Moving From Feedback To Scaffolding: Improving The LTD Student’s Experience

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Chapter 6

Moving from Feedback to Scaffolding

Improving the LTD Student’s Experience

Suzanne Alejandre and K. Ann Renninger

Introduction

A common concern for all instructors of learning technology design (LTD) is *scaffolding*, that is, supporting students’ cognitive development over and above simply providing feedback. LTD students need to understand how people work, how people play, and how people learn. Presumably because these three goals seem commonplace, students assume that they are ready to “just start building” and are often not responsive to feedback (or scaffolding) that would enhance the usability and impact of their product. Student designers can easily lose sight of goals for programming or visual design. In fact, findings from our research indicate that (1) student designers benefit from support in the form of scaffolding and (2) that those who provide scaffolding to students (in this case K–12 teachers) benefit from being able to review the premises, or facets, of scaffolding.

Effective scaffolding-feedback can enable students to rethink their assumptions and revise their designs. However, the open question is, what makes for *effective* scaffolding feedback? In this chapter, we report on the online Teacher Scaffolding-Feedback Module¹ (Module) that was developed to help “live” teachers to scaffold LTD students online.

In the present chapter, we distinguish what we call *scaffolding-feedback*,² or simply *scaffolding*, from *feedback* in the following way. Scaffolding is undertaken with the explicit intention of supporting a student’s cognitive development over and above simply aiding performance on a task. Feedback, in contrast, is often a one-time, one-problem task communication that may or may not aid development. As a result, feedback may or may not contribute to students’ developing insight, skills, and acculturation.

Scaffolding refers to the verbal (here, online) interaction that bridges the distance between what the learner understands and what he or she still needs to understand. This interaction focuses the learner and both provides and fades, or removes, the scaffold as the learner(s) is ready (Collins, Brown, & Newman 1989; Davis & Miyake 2004; Puntambekar...
& Kolodner, 1998; Renninger & Granott 2005; Rogoff, 1990; Sigel 1970; Vygotsky 1978; Wood, Bruner, & Ross 1976). Thus, the task of scaffolding is not necessarily facilitation of immediate task performance (Pea, 2004) and needs to include consideration of subject-matter content (Renninger, Ray, Luft, & Newton 2005; West & Staub 2003).

Work with the online Module indicates that when K–12 teachers scaffold LTD students, the results include understanding and increased appreciation of: conceptual aspects of the design process (e.g., the focus of learning objectives), realistic technical requirements, and project scope. In fact both teachers and students can enhance their understanding. For example, in an exchange with the scaffolding facilitator, a teacher reported on first reading that the strongest mathematical topic in a group of students’ game draft looked like it was going to be coordinate graphing. Instead of saying this to the students directly, she engaged them in thinking with her about their design, making sure that her interpretation of their intentions was accurate. She allowed them to identify graphic coordinates as a focus of their work and to further articulate their learning objectives for the age group with respect to their understanding of coordinate graphing, rather than telling them to focus on coordinate graphing.

TEACHER: What I’m understanding then is that this game is meant to practice skills and concepts that the students have already encountered in class, but the playing of the game will not extend these skills. Is that true?

STUDENTS: Oh, the learning objective of this game is to improve and enrich some of the mathematical concepts that students in third and fourth grade encounter. There are several areas in which the game is concentrated; graphing coordinates, geometry vocabulary, addition, subtraction, multiplication, pattern matching.

TEACHER: I get it, thanks. Your game is intended to supplement key areas in the curriculum. You’ve made a decision to address a number of topics at once and this might be an effective tool. If you were to target only one topic, however, which would that be? I’m wondering if something more focused might be more useful. Often in my classroom, for example, having a tool that bootstraps understanding in one area is very helpful.

Because student projects are a core feature of LTD courses, scaffolding is critical to the usability and development of their projects. LTD students are likely to require support to think about how any discipline is learned. Not only do they need to consider their learning objectives, they need to think about the mathematical content of the game design. Thus, designing...
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a game about fractions is not simply about knowing or presenting algorithms. As we have found, for example, most student developers do not bring a background in education or the psychology of learning to the design process and many do not think that design requires attention to both functionality and subject-matter content. (Renninger, Frost, & Alejandre 2004). Therefore, LTD students need to be encouraged to rethink their understanding and the underlying concepts that users engage in order to develop their mathematical thinking. An added difficulty is that so many people, including undergraduate LTD students, view mathematics as limited to arithmetic and algorithmic applications. This type of understanding of mathematics constrains design. For this reason, the LTD students often require scaffolding that challenges them to account for functionality and subject-matter content.

