What Teachers Would Expect from a Pedagogical Agent System Working at a Classroom Level: A Focus Group Study

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Abstract. Applications of pedagogical agent (PA) systems incorporating animated characters in school settings have mainly addressed students at an individual level. However, how these systems could be used and designed for supporting teachers while taking advantage of artificial intelligence (AI) technology is an open question. Therefore, we carried out a focus group to understand what teachers would expect and need from such a system at a classroom level. Our focus group protocol sought to discover design and practical considerations in four dimensions. 1) System design considerations, where teachers expect the system to incorporate speech recognition and to "learn" from them while doing their practice. 2) System collaboration, teachers wanted support in their pedagogy by considering students' achievement profiles, and by finding and sorting learning material as needed. 3) PA role in the classroom, we identified the following roles: annotator, scaffolder, peacekeeper, and substitute. 4) PA ethical considerations, teachers perceive PA as a possible replacement threat and controversial opinions on the use and meaning making of this technology. We discuss our findings and present future research directions to develop a PA that could empower teachers with AI pedagogy in the classroom, hence, indirectly supporting learning.

Keywords: Pedagogical Agent, classroom level technology, artificial intelligence pedagogy, focus group, educational technology.

1 Introduction

Educational technology that incorporates Artificial Intelligence (AI) is rapidly gaining attention, as it can serve to automate parts of problem-solving processes comparably to how humans will tackle them [1]. For example, pedagogical agent systems are shown to have positive impact on students' learning [2] by playing pedagogical roles (i.e peer, mentor, tutor, expert) when interacting with learners [3]. However, design and ethical considerations when deploying these systems on a classroom level to support both, teachers' pedagogy and students' learning, are not yet well defined. This paper explores

what teachers would expect from PA systems when deployed on a classroom level in the K-12 context.

PA systems derive from intelligent tutoring system (ITS) and are capable of simulating teachers' personalized help to students. PA systems incorporate digital entities (agents) that can be implemented in multiple multimedia formats (i.e., text, voice, 2D or 3D characters) [4]. Such systems provide timely feedback and support to students based on estimations of continuously updated models of students' interactions and behaviors [5, 6]. Despite reviews reporting on ITSs effectiveness to support students' learning [7], it is not clear how teachers can benefit by integrating it into their pedagogy [8, 9]. Yacef [10] proposed to jointly support students and teachers with ITS and reconceptualized them as "intelligent teachers assistants" (ITAs). Related research suggests that these systems could increase students' learning by leveraging teacher's practice in the classroom [11, 9, 12]. For instance, [11] suggested that ITSs would need to consider leveraging teachers' practice including time management across multiple students, reducing orchestration load, feedback on teachers' own support to students, actionable diagnosis rather than just data visualizations, students' motivation and frustration management, customize the ITS to fit teachers' pedagogy needs, entirely taking control over the ITS, and allow teachers' eyes and ears to be on the classroom instead of metric dashboards. Other studies have taken a broader scope to understand teachers' perception of AI as a tool to support their practice. For instance, [13] found teachers to have limited or basic familiarity with AI. However, teachers suggested that AI could be a means to foster creativity in their practice, automatically forming groups considering students' knowledge state, and sorting learning materials according to the difficulty level. Conversely, teachers perceived AI use in education to hinder human communication, creating passiveness and/or replacing the human factor.

We build on existing work to contribute toward an effective AI pedagogy. Our work differs in that we focus on pedagogical agent (PA) systems [14] incorporating 2D virtual animated characters that have been used with individual students. This is important to address as some authors have report teachers' passiveness in the classroom when students interact with such systems [15]. We carried out a focus group in which teachers engaged in discussions and shared their insights in four broad categories aiming to integrate PA as an effective pedagogical aid: (i) system design considerations, (ii) PA collaboration, (iii) PA role in the classroom, and (iv) PA ethical considerations.

2 Method

2.1 Study Design

A focus group qualitative method was appropriate for this study as it facilitated the researchers to get new insights and understandings about participants [16] in a cooperative manner where participant's interaction will likely yield the best information for the study [17]. The focus group was hosted online in the last week of November 2021. The consent forms were sent via email, and participants granted permission for video and audio recordings for analysis purposes. Our study considered purposive nonprobability sampling [18]. In total, five K-12 STEM subject teachers and one language

teacher participated in the focus group (5 female, 1 male). Five participants were active teachers also studying a master's or PhD program in education-related fields (3=MA, 1=PhD), and two were solely teaching. STEM-related represented subjects were natural science, mathematics, robotics, informatics, and physics. Four teachers expressed to always use technology in their classroom, one most of the time, and one sometimes. They further explained to use mainly technology like projectors, computers, mobile devices, smart boards, and robots, but no specification was provided software-wise. Only one of the teachers had previous experience with PAs or ITSs.

