

In conclusion, this research provides a detailed analysis of hybrid teacher-AI collaboration and illustrates the triangular relationship between teacher, AI and students [9]. In this system, the AI informs teachers while either replacing or complementing pedagogical didactical practices. For students, this can increase diversity in the curriculum and lead to higher levels of personalized

education. Consequently, the interplay of replacement and complementation establishes new collaborations between teachers and the AI tools.

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Declaration on Generative AI

The author(s) have not employed any Generative AI tools.

References

[1] V. Aleven, E. A. McLaughlin, R. A. Glenn, and K. R. Koedinger, 'Instruction based on adaptive learning technologies', *Handbook of research on learning and instruction*, vol. 2, pp. 522–560, 2016.

[2] van de Wetering, 'Education in an artificially intelligent world'. 2020. [Online]. Available: https://www.kennisnet.nl/app/uploads/Kennisnet-Technology-Compass-2019-2020.pdf

[3] K. VanLehn, 'The Relative Effectiveness of Human Tutoring, Intelligent Tutoring Systems, and Other Tutoring Systems', *Educational Psychologist*, vol. 46, no. 4, pp. 197–221, Oct. 2011, doi: 10.1080/00461520.2011.611369.

[4] S. Narvekar, 'Curriculum Learning for Reinforcement Learning Domains: A Framework and Survey', *Journal of Machine Learning Research*, vol. 21, no. 181, pp. 1–50, 2020.

[5] M. Vaccaro, A. Almaatouq, and T. Malone, 'When combinations of humans and AI are useful: A systematic review and meta-analysis', *Nat Hum Behav*, vol. 8, no. 12, pp. 2293–2303, Oct. 2024, doi: 10.1038/s41562-024-02024-1.

[6] Z. Buçinca, M. B. Malaya, and K. Z. Gajos, 'To Trust or to Think: Cognitive Forcing Functions Can Reduce Overreliance on AI in AI-assisted Decision-making', *Proc. ACM Hum.-Comput. Interact.*, vol. 5, no. CSCW1, pp. 1–21, Apr. 2021, doi: 10.1145/3449287.

[7] Y. Zhang, Q. V. Liao, and R. K. E. Bellamy, 'Effect of confidence and explanation on accuracy and trust calibration in AI-assisted decision making', in *Proceedings of the 2020 Conference on Fairness, Accountability, and Transparency*, Barcelona Spain: ACM, Jan. 2020, pp. 295–305. doi: 10.1145/3351095.3372852.

[8] D. Dellermann, P. Ebel, M. Söllner, and J. M. Leimeister, 'Hybrid Intelligence', *Bus Inf Syst Eng*, vol. 61, no. 5, pp. 637–643, Oct. 2019, doi: 10.1007/s12599-019-00595-2.

[9] I. Molenaar, *Mens-AI samenwerking in het onderwijs: De hybride toekomst*, (Sep. 26, 2024). [Online Video]. Available: https://vimeo.com/event/4352299

[10] O. Viberg *et al.*, 'What Explains Teachers' Trust in AI in Education Across Six Countries?', *Int J Artif Intell Educ*, Oct. 2024, doi: 10.1007/s40593-024-00433-x.

[11] I. Molenaar, 'Towards hybrid human-AI learning technologies', *Euro J of Education*, vol. 57, no. 4, pp. 632–645, Dec. 2022, doi: 10.1111/ejed.12527.