Figuring out how to provide scaffolding of LTD students that can impact the development of educational products is both essential and complex. Over the last four years, we have investigated the use of scaffolding in ten LTD courses at four universities. In these courses, experienced teachers have had a variety of roles:

- as clients for student projects where they requested specific educational content to be built;
- as reviewers at the design stage where they react to one or two student proposals;
- as reviewers of prototype learning technologies, typically a beta version (sometimes the teachers’ students also participate).

Teacher feedback about their roles in LTD classes included requests for more direction about how to work effectively with LTD students. They were concerned about how to ensure the development of requisite knowledge despite potentially low motivation of students to do so. Analyses of LTD students’ readiness to work with scaffolding from the teachers indicated, for example, that:

- students realized that the teachers were an important audience for their designs;
- students need to feel that their ideas are respected and that they are in a conversation in order for change to occur; and
- teachers sometimes raised questions intending to support thinking and instead had no effect, and students felt reinforced to stay with their original plan (Renninger & Kelley 2007).

Findings such as these informed the development of the Module. Its design encourages teachers to react to product content, identify specific
subject matter content (e.g., ratio and proportion), assess goals for learning, and practice scaffolding, including the offer of suggestions.

**Design and Development of the Module and its Facets**

Assignment of collaborative projects is common in the LTD classroom. Assessment is often staged to involve several iterations of revision. Involving teachers and/or their pupils in this process provides authentic feedback that can powerfully influence LTD student learning.

The Module was first developed in response to teachers’ requests for support to provide scaffolding for LTD students. It is presently in its sixth iteration. It provides teachers working with LTD students an opportunity to orient themselves to an environment that involves technology, subject-matter, and possibilities (see screenshot, Figure 6.1). The Module supports

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**Figure 6.1** Screenshot, overview page, online Teacher Scaffolding-Feedback module

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Teachers to think together about how to stretch student understanding of classroom technology tools, engaging teachers in a simulation of the scaffolding process. Teachers work first with a facilitator and five facets of the Module (reacting to, identifying and assessing content, and practice scaffolding, including suggestions). After this, they are then either assigned to students’ projects as mentors or they begin communicating with the students depending on the design and scheduling needs of the LTD course.

An open question for LTD has been what forms of feedback could be used to help student developers to use information about learning to inform design: How can students completing projects in LTD courses reach their highest potential? LTD courses often include projects requiring a combination of expertise in K–12 education, pedagogy, use of technology in the K–12 classroom, computer science, and the visual arts. In the Module, these questions are addressed through scaffolding and focus attention on the sequence of exchanges/activities that could develop and deepen student understanding of how people work, play, and learn. In fact, use of the Module has been found to stimulate rich conversations about learning by a range of participants many of whom have not previously demonstrated this capacity (see contributions by Jason and Rebecca in Appendix A and Appendix B).

In addition to providing an authentic task, having K–12 classroom teachers scaffold LTD students’ work with design projects serves as a pedagogical model for LTD instructors. This type of virtual fieldwork offers the opportunities of integrating and balancing the development of technological knowledge, pedagogical knowledge, and subject matter content (see related discussion in Levine, 2006). The teacher as model and source of scaffolding broadens the expertise of the instructor and anchors project design in its usability.

In order to leverage the potential of this kind of virtual fieldwork, we first experimented in one LTD class with teachers from the Math Forum community. Findings from this effort indicated that the instructor was enthusiastic about the teachers’ participation and the students did benefit from the feedback/scaffolding of the teachers. The interviews at the completion of the project, however, revealed that the teachers needed more specific information about how to provide scaffolding to this student population.

