Scaffolding Teacher Adaptation by Making Design Intent Explicit

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Abstract: Fostering adaptations that are congruent with designers’ original intentions is a constant challenge. In this paper, we explore a technology-facilitated means of scaffolding teacher adaptation of curriculum materials design. We found that teachers are able to inspect multiple aspects of connections within and between lessons and the consequences of their modifications. This study informs the design of environments that aim to support mutual understanding between teachers and curriculum designers with respect to curriculum coherence.

Introduction
As curriculum researchers and designers aim to create rich learning environments for students, curriculum units have become more complex. Recent standards-based reform movements have encouraged curriculum researchers and developers to address content standards and benchmarks using designs that link scientific ideas together across multiple lessons and activities (Kali, Linn, & Roseman, 2008). Teachers face many challenges in interpreting and enacting these complex materials, and often must make modifications to fit local contexts and constraints. To avoid making adaptations that inadvertently alter the core ideas of these curricula, teachers and curriculum designers must collaborate to construct a common understanding of the innovative ideas behind the units (Stahl, Koschmann, & Suthers, 2006).

To help teachers make sense of innovative curriculum materials, prior studies have employed strategies that demonstrate the relationships between lessons and overall learning goals (Davis & Varma, 2008). However, these efforts focus more on helping teachers improve their understanding of coherence related to a specific lesson and less on becoming aware of deeper curriculum design intent, such as how lessons work together to address learning goals across an entire unit. In this study, we explored how technology-based scaffolds may help teachers consider how their modifications to curriculum materials affects the relationships between individual lessons and broader learning goals as well as connections between and across lessons that are intended to create effective learning experiences.

An idealized modification practice might include the following elements: (1) Compare lessons; (2) Examine the coverage rates of standards and connections in a unit; (3) Examine change in the coverage rates of standards and connections as a result of modifications; and (4) Reflect on understanding and modification strategies (Clark & Yinger, 1987). When making curriculum changes, experienced teachers’ plans are explicit and rich in interconnections, because they can better predict what will happen as a result of a particular lesson. In contrast, the planning of novice teachers may consist primarily of daily lesson planning, and tend to provide simple descriptions of isolated events, instead of making inferences about the underlying structure of the teaching and student learning (Borko & Putnam, 1996). In prior design research, we found that science teachers have a reasonable understanding of the relationships between individual lessons and learning goals, but have difficulties identifying connections among lessons, or the deeper structure of the curriculum (Lin & Fishman, 2004, 2006).

We explore some of the elements that constitute curriculum coherence and we call these elements “unit structures.” Unit structures refer to four elements: (1) the relationships between individual lessons and learning goals addressed in a unit; (2) the connections that exist between lessons; (3) the number of covered relationships and connections across lessons; and (4) the rate of coverage of these relationships and connections in a modified unit. The first and second elements of unit structures are the focus of previous studies on curriculum coherence. In contrast, the third and fourth elements have not received as much attention and may be useful to teachers when they make decisions about whether to keep or remove parts of a curriculum unit.

Based on socioconstructivist theory (Brown, Collins, & Duguid, 1989) and scaffolding design principles (Quintana et al., 2004), we examined how the following three scaffolding strategies help teachers understand curricular coherence: (1) Providing visualizations to help teachers inspect multiple aspects of curricular coherence; (2) Demonstrating changes in the coverage rates of learning goals as a consequence of modification; and (3) Encouraging reflection about the modifications and their impact on coherence. The research questions addressed in this study are: 1) Does teaching experience relate to teachers’ understanding of curricular coherence? 2) What are the roles of software scaffolds in helping teachers consider more complex elements of curricular coherence when they modify curriculum units? and (3) When teachers make changes in curriculum units with the assistance of the software scaffolds, how do they reflect on their understanding of curricular coherence and their curriculum modification strategies?
The Planning, Enactment, and Reflection Tool (PERT)
We developed PERT, a software tool designed to help teachers consider higher levels of unit structures by addressing the scaffolding strategies described above. PERT includes three modules. In the Select Lesson module, PERT demonstrates the structure of lessons in a unit, the learning goals related to a lesson, and the target and current class periods selected for inclusion in the unit. The See Coverage of Standards module demonstrates the relative coverage rates of content and inquiry standards and the details of the coverage in the unit. The See Coverage of Connections module demonstrates the relative coverage rates of content and inquiry connections and the details of the connections in the unit.

