Project Report:

CASUM: Conversations About Science Using Media

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CASUM is an intervention we designed to help teachers manage classroom conversations about science in which students build on each other's' ideas to construct explanations of science presented in teacher-controlled Flash animations. CASUM dialogs were inspired by two independent project components: a) the Flash animations that were developed for MyST-MP&D, and b) Questioning the Author, the approach developed by Isabel Beck and Margaret (Moddy) McKeown for teachers to manage conversations in which children talk about what the author is trying to communicate after reading students a passage of text.

We wondered why QtA, and classroom conversations in general, are not pervasive in US classrooms. Two large scale studies of classroom discourse, conducted by Nystrand and Gamoran (1991) and Nystrand, Gamoran, Kachur, and Prendergast (1997) indicated that teachers rarely ask students authentic questions that can lead to classroom discussions, and that extended conversations are practically nonexistent in elementary and middle school classrooms in the US.

These finding are puzzling, given that a) influential theorists and many educational researchers have both advocated and investigated benefits of collaborative discourse in classrooms, and b) meta-analyses of programs in which teachers learn how to facilitate classroom discourse provide strong evidence that well-managed classroom conversations improve learning and comprehension of texts (Murphy, Wilkinson, Soter, Hennessey, & Alexander, 2009; Soter et al., 2008).

During our interviews with teachers who used CASUM, several teachers independently shared that they did not feel comfortable classroom conversations in which students do most of the talking. This was especially true for the Magnetism and Electricity module, where conversations may lead to questions that teachers do not have the depth of knowledge to answer. This is not surprising, given that most teachers receive much less professional development related to science teaching, relative to reading and math. Teachers are comfortable teaching, they are less comfortable, and most have received little or no training, on how to facilitate classroom conversations.

After developing the sequence of activities in each tutorial dialog in MyST-MP&D, we realized that the Flash applications could be controlled by teachers, who could then ask students questions about the science exactly as Marni does in MyST dialogs. We therefore decided, with the enthusiastic support of Dr. Samantha Messier, the science curriculum director at BVSD, to investigate the feasibility of having teachers control the MyST-MP&D Flash applications while asking students questions designed to help them make connections with and build on each other's ideas to explain the science presented in the Flash applications. Two researchers associated with the MyST project, Cindy Buchenroth-Martin, who developed MyST dialogs and worked as a project tutor, and Liam Devine, who developed the Flash applications, worked with Ron Cole to implement the CASUM program. Cindy a) developed a Teacher Guide for each Flash application so teachers could review the Flash application, learn when to stop the animations and what questions to ask to initiate discussions, b) provided teachers' with professional development, and c) modeled one or two sessions for teachers before they conducted their own QtA dialogs with the Flash applications. Cindy also provided feedback to teachers following their first "solo" CASUM dialog.

During a CASUM dialog, the teacher initiates the discussion by displaying an illustration or animation. After a short interval during which students study the visual, she asks an open-ended question such as "What's going on here?" As students present their ideas, the teacher facilitates the conversation using a small number of effective "discussion moves" that help students clarify or expand their own or others' explanations, make connections between ideas presented by different students, and challenge them to apply their explanations to new situations. At appropriate points in the discussion, the teacher refers to the illustration or animation while posing an authentic question that challenges students to apply their knowledge to a new situation. For example, if the animation shows electricity moving through a circuit, the teacher may ask her students what would happen if she flipped over the D-cell (battery) in the circuit. After facilitating discussion on this topic, which may lead to alternative explanations or consensus, she says "let's see what happens" and uses the mouse to click on the battery, which causes it to flip over and reconnect to the insulated wires on either side. Students are able to observe that the flow of electricity is reversed, and that a flag on top of motor changes direction. The teacher can then ask, "What just happened?" This experience with scientific conversation blends several dynamics widely recognized as cultivating scientific sophistication: it elicits the student's thinking and draws the student into externalizing that thinking; it nurtures appreciation for alternative explanations and testable hypotheses; it emphasizes the role of observation and connecting observation to hypothesis; and it emphasizes the role of reflection and analysis after observation. The CASUM project relies on and researches this blend of dynamics as they are implemented through media.

