Supporting Exploratory Learning through data visualisation and notification tools for Teachers

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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
- simulators

However,

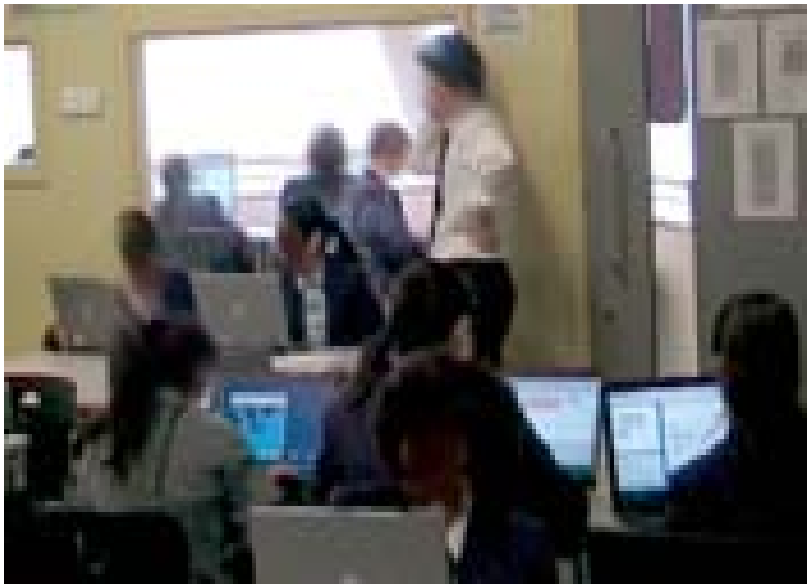
- there is generally not a direct link between students' interactions and the knowledge domain
- tasks are open-ended and there is not a single "correct" answer; balance is needed between students' freedom to explore and guidance towards achieving learning goals

Research Motivation

Hence key obstacles to the integration of ELEs in the classroom include:

- the need to provide *support to students*, so as to ensure their productive interaction with the learning environment and achievement of task learning goals

- the need to provide *support to the teacher*, to enhance their awareness of the classroom ‘state’ and of students’ engagement and progress with tasks set; also to overcome teachers’ perceived lack of ‘control’ over their students’ learning activities when ELEs are used in the classroom



Our approach

- We design intelligent components, integrated into the ELE, that provide **personalised feedback to students** as they are working on the task set
  - The feedback is generated based on the system's detection of the occurrence of significant ***indicators*** as the student interacts with the ELE, combined with the student's recent history of interactions, achievement of learning goals etc.
  - A variety of computational intelligence techniques are used to detect indicators and to generate student feedback (e.g. case-based reasoning, rule-based reasoning, pattern-matching, sequence detection)

Our approach

- This intelligent support for the student cannot completely replace the teacher of course, whose role in an Exploratory Learning setting is that of ‘facilitator’ or ‘orchestrator’
- Hence we also provide a range of tools for the teacher, each tool ***notifying and/or visualising*** the occurrence of a subset of indicators, so as to enhance the teacher’s awareness of the classroom state and of students’ progress on the task set, and to inform the teacher’s interventions to support students individually and the class as a whole

m:gen intelligent support for mathematical generalisation

http://www.migen.org

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T·L·R·P Technology Enhanced Learning

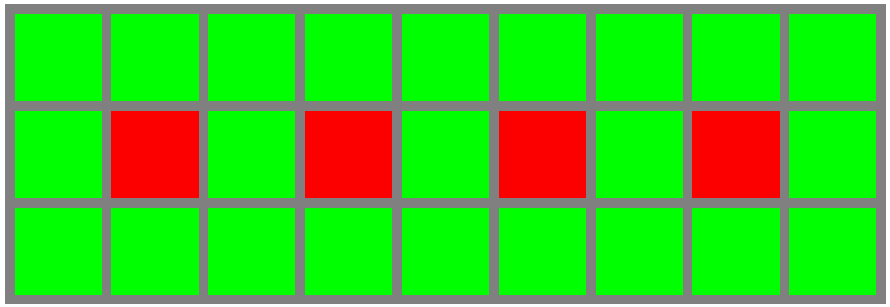
E·S·R·C Economic & Social Research Council

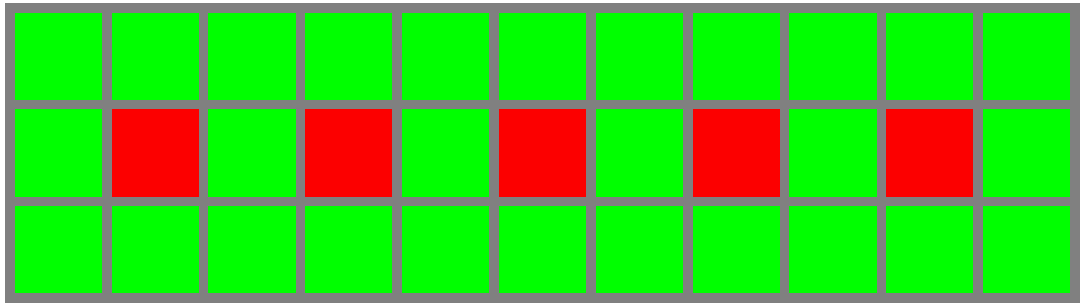
EPSRC Engineering and Physical Sciences Research Council

MiGen Project Aims

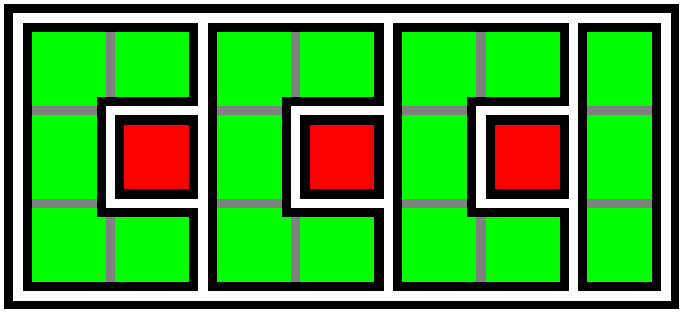
- MiGen allows students to create and manipulate *patterns* and *algebraic expressions*, and explore the relationships between them
- students are asked to construct “generalised patterns”, to derive expressions, to test out their patterns and expressions on new problem instances, and to compare their constructions with those of other students
- our aim is to support students’ exploratory construction while also fostering progressive knowledge building

