"Learning Arc": The Process Of Resolving Concerns Through Student-Student Discourse

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Abstract. In reformed classrooms that utilize student-student interactions, a student's concerns can often be resolved through student-student discourse with minimal to no direct input from the instructor. To gain insight into such interactions, we used video data from a Florida International University reformed introductory physics classroom. We micro-analyzed a segment in which the discourse between a group of students leads to the resolution of a concern. In this study, we identified a pattern of discourse which we are calling a "Learning Arc." In this paper, we present the "Learning Arc" as a 3-stage process by which students use discourse as a means to achieve a consensus that resolves a concern.

Keywords: student-student discourse, consensus-building, apprenticeship.
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INTRODUCTION

Research into student group-work and collaboration has shown that there is much more to a group's collective learning than a simple pooling of knowledge [1]. In a reformed classroom that utilizes and facilitates student-student interaction, one potential place where collective learning occurs is when a student's concerns are resolved through student-student discourse with minimal to no direct input from the instructor.

In this situation we can then ask, "What is the mechanism by which a student's concerns are resolved through student-student discourse?"

This paper identifies and defines one such potential mechanism as a pattern of discourse which we are calling a "Learning Arc." In identifying this mechanism, we are not claiming that this is the only pattern of discourse [2, 3], but that the "Learning Arc" is one pattern that emerges from the data.

THEORY

When students interact in order to resolve a concern about the (physics) content, this brings into interaction multiple asymmetries of knowing in regards to that particular concern. One of these asymmetries might mean that one student has more content knowledge of the concern than another. This asymmetry of knowing could be understood through a cognitive apprenticeship model [4]. Within this model, one student is constituted as "more-knowing" of the concern while the other student is constituted as "less-knowing" of the concern. However, this identification of roles is a labeling of students' demonstrated asymmetries of knowing, and is not necessarily a reflection of a dichotomy in their intellectual capabilities [5].

Traditionally, cognitive apprenticeship calls for roles of "expert" and "novice." However, the "expert" role can be further distinguished as either macro-expert or micro-expert. A macro-expert exhibits expertise regarding that subject or field as a whole, while a micro-expert [5] exhibits expertise regarding a specific concern or instance in a subject or field.

If one student evaluates something another student has done, offers advice, or delivers a directive, it can be said that those actions constitute the speaker as being knowledgeable enough to perform those actions. This may also indicate that the recipient is lacking, and in need of those actions. Thus, the speaker can be viewed as being more-knowing, while the recipient can be viewed as less-knowing [5]. In contrast, if one student asks another student for information or advice, this constitutes the speaker as being the one who is less-knowing, and the recipient as being the one who is more-knowing. Therefore, the less-knowing student is representative of a novice, and the more-knowing student is representative of a micro-expert.

The roles of micro-expert and novice are fluid and may shift as time passes in an interaction. For example, one student may offer advice to another,

indicating that they are more-knowing regarding the content concern, and the recipient may reject it based on facts or logic. This would therefore ratify the roles of micro-expert and novice that had been previously established.

METHODOLOGY

Data Collection

The video data for this research is from the recordings of a Florida International University (FIU) reformed introductory physics classroom during the 2010 Fall semester. In this classroom, students completed assignments and lab work in small groups and then later presented their findings with the other groups in large group meetings. Each day, two cameras were individually operated by a videographer who chose one small group of students to follow, as well as capturing the larger group meetings.

Method Of Analysis

This work was completed as a part of a larger project designed to capture moments of video that describe the Modeling Instruction [6] environment. Researchers involved in the larger project selected approximately three video clips from each day of the two-hour class, resulting in approximately 75 video clips which were later transcribed.

In viewing these video clips, we noticed that students were often articulating content concerns and resolving them with little to no interaction with the professor. We chose to focus on a subset of these segments with the intention of describing the process students went through to resolve the concerns they raised. Analyzing numerous video clips using a detailed analytical lens [7], we observed a process developing which we labeled the "Learning Arc." We identified the "Learning Arc" as a description of one process that students move through in order to resolve a concern. In this paper we present one case of students resolving a concern and outline the Learning Arc process.

THE LEARNING ARC

The Learning Arc is a 3-stage process by which students use discourse as a means to achieve a consensus that resolves a concern with minimal to no direct input from the instructor.