2.2 Focus Group Protocol and Coding Procedure

We organized our focus group protocol questions into four initial categories: 1) PA design considerations aiming to explore how teachers would like to intervene or interact with the system; 2) PA collaboration, aiming to exploring possible co-teaching processes, that teachers would like to be assisted with by the PA; 3) PA role in the Classroom, aiming to identified roles the PA would need to perform when deployed in a classroom; and 4) PA ethical considerations, aiming to understand issues and threats teachers would raise when deploying this technology.

We transcribed the recorded audio file to text, anonymized the data, and all utterances were divided, and organized in a spreadsheet. We followed an inductive approach proposed by Thomas [19] consisting of the following phases: (i) Initial reading and identification phase, where all utterances containing key pieces of information related to our study objectives were marked with bold. (ii) Labeling phase, where an independent parallel coding was carried out in which the first author introduced the initial four categories to the second author. Then, both coders independently labeled key pieces of information to identify specific topics. (iii) Reducing overlapping categories phase, where both researchers discussed the created labels and reduced them to nine different topics in which all utterances were re-coded. To validate coders' concordance and reliability, we used Cohen's Kappa. (iv) Finally, in the creating a model process phase, we further allocate those nine topics (subcategories) into the initial broad categories of our focus group protocol. Our final data consisted of 73 distinguishable utterances.

3 Results

3.1 PA System Design Considerations

Teachers expressed the necessity to interact with the system by using voice commands (speech recognition technology). This was supported by excerpts like "*... saying a command, that would be amazing because if you have to insert… a code… or touch it [system app]... takes time and time is very precious in the classroom. If I can just say it [command to the system] then it would be easier… if you make it [PA interaction] time-consuming or difficult, then teachers won't use it*". Another system interaction requirement was linked to the need for monitoring and controlling the students while teachers must go momentarily from the classroom. An example of the latter was "*If I am in the*

classroom they know that they [students] have to behave, I am usually talking with them [students] and they feel like somebody is there watching them. I think my replacement [referring to the PA] could alert me if there is a problem, sending a SMS or something like that, I could quickly come back.". Regarding how teachers would like to intervene in the system, one teacher expressed the need for the system to be able to "learn" and re-configure pedagogical aspects. Excerpts of the latter were *"... the scenario that comes to me is… I could use a code word to stop it [the PA system] for a minute, and if it [PA] could be that smart… to learn from me, that would be amazing… Maybe after my lesson, help it [PA] to improve it. I mean, I think that's like artificial intelligence…. If the pedagogical agent can learn… that would be very resourceful for me to use it then… and I would definitely put the time to help it [PA] learn*".

3.2 PA Collaboration

Teachers expressed the need to collaborate with a PA to be able to alternate their attention between individual and classroom needs. This was supported by excerpts like "*For me, the most important part… is that I could give them [students] individual help, but at the same time, think about all the children together. So… the system could probably help me to… give attendance to the students… so… if I have somebody near me… doing a reading exercise, I can give them [students] personal feedback*". Another need for collaboration was custom support depending on students' achievement profiles. One teacher mentioned, "*In Estonia… there is a big problem. We don't have time to help or guide very smart students. It's sometimes too hard [the exercises or activities] for some students… and my smart ones have done all the work. I don't have the time to give them [advanced students] something harder*". Another collaboration request was for the PA to look and show real-life examples where abstract or difficult topics could be applied. One teacher said, *"...some students have a hard time understanding some topics. So… the agent could help me with some… real-life examples so that the students would understand the topics better*". Finally, last request was for managing internet resources while teachers are addressing the classroom, we found this is utterances like *"... I have to always show pictures… so it would be great if like the agent has already all these pictures… I need*", another teacher followed with "*I absolutely agree with this because my students are always [asking] please, show us, show us this picture on Google*".

3.3 PA Roles in the Classroom

We found teachers' requesting the following roles:

The Annotator will have to manage students' turns (forming a cue for the teacher to assist them) and take notes of students' questions. This was supported by utterances like "*For me… it's quite usual that I give the students an experiment to do in pairs and then, I walk around in the classroom and see how they are doing… solving the problems. So, if I could have someone at the front of the classroom to contain them [students] while I am going around, that will help*". The same teacher later added, *"... and the problem… students forget what they wanted to ask or get confused.*".

