A Summary of Research Exploring Hard and Soft Scaffolding for Teachers and Students Using a Multimedia Supported Learning Environment

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Abstract

*The purpose of this paper is to summarize and synthesize findings from a line of research investigating the potential of scaffolding for supporting student inquiry about ill-structured social problems. Specifically, we implemented a problem-based, student-centered instructional unit (*Decision Point!*) with 11th grade general history students in our partner teachers' classroom on three separate occasions. In this paper, we use data obtained from these implementations to address the following questions: Can we design scaffolds to assist students with engaging in ill-structured content more deeply so that they can perceive the complexity of ill-structured problems?; Can scaffolds assist students with considering alternative perspectives and arriving at problem solutions?; Can scaffolds assist students with handling the cognitive demands required of disciplined inquiry?; How can we support teachers in providing more effective soft scaffolding for students?*

Student-centered learning activities are designed to provide students with opportunities to take a more active role in their learning by shifting the responsibilities of organizing, analyzing, synthesizing, and evaluating content from the teacher to the student (Means, 1994). While there is growing evidence that student-centered learning activities promote the development of higher-order skills such as critical thinking and problem solving (Barab & Landa, 1997; Gallagher & Stepien, 1996; Savery & Duffy, 1995), there are difficulties associated with supporting student-centered learning. From the student's perspective, succeeding with student-centered activities require students to set meaningful goals for completing the activity, assume more responsibility for meeting those goals, and monitor their progress in order to determine if the strategies they are using to accomplish their goals are effective (Glasgow, 1997; Hannafin, Hill, & Land, 1997; Palincsar & Brown, 1984). From the teacher's perspective, the process of continually monitoring student progress during these activities and providing necessary guidance and support to students while they are struggling to complete more inquiry-oriented endeavors can be difficult, especially if the teacher has limited experience managing a student-centered classroom (Hannafin, Hall, Land, & Hill, 1994; Saye & Brush, in press).

These issues have led to the proposal that additional aids, or *scaffolds*, are needed to assist students and teachers engaged in this type of learning (Krajcik, Soloway, Blumenfeld, & Marx, 1998; Roehler & Cantlon, 1997). Scaffolds are tools, strategies, and guides which support students in attaining a higher level of understanding; one which would be impossible if students worked on their own (Hannafin, Land, & Oliver, 1999; Jackson, Stratford, Krajcik, & Soloway, 1995; Linn, 1995; Vygotsky, 1978).

The term "scaffolding" was initially introduced by Wood, Bruner, and Ross (1974) as tutoring or other assistance provided in a learning setting to assist students with attaining levels of understanding impossible for them to achieve without assistance. They viewed scaffolds as personal in nature; that is, aid provided by a teacher or peer to help with the learning process. More recently, the concept of scaffolding has been broadened to include a multitude of different tools and resources that can be used by students to assist them with instructional activities. These tools can be embedded within multimedia and hypermedia software to provide students with support while they are using the software (Kao, Lehman, & Cennamo, 1996).

In our curriculum development, we conceptualize two types of support: soft and hard scaffolds (Saye & Brush, in press). *Soft scaffolds* are dynamic, situation-specific aid provided by a teacher or peer to help with the learning process. Such scaffolding requires teachers to continuously diagnose the understandings of learners and provide timely support based on student responses. This type of assistance is generally provided "on-the-fly," where the teacher monitors the progress students are making while engaged in a learning activity and intervenes when support or guidance is needed. For example, if students fail to discern differences in the messages of two civil rights figures, a social studies teacher might help them think more deeply about the texts by asking questions such as: "What does John Lewis mean when he says ____? Why do you think he uses the word ____? Do you find similar words in Martin Luther King's speech? Do you notice any difference in his tone and King's (Saye & Brush, in press)?" Once students discover that differences exist, the teacher might refer them to other documents that could help them understand the origins of those differences.

In contrast, *hard scaffolds* are static supports that can be anticipated and planned in advance based upon typical student difficulties with a task. These support structures can be embedded within multimedia and hypermedia software to provide students with support while they are using the software (Kao, Lehman, & Cennamo, 1996; Krajcik et al., 1998). For example, Jacobson, Maouri, Mishra, and Kolar (1996) embedded hyperlinks within a database dealing with technology and the 20th century in order to provide students with conceptual links between information in the database. Results of their research demonstrated that students gained a deeper understanding of the instructional content when they were provided with these conceptual links as opposed to students who explored the database freely.