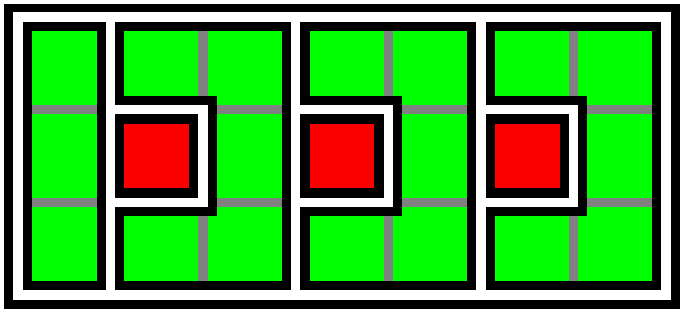
Generalised patterns

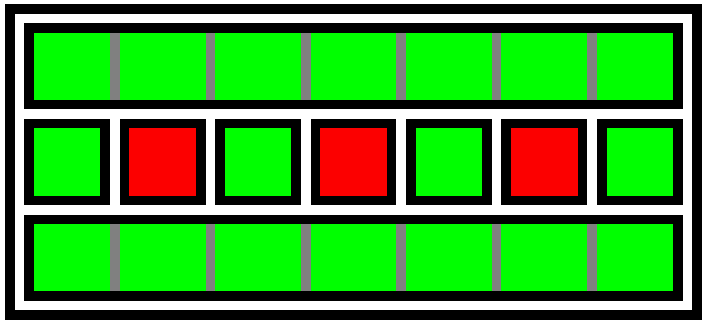


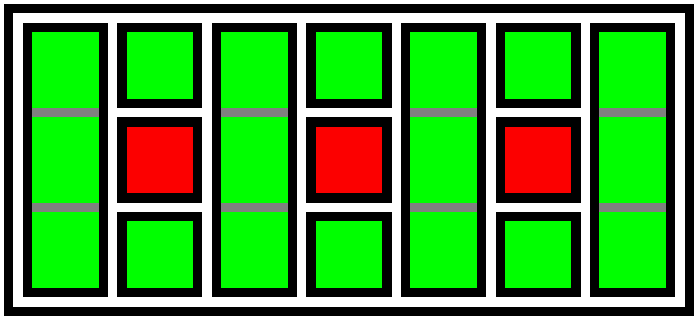


Possible construction approaches

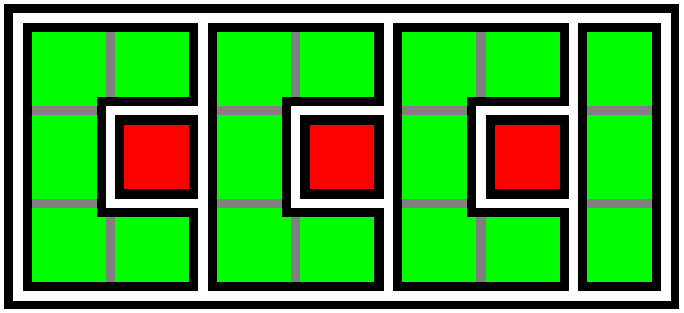




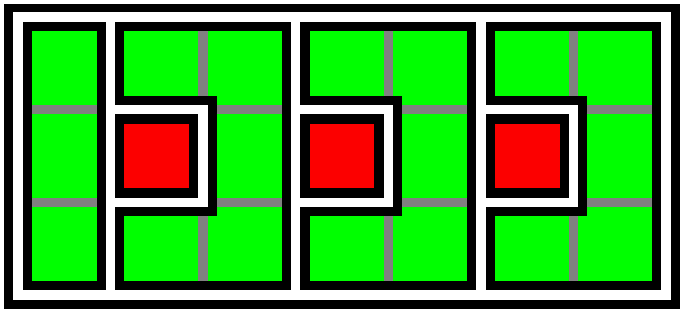




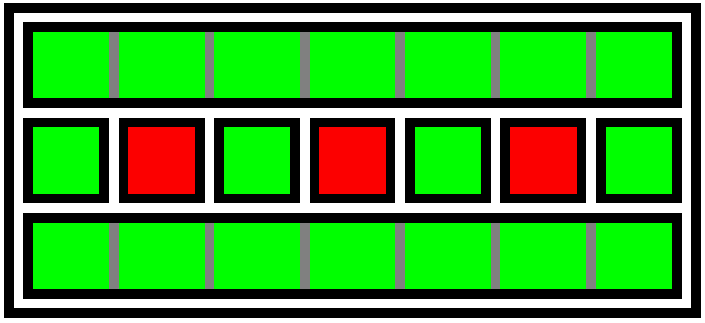
