Constructionist Discussions With and Around Microworld Referable Objects

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Abstract

This demonstration highlights design features that are derived from the requirement of enabling discussions around constructionist artefacts. We present the integration of a microworld and a tool for structured discussions resulting in an environment that allows students to share, discuss, critique and ask help about their work in the microworld. The paper summarises the learning environment, its innovative features and how it supports constructionist activity.

Keywords:

microworlds, referable objects, collaboration, discussion

Introduction

Technological advances are making collaborative problem solving and co-construction of knowledge possible even for remote participants. Commonly-available tools for working and learning together range from collaborative editing of documents to controlling and manipulating shared spaces. Notable examples specific to learning include dual-spaces such as the one provide by the Virtual Maths Teams (VMT) project that integrates a chat with a shared graphical work area (Muuhlpfordt & Wessner, 2009). In parallel, research has demonstrated that focused collaborative computer-supported argumentations and discussions promote learning and enhance students' argumentation. Justification and reasoning skills help even co-located students make their thoughts and contributions explicit. State-of-the-art argumentation and discussion tools go beyond simple chat or threaded forum interfaces to provide a shared graphical representation of discussion (see a review in Scheuer et al., 2010 and examples on page 4).

We are interested in exploring the possibilities afforded by the integration of microworlds with such collaborative environments in order to provide unique learning opportunities that are closely aligned to the emphasis constructionism puts in the social element of meaning generation activities (c.f. Resnick, 1996 that introduces the notion of 'distributed constructionism' and three activity categories of *discussing*, *sharing* and *collaborating* on constructions). Supporting such activities is challenging both from a pedagogical and technical perspective. While research is underway to identify both the appropriate pedagogy and the potential of such possibilities, in this demonstration we present our first steps towards an integrated environment that provides a space that encourages students to discuss, argue, seek and offer help about microworld artefacts.

Our prototype tools revolve around a microworld for algebra and a discussion environment that can accept contributions embedding so-called 'referable objects' from the microworld, with the primary objective of enabling *joint attention* and *mutual engagement* — key aspects of successful collaborative groups (Barron, 2003). Below, we present the microworld and its referable objects functionality and provide examples of the integration with the discussion environment. We conclude with a brief discussion about the potential of the integrated tools and future work.

The microworld and its 'referable objects'

The microworld

The MiGen project has designed a microworld where 11-14 year old students can construct patterns of repeated building blocks of square tiles and identify their associated algebraic rules (see Figure 1). Underlying this goal, the main objective is to promote students' appreciation of the expressivity of algebra and support algebraic ways of thinking (Mavrikis et al. in press). Due to space limitations we do not describe in detail the microworld here, but it is worth mentioning a key feature: the use of variables the values of which change dynamically to test the structural generality of a model. Fig. 1 shows an example of a student's construction as it appears when shared on a web page (see also Fig 2 that shows part of the actual space of the students' view in more detail). A variable '*n*' represents the number of houses in the model. The model changes dynamically as the variable takes random values thus resulting in an animated model. In order to colour the patterns in the model, students are challenged to specify algebraic expressions that represent the number of tiles in each pattern. Subsequently they define the 'model rule' that represents the total number of tiles in the model in terms of the variable 'n'.

There are several tasks that one can design in this microworld (e.g. tasks with increased complexity of the rules). Previous work (Geraniou et al, 2011) demonstrated the importance of collaborative tasks where students are encouraged to construct a particular pattern but in structurally different ways. This leads to different — but usually equivalent — model rules and encourages discussions among students about their algebraic equivalence or lack thereof.

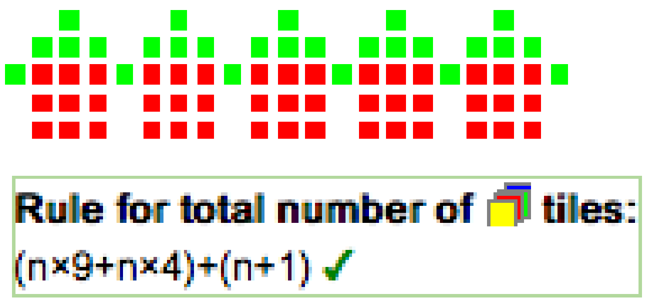

Figure 1. A snapshot of a students' model for n=5 (where n is the number of houses) and the corresponding rule for expressing the total number of square tiles in the model.

Referable Objects

To enable referencing and sharing artefacts from the microworld it was enhanced to allow the creation of 'referable objects' i.e. elements from the microworld that can be viewed as live thumbnails in other tools and can also be accessed in the context of the microworld upon request.

By accessing a menu item, students can share either just their model or their model and their rule. By doing so, a link is provided to a live thumbnail — a web-page that can be embedded anywhere else. An example appears on Fig 1 and, when live, it can be clicked to make the model start and stop animating.

In addition, students can share particular elements (patterns and expressions) of their model. The interaction in the microworld relies generally on contextual menus and therefore when elements are clicked, one of the options provided is to share the element.

