Intelligent Group Formation in Knowledge Communities: A Role for Orchestrational Analytics

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Abstract. In this poster, we present the design of a group-formation tool used to support the orchestration of a Knowledge Community and Inquiry (KCI) curriculum in Grade 12 Biology. The tool was built as part of a broader learning environment called *CKBiology*, and enables the teacher to form groups "in the moment" using on protocols such as *group by progress*, *specialization recommender*, *jigsaw*, *random*, and *manual mode*. The poster will present preliminary findings from the deployment of this tool in a high school biology classroom, including the activity sequences in which each protocol was used. Teacher interview data will be used to elaborate on use-cases in which different grouping protocols were valued.

Keywords: knowledge community, orchestration, learning analytics.

1 Introduction and Theoretical Background

Many have acknowledged that traditional modes of instruction, such as lectures and content-based tests, are inconsistent with the task demands of a 21st century "knowledge economy" [6, 8, 14]. In response, several research programs have investigated new forms of learning in which students work together collaboratively as a "knowledge community" to create and advance knowledge [e.g., 1, 3, 10]. An example of such an approach is the *Knowledge Community and Inquiry (KCI)* model, which was developed in the late 2000s by Jim Slotta from the University of Toronto [11, 12]. KCI curriculum designs enable students explore big ideas and work together to create and advance knowledge within a persistent community knowledge base, while at the same time have specific targeted learning goals, including assessable outcomes, that can be mapped to curriculum content expectations. Overall, the KCI model informs the design of inquiry curricula that engage a community of learners at three levels of granularity: (1) the individual level, (2) the small group level, and (3) the whole class level [11, 12].

1.1 Learning Analytics and Orchestration

Learning analytics entails the measurement, collection, analysis and reporting of data about learners and their contexts, with the purpose of understanding and optimizing learning, including the environments in which it occurs [7]. However, a central challenge in learning analytics research is to incorporate the process of interpreting and responding to analytic information within the flow of curricular activities [15]. A curricular *script* is a set of instructions that specifies how and when to constrain particular interactions, the sequence in which activities take place, and the roles and responsibilities of individuals within the community [5]. Whereas *scripting* refers to the structuring of activities before they are run, *orchestration* refers to the process of executing a curricular script once the activity has already begun [13]. Orchestration is the processes by which learning experiences are designed, managed, adapted, and assessed, using the resources that are available to achieve the maximum learning effect [9]. Of importance to this work is the notion of *orchestrational planes* [4], which refers to the orchestrational activities that occur at the individual, small group, and whole class levels. In the context of a knowledge community, the information generated from each orchestrational plane influences the activities, materials, and interactions that occur in another. It is therefore important to consider the design of technology supports that may facilitate these transitions.

This poster focuses on one such aspect of orchestration—i.e. intelligent group formation—and responds to the following research question: How can the formation of small groups within a knowledge community be supported by real-time analytics?

2 Methodology

This study employed a design-based research methodology [2] wherein we worked closely with a high school biology teacher to co-design a KCI curriculum and corresponding technology environment called *CKBiology*. This design was enacted across two course sections of Grade 12 Biology students (n=30) throughout the 2016-2017 academic year. The course consisted of five curricular units, with each unit being treated as one design iteration. Although the content for each unit differed, the activity structure across units remained fairly consistent: Following a 'traditional' (i.e. lecture-based) lesson held in their regular science classroom, students would log onto the CKBiology platform and work together as a knowledge community to co-construct a shared knowledge base related to that day's topic. Tasks within the knowledge base included providing written explanations for various terms and concepts, identifying relationships between concepts, and vetting explanations that were submitted by other members of the community. Students would earn progress points for completing these tasks, and could optionally earn a gold star if they went above and beyond their assigned work in an effort to improve the progress of the community. Near the end of every unit, students drew from this knowledge base and worked together in groups to complete a "review challenge" activity over several class sessions. These review challenges took place within a specially designed "Active Learning Classroom" within the school, which was built with the explicit aim of fostering productive collaborations between

students. This paper focuses specifically on the formation of groups for the purposes of these review challenge activities occurring within the active learning classroom.

3   Results and Discussion

We designed and built a group formation tool for CKBiology (see Fig. 1), which enabled the teacher to form groups "in the moment" using the following protocols:

- **Group by progress** – matches students with similar mean progress scores
- **Group by specialization** – recommends a specialization group for each student based on a CKBiology performance score for each topic
- **Jigsaw** – shuffles specialist groups (also accounting for student absences)
- **Random** – distributes students into groups randomly
- **Manual mode** – allows the teacher to modify any of the above groups, or to form groups by manually dragging-and-dropping student names
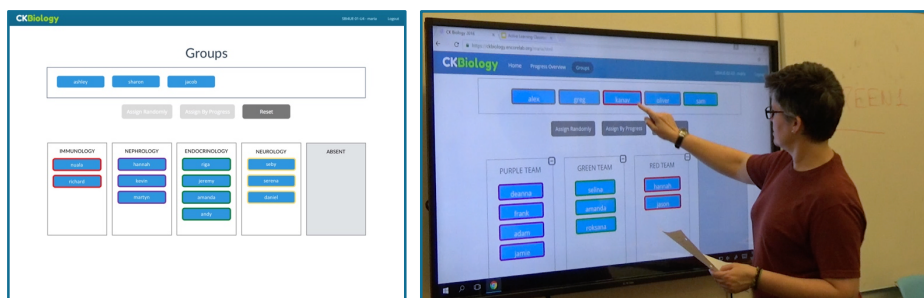

Fig. 1. Group formation tool in CKBiology

To use the tool, the teacher begins by adding the desired number of teams or groups, which appear as a series of empty boxes. After moving any absent students to the "absent" box, the teacher then selects the desired grouping protocol using one of the buttons on the screen. At her option, the teacher may modify group membership manually if adjustments are required. In our poster, we will elaborate upon each of the above grouping protocols, including when in the activity sequence each of them was used.

3.1   Teacher's Perspective on the Group Formation Tool

In the final unit of the course, groups were formed using the "group by progress" protocol. In a follow-up interview with the teacher, we asked whether she noticed any differences regarding the effectiveness of the high-, mid-, and low-progress groups. The teacher responded that the high-progress group "clearly knew what they were doing and they were able to complete the activity pretty much without a glitch." On the other hand, the low progress group "didn't have a clue what was happening…Some of them did make an effort, but without preparation…you don't actually have the tools or the know-how to go through the activity." The teacher went on to say that grouping by

progress is most useful and beneficial when there are fixed time constraints for an activity. Conversely, grouping students by mixed ability would benefit lower-performing students in cases where time is more flexible and the activity is not for marks.

4   Implications and Next Steps

During the next stage of analysis, we will analyze audio and video recordings of the groups formed using the different grouping protocols, including the learning artifacts they produced. The aim would be to identify the ways that the different grouping protocols may have influenced the quality of group collaborations.

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