Analysis of Teachers Understanding of Spreadsheet Dependability
Teacher Interviews

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Each year, the grant support varying numbers of teachers to investigate spreadsheets with the intent of integrating teaching mathematics/science with spreadsheets. These teachers were taught to focus on teaching about key concepts of spreadsheet design while they also taught with the spreadsheets as tools for learning mathematics/science. As part of their instruction they investigated the developing prototypes as tools that focused on key concepts of the design of accurate and dependable spreadsheets. During the first year of the project, some teachers attempted to directly transfer their activities with the prototypes to their classroom situations. However, many technical difficulties arose due to the stability of the prototypes. Therefore, the Education/Outreach staff focused the instruction on dependability and creating dynamic spreadsheets. The focus on dynamic spreadsheets was to emphasize that the spreadsheets were accurate as new data and values for specific variables in the problem are visible (rather than being stored in formulas buried in particular cells).

The question for this study was focused on determining whether the teachers were able to transfer their understandings of dependable and dynamic spreadsheets to their instruction of students in their science/mathematics classes.

Method

All teachers who participated in the EUSES project to date were emailed a request to complete the protocol questions. Specific questions were directed at gathering their understanding of teaching these concepts:

1. What is a dynamic spreadsheet to you?
2. Do you find it useful to guide your students in developing dynamic spreadsheets? If so why? If not why not?
3. What are key concepts about dynamic spreadsheets that need to be taught?
4. How comfortable are you with helping your students design and work with dynamic spreadsheets? Please explain.
5. Dependable spreadsheets produce accurate and reliable results upon changes in the data. Of what value for your students is emphasizing the creation of dependable spreadsheets?
6. If you find it valuable, how do you guide your students in designing dependable spreadsheets? If not, why not?

7. What are key concepts about dependable spreadsheets that need to be taught to students if they are to understand using and creating dependable spreadsheets?

Year of Project	Number of Teachers in the Project	Number of Responses
2004-2005	3	0
2005-2006	10	4 (3 of these 4 regularly integrate spreadsheets in their curricula)
2006-2007	11	5 (3 of these 5 regularly integrate spreadsheets in their curricula)

Interview Results

1. What is a dynamic spreadsheet to you?

All teachers understood the notion of a dynamic spreadsheet.

> A dynamic spreadsheet is one where data can be changed, without having to change formulas to get the desired results. The best dynamic spreadsheets can easily be adapted for a multiple problems simply by changing one number. (L)

> A spreadsheet where basic parameters are defined up front (at the top), and the entire spreadsheet is dependent on those parameters. (F)

2. Do you find it useful to guide your students in developing dynamic spreadsheets? If so why? If not why not?

With respect to the amount of guidance, the teachers were somewhat conflicted. They found that it was important in the students' learning if they developed the spreadsheets independently because it was part of the science/mathematics being taught in the problem. But, the teachers recognized students' limited understandings of spreadsheets and felt that because of that limit, students needed guidance.

> Yes, my students have had very little exposure to developing spreadsheets and they need the guidance to be successful. (M)

> I feel it would be helpful in teaching basic spreadsheet skills and to show students the importance of setting the spreadsheet up to be dynamic rather than static. As the year progressed however, and the problems got more complicated, I would want students to start to see the relationships between two or more problems and begin to set up their own spreadsheets without much guidance. I think the concepts would be better understood if students derived their own conclusions, then if I always guided them through the process. (J)

> I have to guide my students in setting up dynamic spreadsheets. For most of my students, my class is the first introduction to spreadsheets. Getting students to use formulas correctly is a major accomplishment. I believe that some students could handle the designing of a dynamic spreadsheet on their own. However, for most of my students, the level of reasoning is not quite there yet. This compound with the unfamiliarity of spreadsheets makes the students anxious and

unsure about what they are doing. Some guidance is needed to help students think about the mathematics and the spreadsheet on a deeper level. (L)

3. What are key concepts about dynamic spreadsheets that need to be taught?

The teachers linked the key concepts of dynamic spreadsheets with debugging and the importance of basics for spreadsheets (not hard coding values, using cell references).

> Entering equations
> Linking cells within a spreadsheet to result in changes produced by making related changes in values
> Debugging spreadsheets in some method to catch any errors in equations or processes. (M)
>
> Key concepts are simply those things that make a spreadsheet dynamic in the first place. Getting away from hard coded values and using cell referencing in a concept in and of itself. It is through this that students should start to see the value of relationships and associations rather than plug and chug type solving. (J)

4. How comfortable are you with helping your students design and work with dynamic spreadsheets? Please explain.

While most of the teachers expressed comfort, two of the teachers who had limited implementation of spreadsheets in their teaching, expressed discomfort.