It sounds simple. The university instructor finds a group of classroom teachers who view LTD projects and provide scaffolding; the students revise their projects, and the products improve by becoming more relevant to the needs of a K–12 classroom. Putting this into place, however, can be complicated. How will the teachers have access to view the projects? What software and hardware do they need in order to do this? What kind of
scaffolding are they in a position to do? How will the LTD students work with this scaffolding? What role does the instructor have in this process? Is he or she facilitating the work of the teachers with the students over four or five iterations of a student’s assigned LTD project, or is there a teacher’s aide (TA) or other outside person who is a facilitator? What does the instructor, TA, or other person know about technology, pedagogy, the content of the project or scaffolding? How does communication among the teacher participants, student participants, and instructor/facilitator occur?

Module: Facet Content and Use

Teachers do not all come to working with LTD students with the same experience or skill set, and not all LTD courses are designed in the same way. For this reason, the Module was developed to include five facets of scaffolding, each of which has an introduction, an activity or task, and a discussion (see Appendix C). The first three facets orient the teachers to a learning environment in which they will be working with LTD students. The fourth facet introduces the critical difference between simply providing feedback to students that could cause them to become defensive and resistant and content-informed scaffolding that enables the students to explore ideas with the teachers and stretches their understanding of what their game could include to make it educational. The fifth facet functions in one of two ways depending on the scheduling and instructional needs. Done in the context of providing scaffolding to LTD students, the fifth facet would naturally initiate discussion between teachers and students; undertaken prior to beginning work with students, the fifth facet prompts the teachers to generate a list of authentic topics for LTD projects that could be used with classroom students.

More specifically, the first three facets address reacting to product content, identifying specific subject matter content (e.g., ratio and proportion), and assessing goals for learning and are entitled First Impressions?, Where’s the Math?, What Did They Learn? respectively. Whether revisiting the concept of scaffolding or coming to it for the first time, the first three facets anchor teacher understanding of the learning environment. These three facets are appropriate for teachers who will be working with LTD students in courses that range from computer science gaming to educational technology. They provide an essential basis on which the scaffolding practice of the fourth facet builds.

In the fourth facet, the teacher is provided with a vocabulary necessary for making a distinction between giving feedback and scaffolding. The teacher then applies the actions described by the vocabulary to LTD student work. Finally, the teacher engages in discussion with others to
identify what would be the best method of scaffolding for this LTD project they are using as practice. What can they find to praise in the LTD student’s project? How can they best phrase a question to address an area of the project that needs improvement or more consideration? The fourth facet provides teachers with an opportunity to practice implementing their insights from working with the first three “orienting” facets.

In order to support the teachers to reflect on, ask questions about, and consider different approaches for working with LTD students, the Module models practices that support the stretching of thinking: targeted questioning and the explicit directive that responses should be no longer than the student’s comment.6

The fifth facet, labeled “Suggestions,” provides an opportunity for teachers to give project topic suggestions to LTD instructors and/or begin communicating with students depending on the instructional timeline.

**Scaffolding in the Context of Learning Design**

*Scaffolding* refers to an ongoing process of the teacher adjusting feedback in relation to what the student does and what the student still needs to be able to do. The process includes fading, lessening support in relation to the learners’ developing understanding over time. It involves supporting the LTD students to engage content that they may not be quite ready to embrace independently. It can be a rich experience for both the student and the mentor providing the feedback; it is also a complicated process.

Appendices A and B provide examples of teachers reflecting on scaffolding possibilities during work with the Module. In Appendix A, the teachers are thinking with one another about how they might focus LTD students on content. They decide to ask the students how they will assess the student learning with the intention that this question will lead the students to figure out whether they included good math content in their game. In this instance, the scaffolding required is not novel—certainly, backward-design is an excellent and, by now, well-respected solution (Wiggins & McTigue, 1996). But, deciding to use a strategy to support the students to think was a novel and important step for these teachers as they worked to develop their skills with scaffolding.

By design, the Module surfaces the content of student work for teacher discussion and supports the teachers, in turn, to engage in content-informed scaffolding (Renninger et al., 2005). The goal for the teachers is that they respond in a way that acknowledges what the students are presently able to do, engages them, and also allows them to assume responsibility for helping to think about revisions to their project work. Questions are suggested as tools for encouraging students to rethink prior work and
revise it. Importantly, the kinds of questions that a teacher might pose can be adjusted so that across an exchange the teacher can fade how explicit his or her suggestions (through questioning) are in relation to the students’ demonstrated understanding (reflected in their project designs).