Methods
We recruited twenty middle school science teachers to participate in this study. Each teacher was teaching project-based science units and had varying levels of experience teaching project-based science units. Teachers were told that they needed to shorten a unit because they had less time to teach the unit than was specified by the curriculum’s designers. We observed their decisions about how to shorten the unit without the support of scaffolds beyond what is already available in the curriculum materials. At the end of their modification, they were asked to estimate the coverage rates of standards and connections addressed in the modified unit in comparison to the original unit. Next, teachers learned how to use PERT by following step-by-step instructions and conducting a few short practice activities. Then they were asked to modify the curriculum unit again with PERT. Teachers had opportunities to examine the difference between their estimated coverage rates and the actual coverage rates of standards and connections, explore the details of unit structures, and make changes to their lesson selections to better meet their goals for teaching the unit. Finally, we debriefed teachers with questions about their experience in the curriculum modification activities. We conducted a qualitative verbal analysis to transform qualitative data into numerical values, and used t-tests to examine the impact of the software scaffolds in helping teachers consider higher levels of unit structures in their modification practice.

Findings
Teachers’ amount of experience is not related to their level of understanding of higher levels of curriculum coherence. First, experienced and novice teachers have better understanding of and focused more on lower levels of unit structures in the lesson selection activities in the without-scaffolds situation. For example, they showed better understanding of the coverage rates for standards (intermediate level) than of the coverage rates for connections (advanced level). Second, teachers were able to use more precise methods for coverage of standards (lower level) than for coverage of connections (higher level). In addition, their estimation methods for coverage of connections varied more than those for coverage of standards. Although teachers with more experience and understanding were able to use more precise methods for estimation, the relationship mainly exists for simpler elements of unit structures, such as content and inquiry standards addressed in individual lessons.

The three scaffolding strategies helped teachers consider more types of unit structures, consider unit structures more frequently, and consider higher levels of unit structures when they modify a curriculum unit and when they examine their understanding of unit structures and strategies for modifying curricula. For example, scaffolds for identifying strong and weak coverage rates helped teachers compare relative coverage by considering higher levels of unit structures. A t-test showed a statistically reliable difference between the mean number of level of unit structures in the without-scaffolds situation (M = 0.20, SD = 0.62) and the with-scaffolds situation (M = 2.30, SD = 0.24) when teachers identified weak coverage rate, t(19) = 3.009, p < .001.

Discussion and implications
The findings indicate that experience with project-based science units does not contribute to deeper understanding of curricular coherence on its own. One possible reason is that the complexity of curricular coherence is not easily grasped by merely teaching these units, even teaching them multiple times. In addition, the representations and learning support currently used in printed curriculum materials may not be sufficient to express deeper design intent such as the more complex elements of curricular coherence. This study demonstrates that, with appropriate support, both experienced and novice teachers are able to consider deeper design intent and use this information in making changes to the unit. In order to help teachers make changes that are congruent with designers’ intent and improve their understanding of curricular coherence, curriculum designers should consider providing support that not only shows the details of curricular coherence, but also information useful for making informed decisions.

The software scaffolds explored in this study can inform the design of future supportive systems that aim to help a larger group of teachers understand curricular coherence and make curriculum modifications congruent with the original design intent. The scaffolds examined in this study can provide teachers with more dynamic representations than existing paper-based educative curriculum materials. In comparison to information
provided through face-to-face workshops, the software scaffolds are more capable of providing proximal support to teachers that is situated in their daily practice (Putnam & Borko, 2000). For example, teachers can get access to these software tools in an online professional development system and share their ideas of lesson planning with other teachers. In addition, the supports examined in this study can also be used for demonstrating coherence across a series of interconnected units within and across grade levels (Krajcik, Slotta, McNeill, & Reiser, 2008). With these advantages, scaffolds such as those in PERT can serve a larger population of teachers and be a vehicle for supporting larger scale implementation of coherent curriculum materials (Fishman, Marx, Blumenfeld, Krajcik, & Soloway, 2004).

Finally, the software scaffolds can be used to build a platform in which curriculum designers may share their ideas. Novice curriculum designers can learn from experienced designers by examining cases of curriculum design and seeing how their changes or additions affect the overall goals for coherence as specified by expert curriculum developers. In addition, teachers and curriculum designers could negotiate their understanding of the coherence of curricula and encourage collaboration between them.

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References