The first stage of the Learning Arc is the expression of a concern. A concern is an idea about which a student expresses confusion, uncertainty, or ignorance.

The second stage of the Learning Arc process is the concern-resolving discourse. After the concern is expressed, students engage in discourse as they attempt to resolve the concern. The dynamics of this concern-resolving discourse describe a cognitive apprenticeship. In this apprenticeship, one student takes on the role of a micro-expert and another student takes on the role of a novice [4, 5]. These roles are identified by the students' asymmetries in the knowledge expressed regarding the concern.

The third stage of the Learning Arc process is the resolution of the concern. The resolution of the concern occurs once a consensus is reached among the micro-expert and the novice. We identify the resolution of the concern when there is an apparent appeasement of both parties, and they no longer address the concern as such.

DATA AND ANALYSIS

This segment takes place in the second week of classes. In the time leading up to the first section, the students have participated in a large group discussion regarding constant acceleration, and then assigned an activity requiring them to plot position, velocity, and acceleration versus time graphs. The data that follows shows a small group of three students as they work on the activity at their desks. However, only two of these students are interacting in the segment.

In the following sections we identify each of the three stages of the Learning Arc process as they occur during the segment. Our focus is a concern expressed by one student, Ameera, as she and another student, Marta (both pseudonyms), seek a resolution.

Stage 1: A Concern Is Expressed

1 **Marta:** And…the velocity is slowing down, right?
2 **Ameera:** Going down, right. Is it going to be this way? That's my confusion all the time. Is it going to be this way, or this way?

In this section, in turn 2, Ameera explicitly expressed her concern in the form of a question. She was confused about how the velocity versus time graph should be drawn, and expressed this concern to Marta.

Stage 2: Concern-Resolving Discourse

Following turn 2, Marta provided a curt response saying, "Velocity's a straight line." Ameera responded by silently staring at Marta for 2 seconds. Following the stare, they both returned working on their

papers individually for 10 seconds before Marta re-starts the conversation again in turn 3.

3 **Marta:** And the way that I figure out from position, whether it's this way or that way, is I look at what's happening to it. Like, OK, the fact that it's going this way…
4 **Ameera:** uh-huh.
5 **Marta:** …and like this way, instead of this way, means that you're just moving more away.
6 **Ameera:** OK.
7 **Marta:** OK fine. And this way is you're moving closer.
8 **Ameera:** Like…give me a situation.
9 **Marta:** Like…I'm driving away from you…

Following turn 9, Marta continued to explain, while Ameera made interjections such as "OK," "mhmm," "uh-huh," and "right" until turn 26.

26 **Marta:** OK, so first think this, then decide what's happening…This looks like zero, so this is no acceleration…
27 **Ameera:** No acceleration.
28 **Marta:** …so you're speeding up.
29 **Ameera:** OK.
30 **Marta:** Right? This looks like zero…
31 **Ameera:** mhmm.
32 **Marta:** …so you have to get smaller. Slope got smaller.
33 **Ameera:** OK.
34 **Marta:** That means you're slowing down.
35 **Ameera:** Got it. OK listen, for this one let's say someone is coming towards me, right?
36 **Marta:** OK.
37 **Ameera:** So it's gonna be this way?
Ameera draws on her paper.
38 **Marta:** Right.
39 **Ameera:** Right?
40 **Marta:** Right.
41 **Ameera:** From here, I need to decide here, like someone is…
42 **Marta:** No. This is why you get confused, because look at how my lines are drawn. Like this one goes up, so these lines face like this.
43 **Ameera:** OK.

Throughout this section, Ameera and Marta were engaged in concern-resolving discourse, attempting to resolve Ameera's concern. During this discourse, Marta took on the role of the micro-expert, as she exhibited an expertise regarding the specific concern. Ameera, on the other hand, took on the role of the novice as she exhibited a lack of expertise.

In turn 3, Marta's statement, "And the way that I figure out position . . ." is exemplary of her role as a micro-expert. Marta was communicating her knowledge of the concern in response to Ameera's question.

This dynamic is also evident in turns 8 and 9. Ameera asked Marta to give her a specific situation and Marta responded by providing one. Ameera, by asking for a situation, is expressing that her concern was not yet resolved. As Ameera continued to ask Marta questions that were related to her concern, she continued her role as the novice. Marta provided Ameera with a corresponding situation, which is consistent with her role as the micro-expert.