Another aspect of the design is that the teachers rehearse their answers to the students and engage in conversation about their questioning techniques. In Appendix B, for example, the teachers together recognize the power of questioning as a form of feedback that enhances student thinking and map a plan for their responses.

As described, the Module provides scaffolding for the teachers, which is similar to the scaffolding the teachers are encouraged to provide to the LTD students. Optimal use of the Module includes online asynchronous facilitation of its use by a live facilitator. The facilitator models scaffolding and also provides teachers with back-up support to work with students. The facilitator also coordinates recruitment and assignment of teachers to student groups and synchronizes the scaffolding-feedback activities with the course timeline.

**Case Example: Teacher(s) Scaffolding Students**

There are three issues central to the usability of designing educational products about which LTD students, as well as their instructors and the teachers who provide the scaffolding, need to be aware: the conceptual content of the design, realistic technical requirements, and project scope. Addressing these three issues is essential for the design of effective educational technology products. They are explained in the sections that follow.

**Conceptual Content of the Design**

Whereas feedback might only signal that content needs to be a concern in the design process and this may or may not be used, scaffolding allows the teacher to refocus LTD student attention through questioning, examples, and so forth. Over time, through interactions with the LTD student, teachers can support students to rethink their own understanding of content and what conceptually a pupil needs in order to be able to learn. In the case that follows, for example, there was a difference of opinion about whether a worksheet would advance conceptual understanding. Important in this exchange is the coordinated reflection that supported decision making.

In the case that follows, Sonia is an outside facilitator familiar with an LTD course. Connie is a teacher with recent middle-school classroom
experience who had completed the Module and was assigned to provide scaffolding to a group of three students about their prototype; other teachers had been assigned to other groups for that class. Dennis was one of the three LTD students for whom Connie was responsible. Dennis had self-selected to become the spokesperson for the group.

The exchange between Dennis and Connie starts with polite “getting to know you” posts. Behind the scene, Sonia was providing Connie with support to use the required technology. When Dennis asks Connie to take a look at the group’s prototype, she answers him by praising something that she likes in the group’s project and asking questions about things that she is either not sure about or possibly does not like. By asking questions (behavior she was prompted in the Module to use), she focuses the student’s attention to thinking about the prototype. What you do not hear from Connie is direct criticism. Instead, work with the Module led Connie to consider the nature of the scaffolding she could provide. Working through the Module, she was required to reflect on what providing useful feedback might mean and she was given examples of questioning techniques she could use.

Message 1:
Thank you so much Sonia for your help. This is great, for us to have a discussion forum for discussions about the project.

Also, I am not sure if Connie, the teacher that gave us feedback, is monitoring this discussion board. I want to thank her on behalf of the group, for all her excellent feedback. We will definitely take the issues raised as we design our hi-fi prototype.

Thank you both once again,
Dennis.

Message 2:
Dennis,
I just wanted you to know that I am here and will be monitoring this discussion group. If there is anything about my comments you would like to discuss further I would be very happy to do it.
Connie.

Message 3:
Hi Connie,
Thanks again for giving us comments. We are near completion of a hi-fi prototype. The only piece missing is a tutorial prior to the visualization segment (i.e., the show me visually segment). Anyway, do you mind taking a look? I hope that this prototype will be easy to understand w/o instructions.
The prototype can be found at: (temporary URL provided)
Thanks,
Dennis

Message 4:
Dennis,
Thanks for responding. I am happy to give you my comments.
First, I really like the graphics. They’re great! There’s a lot of potential here.
But I am wondering who is the intended audience? The tone in the beginning, especially with asking for names, seems to me for a young child, maybe 5 or 6. And then later on, you want to do something with quadratic equations. That subject usually isn’t covered until age 14 or so. You might want to pick a target age range and keep that in mind as you design.
I’m wondering if the math you are referring to is the Area = length * width? That is the way I would handle the problem and not with a quadratic equation.
I have a number of other specific comments I could make about the individual screens, but I would like to hear your response first to my first comments.
I’ll keep monitoring this discussion board to hear from you.
Connie.

Note that Connie keeps her comments relatively short. She does not explain to Dennis everything that she is thinking. She praises, states a limited number of things she is wondering about, and she alludes to more that could be discussed later. This leaves Dennis in control of his project. When he responds, he can give Connie more information rather than being on the defensive. She has left the conversation so that it keeps him involved and, before ending her post, she invites him to return.