Possible expressions



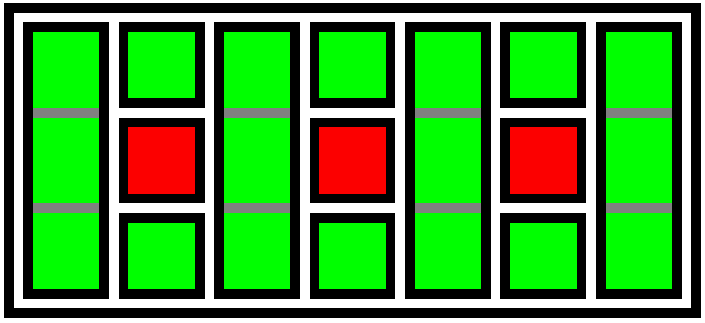
5 x reds + 3



3 + 5 x reds

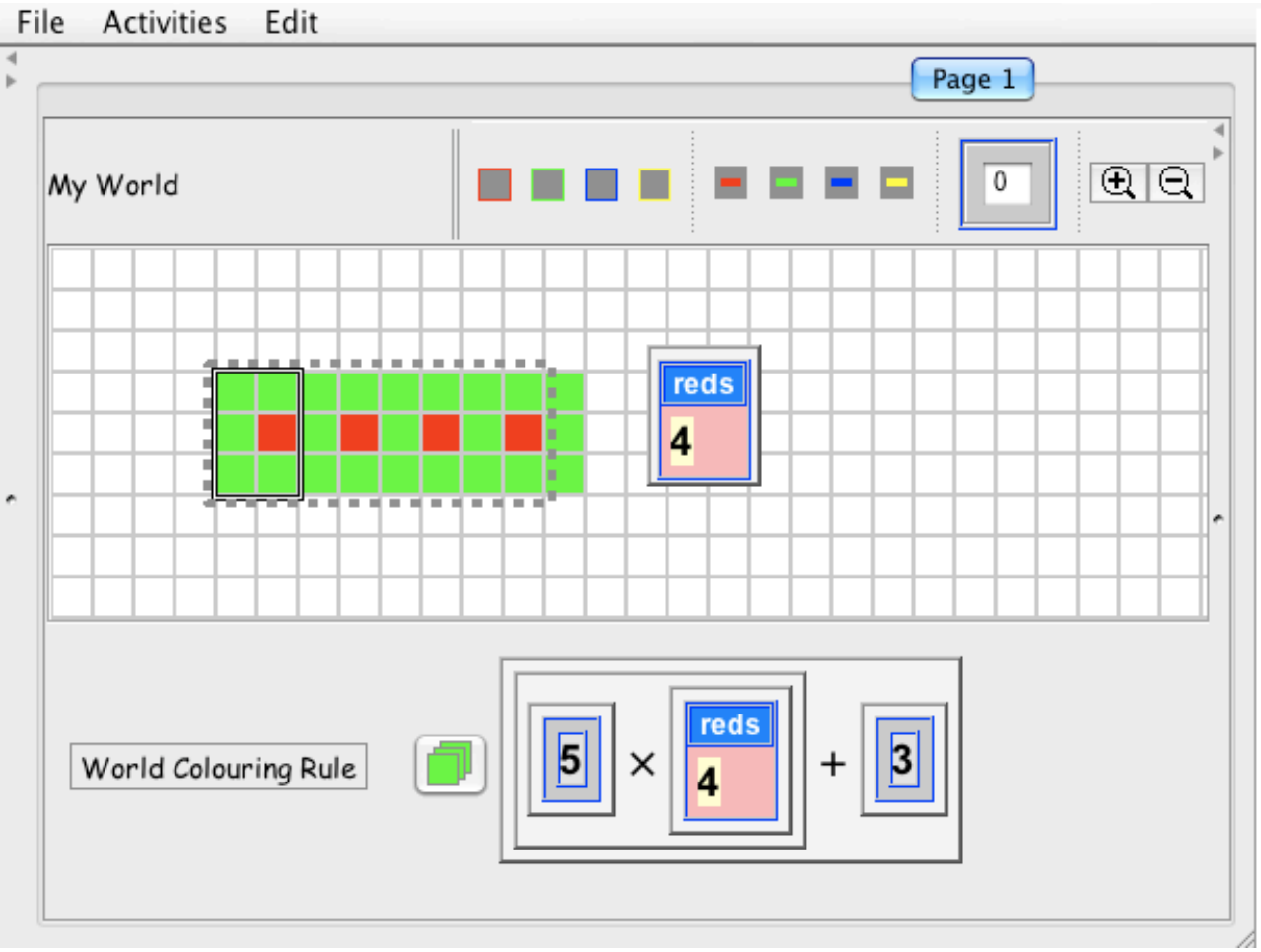


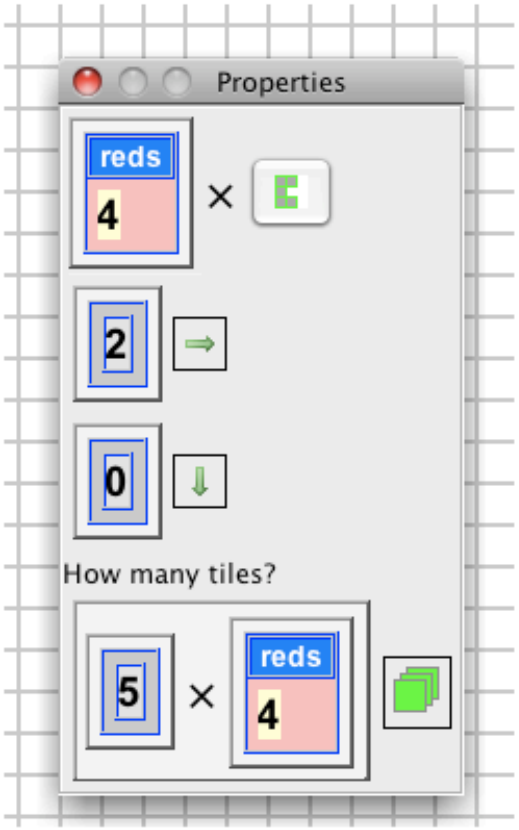
2 x (2 x reds + 1) + reds + 1



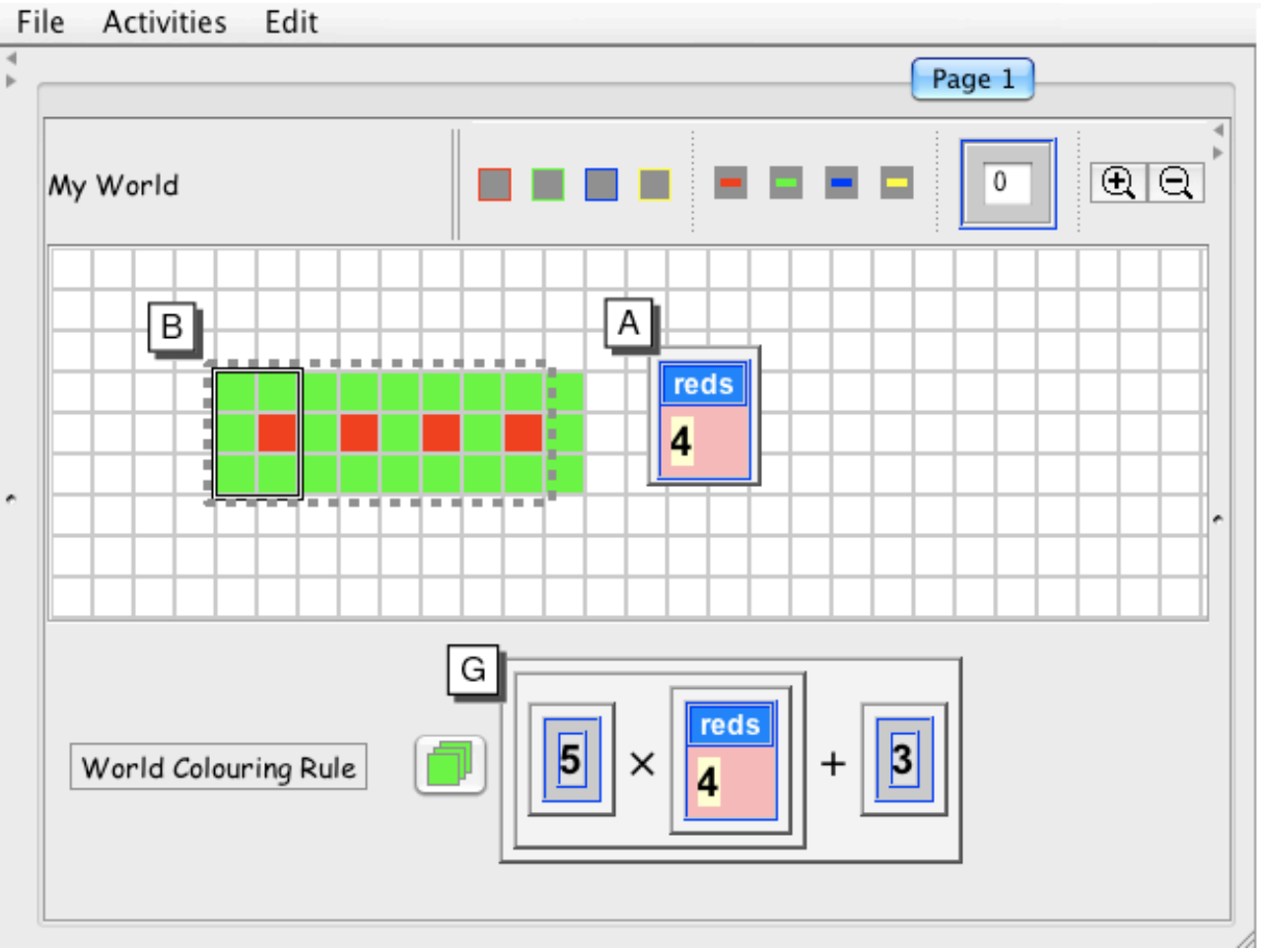
3 x (reds + 1) + 2 x reds