Purpose

This paper summarizes and synthesizes findings from a line of research investigating the potential of scaffolding for supporting student inquiry about ill-structured problems. Specifically, we will address the following questions:

1. Can we design scaffolds to assist deeper students' engagement with ill-structured content so that they can perceive the complexity of ill-structured problems?

2. Can scaffolds help students to consider alternative perspectives and formulate problem solutions?

3. Can scaffolds assist students with handling the cognitive demands required by disciplined inquiry?

4. How can we support teachers in providing more effective soft scaffolding for students?

Description of *Decision Point!*

To experiment with ideas about how soft and hard scaffolding may be used to support disciplined inquiry in social studies, we developed *Decision Point!* (DP), an integrated set of multimedia content resources and tools for exploring the African-American Civil Rights Movement of the 1950s and 60s (Brush & Saye, 2000; Saye & Brush, 1999). The DP environment provides multimedia civil rights content resources in an interactive hypermedia database and scaffolding tools for identifying, collecting, and analyzing historical information. The database features primary print documents, period news footage, interviews, and music. All data are organized into three strands representing primary change strategies: working within the legal system, nonviolent protest, and black power (see Figure 1).
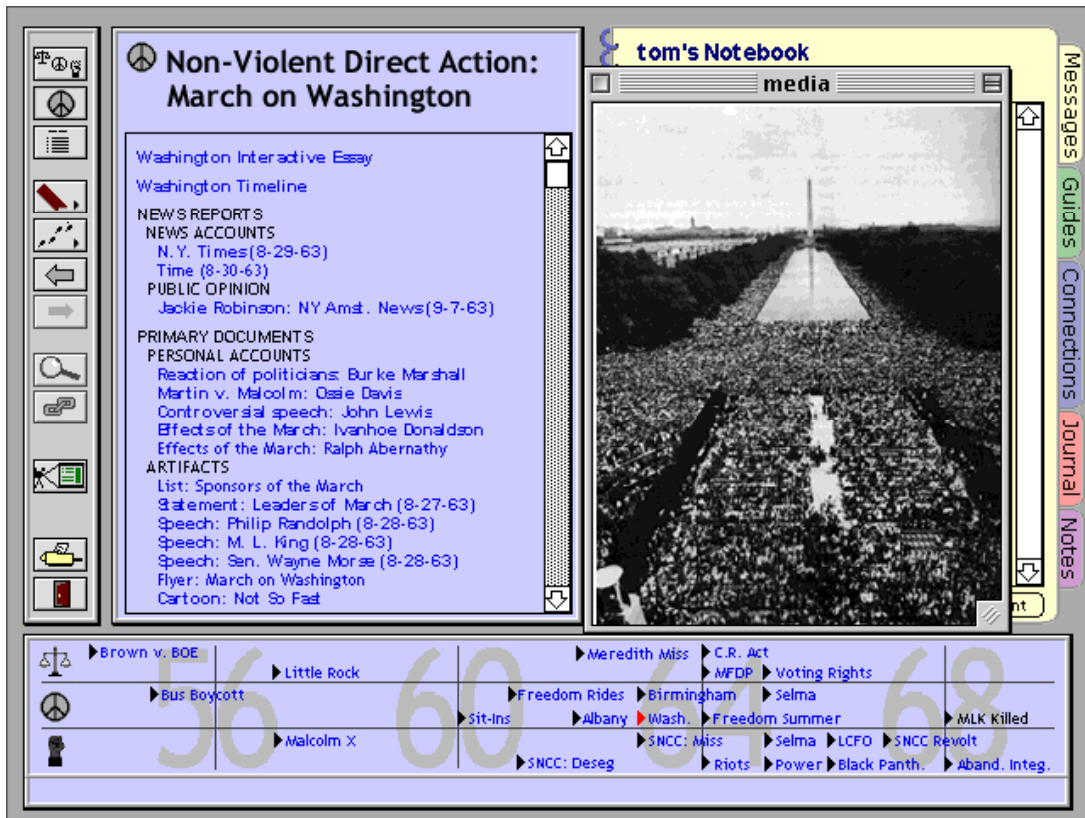

Figure 1. **The DP environment.**

The structure of the DP database provides conceptual scaffolds to help students organize and connect evidence within the broader dimensions of the problem landscape. Events are associated with particular change strategies and primary documents are associated with particular events. Within events, evidence is grouped by document type with the expectation that such categorization will help students consider the source of the evidence. Contextual data retrieval charts associated with each event provide more specific strategic scaffolds by helping students to ask more expert questions of historical evidence. A presentation construction tool provides procedural and strategic support to help students use evidence to author more reasoned problem narratives.