Since the CASUM dialogs were based on the Flash applications in MyST-MP&D, each dialog was aligned to science concepts taught in classrooms using the FOSS program. We tested CASUM with both Measurement and Magnetism and Electricity and Measurement modules.

Sequence of Activities in Each CASUM Dialog

Title Screen: Each CASUM dialog begins with an important title screen (Appendix B, Figure 1a). The title of the CASUM session is presented as a question: Examples of CASUM titles are: What do magnets stick to? What is an electrical circuit? What is an electromagnet? The CASUM dialog is introduced with an authentic question because research has shown that presenting a student with an authentic or deep reasoning question before engaging in instruction or solving a problem improves learning (Driscoll et al., 2003; Gholson et al., 2009; Sullins et al., 2010).

Engaging Real-life Scenario: The first component of a CASUM dialog is a narrated animation that presents a real life scenario. For example, the scenario may show two characters (children, of different ethnicity and genders across different scenarios) talking about how their portable devices (e.g., cell phone, laptop, flashlight) can be turned on and off by pushing a button. How does this work? The scenario also introduces a problem that provides the basis for discussion. For example, Jack may remove a flashlight's batteries, screw the cover back on, push the button, and wonder why it no longer works.

The Scenario introduces the science. It associates the science with materials and situations likely to be familiar to most or all of the students, and provides the basis for a discussion in which students can make connections between their own experiences and background knowledge about the science being learned. The Scenario discussion provides an opportunity for students to introduce vocabulary that the

teacher can use to focus discussion (using a variety principled and substantive dialog moves discussed below): “So Jeannine just mentioned a D cell and electricity, what’s that all about? The teacher could also say: “I heard Jeannine talk about a D cell and electricity. Let’s look at this part of the movie. We see Jack pushing a button and the flashlight turns on. What does that have to do with a D cell or electricity?”

In sum, the Scenario provides the teacher with an opportunity to help students make meaningful connections between the science and their own experiences and knowledge, to introduce and discuss scientific vocabulary and concepts, and to reflect on the Scenario’s problem and its relationship to the deep reasoning question that introduced the CASUM session (Figure 9).

Explaining the Science: After students discuss the science problem, the teacher presents the students with a narrated multimedia explanation of the science. The design of these narrated animations is based on theory and research in multimedia learning, reviewed above. Each narrated animation is segmented into intervals, separated by pauses. Each interval presents a specific concept. The teacher is encouraged to stop the animation at these points and ask questions that lead to discussion of the concept, The sequence of concepts across these intervals are designed to build on each other, so the teacher can facilitate discussions that lead to complete and accurate explanations. For example, the concepts underlying an electric circuit include: a circuit is a complete pathway through which electricity flows, electricity flows from the source of the electricity through the receiver and back to the source, and electricity flows in one direction only, out of the negative side of the battery and back into the positive side. By designing narrated animations that present these component concepts sequentially, the teacher can pause the presentation after each segment to facilitate conversations that help students focus on the concept that was just seen and described, and then work with the teacher to construct an accurate explanation of each component concept, and then work together to integrate the concepts into a complete explanation (Figure 14). When students have demonstrated their understanding of these concepts, the Flash animation enables the teacher to test the students’ ability to transfer their knowledge to a new problem. For example, the teacher can present a simulation of electricity flowing through a circuit, and ask: *What will happen if we flip the battery?*

Formative Assessment (MC Question): The CASUM dialog concludes with presentation of an authentic question that can be answered if students have achieved a deep understanding of the science. The question may be the same as the deep reasoning question that introduced the CASUM session or the question may be presented with a picture and require an answer that demonstrates application of the science knowledge to the situation shown in the picture. Following presentation of the question each student is asked to write an answer in their science notebook. When they have completed this task, students are presented with the question a second time, along with four response alternatives. The teacher then leads a discussion in which students discuss and defend the different response choices. After students have discussed their answers, each incorrect answer choice that students defended is reviewed and the correct choice is revealed and discussed. At the conclusion of the discussion, students may revise the answer they wrote in their science notebook.