> I have developed dynamic spreadsheets in the past for my work as an engineer so I am very familiar with them. I would be comfortable helping students in designing and working with them. (M)
>
> I am absolutely 100% comfortable in helping my students design and work with dynamic spreadsheets. I am confident in my spreadsheet skills, and believe that there is not much trouble a student could get into on a spreadsheet that I couldn't help them get out of. (L)

5. Dependable spreadsheets produce accurate and reliable results upon changes in the data. Of what value for your students is emphasizing the creation of dependable spreadsheets?

Teachers showed that connection of creating dynamic and dependable spreadsheets for encouraging students to explore and experiment with problems. They also recognized that students have a tendency to want to get the right answer and be done.

> My students want to "get the right answer". While this attitude is sometimes a stumbling block to them learning because they don't want to "experiment" with different processes or approaches, they can see the benefit of having an accurate and dependable spreadsheet. (M)
>
> I want to teach students how to create dependable spreadsheets. I would also like to teach them how to create dynamic spreadsheets. However, more of my focus is on creating dependable data. When students are creating formulas, I absolutely do not allow students to hardcode in any values that can be referenced to in a cell. At first, this is very frustrating to the students. They often see the value in the cell that they want to work with and type that number instead of the cell reference. I found however, that this habit can quickly be corrected by making use of the delete key. Deleting formulas and have students redo them with references only needs to happen once or twice before students get the idea. With my students, I have also introduced the idea of absolute

referencing. This is a concept that students struggle with a bit more, however, they are able to grasp it. I found that they are often able to recognize that dollar signs are needed but have trouble with the placement. Often students just want to place them in front of both the letter and the number, instead of just one. With explanation, this is something that students are able to work through though. (L)

6. If you find it valuable, how do you guide your students in designing dependable spreadsheets? If not, why not?

The teachers seemed to connect student experiences with making mistakes and investigating the reason for inaccurate results. They felt that this process was an important learning experience so that students understood the value of checking on the accuracy and dependability of the spreadsheet.

> I would allow them to make mistakes. I would allow them to rely on a spreadsheet that produces inaccurate results so they could see for themselves the importance of being accurate. This could even be its own lesson. A banking lesson could be designed that shows the importance of cell referencing and formulas that do not depend on specific entered values. (J)

7. What are key concepts about dependable spreadsheets that need to be taught to students if they are to understand using and creating dependable spreadsheets?

Debugging appears as a key concept in dependability. Debugging is connected with trying different problems – changing the problem to see if the spreadsheet provides a reasonable solution.

> Correct entry of equations, using tools available to help debug a spreadsheet, functions that are available within the spreadsheet and how to apply them. (M)

> Along with the items mentioned in the last question, a discussion on the limitations of hard coding would be valuable. Also a discussion on the what-ifs from real life situations could show students what harm a seemingly small mistake could make in the 'real-world'. (J)

> The students need to understand that they can't just put values in they need to use a formula. That way the spreadsheet can work for them and not just be a calculator. (D)

Summary and Analysis of the Comments

1. With respect to the first question, most teachers' thinking revolved about accuracy of numbers and responses and that students need to check their work and make sure that they are correct. One teacher's explanation put this into perspective and said that through this aspect of spreadsheets, students learn that accuracy of their results will impact their conclusions – which is very crucial in scientific analysis and work.

2. The teachers used a variety of tools to demonstrate to their students how to create dependable spreadsheets. One teacher showed a movie about constructing dependable spreadsheets; another teacher used significant number rules resulting from the algebraic operations to show students how spreadsheets can help them do that; two teachers modeled the process by intentionally placing a mistake in a spreadsheet lesson or letting students make mistakes and then showing their students how that mistake propagates; one

teacher used deleting and re-entering erroneous formulas a repeating practice for her students until they learned how not to make mistakes through practice; another teacher, suggested that he gives "check-points" to his students at which point they are to stop and check their answers with others. Each of these teachers had a variety of unique backgrounds and teaching experiences and that seemed to have led to their decisions about promoting accuracy in creating spreadsheets among their students.

3. The teachers once again used different ideas to instill in their students the value of dependable spreadsheets. One teacher expressed emphasizing the concept "garbage in = garbage out" to his students and that it's important that students understand the validity of their results is only as good as the validity of the components they have in place for generating those results; another teacher expressed the value of using "what if" questions and showing to her students how small changes in the spreadsheet input data can significantly change the results, for this purpose; using absolute and relative referencing and demonstrating the propagating impact of any error throughout a spreadsheet, was another teacher's idea of explaining to her students how important it is to create dependable spreadsheets. Excel-based debugging tools, and modeling, were other solutions suggested by the teachers.

4. Regardless of the summer program the teachers participated, the main theme was that they (1) saw the value of teaching about the spreadsheet as a mathematics/science learning tool, (2) focused students' attention of the design of dynamic and dependable spreadsheets along with a focus on debugging and assuring the accuracy of the spreadsheet in order to use the spreadsheet to solve more than the immediate problems.