

Design for Negotiated Scripted Tabletop Collaboration

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Abstract: While tabletops offer considerable promise for small group learning, the design of educational tabletop software needs to take account of common difficulties for effective collaboration. This paper explores an approach to help learners work together effectively because they are guided by a *negotiated scripting system*. We describe the elements of the framework for designing scripting for symmetric contexts where learners have equal roles and should contribute at similar levels. We illustrate its use to drive the design of three applications: brainstorming, concept mapping and collaborative design of a poster. Our key contribution is the framework to inform the design of tabletop educational applications that help learners collaborate effectively through negotiated scripts.

Introduction

Collaborative learning scenarios permit all group members to share the work load, externalise different perspectives and build on the expertise of different people. However, a group of people who come together to work on a common task may not necessarily engage in these socio-cognitive learning activities and benefit individually [Dillenbourg, 1999]. According to Dillenbourg (1999), effective collaboration depends upon a number of different conditions including group member strengths, characteristics of the group task, empathy between group members or the affordances of the communication channels. One approach that has been successful in enhancing practice and guidance to help the development of effective collaboration skills is to *structure* the interactions based on a script [Fischer et al., 2007].

Interactive collaborative tabletops are promising devices that can help collocated people collaborate because they augment the natural round-table discussions with a shared digital space that offers equal opportunities of actions and access to the resources available. However, the digital space itself may not improve collaboration if it does not empower effective group dynamics. Scripting collaboration seems promising as a means to facilitate collocated tabletop collaboration. Collaboration scripts suggest learners to engage in a specified sequence of collaborative learning activities, typically with distributed roles. This paper explores a way to create collaborative scripts for enhancing tabletop collaboration in the form of: guidance and structure; advice on how to do the task; and control over constraints afforded by the tabletop. Scripting collaboration on a tabletop can permit different levels of coercion to influence the behaviour in a collaborative activity.

This paper proposes a foundation for designing scripts for the tabletop and highlights a number of issues that need to be taken into consideration when building a scripted interface. We explore these issues through the design of three applications: brainstorming, concept mapping and collaborative design a poster. These issues include: the level of coercion that needs to be enforced between the extremes of free collaboration and tightly scripted collaboration; and the controller of the interaction pattern set out by a script (e.g. users, facilitator or the system).

Analytic foundations for a tabletop scripting software framework

After having created several tabletop applications and much considerable experience in studying the ways that people used them, we concluded that it would be valuable to create a software framework for defining scripts that would help people collaborate more effectively in co-located, technology-enhanced scenarios [Kobbe et al., 2007]. Different from most scripts investigated so far, our framework allows for scripts that learners can negotiate about and to some extent tune to their requirements. Here we introduce our proposed design principles for scripting collaboration at the tabletop, then present three central applications of our scripting framework, namely brainstorming (Figure 1), concept mapping (Figure 2), and collaborative poster creation (Figure 3).

Proposed Design Principles for Scripting Collaboration at the Tabletop

Each of these activities presents a number of design issues to consider when formulating a set of proposed design principles for scripting at the tabletop. These are:

- **People have different expectations and knowledge of the task at hand:** Finding a way to encourage the task to promote egalitarian behaviour to overcome difficulties associated with mismatched knowledge levels and biases from individuals. Also to find ways to provide support to learners who require it.
- **Voting/negotiation mechanisms:** The way a group resolves issues. We present two options: *All* and *Majority* (for groups of 3 or more). Groups decide at the start of the activity, the method by which they will adhere to making decisions for options of a script. These mechanisms are meant to spur rich discussion between group members. This is useful to explore limiting individual bias in egalitarian oriented tasks.
- **The need for sound default settings (and a way for people to see how they were set):** As groups use the system more often, defaults such as timed help screens or unnecessary pauses detract from the system. Over time it is reasonable to look at personalising the activity session based on previous sessions (if it makes sense to do). This level of personalisation will depend on the participants; but doing so, encourages the system to cater for both novice and experienced users.
- **Identifying group collaboration:** Adapting the collection of information to inform metrics to report to the learners and group.
- **Whether the main task was executed as expected:** It is critical whether the main focus of the activity was achieved, and if so, what role did scripting have.