Message 5:
Hi Connie,
Thank you for your comments. The audience is indeed Algebra I students (freshmen in high school). Some of the feedback that we got said that the story is cute, which is both good and bad—i.e., the high school students might not buy it. As for the math, it is Area, although the length and the width are equations (i.e., 7 – 2x and 5 – 2x), which when multiplied, translates into quadratic equations.
Sincerely,
Dennis.
Message 6:
Dennis,
Here are my comments:
1). I really like the graphics. They’re colorful, intriguing, and mostly fill the screen well.
2). I think the beginning part is too young for an Algebra I audience. I think the idea is good—the problem itself, but I’m not sure about having the 14 year olds “name” the avatar.
3). I get confused when you go from the beginning set up to the problem itself. Some of the English language could be clearer. For example “So the outer dimensions of the picture frames should be the same as the other ones.” Could you think of a simpler, clearer way to state this?
4). Try to make all your text simple, clear, and unambiguous. I found myself wondering what you were asking several times.
5). There is a “bubble” that holds text in some of the screens. Could that bubble be moveable? I felt it was in the way and I just wanted to move it.
6). I want to emphasize that I love the graphics!
7). I couldn’t figure out how to use the tool that helps solve the problem.
8). There are actually several ways to solve this problem. You don’t have to use the quadratic formula. I’m wondering if there could be a way for students to use whatever method they came up with to solve this problem????
9). I take it the “teacher help” portion isn’t finished? I couldn’t get it to work!
I look forward to seeing your revision!
Connie.

Now that Connie has more information from Dennis, she praises and praises again, and asks a variety of questions. She is careful to make them clear by numbering them. She keeps her comments positive but, at the same time, there are a variety of things for Dennis to think about and explain to her.

Message 7:
Hi Connie,
Yes, fellow classmates also mentioned that the beginning might be too young. But, the conclusion from our discussion is that it is so young that high school students might find it funny. In fact, in our user testing, some students were laughing out loud. So I guess it is okay.
As for the wording—we tried to reword some of the text. We also developed a worksheet for the students to follow, specific instructions on how to use the visualization tool. Do you mind taking a look at the applet again (the worksheet is attached), with the worksheet in mind? At first we did not think of a worksheet because we thought the students can freely explore and come up with solutions on their own. But as others have suggested, perhaps it is asking too much of the students. So, we came up with a worksheet, per suggestion of classmates. Through user testing, we found that the worksheet might be too hard for students too. Anyway, do you mind taking a look and letting us know what you think?

Thanks for your help,
Dennis.

Message 8:
Dennis,
I will try and give some comments.

I like the worksheet. Now I see that you are expressly trying to teach about quadratic formulas—I thought you were just trying to solve the problem. It might be helpful to state that is your goal—at least it would have helped me.

I still really like the graphics. I like where you summarize and show the frame, picture and matte. It makes it easier to visualize and know what is going on.

I had some trouble doing what I was asked to do. I couldn’t find a “code” to enter into the screens—therefore I was stuck and couldn’t move forward. I couldn’t really move all the way through the project because of this. (e.g., on p 15 I couldn’t move forward). So there was probably more that I just couldn’t see.

I’ll take another look at it and see if I can move forward. In the meantime, let me know if I am missing something with the “code.”

Good work!
Connie.

Dennis responds in a way that shows he is taking Connie’s comments seriously and remains in control of the situation. He is not just agreeing with her but shows that he is thoughtful, used other input, and responds using all of the feedback. He asks her to look at a worksheet that is a new development based on feedback.

Message 9:
Hi Connie,
I am really sorry for the late response, as I have been ill for the last week. And I do apologize for the “code”, which resides on the
worksheet. The first code is “1234” and the second code is “4321”, in case that you still want to take a look. We have conducted our class-room implementation. It seems like the students are not used to thinking of math this way. They said that it was too hard. But, we think it is good that way, because the students really thought about and struggled with the logic more. And when the teacher went over the solution, a lot of students said “A-hah”... I don’t think those “A-hah” would be there if the teacher would just go through a standard lecture.

Dennis.

