A SOCIAL ROBOT THAT LOOKS FOR PRODUCTIVE ENGAGEMENT

A PREPRINT

Jauwairia Nasir
Computer-Human Interaction in Learning and Instruction (CHILI) Lab
Swiss Federal Institute of Technology in Lausanne (EPFL)
Switzerland
jauwairia.nasir@epfl.ch

Barbara Bruno
Computer-Human Interaction in Learning and Instruction (CHILI) Lab
Swiss Federal Institute of Technology in Lausanne (EPFL)
Switzerland
barbara.bruno@epfl.ch

Pierre Dillenbourg
Computer-Human Interaction in Learning and Instruction (CHILI) Lab
Swiss Federal Institute of Technology in Lausanne (EPFL)
Switzerland
pierre.dillenbourg@epfl.ch

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1 Background and Research questions

1.1 What research question are you trying to address?

I am trying to address the following research question: “Will a supportive social robot peer equipped with a goal-centric engagement model be better in advancing team’s learning in a collaborative open-ended activity over a typical supportive baseline?"

1.2 What learning theory or theoretical background do you plan to use?

Inspired by the behaviour and pedagogical principles of human teachers, we believe that at a given point in time, an engaging robot for education is the one capable of choosing an action that is in line with enhancing the educational goals directly. Based on this, we postulate that to maximize learning, engagement need not be maximized, rather it needs to be optimized. This postulation draws some inspiration from the idea of Productive Failure proposed by Manu Kapoor [1] where he says “Engaging students in solving complex, ill-structured problems without the provision of support structures can be a productive exercise in failure”. We believe that more often that not, there are learners that consecutively fail in a constructivist design, apparently scoring low on perceived engagement that can be biased by performance; however, they end up with higher learning. Same can be true with learners that seem to be succeeding but achieve lower learning. Our research tries to model such engagement that is tied to learning via a goal-centric engagement framework that we refer as *Productive Engagement*. Hence, in our experimental condition, the robot actions are based on such an engagement framework.

In addition to this, the design choices of our collaborative activity are supported by the idea that collaboration only produces learning if peers engage into rich verbal interactions such as argumentation, explanation, mutual regulation [2, 3], or conflict resolution [4, 5].

2 Design

2.1 What is the context to your research?

In educational HRI, it is a common practice to incorporate a social robot with supportive feedback at various events to encourage and motivate the students in a learning activity. Such a robot is then expected to have to a positive effect on the learning goals of the students. We hypothesize that a supportive robot, leveraging *Productive Engagement* framework, equipped with a deeper understanding of which student behaviors can help students move closer to the learning goal would perform better than a typical supportive robot. The *Productive Engagement* model is based on the findings from our previous study in a similar collaborative human-human robot mediated setup. This robot not only gives supportive feedback but also hints at behaviors that the students should undertake for advancing towards higher learning gains.

2.2 Who are your learners?

We are targeting middle-school children aged 9-12 years old at International schools in Switzerland.

2.3 What are the learning objectives?

The JUSThink learning activity aims to (1) improve the computational skills of children by imparting intuitive knowledge about minimum-spanning-tree problems and (2) promote collaboration among the team via its design. The minimum-spanning-tree problem is introduced through a gold mining scenario based on a map of Switzerland, where mountains represent gold mines labelled with Swiss cities names. The children have to connect these gold mines by spending *by spending as little money as possible*. For more details, please see [6].

2.4 Where is the learning occurring? (home, school, elderly facility . . .)

The learning is occurring in the school. However, with the intended setup, the learning can be achieved at homes as well.

2.5 What robot do you use and why?

We make use of the humanoid QTrobot[1] where a few of the motivations for the choice include:

- its high facial expressivity via a screen
- its smaller size
- its stability on a table setup due to immovable legs

3 Assessment

3.1 What methods do you plan to use for the assessment? How do they map with the learning objectives?

We plan to use a pre- and a post-test to evaluate the learning process. Since the underlying activity is an open-ended learning activity to acquire an implicit understanding of *Minimal Spanning Trees*, we expect hit and trial and failing along the way of finding the best solution. Hence, we do not rely on performance in the task to measure learning as our previous studies show that in such a constructivist setup, task performance and learning gain are not correlated [6]. The pre- and the post-test consist of problems where each problem analyzes a specific conceptual aspect of the Minimum spanning tree problem.

While the pre- and post-test evaluation is sufficient to evaluate the research question; we also plan to use a perception questionnaire (based on standard God-speed questionnaire and Intrinsic Motivation Inventory (IMI)) for analyzing robot perception, and self-perception of task and social engagement by the participants similar to the one in [6].

[1] https://luxai.com/qtrobot-expressive-robot-for-research-and-teaching/

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[2] ANIMATAS Project