We have devised a set of design principles which we will be using in future evaluations of our scripted tabletop applications. They define structure and facilitate a better understanding of what is required for scripting tabletop applications. The principles we will employ are:

- **Principle 1 – Regulate learning activities.** Focus on the quality of the process, as well as structure tasks to provide users with roles and responsibilities to induce particular interactions [Weinberger, 2011]. Keep “*activities of learners coordinated and guided according to particular rules, implemented via respective tools in the learning environment*” [Haake and Pfister, 2010].
- **Principle 2 – Foster collaboration.** Organise the activity and the script to promote collaboration. Provide methods for “*sustaining mutual understanding, dialogue management, information pooling, reaching consensus, task division, time management, technical coordination, reciprocal interaction and individual task orientation*” [Meier et al., 2007].
- **Principle 3 – Facilitate egalitarian participation.** Look at mechanisms to modify learner behaviour, so individual and group goals are expressed in the system. For example, removing individual bias in egalitarian tasks through novel voting mechanisms.
- **Principle 4 – Define the level of user control.** Being able to direct and coordinate activities in relation to the context of the activity. For some activities, give users more control in the expression of the underlying script — to do this, provide necessary tools and controls in the environment.
- **Principle 5 – Foster awareness.** Develop an understanding of other participants actions. Allow users to understand the needs of one another to arrive at goals together.
- **Principle 6 – Adaptability.** Adjust the script based on information from the system and the users, providing a way to align people’s learned knowledge with the system.
- **Principle 7 – Use Tabletop Affordances.** Take advantage of the constraints introduced by the tabletop, such as: face to face discussion; and methods to exploit the hardware.

Applications of our scripting framework

For each application, we provide a graphical overview of the whole scripting structure and for the first, we provide details of actual options the learners can negotiate over to influence the behaviour of the scripts used in each stage of the activity. The detailed design of each script is based on analysis of the particular demands of the stage of the activity. In addition, each activity includes a common *starter script* which supports negotiation between team members to establish a consistent set of group decisions for following script options later on in the activity. This defines default values for all the scripts in an activity. Throughout the design, a key design principle is to give the group control over the scripting options. This means that learners can pause at the start of each main stage of a task, to consider the available interface and script options and to establish an agreed set for the whole group.

Brainstorming

Brainstorming is a technique to encourage creativity in small groups. Our approach illustrated in Figure 1 has three stages: idea generation; idea organisation and reflection [Clayphan et al., 2012]. Our proposed framework adds a startup step and then an optional script definition step before main stage. Note that each script has some specialised elements, which we describe below, and several common elements.