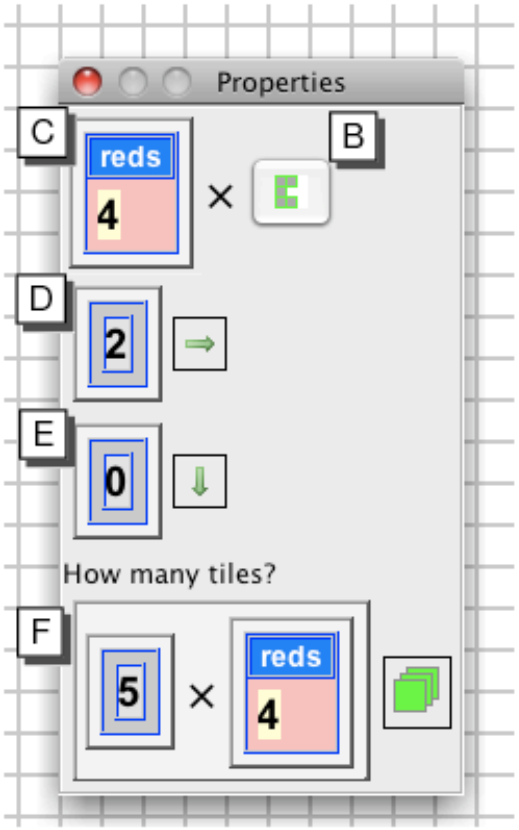
eXpresser microworld



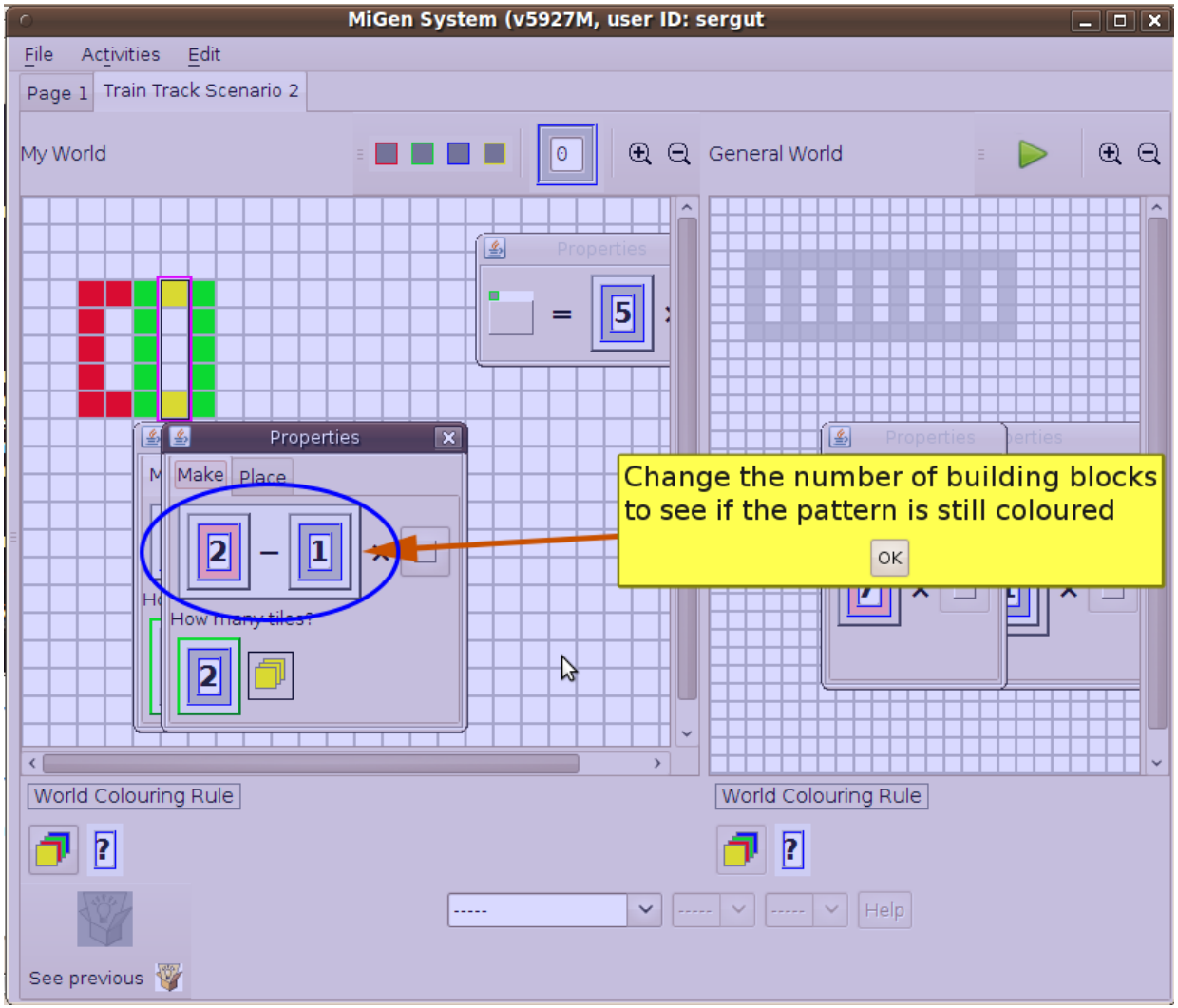


eXpresser microworld

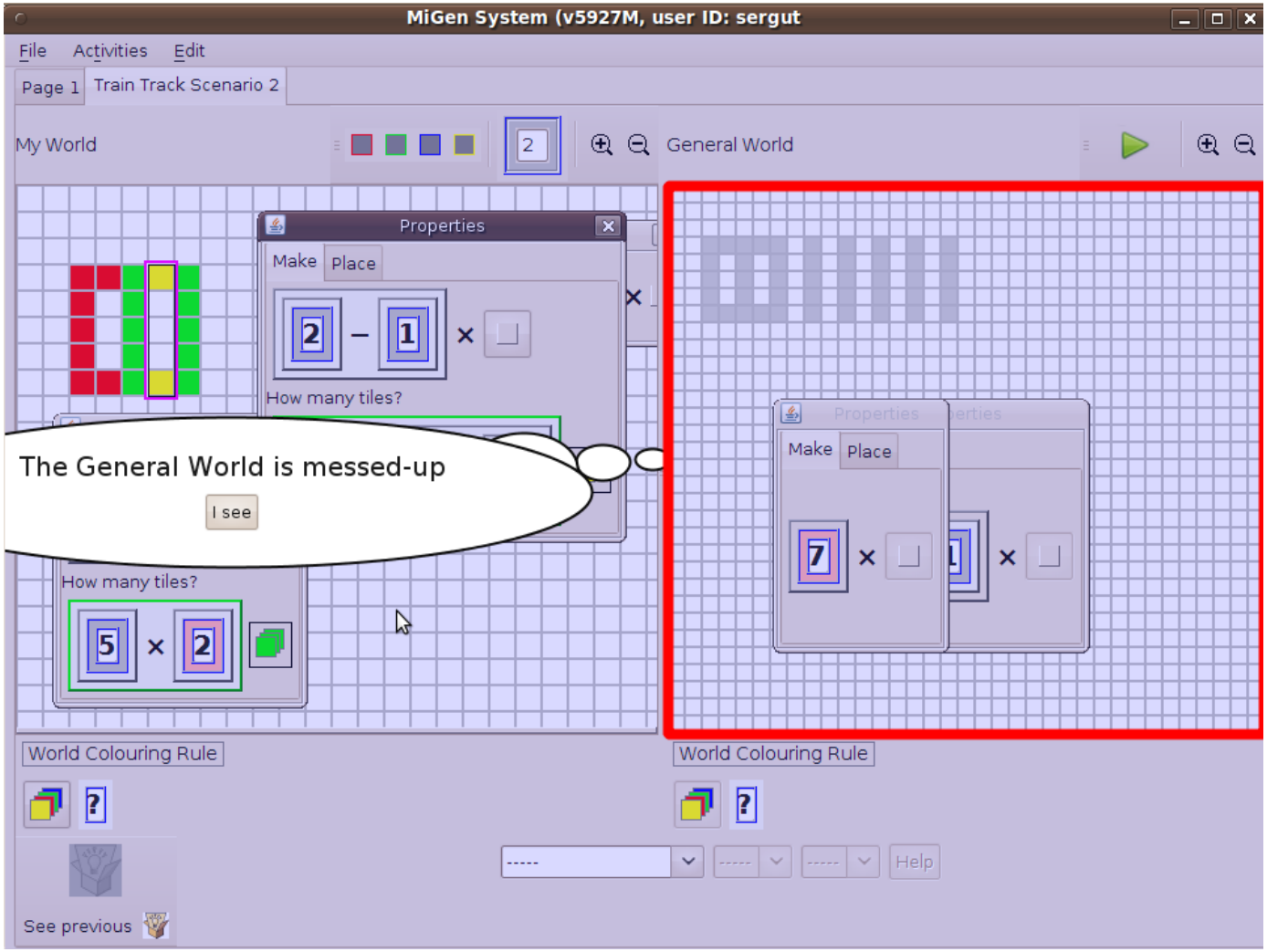




student feedback



student feedback



The data

- Event-based data:
  - Log of students' interactions with the ELE
  - Occurrence of task-independent indicators
  - Occurrence of task-dependent indicators
    - using combination of case-based and rule-base techniques for analysis, aggregation, reasoning
- Students' constructions:
  - models
  - expressions
  - history of development of these

The data (cont'd)