Message 10:
Dennis,
Thanks for your response. I looked on the worksheet for the code (I’m looking now) and still don’t see it.

Do you want any more comments? Or are you through with this project?
Connie.

Message 11:
Hi Connie,
I am sorry for all the problems. Anyway, we are doing our presentations today and so we won’t need any more feedbacks.

But, we really do thank you for all your feedback and participation. Your comments were great, and we tried to iterate our prototype based on your comments. So, once again, a big thank you.

Sincerely,
Dennis

The exchange is aborted owing to technical difficulties and the course time line; however, it clearly provided constructive information to Dennis and his group and supported them to reflect on and revise their prototype to make it more educationally sound. Connie later reports that she was able to provide support to the group because of her training in the Module.

Important is that once Sonia had assigned Connie to Dennis’ group and had helped Connie to work with the technology, Connie was positioned to scaffold Dennis and his group. This exchange clearly benefited Dennis, his group, and Connie and would not have been as likely to occur without a facilitator. As participating teachers reported on the post-project survey, they learned, and they thought that the students learned from the process of scaffolding:
Scaffolding forces me to think more deeply .... It also allows the other party to view their work through a “different lens”. It may be that a different view ... ignite[s] an “aha” moment that would improve the presentation of the product. Scaffolding would also help me to keep in mind an improved way of replicating the product, if the occasion arose in the future.

Keeping the content in mind—having one eye on what the possibilities for the content are and one eye on what the person is actually doing. Asking questions/scaffolding in a way that promotes reflection, so maybe next time the student doesn’t need the same input because they’re looking at their project in a new way.

A benefit to the teachers is the “permission” to take time to think about their students’ strengths and needs and the process of learning. For the teachers, the process of providing scaffolding to LTD students can be a valued opportunity, especially when there is extended interaction that results in new insights. As one of the teachers noted, however, the students who are being scaffolded “...have to want to participate in a scaffolding exchange.”

**Realistic Technical Requirements**

In addition to supporting teachers to help LTD students to understand the conceptual needs of learners using their products, a Module such as this also needs to have realistic technical requirements. If the LTD students’ product is created as an exe. file (a file that has to be decompressed), it is likely to be unrealistic for classroom use. Such files require installation time, access to the system, and opportunities to test whether the software is properly installed and functioning. If the teacher is technically capable and has system access, which is typically not the case, mismatched technical requirements can absorb valuable preparation time and be enough to prevent use.

In terms of providing scaffolding to LTD students, it is a complication that the LTD student enjoys sorting through technical difficulties, and these difficulties are not typically enjoyable for classroom teachers. The kind of technical problems that Connie ran into, for example, presents a difficulty that those with more technological expertise do not always appreciate. She has many skills, but tinkering with technology is not one of them. For her, the amount of time and effort it would take to tinker in order to figure out her technical problems is likely to feel untenable.

A related issue is that LTD students will often use the most recent versions of applications precisely because they are recent and up to date, when these are the very features that either render their product unusable
altogether or require updates of system features that demand a lot of time. The mismatch in understanding the users’ access to technology heightens the need for scaffolding as opposed to feedback in LTD classes. LTD students need to be engaged in interactions with classroom teachers to understand the technical options for educationally relevant design. Such discussion takes time and requires understanding that each is working with a different set of premises of what counts as technical requirements.

**Project Scope**

Understanding the relation between the scope and sequencing of lessons is essential to effective instructional practice. In addition to the tension surrounding technical requirements, teachers providing scaffolding for LTD students often find proposed designs unusable. Typically, the scope of a proposed student design does not map onto classroom practice, is unfocused, and is not discrete enough to be useable. Classroom practice involves having an instructional plan. Sometimes this is mandated, and sometimes teachers have more flexibility.

Students need to realize that an assigned seven-week lesson plan is and exercise, and its implementation, in its entirety, is unlikely. Short supplementary material that targets particular skill sets or concepts, conversely, are often welcome because teachers have a clear idea of students’ difficulties with certain concepts and targeted work on these is helpful. Teachers sign on to provide scaffolding for LTD classes with the expectation that they can inform project design. These are teachers who are excited about technology and its possibilities and recognize its potential utility for classroom learning. They describe their role in scaffolding as “…using questions to stimulate students to think about how they can adapt their product or technique in the future.” They recognize that scaffolding “…works better than giving students a list of things to change or that they should have done better.”

