Blooming Collaboratively at the Tabletop

Abstract
It is important that teachers design learning materials that are at the right level. Bloom’s Taxonomy is widely-used to classify objectives in educational activities, yet there are challenges in making effective use of it. We present the BloomTop system to support teachers in reaching agreement on the quality and level of learning materials. Research indicates discipline specialists may disagree on the Bloom level due to a misunderstanding of the framework or may well have forgotten what a classification represents. Our system aims to resolve these issues through scripted collaboration. We illustrate our approach with an introductory computer science case study.

Keywords
Tabletop, Collaborative Learning, Bloom, Education, Computer Science.

ACM Classification Keywords
H.5.3 [Information Interfaces and Presentation]: Group and Organization Interfaces - collaborative computing.

Introduction
Bloom’s Taxonomy is widely-used to classify objectives in educational activities, yet there are challenges in making effective use of it. Bloom consists of six levels of critical thinking: Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation: moving from lower to higher order processes. We introduce the BloomTop system, which takes a scripted approach on a tabletop to apply the Bloom classifier. We use computer science as our case study. Introductory programming fundamentals sequence of subjects in a computer science degree program must provide students with the opportunity to develop their understanding and maturity of programming concepts in a progressive sequence of difficulty. Students should start with easier/more basic activities and exercises, which should increase in difficulty/sophistication at an appropriately paced rate [10]. Consider the scenario of several teachers writing a common exam. The curriculum states that a students

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Figure 1: Script Sequence for classifying exam questions on the tabletop using Bloom.
Bloom’s Taxonomy can help make sure the questions selected target the appropriate levels of learning [12].

However, computer science educators are experts in computer science, but not necessarily in educational psychology or in applying Bloom. To address this, we create a scripted tabletop application that aims to help computer science educators in using Bloom to classify programming fundamentals exam questions. The application allows users to learn and practice using Bloom in a computer science context. By working together at a tabletop, users are able to discuss their reasoning and assumptions behind each classification choice with their fellow peers. This is expected to enhance their understanding of Bloom and increase classification consistency as a group.

Background

“Shared interfaces create new paradigms for mediating collaboration through dynamic, synchronous environments, where action is as important as speech for participating and contributing to the activity” [11]. We explore the Bloom taxonomy, the place of tabletops, and collaboration scripts as a scaffold for learner guidance facilitating the construction of knowledge, allowing processes of argumentation and discussion to take place.

Bloom’s Taxonomy is an educational framework used for classifying the cognitive demands of learning objectives and assessment tasks [2]. Bloom is used across many educational domains and disciplines. In tertiary Computer Science education, Bloom is used to specify the level of learning objectives in the internationally used ACM/IEEE Computer Science Curriculum Guidelines document [1]. Recently, Gluga [5] presented a web-based interactive tutorial to aid computer science educators in learning how to apply the Bloom Taxonomy to programming fundamentals assessment questions. The tutorial was successful in quickly up-skilling participants who had little or no prior-knowledge of Bloom. However, the results showed that participants still disagreed on the correct classification in a number of different examples where different assumptions about the learning and teaching context were possible. Additionally, the tutorial relied on a “gold standard” as the correct classifications for each example. These gold standard nominated classifications are not necessarily the only correct answer, however, as was shown with one example in particular where none of the participants picked the expert response (Figure 2).

“Tabletops promote natural and effective collaboration, enhancing the awareness of others and promoting equal participation” [6]. Tabletops provide a kind of computer scaffolding, an increasingly popular way of guiding students [7]. However Kollar et. al [9] mention that a lack of explicit procedures may lead to unequal participation and ineffective argumentation of the type needed for this context.

An approach to structure collaborative argumentation that has been proposed is collaboration scripts. These structure collaborative learning by creating roles and mediating interactions designing an environment such that different degrees of expression are made [8]. They are used to provide a scaffold for learning and are suited for face-to-face collaborative learning. Macro scripts in particular help to constrain interactions improving the likelihood of desired interactions [4].

Design Goals

We propose a set of high level goals to drive the design.
DG1 Individual decisions first, then discussion. Allow participants to express opinions of their chosen classification.

DG2 Facilitate argumentation and equity of participation. Allow participants to have an equal voice when expressing their idea (captured by symmetry [3]). Provide infrastructure to advance along dialogue.

DG3 Self Reflection and Dashboards. Allow participants to see their responses in relation to others. Allow to see, classification changes and the extent of such changes.

DG4 Support group interaction at the tabletop. Encourage educators to discuss options and to come to consensus.

DG5 Mediated supported direct at the tabletop. Remove the need for a facilitator. Use of scripts to manage processes of interaction and discussion.

User View
The user view is separated into the application and script sequence.

Application
- The application supports 4 participants at once.
- The application interface is divided into five regions. (Figure 3).
- Each participant has their own region in which to read and interact with (Figure 5).
- The center region is used to show aggregate data that is read by all participants (Figures 4 and 6).

Script Sequence
The basic workflow is expressed in Figure 1 — representing the scripted steps in the tutorial.

1. A programming assessment question is shown in each user’s region. Each user is required to read the question, and consider which Bloom category it belongs to (Figure 5).
2. Each user selects the most relevant Bloom category in their private space.
3. The center region of the table shows how many users have locked in a category (Figure 4).
4. Once all users have selected a category, the center region shows a break-down of the selections. The region also shows the answer of each user signified by colour (Figure 6). Width of the selection corresponds to confidence. Any cross through a circle represents that the user believed that question had a less than average quality — so it may be something the group will later discuss — the questions validity.
5. Users are then asked to discuss their answers and justify their classification choices. There padlocks on the questions are unlocked. During this time, users may change their initial answer — which will update the shared display in the middle. Once they are satisfied, they can decide to lock their answer to make no further changes.

6. Once all users decide to make no further changes (and all have locked their answers), the table will move to the next programming question. (The entire script is then repeated for the new question).

Conclusions and Future Work

BloomTop describes a design for using the Bloom classifier on a tabletop through a scripted approach to facilitate dialogue and interaction. The system is designed to exploit affordances of the tabletop medium and encourage discussion to support the application of Bloom more effectively in education.

Our work aims to improve the use of Bloom and blends research on interactive tabletops, scripting and argumentation. The promise is a more effective framework for classifying the level of educational activities.

Future Work will consist of running a series of evaluations of the system relative to free-form and unstructured discussions. We are interested in finding out whether taking a scripted approach, in particular on a tabletop is of use to the educational community for helping design materials at the right levels for their students. Our design goals aim to facilitate symmetry, private work, argumentation, discussion and group interaction.

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References