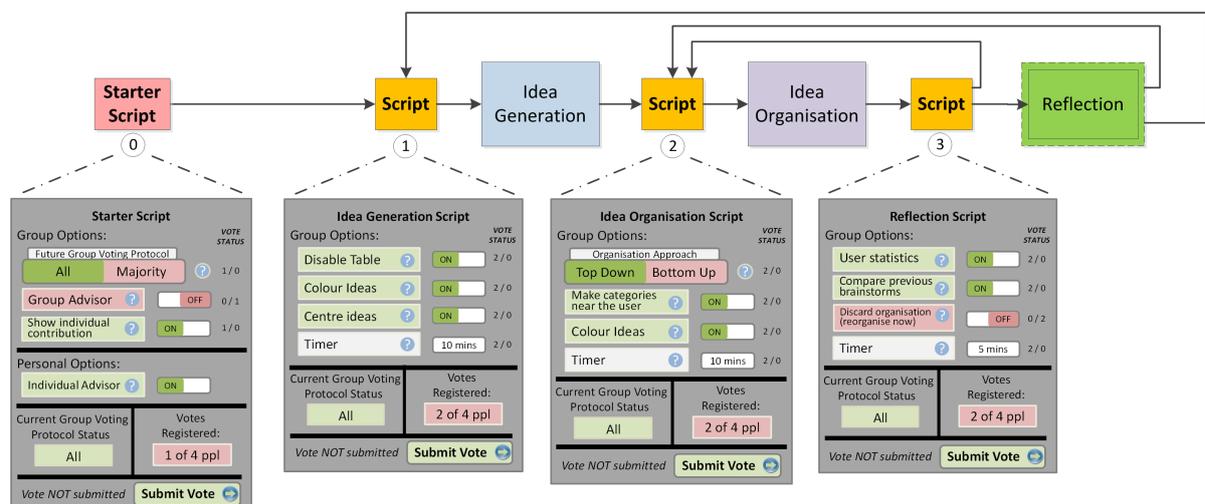


Figure 1: Scripted Brainstorming Process and the options available to the group to control the behaviour of the scripts.

For every element of each script setting, there is a question mark. Touching this causes display of an explanation for the reason this element is available for negotiation, an explanation for the default setting and, where relevant, details of the personalised setting for this user. The starter script options define the infrastructure for all other scripts. Most options require the group to have discussion.

Consider the starter script; The *Future Group Voting Protocol*, lets the group decide on the method of negotiation to be used in later stages, (and for groups of three or more, the majority option is present in addition to the *All* option). The *Group Advisor* if *ON*, will activate scaffolding in the form of advice to the group during the stages of the activity. *Show individual contribution* enables options to show individual contributions. It is *ON* by default for the future scripts in the activity. Personal Options give opportunity to personalise a particular part of the script for the user. If *Individual Advisor* is *ON*, the system will aid the user in the case that such help is required. One example of a corrective action would be to alert the user through an animation to create more ideas if idea generation is low for that individual.

Consider the first stage: *Idea Generation (Script 1)*. *Disable Table* offers the option to disable the table, meaning that the only possible action is typing ideas. We make this the recommended default since it ensures that learners do not start working on organising ideas in this stage. In our studies [Clayphan et al., 2011], we observed several groups where one or more team members failed to follow the directions on how to do this stage; this scripting design ensures that all team members consider making this impossible. The *Colour Ideas* option ensures that each person's ideas are colour coded on the table, making the ownership of the generated ideas clear. We have this option set in our earlier work because it made people more accountable and it improved awareness of the symmetry of contributions. (In the later stage, when ideas may be discarded, it makes people aware of whose ideas they are dealing with.) The *Center Ideas* options makes ideas appear in a concentric circle to the groups, if *OFF*, the ideas are pooled near their original authors. In the figure, these three options are set to *ON*.

Now refer to the second stage: *Idea Organisation (Script 2)*. *Make categories near the user* offers categories to be placed near the author instead of the concentrically in the middle. In our studies [Clayphan et al., 2011] we observed users creating a category, the being disoriented when the category appeared in the middle like the ideas of the previous stage. We saw from our studies, that when a user creates a category, they generally use it straight away, and would much prefer it to be near where they are. *Organisation Approach* offers two options: Top Down and Bottom Up. Top Down encourages groups to make categories first, by disabling the tabletop for 1 minute, encouraging the group to discuss and create categories on their keyboards. Bottom Up places no such restrictions on the tabletop.

Finally, consider the last stage: *Reflection (Script 3)*. *User Statistics* will show metrics related to individual and group contributions. *Compare Previous Brainstorms* will bring up past sessions to compare to, and *Discard organisation (reorganise now)* will save a snapshot of the current organisation (which they can retrieve in a later reflection stage), and then take the group back to the start of the organisation stage and have them re-categorise the content.

The scripts are flexible, encouraging negotiation in terms of how they are constructed. For example, if all participants are experienced in using the system and have their own established preferences, they could all login and find that their individual preferences are not consistent with each other. This might mean that one person likes the concepts colour coded to show who contributed each one and others do not. Our interface encourages the group to negotiate this and come up with the agreed setting to be used. At each stage of the activity, the group can discuss options that can have an impact on their activity. We believe with this level of scripting we encourage collaboration, provide a strong means for dialogue, and remove effects of individual bias over the group.