Figure 2. Sharing a pattern. By enabling its contextual menu an object of the microworld can be shared.

Discussing with and around referable objects

The microworld is currently integrated in the context of the Metafora project that is developing a computer-supported collaborative learning (CSCL) environment that (among other tools) employs a web-based tool (LASAD) that provides a collaborative, shared workspace where students can share, discuss or argue about certain topics in a structured way (Scheuer et al., 2010). Figure 3 shows an excerpt of an actual discussion map constructed by students when discussing the equivalence of their rules. The tool allows the learning designer (or teacher) to customise the types of the possible contributions and links between the elements of a discussion. For example, it has been used typically to support argumentation between students using "claim" and "fact" boxes with links to "support" or "oppose" them. For the purposes of the activities with the aforementioned microworld, we have developed a template based on constructionist ideas that provides specialised boxes. These boxes can embed referable objects, allow students to ask for help on particular elements of their model, and to refer to key aspects of possible actions with the microworld.

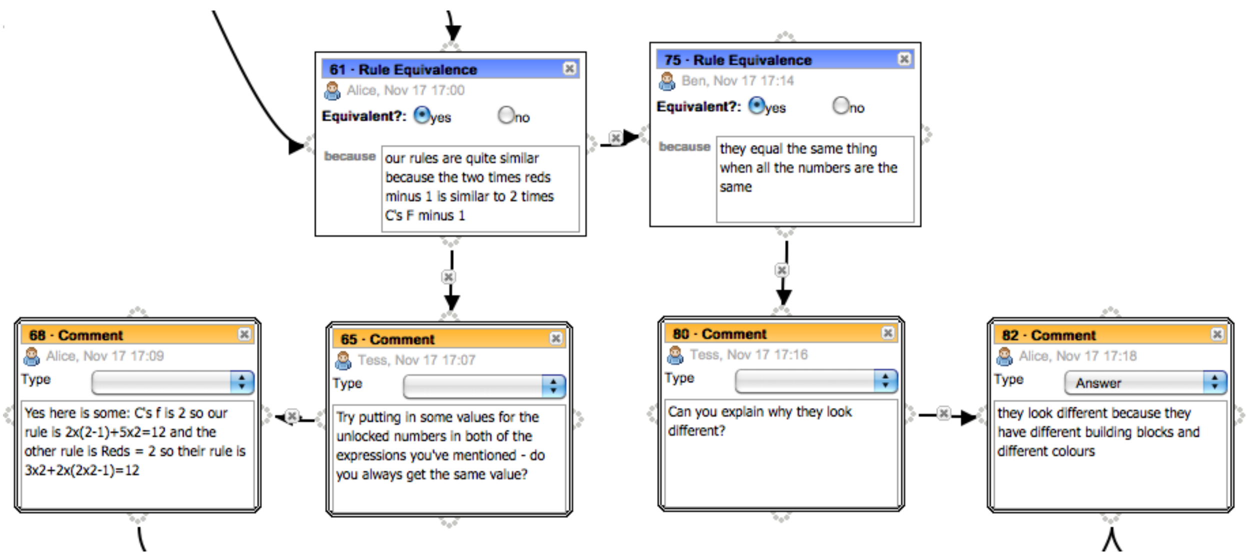

Figure 3. An excerpt of a discussion map. By adding boxes and linking them with each other, students construct maps that can contain several different perspectives. These maps can be constructed both asynchronously to support remote collaboration and synchronously even by co-located participants as a means of externalising their thoughts. The maps persist over time and encourage reflection.

Fig. 4(a) shows excerpts from a discussion using this constructionist template with embedded referable objects. The “My Microworld” box acts as a container for Ben’s shared model and rule. The box has a drop-down list for the type of contribution he is making (in this case an “example” of a solution to the given task). The structure of the box also encourages him to provide a short description of what he is sharing. The same figure shows Alice’s contribution as she asks for clarifications on the rule. Figure 4(b) shows an example of a *Help Request* that gives students the space to ask for help regarding specific elements of the microworld, and prompts them to explain the difficulty they are having. In this case a teacher (Tess) observes their interaction and asks a question and offers a comment. Other boxes provide the possibility to contribute by choosing particular microworld actions from a drop-down list and, for example, to suggest to *find a relationship* or to *change, observe, define, crosscheck, repeat*, or *reproduce behaviour*.