CASUM Pilot Studies

Mandy’ fourth grade classes

CASUM was first piloted in the spring of 2011 at a rural elementary school in Colorado. The teacher, Mandy, had three years' experience teaching science using FOSS. She taught two science classes with an average of fifteen children in a rural Colorado school. Her professional development consisted of an initial one hour meeting with Cindy Martin and Jeannine Moineau (also a dialog developer and project tutor). The group reviewed a set of Flash applications for Magnetism and Electricity (M&E), which Mandy would soon teach, and discussed how QtA could be used with the animations to engage students in discussions. Mandy was provided with Beck and McKeown's book on QtA *Improving Comprehension with Questioning the Author: A Fresh and Expanded View of a Powerful Approach* (Beck & McKeown, 2006). Prior to conducting her first CASUM dialog, Mandy watched Cindy and Jeannine conduct 3 CASUM conversations with her students. Mandy then took over, and was provided feedback on her first CASUM dialog. Mandy then carried out 11 CASUM dialogs with each of her 2 classes over 5 weeks.

Mandy reported that students were fully engaged in the conversations and in listening to and selecting response alternatives to the MC question. She greatly appreciated the ability to pace the conversations, and to play, pause and repeat the videos. She reported that the CASUM experience was a positive one; her students related well to the multimedia explanations, which strongly reinforced the scientific concepts they encountered in the classroom investigations. She noted that several students in her class, including a special education student with limited vocabulary, had great success acquiring and using authentic scientific vocabulary from the media and support from their classmates. Also, Mandy used CASUM in innovative ways: After watching and listening to the Explanations a few times, her students were asked to watch the animation without sound and explain what they were seeing. She asked students to go to the smart board to trace and explain the path of electricity in circuits. On two occasions Mandy had students use clickers to select response choices to the MC question; she reported that students really enjoyed using the clickers and seeing the responses made by all of the students. Mandy offered clear suggestions for improving CASUM which included a) improving the user interface to the Flash applications to navigate within each animation rather than only be able to repeat each segment, and b) shorten the animations; some animations were too long and presented too many concepts, which made the conversation more difficult.

Two CASUM pilot studies with English learners and students with special needs

We conducted two pilot studies of CASUM, in June 2011 and June 2012 with third graders who attended a Science Literacy Camp (SLC) organized by the Boulder Valley School District for ESL and Special Needs students. *All English learners who attended the SLC had low English language proficiency, based on test of English language proficiency administered by the Boulder Valley School District.* One week before the start of the SLC our project team held a 2 hour PD workshop with the 11 third grade science teachers. We discussed the goals of the pilot study, the scientific basis for CASUM dialogs, and conducted a CASUM dialog with teachers for "What is a Meter?" (The focus of the SLC was measurement; the students planned and planted a garden and conducted science investigations in the FOSS Measurement science module.) The June 2011 study involved 11 third grade classrooms in four schools, with approximately 15 students in each classroom. The June 2012 study involved 7 third grade classrooms in three schools. The students who were invited to attend the Science Literacy Camp consisted of English

learners with low English language proficiency based on a standardized test administered by the BVSD school district, and special needs students. The 18 classrooms in the two studies taught the same science content, the same professional development for teachers, the identical Flash animations, and teachers were administered the same surveys at the end of the summer school. Based on these similarities, we combined the results of the two studies.

The day before the SLC began we visited each of the 18 participating classrooms to show teachers how to navigate within the Flash applications to present the media and pace discussions. Each teacher was given a teacher guide that summarized the Flash application, suggested logical stopping points, and provided examples of questions that could be asked to initiate discussions. During the second day of classes in the SLC, a BLT project tutor skilled in QtA dialogs (through experience in the My Science Tutor project) conducted the first CASUM dialog in each of the 18classrooms. Each of the 11 teachers conducted 3 to 5 CASUM dialogs. Two or three days later, after students had completed a science investigation on measurement, teachers conducted their first QtA dialogs with students using the Flash application aligned to the science investigation and classroom instruction. A BLT project tutor attended each of these initial CASUM sessions, and provided feedback to the teacher. Teachers then conducted the remaining CASUM dialogs independently.