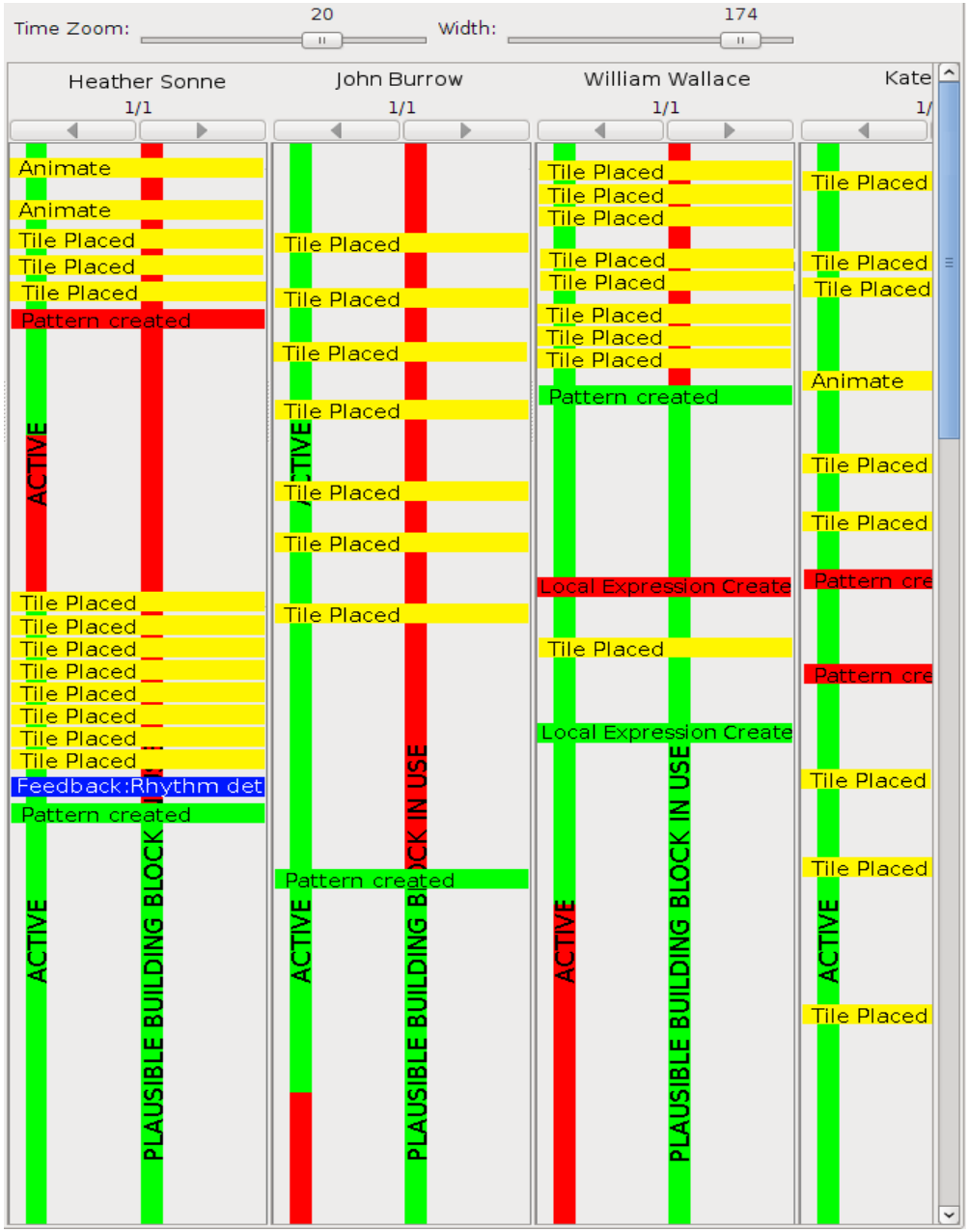
- Task information
  - description
  - task learning goals
  - possible solution approaches
- Students' learner models:
  - task short-term model
  - task long-term model
  - domain model

'V' attributes of the data c.f.Big Data

- Volume
- Velocity
- Value
- Veracity
- Variety
  - unstructured
  - semi-structured
  - structured

First Teacher Tool we developed

- Student Tracking tool shows occurrence of all the TI and TD indicators identified through by our teacher collaborators through an iterative process of prototyping/trialling as being meaningful:
  - 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



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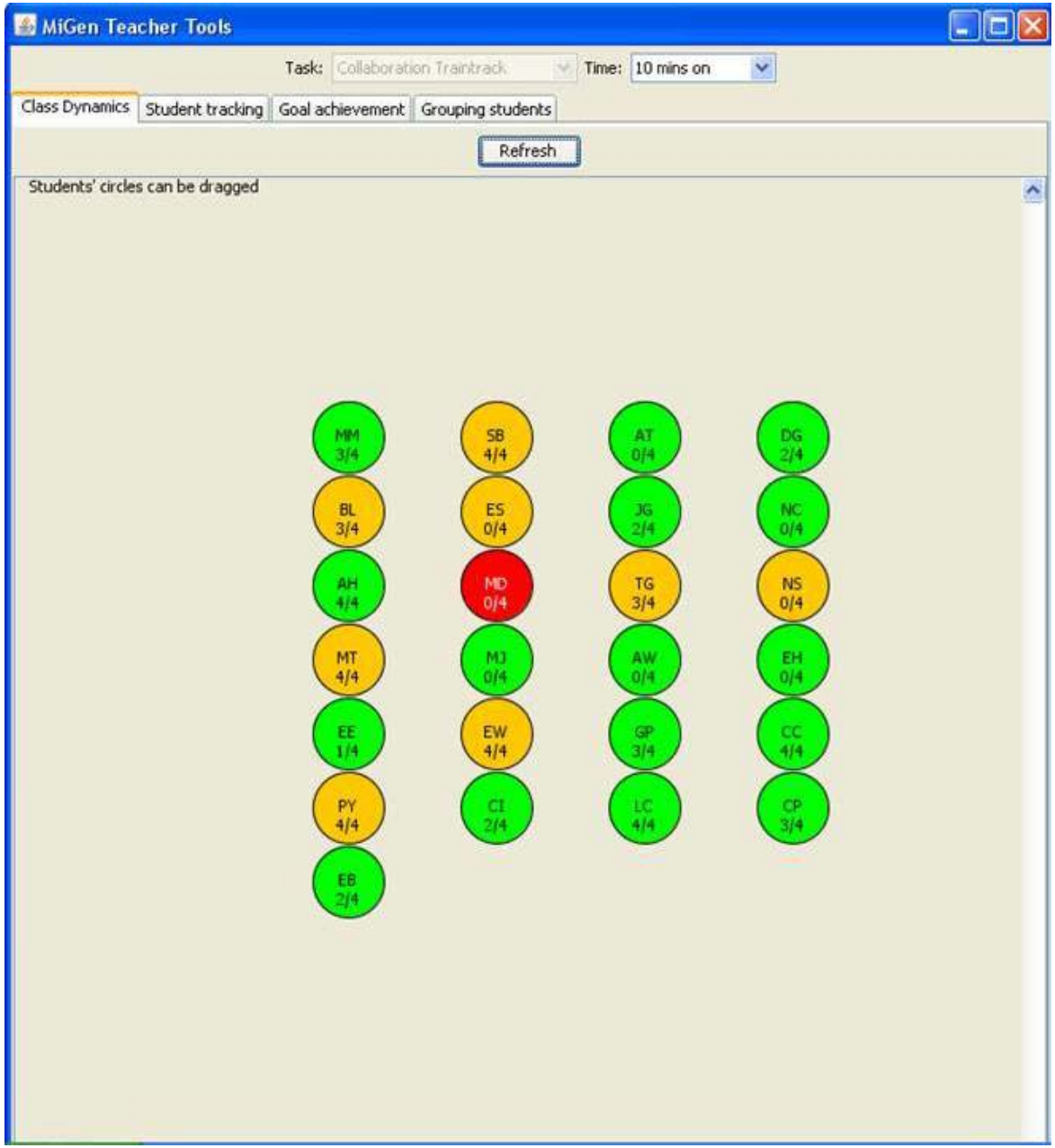
Led to more contextualised usage scenarios for Teacher Tools