In order to provide a mechanism for using DP in a classroom setting, we collaborated with a high school social studies teacher to develop a two-week problem-based unit utilizing DP resources. In the unit scenario, students assume the roles of civil rights leaders in 1968, following the assassination of Martin Luther King, Jr. Students work collaboratively to develop a solution for the unit problem: What strategies should be pursued in 1968 to continue the struggle for a more just, equal society? Student groups are expected to use the DP tools to construct a persuasive multimedia presentation that explains possible actions, evaluates the likely consequences of each alternative, and defends their solution as the best course of action. Individuals then compose post-unit essays on a related problem.

Scaffolds in DP

Within the DP environment, we embedded a variety of hard scaffolds to assist students in determining what data to consider when solving a problem, monitoring and regulating their progress, and considering alternative solutions to the unit problem. (Refer to Brush & Saye, 2001, for a more elaborate description of hard scaffolds.) These scaffolds are described below.

Interactive essays. Each of the events within the DP database contains a hyperlinked "interactive" essay that provides students with a conceptual scaffold for that event (Hannafin et al., 1999). To extend the integration of the interactive essay with the other documents in the database, hyperlinks are embedded in the essay linking specific contextual areas of the essay with specific documents.

Recommended documents. Specific documents are highlighted in the menus of each DP event to provide guidance for researching each event.

Student guides. The "guides" section of the student notebook offers a conceptual scaffold by providing data analysis categories that an historian might use to organize and synthesize evidence about an event (see Figure 2).
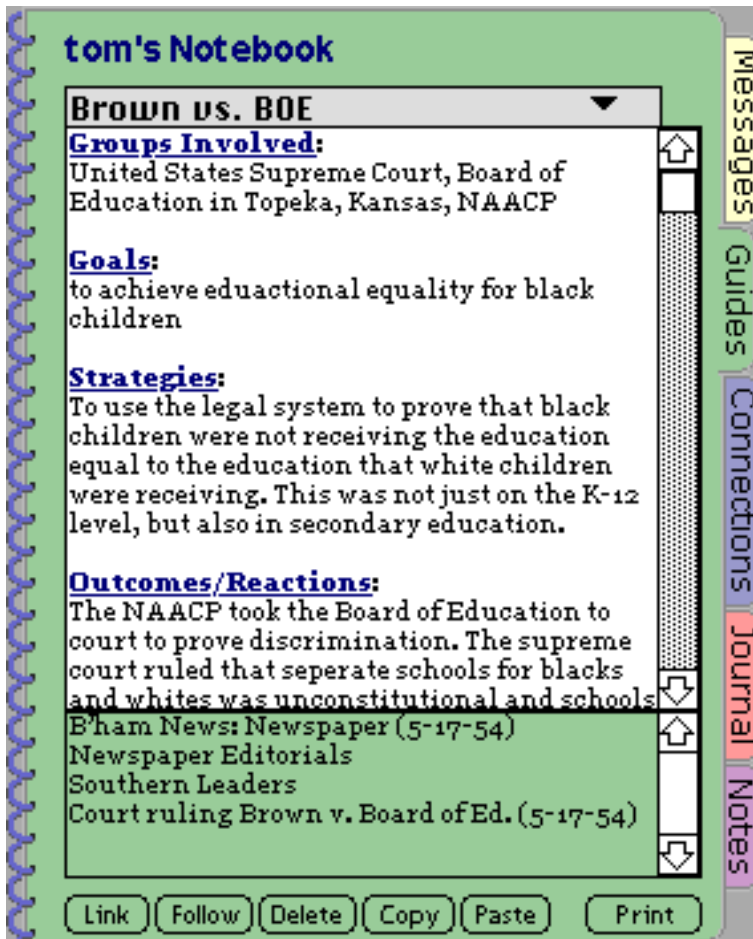
Figure 2. **Guides** **section of the student notebook.**

Student journal. This section of the notebook was designed as a metacognitive scaffold to assist students in determining the success or failure of the information-gathering strategies used each day. Student groups use the journal to record the progress they have made each day towards completing the task, problems they encounter, and questions or issues that require assistance from the teacher.