Concept Mapping

Concept Mapping is a technique that helps students to represent their knowledge about a given topic in a graphical format and make use of meaningful propositions to link main concepts within a domain of interest. Building a concept map at the tabletop can help students to visualise different perspectives of the same topic and trigger discussions towards the agreement on the main ideas that describe the knowledge domain [Martinez et al., 2010]. Collaborative scripts can be set to drive groups of students to produce better quality concept maps or enhance collaboration dynamics by scaffolding the process of collaborative concept mapping.

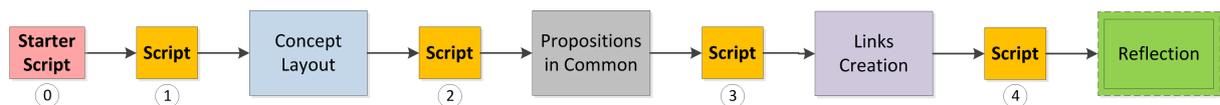


Figure 2: Scripted Concept Mapping Process, with a very tightly controlled approach.

The collaborative concept mapping activity can be empowered by the definition of a series of scripted steps that can increase the generation of discussions around the students actions. On what to script in concept mapping is: asking students to layout the concepts they think are the most general and agree on the physical arrangement of them (Script 1). For example, by placing the most general one in the middle or at one side of the tabletop. In order to encourage students to discuss on concepts and arrangement, some controls can be disabled, such as created links between them or controls for reorientation of elements. Then (Script 2), can serve to present students with a set of suggested links between concepts that they can use to begin the construction of a group concept map without starting from scratch. Then, Script 3 would involve the step in which students can access all elements and actions on the tabletop so they can finish building the concept map. In this case, there would no need to ask students to come back to previous steps since each incremental step consists of unrestricting the actions that can be performed. In Script 4, Options for Group Reflection can be set up to allow the group to reason over possible problems with the constructed map, such as repetition of concepts or checking links that are in a list of most common misconceptions.

Poster Creation at the Tabletop

This application focuses on small groups coming together to build a poster exploring a common theme in learning (for example: a school trip about dinosaurs or reflecting on the last year of high school.) [Collins et al., 2012]. In Script 1, each member of the group is given a digital device (an iPhone or iPad) and told to collect resources (textual notes, pictures and audio snippets) with their personal device. In Script 2, methods for group collaboration and cooperation are explored. The groups are explained methods of how to collaborate: either round-robin of each individual or parallel activity of all learners. Groups are then given instruction on how to sift through content placed on the tabletop, emphasizing each individual to have an expression on the collaborative poster.

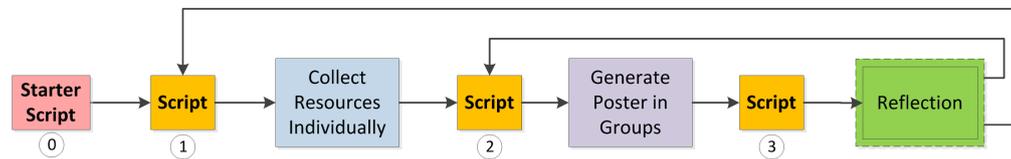


Figure 3: Example of the process for poster creation

In each of these applications, scripts are deployed in a different way.

- **Brainstorming:** The control of the script is held by the group.
- **Concept Mapping:** The script is strictly set by the designer.
- **Poster Creation:** The script is set between the two extremes.

Conclusion and Future Work

As tabletops become prominent in everyday life and used more for group based activities, it is increasingly important to find ways to support these activities. Scripting offers a method to take advantage of affordances offered by the tabletop whilst providing rules to engage interaction processes of the activity. Flexible scripting allows for a compromise between a rigid set of rules that may disinterest learners and no rules which may result in no collaboration at all. We emphasize it is important to find the right level of flexibility, and so have explored negotiated scripting, delegating part of the search to the learners themselves.

We hope this will lead towards uncovering optimal defaults and a better understanding of both the activity and constraints offered by the tabletop. Future work will evaluate negotiated scripting at the tabletop for the brainstorming application to gain an understanding of the level of negotiation initiated by learners.

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