- Specific Use Cases for teacher assistance tools emerged as ST tool was trialled the classroom:
  - 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 the co-design, development and evaluation of additional Teacher Assistance tools

- Classroom Dynamics tool
- Goal Achievements tool
- Grouping tool



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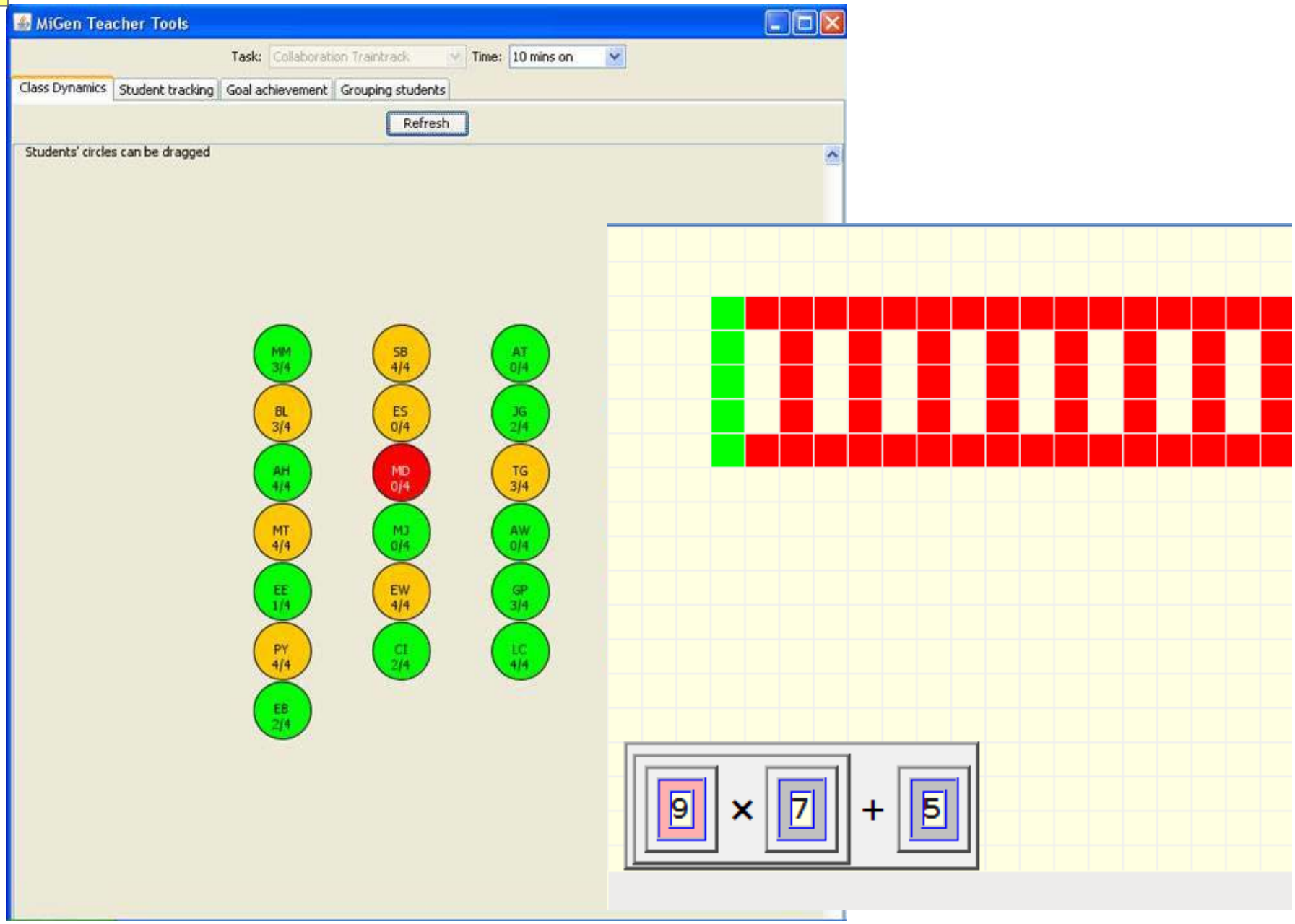