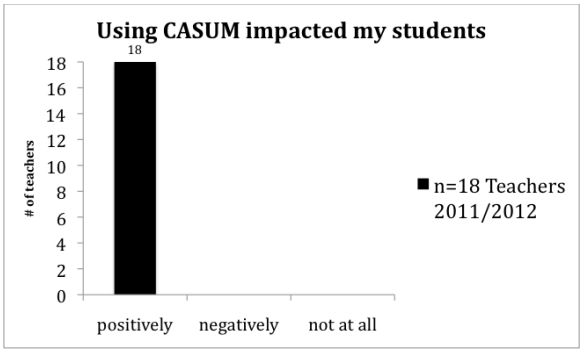
The CASUM dialogs for measurement featured two students, Jack and Jill. In the initial scenario, Jack and Jill set up the problem. For example, Jill offered Jack half of her milkshake. After pouring about half into Jack's glass (which was a different size than Jill's), Jack asks Jill how they could figure out how to share a drink and be sure each person had exactly the same amount. In the problem solving scenario, Jack and Jill work through the problem. Each of the 12 CASUM dialogs developed for Measurement featured Jack and Jill first introducing, and then working through a problem. The third grade students in the 18 classes became big fans of these characters.

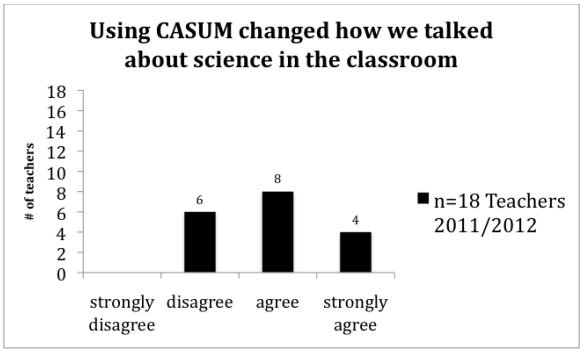
Results of the 2011 and 2012 CASUM SLC pilot studies. All 18 teachers responded to a 20 item survey and provided optional written comments following each question. A 4-point Likert scale was used to assess teachers' impressions of CASUM. The questionnaire included a set of positive statements, such as "CASUM conversations helped students speak more confidently" and teachers responded to the statement by selecting one of the 4 response categories: Strongly Agree, Agree, Disagree, and Strongly Disagree.

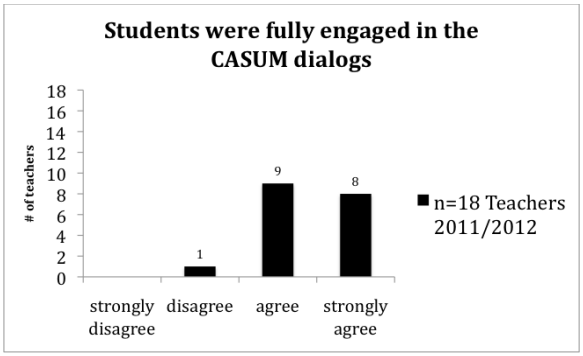
Teachers' responses to the survey questions are presented below as histograms that show the distribution of responses of the 18 teachers to each statement. It can be see that over 90% of all responses to questions about the perceived value and benefits of the program fell into the Strongly Agree and Agree categories. Teachers' written comments indicated that most were extremely enthusiastic about the potential of using CASUM dialogs, and would like to implement the treatment in their classrooms during the regular school year.

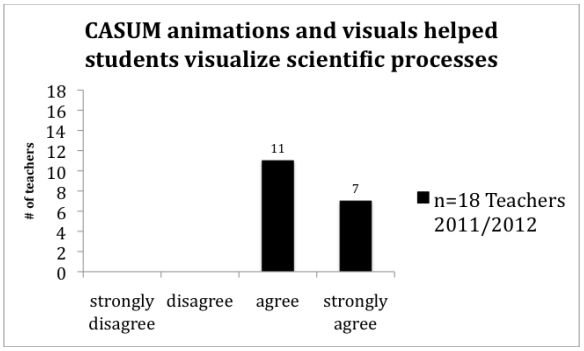
We have submitted two proposals to the IES and one to the NSF to develop and evaluate CASUM dialogs. These proposals were declined.