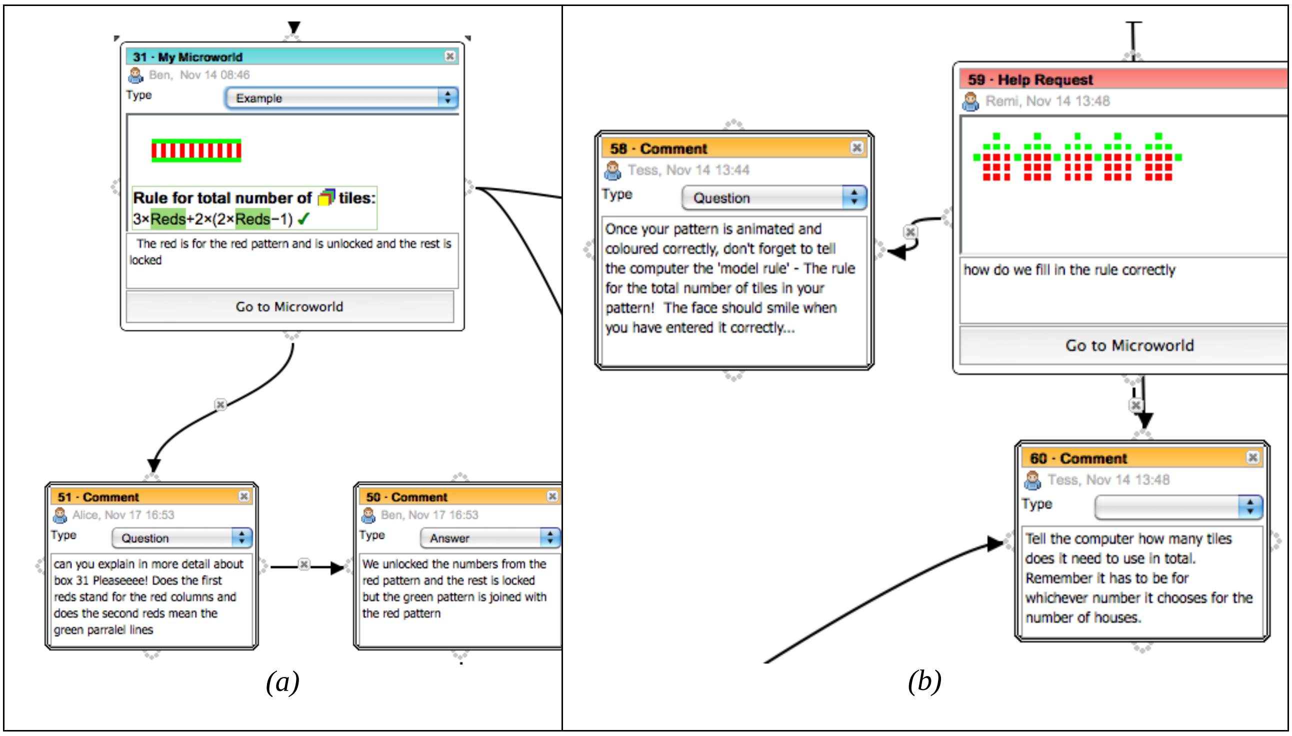

Figure 4. Excerpts from a discussion map with embedded microworld objects. In (a) Ben (Box 31) is sharing his model and offers a description on which Alice asks for clarification (Box 51). In (b) Remi is requesting help for his model (Box 59). A teacher (Tess) who is observing the dialogue remotely is able to support him (Box 60). Clicking “Go to Microworld” allows the participants to see the referable object in its original context of the microworld itself.

Discussion and Future Work

The design presented here describes the early stages of a larger design-based research experiment. The prototype integration of the microworld and the discussion space allows referencing objects as a means of establishing joint attention (c.f. Stahl, 2009) and has the potential to satisfy a key requirement of collaborative learning; mutual engagement (c.f. Sarmiento-Klapper, 2009; Barron 2003).

We have observed in pilot studies how students bringing individual work into the collaborative discussion space can encourage not only sharing individual artefacts, but also seeking and offering help. For example, student with better understanding from others can provide support by sharing particular examples (a form of peer tutoring). In addition, elements from the microworld and particularly expressions become elements of students’ justification efforts. Lastly, by offering a space to compare and discuss their artefacts and by allowing the outcome to persist over time, students can reflect both on their actual domain and microworld-specific interaction as well as their collaboration process itself.

As development continues, design questions remain. One example is identifying (in a user-centred fashion) what should happen when a collaborator follows a referable object that has changed since it was originally shared. As shown in Fig. 4 a live snapshot of the state of the microworld is provided at the time of creation. Although it is possible to provide an up-to-date snapshot as it is changed, we consider it important to maintain the history of the discussion as it evolves. By clicking “Go to microworld” we have the ability to provide access either to the historic instance of the model at the time of sharing or the latest version. This raises questions such as: Should the provided model be editable? If the historic instance is editable, what should happen to subsequent edits and how could they be maintained, represented and shared? At the time of this writing, when a referable model is accessed but has changed since it was shared initially, the user is asked to choose whether they want to access the original state (and essentially branch out if they make edits) or to access the latest state (with the caveat that a referred object could be missing). The implications of this complex interaction remain to be tested. Another set of design questions relate to an interface for allowing flexibility in the choice of discussion maps. Our current approach relies on predefined sets of maps where the referable objects eventually appear automatically. In the integrated Metafora system[1], however, we are looking into the possibility of user-defined maps that serve different purposes for example, offering distinct spaces for comparing models or others for requesting help.

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[1] Metafora is an EU-R&D project “Learning to Learn Together: A visual language for social orchestration of educational activities” (EC/FP7, Grant agreement: 257872).