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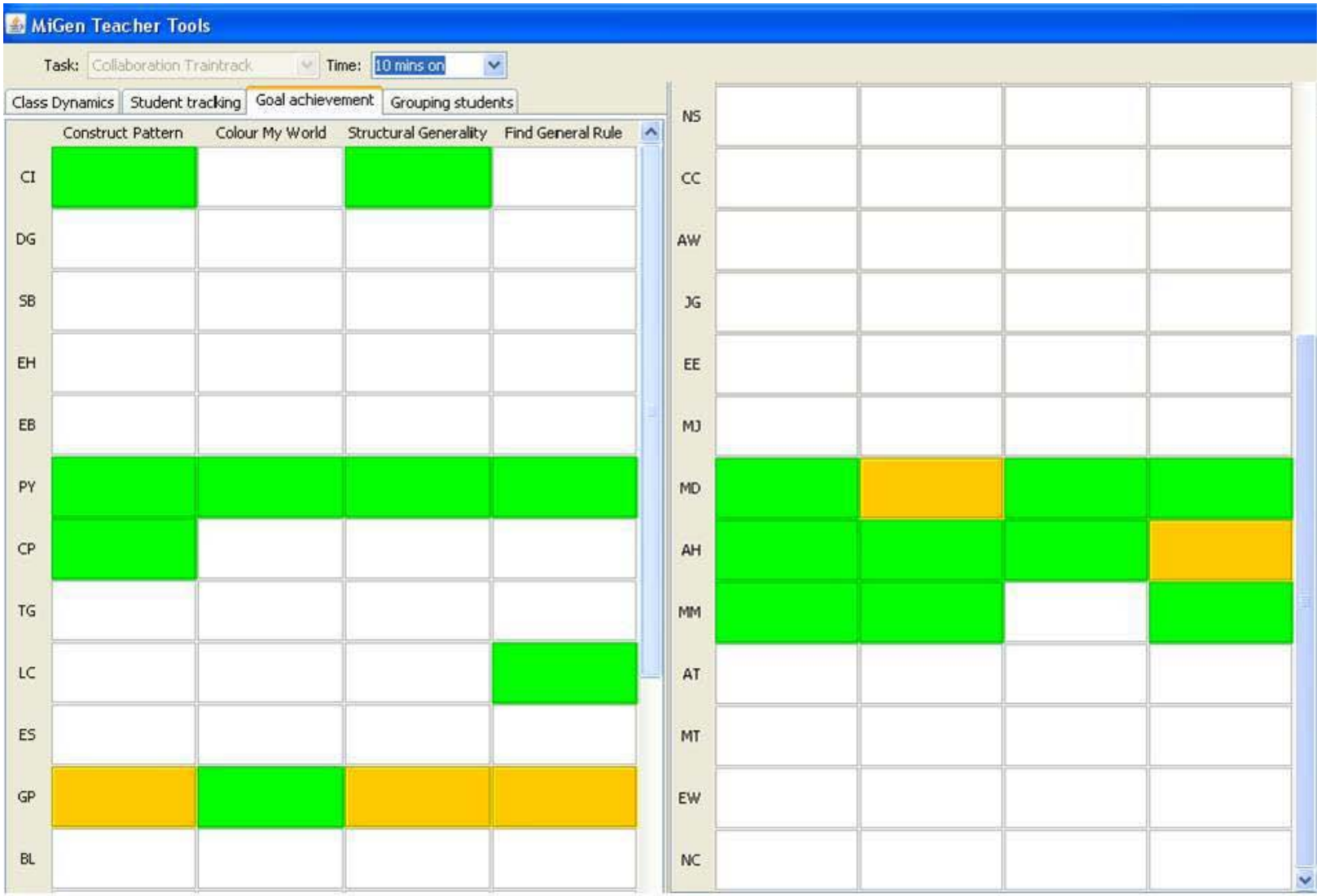

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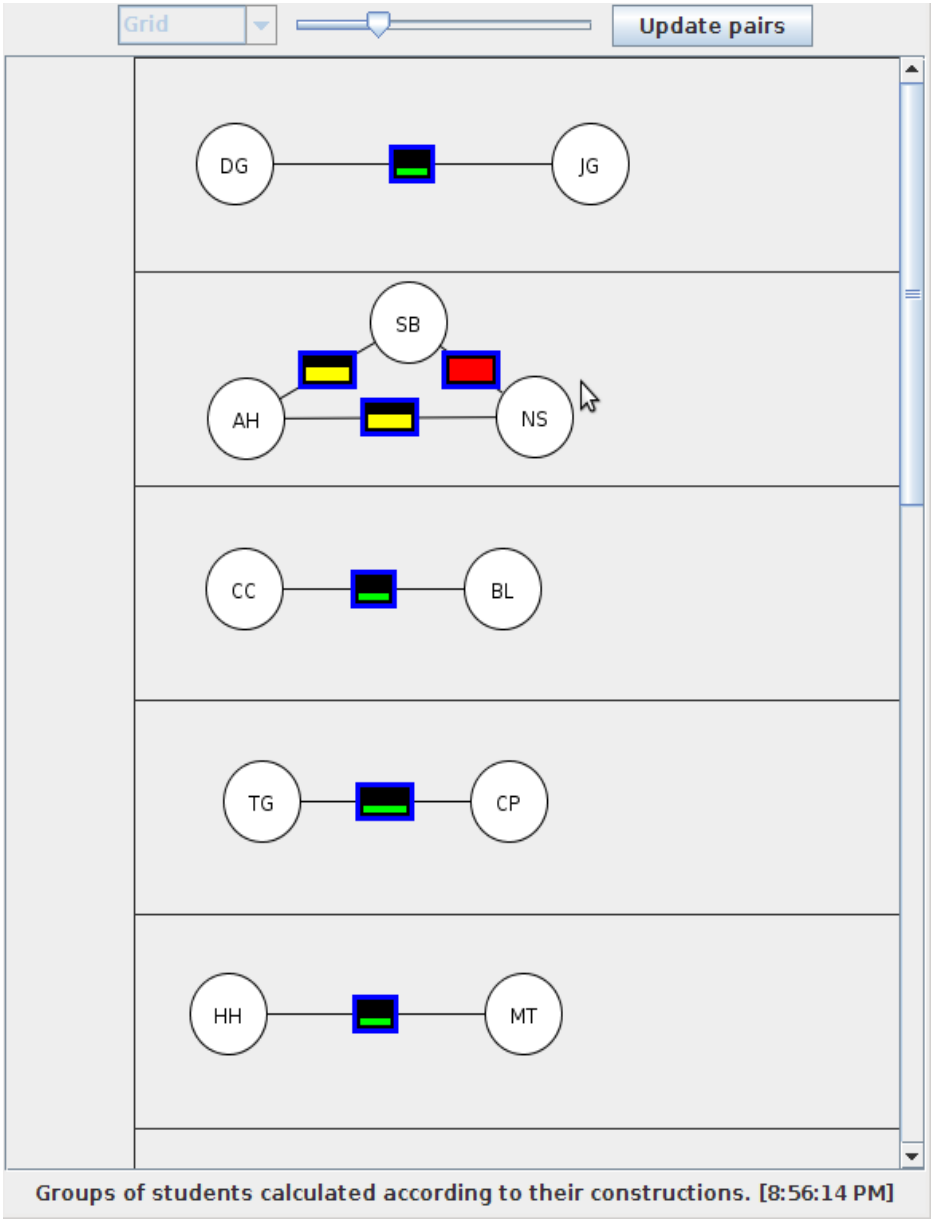

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Ongoing work and collaboration possibilities

- development of TA tools for other exploratory learning environments
- scale-out of TA tools to online exploratory learning settings
- development of new data analyses and visualisations to enhance Exploratory Learning
  - for students, teachers, researchers, policy makers, administrators etc

Possible ways to collaborate

- Co-supervision of MSc projects / internships of LKL students in your organisation:
  - MSc in Learning Technologies
  - Several other MA and MSc programmes
- Joint development of new degree/training programmes to meet the needs of your organisation
- Knowledge Transfer Partnerships
- Sponsorship of PhD students
- Consultancy
- Collaboration on research projects