Intelligent Cognitive Assistants to Support Orchestration in CSCL

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Abstract: This design paper proposes an intelligent cognitive assistant framework that utilizes AI-based multimodal learning analytics for developing a teacher dashboard. Using six data streams, we suggest this design can extend teacher's instructional capacity in technology-rich collaborative inquiry-focused science classrooms. We discuss how this tool can support teacher's orchestration in relation to relevant learning practices in complex problem-solving activities in a CSCL environment.

Introduction

Teacher orchestration is critical for supporting CSCL. It is defined as productively coordinating supportive interventions across many learning activities occurring at multiple social levels (Dillenbourg et al., 2009). Because it requires teachers to instantly facilitate a range of activities and resources at the same time, teacher orchestration is considered to be an exceptionally complex task (Prieto et al., 2018). Teacher professional development (PD) can be a promising solution; however, it often takes teachers away from the classroom. Traditional PD formats do not provide the most relevant and contingent support when teachers need it most (Jenkins & Agamba, 2013). Thus, we propose how an intelligent cognitive assistant in a teacher dashboard can provide just-in-time guidance. Employing learning analytics affords teachers opportunities to track students learning activities and extend their instructional capacity to provide contingent and adaptive teaching (Ferguson, 2012). In this poster, we outline the design principles of the *Intelligent Augmented Cognition for Teaching* (I-ACT) framework that uses AI-based multimodal learning analytics for developing a teacher dashboard.

Using multimodal learning analytics for the design of I-ACT cognitive assistant

In inquiry-based CSCL environments, a core competency of effective teachers is classroom orchestration which ranges from engaging learners as both individuals and groups, establishing learning priorities, assembling instructional resources, supporting complex thinking, and enabling students to build connections between ideas (Prieto et al., 2017). In the collaborative learning environment, teachers are often asked to conduct multiple forms of learning activities which pose considerable orchestration load (Prieto et al., 2017). Tools for learning analytics seek to use data from learners and the classroom and promote awareness and reflection through collecting, analyzing, and synthesizing multiple data sources into visualizations (Ferguson, 2012). Several dashboards have focused on classroom orchestration and support for teachers to support collaborating groups such as TinkerBoard (Son, 2012) and Collaid (Maldonado et al., 2012). Typically, in these dashboards, activity information is visualized on a large display to capture learner performance and to deliver insight into collaboration among students using audio, physical, and positioning traces of student activity. Emphasis is placed on providing real time data visualizations including social interaction, time spent, or artifacts produced to enable teachers to detect when to intervene.

The I-ACT cognitive assistant will be designed to directly support K-12 science teachers by providing context-sensitive guidance. It will be driven by AI-based multimodal learning analytics (see Figure 1) from six data

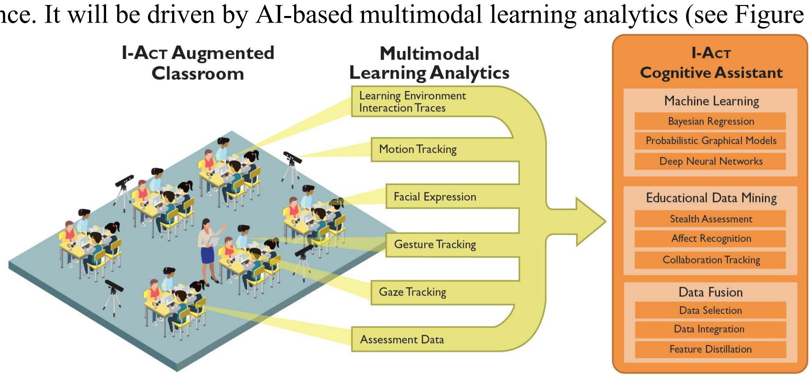

Figure 1. I-ACT Teacher augmentation in the classroom.

streams: learning environment interaction traces, motion tracking, facial expression tracking, gesture tracking, gaze tracking, and assessment data. First, I-ACT science classrooms will track students' problem-solving interaction data. I-ACT will track not only the location and movement of teachers and students in the classroom but also students' facial expressions, gestures, and gaze to supply a rich set of learner information. Additionally, I-ACT cognitive assistants will collect assessment data during the course of students' problem solving. Collectively, the multimodal learning analytics will guide teachers in effectively orchestrating science inquiry with a data-rich picture of student problem-based learning (PBL) and collaboration. During class, the I-ACT cognitive assistants will provide real-time recommendations and guidance to teachers to reduce orchestration load so that they can effectively scaffold learners throughout the full teaching workflow in science PBL through their laptop or tablet. For example, the I-ACT cognitive assistant will alert teachers to tell which students need assistance with the highest priority, what types of problem-solving and collaboration support strategies might be most effective, and when they need to pause activities to provide a mini lecture, either to particular students, to specific groups of students, or the whole class.

More specifically, I-ACT will reduce orchestration load across three phases of implementation: (1) prospective guidance, (2) concurrent guidance, and (3) retrospective guidance post-implementation. In prospective pedagogical guidance stage, I-ACT will provide "forward guidance" to plan successful classes and anticipate triggers that might lead to failure. The assistant will proactively suggest strategies and anticipate potential obstacles to manage orchestration load. Next, in the concurrent pedagogical guidance stage, I-ACT will help teachers with facilitation such as initiating inquiry, scaffolding problem-solving process, and pushing for deep knowledge construction. Classroom implementation of technology-rich inquiry puts an extremely high orchestration load on teacher performance so the assistant will be beneficial for teachers during this stage. Lastly, in retrospective pedagogical guidance stage, I-ACT will guide teachers in reflecting on their orchestration moves and help them make successful ones continue. It is a critical step to provide reflection space to make sense of what went well, what did not, and why, because what teachers encounter in the classroom is new. Further, the I-ACT cognitive assistants' prospective, concurrent, and retrospective guidance will be improved with the same multimodal data that was collected during class time in a tight feedback loop. This poster will present a design case of middle school students participating in a life science unit in which they learn about ecosystems. We test our design as students collaboratively engage with a problem scenario centered on an aquatic ecosystem that has become polluted as a result of human activity using the Crystal Island narrative game (Rowe et al., 2011), which generates highly granular problem-solving logs during three stages of orchestration.

Conclusion

Although there has been a lot of research and development of learning analytics tools and resources over the last decade, much of the existing research and practical tools has not fully supported enabling and transforming teaching and learning practice, which is, in part, due to the lack of meaningfully developing these metrics in relation to relevant learning practices. I-ACT cognitive assistant will demonstrate a promising design case that can help teachers extend their teaching capacity to provide contingent and adaptive scaffolding in technology-rich inquiry teaching environment, where learning technologies support both student collaboration learning and PBL.

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