Storyboard templates. We developed a storyboarding process to assist students with planning the scope and sequence of their presentations. Groups use a five-page template that corresponds to the sequence they are expected to follow in their actual presentations.

Research Methodology

Participants and setting. For each iteration of the DP unit discussed in this paper, we worked with one teacher and the 11th grade students in her intact U.S. history classes. The class was part of the required program of study for all 11th grade students not enrolled in honors history. The teacher was an 18-year veteran with a MAT in history. Observations of her classroom over that time suggested that teacher-directed lecture,

recitation, and individual seatwork were her most commonly used instructional strategies. Before our work with DP, neither she nor her students had past experience with student-centered learning activities. She was skeptical about the effectiveness of student-centered learning and reported uncertainty about how to integrate technology into her teaching.

The unit was implemented on three separate occasions in the teacher's classroom. The setting for each of the implementations was a high school located in a small southeastern city. Approximately 1,160 students were enrolled at the school. Of these, 68% were white, 28% were black, and 4% were Asian. The median family income for the school district was $35,876. Each classroom in the school was equipped with five networked student computers and a teacher station connected to a video projection unit. However, according to teachers and students there were few classes in which students used the computers for instructional purposes.

Design and data sources. Our line of inquiry to this point has involved a series of generative case studies that inform curriculum development (Merriam, 1988). As Merriam (1988, p. 28) states, "Case study design involve[s] description, explanation, and judgment [of an intervention]…" In our work, we have found case study design to be particularly useful in that it provided us with the methodological structure to explore situations in which an intervention being evaluated may have a variety of different outcomes (Yin, 1984). Our analyses attempted to describe the context in which the DP unit was implemented, to explain the successes and problems that occurred during each implementation of the unit, and to explore possible changes or modifications which could improve the effectiveness of the unit (Guba & Lincoln, 1981; Yin, 1984).

A variety of data sources and analysis methods were used in order to determine the effectiveness of the unit. The use of multiple data sources, or triangulation (Mathison, 1988), helped to increase the reliability and validity of the interpretations. These data sources included:

Classroom observations. During each implementation of the DP unit, the classes were observed by one or two researchers. These researchers kept field notes of classroom observations and discussions, including their impressions of teacher interactions with students, student behaviors, and perceptions regarding the progress students were making in completing the unit.

Student interviews. After each DP unit implementation, a minimum of five participating students were selected for post-unit interviews. Student interviews explored respondents' perceptions of the technology-supported unit and its effects on their learning. The interviews were semi-structured and asked several common questions, including "What aspect of the unit did you like best/least?"; "Do you prefer to learn in a way that is more teacher-directed or student-centered?"; and "Was this unit different from other history units that you have experienced?"

Teacher debriefings and interviews. Throughout each DP unit implementation, one of the researchers met with the teacher after each class session and asked her to discuss her impressions of the class, including student issues or problems and an assessment of her management of the unit activities. The teacher also participated in post-unit semi-structured interviews at the end of each unit. The interview sought her perceptions about the strengths and weaknesses of the unit and any effects that the unit had on student learning and the classroom environment.

Analysis of student products. After the completion of each unit, the computer-based notebooks and presentations from each of the groups were collected for analysis. The notebooks included the information students entered into the scaffolding tools to assist them with solving the unit problem. The presentations were the culminating projects of the unit, and were used to evaluate the success of the student groups in determining a viable solution to the unit problem.

Post-unit essays. A key outcome measure for the students participating in each implementation of the DP unit was an essay test of higher order reasoning that required students to use unit knowledge to make a judgment about an issue related to the unit problem: Who had the greater justification for revolution, American colonists in the 1770s or African-Americans in the 1960s? A detailed set of criteria was established for each element of the essay in order to measure substantive factual knowledge and persuasive and dialectical reasoning (Newmann, 1990; Parker, Mueller, & Wendling, 1989). For more detailed information regarding the scoring criteria for the post-unit essay, please refer to Saye and Brush (1999).

