Designing awareness tools for teachers in exploratory learning settings

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Research Motivation

Advantages of Exploratory Learning environments for students’ engagement and “deep” learning e.g.

- microworlds
- virtual science labs
- educational games
- physical computing kits

Role of the teacher in an Exploratory Learning setting is that of facilitator/orchestrator/coach
Obstacles to teachers’ use of ELEs include:

- the need to provide support to students (through the ELE and by the teacher) so as to ensure productive interaction with the learning environment and achievement of learning goals.
• the need to overcome teachers’ perceived lack of ‘control’ over their students’ learning activities when ELEs are being used

• our approach: provide Teacher Assistance tools to enhance teachers’ awareness of students’ engagement and progress with the task set
Challenges of providing support

• generally not a direct link between students’ interactions in the ELE and the knowledge domain
• tasks are open-ended and there is not a single ‘correct’ answer
• balance is needed between students' freedom to explore and guidance towards achieving learning goals
• teachers are less familiar with tools that facilitate exploratory learning; so harder to elicit their requirements regarding the support that Teacher Assistance tools should provide for them
Our approach

• Design intelligent components, integrated into the ELE, that provide personalised feedback to students as they are working on the task set

• Design a suite of Teacher Assistance tools, each visualising the occurrence of a set of key indicators and serving a particular purpose
  • aim is to enhance the teacher’s awareness of students’ progress on the task set, and inform the teacher’s own interventions to support students both individually and the class as a whole
  • a variety of computational intelligence techniques are used to detect indicators (case-based reasoning, rule-based reasoning, pattern-matching, sequence detection)
Methodology

1. Design a first version of the ELE itself (if not an existing ELE)

2. Design feedback for students
   - successive prototypes of increasing functionality co-designed and trialled with groups of students and teachers
   - trials inform also refinement of the ELE itself

3. Identify indicators and design TA tools
Example 1: eXpresser microworld
eXpresser microworld
student feedback

Change the number of building blocks to see if the pattern is still coloured.
student feedback

The General World is messed-up

I see
Methodology – teacher tools

Phase A:
• Requirements elicitation and prototyping, working with teachers in focus groups and one-to-one
• Results in a preliminary set of indicators to be detected and visualised, and early versions of tools

Phase B:
• Classroom sessions trialling the tools with teachers
• Results in refinement and extension of the tools
• Also in the identification of a full set of Usage Scenarios for the tools
Methodology – teacher tools

Phase C:
• Formative evaluation of the tools with respect to the Usage Scenarios (lab-based and classroom-based)

Phase D:
• Summative evaluation (lab-based and classroom-based)
First Teacher Tool developed

- *Student Tracking* tool shows occurrence of all indicators identified through by our teacher collaborators as being useful (Phase A):
  - green : productive interaction
  - red : unproductive interaction
  - yellow : could be either

- A default subset of most important indicators is displayed by the ST tool

- Teacher can select to turn on/turn off others
Trialling in Phase B identified contextualised usage scenarios

- Who needs my help right now?
- Who isn't working on the task set?
- How are students approaching the task?
- How are they progressing with the task goals?
- Have they finished the task?
- How should I pair students for productive discussion of their solutions?
Leading to co-design and evaluation of additional Teacher Assistance tools

- *Classroom Dynamics* tool
- *Goal Achievements* tool
- *Grouping* tool
Students' circles can be dragged

\[
\begin{array}{ccc}
9 & \times & 7 \\
\end{array}
\] + 5
Groups of students calculated according to their constructions. [8:56:14 PM]
Example 2: SAM labs
Phase A – teachers’ questions

• What SAM blocks do the students use?
• What circuits do they put together with the blocks?
• How do they evolve their circuits over time?
• To what extent do they change their circuits in order to make them functionally correct?
• When looking at a specific change, what previous moves informed that change? What future moves are triggered by that change?
• ...

Students’ progress on circuit construction
Students’ creation of links
Students’ link usage summary
Future work

• completion of Phases B-D for SAM Labs
• design of TA tools for other exploratory learning environments
• scaling out TA tools to online exploratory learning settings
• developing new data analyses and visualisations to enhance Exploratory Learning
  – for students, teachers, researchers, policy makers, administrators etc.
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