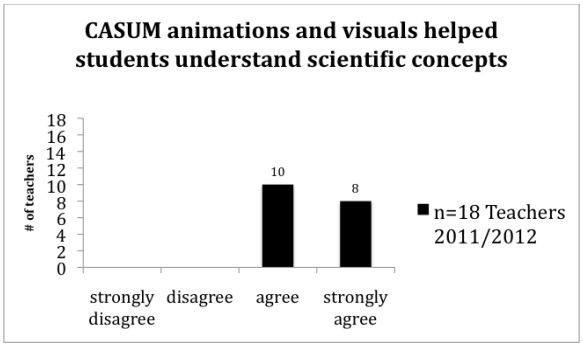
Figure 16 – Teachers Impressions of CASUM

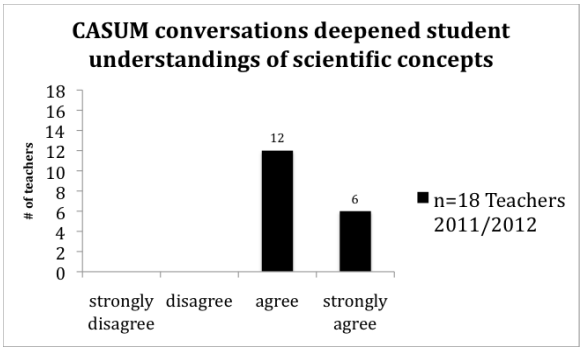


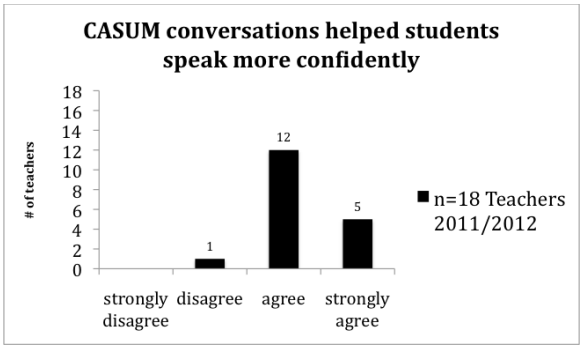


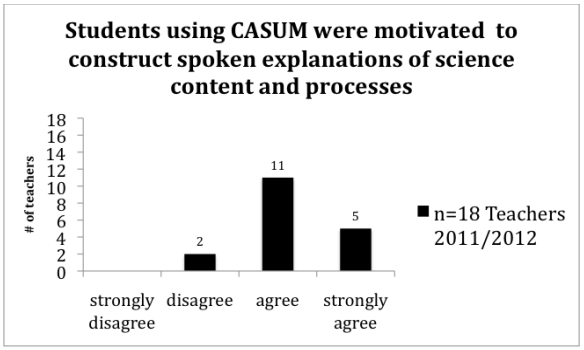


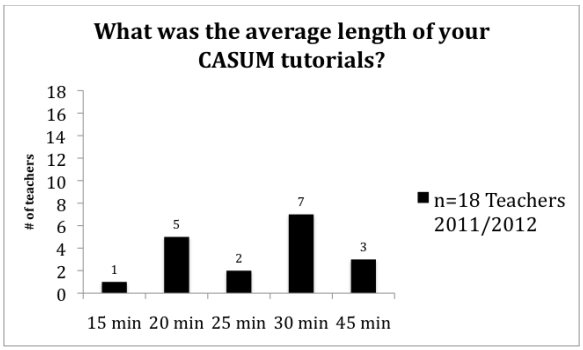


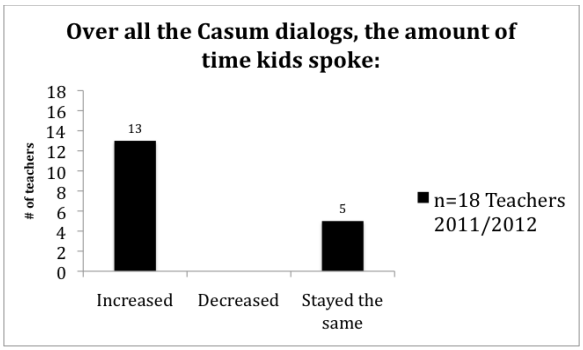


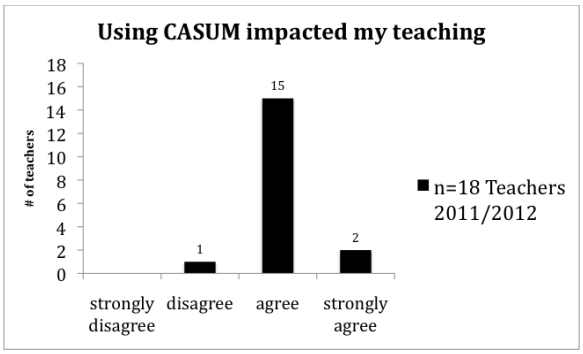


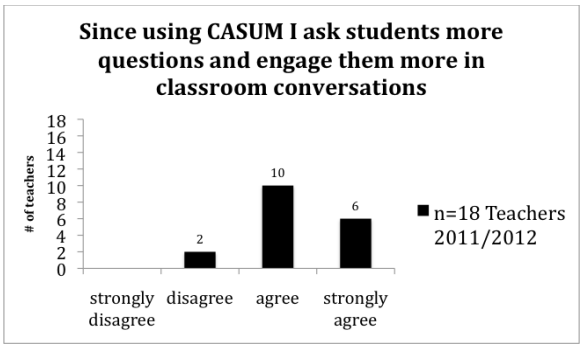


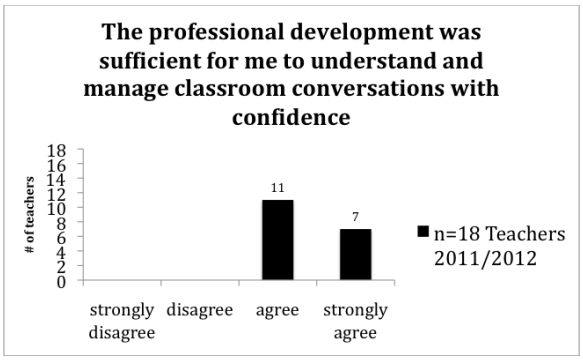