The context of the LTD class can introduce a disconnect between the expectations for use of student design projects and student understanding of what they stand to learn through interactions with teachers about their projects. Scaffolding becomes a tool for promoting LTD students’ understanding of classroom needs and practices.

**Next Steps**

In the LTD context, interactions between K–12 teachers and students/student groups have the potential to dramatically influence the course and direction of student projects as well as the teachers’ and the students’ own learning. Research evidence corroborates the importance of scaffolding as
a support for learning and as distinct from simple feedback (Puntambekar & Kolodner, 1998; Renninger et al., 2005; Rogoff, 1990; West & Staub, 2003; Wood et al., 1976). In developing the Module, we made an explicit distinction between scaffolding and simple feedback because this benefited the LTD students and the teachers with whom we worked. This distinction emphasizes the critical importance of teacher mentors thinking with LTD students in the design process.

Scaffolding facilitates reflection and revision. Extended interactions between teachers and LTD students can substantially impact the content and usability of educational technology products. Though the online Module supports teachers to engage with LTD students in these types of online interactions, the facet content could also be disseminated through face-to-face workshops. The facets of the Modules and not the functionality of the Module, per se.

What may be most important about the Module in its present iteration, however, is that it opens the possibility of LTD students’ working directly with classroom teachers. Interactions with classroom teachers are LTD students’ key to having their educational products used.

Appendix A

Sample Teacher Posts, from Module, Facet 3 (assessing goals for learning):

What did they learn?

JASON: I like to ask questions about how they are assessing what the students are doing. My kids love to play 24 online because they move through levels and they know what their score is relative to the other students in the class. The game itself is kind of repetitive but it holds their attention because they have immediate goals that they are trying to accomplish. I think that the success of that game comes from its ability to give the students an accurate assessment of where they stand. It would probably be helpful to the college kids if we prioritized how they assessed the skills and communicated that to the kids. I would ask them questions about how they are letting the student know if they have succeeded or failed at the designated task.

LOUISE: One idea I’ve heard of is “backwards design,” where you figure out your educational goals and how you’ll assess them before you even start to plan the activity. I think focusing LTD students on assessment is a great way to get them to think about “Gee, am I using a lot of good math content in this game?”

REBECCA: I think they have to be reminded to keep the mathematical goals/objectives/standards (whatever they’re called this week) in mind at all times while designing their tools. Then when the program
is completed, have them work backwards and figure out if the end product produced what they were aiming for.

JASON: I agree with the “working backward from the goals and objectives” strategy and I think that the kids need to keep what they are trying to teach the kids in mind. The problems that I had with the games were not in the math skills being addressed (since most of the skills were very basic) but that the kids did not present what the students had accomplished to the students in a clear way. For example, the game that I thought was the most effective, Flash Math, succeeded at what it was meant to accomplish but the creators of the game did not come up with a good way to explain to the kids what they had learned. The kids were never asked that final question or asked to do that final task that shows whether or not they have really grasped the central skill being taught.

Appendix B

Sample Teacher Posts, from Module, Facet 4 (practicing scaffolding):

What’s the feedback?

JASON: I think that questions are the best way to give feedback because it gives the person the opportunity to respond rather than just comply with what you tell them to do. In this situation most of these kids who are creating the games know more than I do about what they are doing so I don’t have much room to tell them what to do. I guess that the fear is that they won’t do what we want them to do if we don’t tell them exactly what we think is wrong and what we want changed. It has generally been my experience that if someone just tells me what to do I will listen to them less. Maybe this means that using questions to give feedback is a means of keeping them in the discussion.

LOUISE: One of my favorite things about when people give me feedback as questions is that I can usually apply those questions on my own later if they’re good questions. Like if someone says: “I think you should have used the chalkboard more efficiently during that lesson” I just apply it to the past, but if someone puts in a question, like: “What are some important things to consider when you organize material on the board,” then I’ve come up with some key ideas to think about in the future, and the advice is more likely to stick with me.

REBECCA: I think the best guiding questions are those that are open ended enough to leave room for exploration of a topic, not just finding answers. I feel these students can also learn how to use good questioning skills themselves, if we present our questions to them in the best way. (No yes or no answers will be accepted!)
Appendix C

The First Three Facets of Scaffolding, Content of the Module.