The Scaffolder will need to repeat, keep track, and explain instructions introduced by the teachers to allow students to complete the activities at a different pace. Teachers pointed out this as a strategy to reduce classroom orchestration load and unnecessary fatigue. The latter was stressed by "*I thought of one example… how it would really help me. I have to give instructions to the ones [doing the activity] fast, and I have to be ready to help those who are behind… I repeat my sayings [instructions] in the class… this pedagogical agent could repeat that for me because I have to do this a thousand times.*"

The Substitute would need to be capable of being to momentarily take over the class, or if teachers are not able to go to class, substitute them. For instance, one teacher said, "*The problem that occurs with my students is that during the breaks, I can't go even to the toilet… every time I come back there is some kind of problem…. and the lesson usually begins with me solving like 10 problems*."

The Peacekeeper should be able to mediate students' interactions to avoid conflicts. This was illustrated by the following excerpt, "*Ok, if you could use [PA] in a group that is working together… they [the students] start fighting, so it would be amazing if [the PA] could move them in the right direction. [With some questions] like are you working? What are you talking about?... That's what I would like.*"

3.4 PA Ethical Considerations

Teachers expressed their concerns about PA as a threat of possible replacement rather than empowerment. One teacher said *"...important that I am the teacher in the class… not… this agent. I make my rules and it [PA] has to follow them. This is important because maybe schools don't need us anymore. I need my money, but if I don't have money, I can't drink my coffee*". Another important ethical aspect to consider was in relation to personal data and students' psychological wellbeing, this was found in excerpts like "*I was thinking about privacy, maybe some students are not afraid of anything because they are born with computer and mobile phones [digital natives]. But parents might be afraid that this agent is recording something or doing something bad with data, like their [students'] faces or grades.*" One teacher said, "*If education goes more and more to distance learning, then agent games may be more useful and teachers won't be necessary*". Another controversial aspect teachers raised was regarding assessing and grading. The physics teacher mentioned "*When students are doing a test… I would leave the grading to myself because it would create a bad situation when agents follow a different logic in grading. Usually, computers are harsh… but when I grade, I see what they [students] are doing and if they [the students] are going in the right direction, then I am going to give them some points.*" This was discussed by the math teacher with "*But still, these agents could do something [in relation to grading] for us… but the final word is ours, not theirs [referring to PA].*" Another controversial aspect that raised discussion was in relation to a possible modality where the animated character is a virtual puppet, in other words, the PA functioning in a modality where a real human is fully or partially controlling the agent. Teacher 1 mentioned "*I think in*

the situation where the puppet [animated character] is controlled remotely by another person… then for me… I would rather take the teacher in the remote station with me in the classroom. But if the system doesn't need an extra human resource, then it would be acceptable for me. We have a problem in Estonia… we don't have enough teachers and I think it would be a waste of resources to use another person somewhere else… just to make it fun for the students" To this argument, another teacher responded, "*But what about teachers that can't teach in the class? Maybe they have some kind of [disability]... they are in a wheelchair, for example… We have teachers at home that can't teach, and they want to teach… and they have so much to give, and they really want to do their job… This agent gives them the opportunity to work.*"

4 Conclusion

Our study suggested design and practical considerations for PA systems incorporating an animated character at a classroom level in the following categories: System Interventions and Interactions. Teachers expect to be able to intervene in the system to make the PA learn and reconfigure itself to match the teachers' pedagogy requirements. PA collaboration. Participants expected the PA to allow them to (i) alternate their attention between individual and classroom needs, (ii) offer custom support depending on students' achievement profiles, (iii) and look and show real-life examples where abstract or difficult topics are applied. PA Role in the Classroom**.** We found four distinctive roles the PA should be able to perform to support teachers meaningfully. (i) The annotator will have to manage students' turns and questions to help teachers with a cue of assistance, as well as keep track of students' doubts to address them. (ii) The scaffolder will need to repeat, keep track of, and explain instructions introduced by the teachers, so students will be able to do the activities and teachers will avoid unnecessary fatigue by repeating instructions. (iii) As the substitute, the agent would need to be capable of momentarily taking control over the class, or if teachers are not able to go to class, substitute them. (iv) Peacekeeper. Teachers expressed the need to have aid when the activity is carried out in small teams. In this case, the PA should be able to mediate students' interactions to avoid conflicts. All teachers shared similar concerns to relevant literature where AI usage in education is perceived as a potential threat to hinder human communication [13], and to be designed to replace them rather than empower them [11]. However, teachers also engaged in controversial discussions that might depict designing flexibility requirements to meet teachers' preferences when incorporating PA technology in their practice, or practical implications in the case the PA system would partially be controlled by a real human from a remote station. We argue that artificial intelligence (AI) pedagogy [1], should empower teachers by leveraging their practice and support their well-being in a holistic meaningful manner.

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