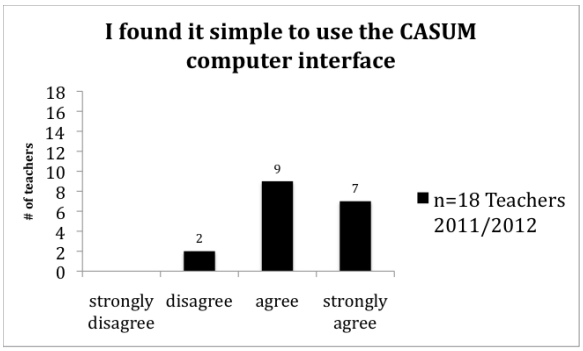

What was the average length of your CASUM tutorials?
# of teachers
18
16
14
12
10
8
6
4
2
0
1
5
2
7
3
15 min
20 min
25 min
30 min
45 min
n=18 Teachers 2011/2012

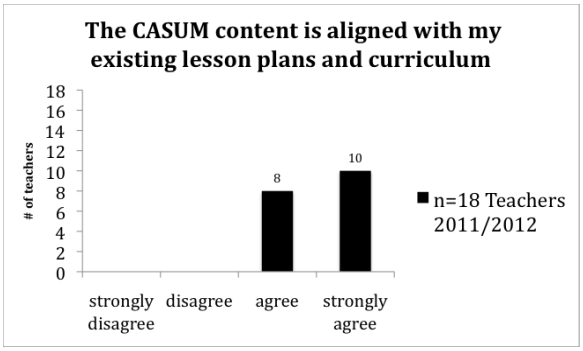

Over all the Casum dialogs, the amount of time kids spoke:
# of teachers
18
16
14
12
10
8
6
4
2
0
13
5
Increased
Decreased
Stayed the same
n=18 Teachers 2011/2012