It is evident that these are established roles that persist throughout the conversation. For example, in turns 9-34, Ameera simply followed along while Marta was doing the explaining.

In turns 37 and 39, Ameera looked to the micro-expert, Marta, for confirmation.

In turns 41 and 42, Ameera began to explain a situation when Marta interrupted her saying, "No. This is why you get confused . . . ." By saying "No" in response to Ameera's explanation, Marta called attention to the fact that Ameera's concern was still not resolved. Ameera, by providing an incorrect explanation as evidenced by Marta's quick evaluation, continued her role as the novice. Marta moved on to diagnose why Ameera is confused in turn 42. Marta showcased her knowledge of the concern and her active interest in attempting to resolve the concern, which is consistent with her role as the micro-expert.

Given the establishment of the students' respective roles as novice and micro-expert, the dynamics of the concern-resolving discourse resembles that of a cognitive apprenticeship [4].

Stage 3: Concern Resolution

This section continues directly from turn 43, with Marta continuing to explain to Ameera.

44 **Marta:** Right. This one's going down, right, so my lines have to face like this…
Marta draws on her paper while Ameera observes.
45 **Ameera:** Ohh…yeah, yeah, I got it.
46 **Marta:** Right?
47 **Ameera:** So from there you decide. Here your slope is zero, and here your slope is zero.
48 **Marta:** Right.
49 **Ameera:** OK, I got it.
50 **Marta:** So this is you speeding up, and this is you slowing down.

In this final section, the concern is resolved. In turn 44, Marta was explaining. In turn 45, Ameera

expressed her belief that she's ". . . got it." Ameera then confirmed her understanding by providing a recap of the consensus in turn 47. This recap appeased both Ameera, as indicated by her saying "OK, I got it." in turn 49, and Marta, as indicated by her confirmation in turns 48 and 50. This is evidence of a consensus being reached. At this point, the students no longer address the concern as such, and we identify the concern as resolved.

CONCLUSION AND DISCUSSION

In this study, we identified a pattern of discourse where a concern is resolved through student-student discourse with minimal to no direct instructor input. Once the "Learning Arc" has been completed, the students have reached a consensus, and thus resolved the concern amongst one another. Therefore, if students do not reach a consensus amongst each other—if they get stuck beyond resolve, stray away from the concern, or if they cannot come to a mutual agreement, etc.—then the Learning Arc does not apply.

Additionally, the Learning Arc is not apparent when there is significant instructor input. For example, if an instructor is engaging in discourse with students who have a content concern, and the instructor provides significant input that leads to a consensus among the students that resolves the concern, then we cannot identify a Learning Arc in the discourse.

On the other hand, if the instructor provides minimal input, and the students reach a consensus that resolves a concern, we can say that the Learning Arc has been completed. One example that we have from additional data involves a group of three students working on determining the energy of a system consisting of a book sliding across a table. One student has a concern regarding whether or not the inclusion of gravitational potential energy into their energy diagram is necessary, since it remains constant. After engaging in discourse with one of her group members, the instructor approaches the table and is presented with the concern. The instructor then suggests that the gravitational potential energy be erased from the diagram, and asks one student to explain that decision to the others. This student takes on the role of the micro-expert and leads the other student to reaching a consensus and resolving the concern. This is an example of the Learning Arc being applicable with minimal instructor input.

It is important to note that whether or not the consensus is correct is irrelevant in the sense that the Learning Arc has been completed, and a consensus has been reached. This consensus can now be referred to and applied in the future.

Defining the Learning Arc as this 3-stage process gives insight into how students resolve concerns both by themselves and with minimal input from the instructor. By attending to the discourse that students use to resolve concerns, we make apparent certain aspects of the concern-resolving discourse (prompts, statements, gestures, diagrams, examples, questions, etc.) which are most effective at resolving the concern. These can then be implemented by the instructor in order to improve classroom efficacy.

In our future work, we can also compare the Learning Arc to processes which involve instructor-student interactions. For example, compared to instructor-student interaction, a specific concern may be resolved differently through student-student interaction, as identified by the Learning Arc. Using the Learning Arc to format curricula which balances the instructor-student interactions and the student-student interactions may prove to be effective for the purpose of resolving a variety of student concerns.

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