BUILDING AGENCY IN AN EPISTEMIC COMMUNITY

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Abstract - The study explores the process by which students build epistemic agency and examines the role of epistemic tools in social mediations. 299 pupils participated in this study. Using 360 VR video cameras, 655 hours of video were recorded and 120 hours were fully transcribed. Findings indicate that the interplay lead students to negotiate some important epistemic criteria. This includes what counts as scientific evidence, why the same data and reasoning can support or result in different conclusions, and what experimental conditions are required to test ideas scientifically. The analysis suggests that having a shared epistemic goal that emerges out of a need to accommodate material resistance is a driving force shaping students' epistemic activity. Our findings have implications for designing learning environments in which pupils are situated to pursue step-wise epistemic goals and building agency.

Index Terms - About Four Key Words or Phrases in Alphabetical Order, Separated by Commas.

I. INTRODUCTION

The use of external graphic representation has the potential to support co-knowledge construction, especially when building a scientific model or producing a scientific argument or explanation These graphic epistemic tools are often used as scaffolds that act as prompts or conceptual guidance tools for use in different phases of discourse. [1]–[5]. A number of studies have investigated the effects of using these representational tools to support students and to pre-service teachers' scientific practices in order to improve performance when producing scientific models and explanations Some studies also analyzed the learners' discussions while using these tools [1] – [2] However, most studies considered the quality of the final product to be evidence of an improvement in learning [3], and ignored what was discussed during the drawing or recording of the representation [4]. While a few studies looked at what was said and how the learners talked to each other as they used a representational tool [4], changes in the resulting representation were not necessarily reflected in the discourse analysis [5]. That is, the dialectical interplay between the discussion and the representation—how changes in speech affect the representation, and vice versa—has not been fully investigated. Consequently, knowledge construction's role as an epistemic tool has been investigated for use as a modeling or representational tool, yet mediation's role, which leads to continuing reflection, modification, and evaluation, is under-explored. This certainly requires more attention in order to fully understand how knowledge is co-constructed. In this study, the focus was on the external modeling or representational tool's roles as an epistemic mediation tool and as a social mediation tool. The specific research questions guiding this study are as follows: 1) How does the interplay between talking and creating representations change over time? 2) How does this interplay become an epistemic mediation tool over time? And 3) Could the use of representations have a social mediation role?

II. METHOD

Over the course of an academic year, 289 tenth-grade students (149 male and 140 female) from 10 science classrooms participated in this study. The general high school is located in the suburban area of Seoul, the capital of South Korea. While the area is fairly wealthy, the academic achievement level of this school is relatively low, as many students attend specialized, high-performance schools. The study was conducted during integrated science classes, which occurred once a week in 2-hour sessions. The main participant structure involved small group discussions followed by gallery talks. Each group consisted of 3–4 members of mixed gender and academic achievement. Each member's pen was a different color. These were used to draw or write down ideas as the members conversed. A member of each group explained their group's produced representation, and members of each group visited the other groups. The groups participated in discussions of 12 different topics, consisting of debates about basic scientific concepts, socio-scientific issues, and the construction of models for scientific phenomena. Example topics included the designer baby and CRISPR-Cas9; the comparison between natural and artificial vitamins; and ways to design a safer roller-coaster, considering the conservation of energy.

To collect data, 360-degree virtual reality cameras were used; a camera was positioned in each small group to effectively capture both drawing and talking. Several snapshots of representations were taken separately from the video recordings. Every piece of representation produced was archived for further

analysis. A video camera was placed at the front of the room to film the whole class, and another was stationed at the back of the classroom to record the teacher's voice and movements. All videos were logged and brief narratives were recorded. A few weeks later, 1 or 2 focus groups from each class were selected for microanalysis to compare the development of the discussions and representations. The groups selected as focus groups showed a higher or lower performance in the science class. During these focus groups, discussions were fully transcribed and the development of representations was traced through snapshots and video records.

III. FINDING

The initial analysis showed how the dialectical interplay between modeling/representation and talking helped students make quality epistemic decisions, such as what counts as evidence, reasoning, or a scientific claim. When students were asked to discuss within their own group (inner group discussion), and were then asked to visit other groups to compare ideas (inter-group discussion), the representations were used as external references with which students visually and physically sought claims, evidence, and reasoning, for their own and those of others. To specify, when a student from one group mentioned that their group found 3 different kinds of evidence to support their idea and presented their representation, students from other groups asked the student to locate the evidence from the representation. When the representation was underdeveloped compared with other groups, students reflected that they needed to develop more ideas and evidence. As the academic semester went by, students modified ideas or developed a representation while they came up with new ideas, instead of talking first and then developing a representation. Although the basic rules for using the representation were simple, and identical for all students across groups, grades, and classrooms, some groups or classes eventually generated similar, but slightly different, signs and rules.

The results of the initial analysis allowed us to apply a further analytical framework, the dance of agency, in which Pickering (1995) conceptualized science as an interplay between material and human agency in a dialectical relationship. Scientists normally used graphic tools to represent their models and ideas. But, at some point, established models and representations might help scientists shape and develop their models and ideas. For example, the periodic table is the representation in which chemical elements are arranged by their atomic numbers and recurring chemical properties, which show periodic trends. The development of the periodic table allowed chemists to predict the existence of undiscovered elements that were, in fact, found later. Pickering (1995) also highlights the dynamic processes of resistance and accommodation in this interplay between material and human agency. Drawing on the dance of agency as an analytical framework, the ways that students developed the procedures with which they drew models and wrote down their arguments was traced. At first, they wrote down almost everything that was said. However, the ways in which they used this representational tool evolved over time and mediated what they drew and discussed. It also informed their decisions about what counted as a good model and argument.

While the study originally focused on the epistemic mediation role of a representational tool, the analysis also revealed the role of social mediation, which supports distributed participation as well as shared epistemic goals and responsibilities. For example, using a different color for each member not only encouraged less participatory members to talk, draw, and write more, but also seemed to implicitly press the most active and dominant member of the group to control his or her contribution. When, using their representation, each member was in charge of explaining their models and ideas to the other groups, that member became more attentive to the discussion. After repeating the exercise a few times, the degree to which most members participated in discussions using representation seemed to increase.

CONCLUSION

The study examined how the interplay between talking and writing or drawing representations affected the ways in which students made epistemic decisions through continuous modification and evaluation. Using the dance of agency as an analytical framework, it was found that the ways in which students became involved in talking and writing representations evolved over time. While the students initially used the representational tool to express and represent their concepts, models, and ideas, their later established rules, forms, and orders of representation gradually began to shape and mediate how they developed and regulated their models and ideas. The representational tool became a collective epistemic platform through which the students shared goals, rules, and responsibilities to build and process knowledge together.

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