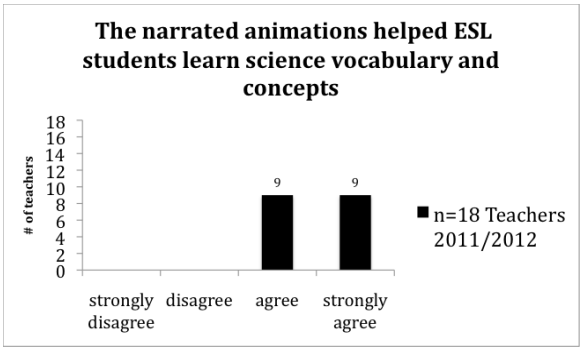

Using CASUM impacted my teaching
# of teachers
18
16
14
12
10
8
6
4
2
0
1
15
2
strongly disagree
disagree
agree
strongly agree
n=18 Teachers 2011/2012

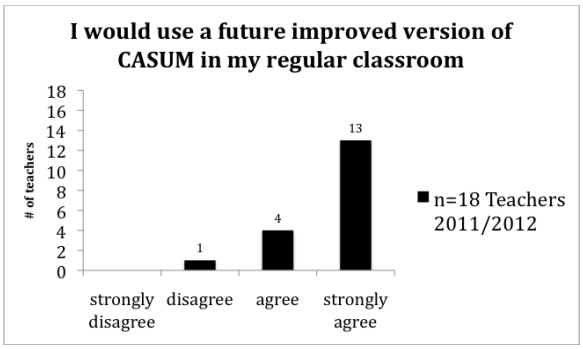

Since using CASUM I ask students more questions and engage them more in classroom conversations
# of teachers
18
16
14
12
10
8
6
4
2
0
2
10
6
strongly disagree
disagree
agree
strongly agree
n=18 Teachers 2011/2012

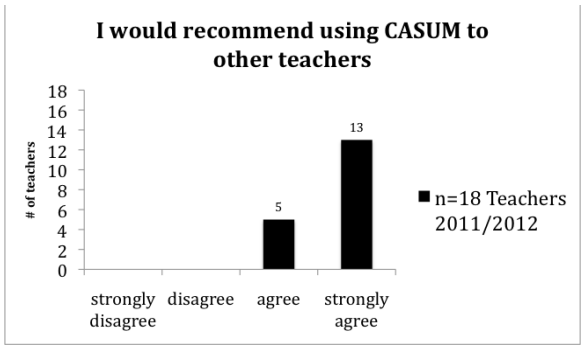

The professional development was sufficient for me to understand and manage classroom conversations with confidence
# of teachers
18
16
14
12
10
8
6
4
2
0
11
7
strongly disagree
disagree
agree
strongly agree
n=18 Teachers 2011/2012


I found it simple to use the CASUM computer interface
# of teachers
18
16
14
12
10
8
6
4
2
0
2
9
7
strongly disagree
disagree
agree
strongly agree
n=18 Teachers 2011/2012


The CASUM content is aligned with my existing lesson plans and curriculum
# of teachers
18
16
14
12
10
8
6
4
2
0
8
10
strongly disagree
disagree
agree
strongly agree
n=18 Teachers 2011/2012


The narrated animations helped ESL students learn science vocabulary and concepts
# of teachers
18
16
14
12
10
8
6
4
2
0
9
9
strongly disagree
disagree
agree
strongly agree
n=18 Teachers 2011/2012


I would use a future improved version of CASUM in my regular classroom
# of teachers
18
16
14
12
10
8
6
4
2
0
1
4
13
strongly disagree
disagree
agree
strongly agree
n=18 Teachers 2011/2012


I would recommend using CASUM to other teachers
# of teachers
18
16
14
12
10
8
6
4
2
0
5
13
strongly disagree
disagree
agree
strongly agree
n=18 Teachers 2011/2012

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