Facet 1: First Impressions?

Three LTD projects cataloged in the Math Forum’s Math Tools digital library are used throughout the module as the examples of student projects. They are:

Mars Exploration http://mathforum.org/mathtools/tool/11931/
Space Math http://mathforum.org/mathtools/tool/19142/
Flash Math http://mathforum.org/mathtools/tool/19141/

The projects range in their effectiveness (none are perfect). Teachers are asked to give their gut reaction to each of the three “tools.”

The Module is designed so that the other teachers are not able to view each other’s work. Only the facilitator can see it. In each section, however, there is a link to a discussion so that the teachers can have a discussion.

Facet 2: Where’s the Math?

Teachers are asked to consider the three tools, list their favorite grade level of the students who would use that tool, and list and/or explain what math a student could learn by using it. After identifying the grade level and learning addressed by the tool, they are asked to assume they are communicating with the LTD students who have created the tool. They are asked if the LTD students have missed any opportunities to teach math. Their task then is to write three questions to ask them about the mathematics addressed in their tool. A link to a discussion for section 2 is provided.

Facet 3: What Did They Learn?

The teachers are asked to select one of the three tools and list and/or explain how they would assess the learning of the content that was identified in the “Where’s the Math?” section of this module. Next they are to assume they are communicating with the LTD students who have created the tool. Have the students included any assessment opportunities in the tool? The teachers are asked to write a question to ask the LTD students about how they will know if learning is taking
place as a user interacts with their tool. A link to a discussion for section 3 is provided.

**Facet 4: What’s the Feedback?**

It is explained that people do best if feedback is short and to the point; a good rule of thumb is for the feedback offered to be no longer than the original response.

Providing feedback means prioritizing what you say first. If you’ve asked a question that engages the person, they’ll come back and you’ll be in a position to give them further feedback.

The teachers are given two examples and asked to use the style illustrated above, what questions could be asked of the LTD students about their tool? These phrases are offered as examples:

- I wonder if ....
- Have you considered ....
- How could you follow up on the idea ....
- Is there a way ....

A link to a discussion for section 4 is provided.

**Facet 5: Suggestions?**

Teachers are asked to use a link that will take them to a discussion area to “meet” the students in the LTD class. In some cases the teachers suggest some topics/concepts for which they would like to have games developed thus seeding the project direction of the LTD projects. In other cases the students have started the design of their project and have been given the assignment to post an introductory note that initiates their interaction with the teacher. There are a variety of ways to begin the interaction depending on the LTD course outline and the instructor.

**Notes**

1 The version of the online Teacher Scaffolding-Feedback Module referred to in this chapter was developed by the authors as part of a research and development grant funded by the National Science Foundation (Grant No. 0205625). The current version can be found on the Web at the Math Forum, Drexel University at [http://mathforum.org/tsm/](http://mathforum.org/tsm/).

The content of the Module can be adjusted to enable use in other subject areas. It has been used now with preservice teachers, in-service teachers taking a graduate level course, and members of an online mathematics learning community, The Math Forum @ Drexel. For the purposes of the present discussion examples and data draw specifically on student learning in LTD courses.
Scaffolding-feedback is used to refer to the process of scaffolding in this chapter and in the online Teacher Scaffolding-Feedback Module. Hyphenating “feedback” is intended to provide readers unfamiliar with the term “scaffolding” an anchor for its process.

Parallel examples can be constructed for design content in every discipline. In writing, for example, where the algorithm often is including a topic sentence and three key points, the goal for writers includes both communication of and the opportunity to think through ideas (Hayes & Flower, 1987).

Depending on the university course structure, the projects and the mentors’ interaction with the students varied.

Names mentioned throughout the text are all anonymized.

When people do not have regular contact with students, it is sometimes hard to remember how short and to the point the information they are giving needs to be.

The facilitator could be an instructor, a TA, or an outside facilitator who is familiar with the technology and subject-matter topics that are the basis of the project.

Math Tools, an area of the Math Forum @ Drexel’s Web site, is a community library of technology tools, lessons, activities, and support materials for teaching and learning mathematics. <http://mathforum.org/mathtools/>

Bibliography