Findings and Implications

As stated above, the purpose of this paper is to summarize and synthesize findings from a line of research investigating the potential of scaffolding for supporting student inquiry about ill-structured problems. Specifically, we implemented a problem-based, student-centered instructional unit (DP) with 11th grade general history students in our partner teachers' classroom on three separate occasions. Below is a summary of our findings organized by the research questions that drove our inquiry.

Can we design scaffolds to assist deeper student engagement with ill-structured content so that they can perceive the complexity of ill-structured problems? The hyperlinked interactive essays and recommended document scaffolds may have assisted students with focusing on critical information, thus assisting them with acquiring a deeper contextual framework to solve the unit problem. Encountering the documents within the framing context of the hyperlinked essays may have allowed students to see more relationships between documents and the surrounding flow of events (Brush & Saye, 2001; Saye & Brush, in press). As one student stated when asked whether he used the hyperlinks embedded in the DP database, "Yeah. Because if you didn't know about a certain thing very much then you could just click on it and like read about it really quick 'cause they were never really long or anything, they just basically told you what it was talking about." Another student responded, "Oh yeah! Any way you start…it's a lot of links and stuff I never knew about. It really is a good idea" (Brush & Saye, 2001, p. 359).

Comparisons of observation data of students using DP to students participating in a more traditional civil rights unit suggested that students participating in the DP unit were more engaged with the content than their non-DP peers. Interviews with DP students suggested that students enjoyed the unit and believed that their experiences provided a more authentic context for encountering historical content, provoked a more empathetic view of historical dilemmas, and encouraged meaningful encounters with historical issues that promoted retention (Saye & Brush, 1999; Brush & Saye, 2000). For example, in a post-unit interview one student stated that she would retain the information from the DP unit longer than other social studies topics:

…you can learn more maybe in an encyclopedia or in a book, but will you want to know more? I mean it's like…will you carry it on? Like next year will I remember what I read in this book? Probably not, but I will remember those pictures I saw because they'll stay in my mind. And it's more about what I carry with me later…I mean when you say "learning"…I can learn facts, but I won't learn, you know, the experiences…and I think that's what a lot of people remember and those experiences help them to learn like other things.…we're doing Vietnam right now and I'm just, like, I'm already tuned out…but I still remember lots about the civil rights stuff… (Brush & Saye, 2000, p. 92).

Can scaffolds help students to consider alternative perspectives and formulate problem solutions? Interview data suggested that DP students believed that their experiences in the multimedia environment provided a more authentic context for encountering historical information that promoted empathy, deeper engagement with historical issues, and greater retention. For example, one student thought that he may have learned more because "it was more realistic because you could actually see, like, the people talking about it…and see the newspaper reports where somebody actually wrote it down, rather than just have a textbook saying this happened and that happened." Most respondents also claimed that expanded student empowerment and collaborative learning in this unit helped them construct more complex knowledge while making learning more enjoyable. As one student stated, "I really learned more [than in a normal unit]; I got to see things I wanted to see—more than might be assigned" (Saye & Brush, 1999, p 494).

When comparing post-unit essays of students who completed the DP unit to those students who participated in a more traditional civil rights unit, the DP essays were significantly stronger in their examination of diverse perspectives and alternative views regarding the problem solution. For example, when examining the inclusion of a dialectical argument (i.e., the student acknowledges the existence of a counterargument to their stated position) in the post-unit essays, only 8% of students participating in the traditional civil rights unit made such an argument; 35% of the DP group demonstrated such reasoning (Saye & Brush, 1999, p. 492).

Can scaffolds assist students with handling the cognitive demands required by disciplined inquiry? In each of the three iterations of the DP unit, students often ignored the guiding structures built into the DP environment. After some prompting they used the categorizing questions in the Guides section, but unreflectively filling in the spaces became the task rather than using the Guides to help them find connections among events (Saye & Brush, 1999). In addition, none of the groups spent any significant amount of time completing the Journal activities. Although the teacher required students to complete their Guides and their Journals, she may not have adequately held students accountable for completing these tasks. As she stated in one of her post-unit interviews, "I am going to have to find ways to hold them more accountable. I'm not sure how much to let them guide themselves" (Brush & Saye, 2000, p. 92).

Many students stated that they felt overwhelmed by the amount of information they were asked to synthesize in the DP unit. Many students suggested having "roadmaps" for the database or providing them with more structure during the initial phase of the unit (Brush & Saye, 2000). During the initial implementation of the unit, one

student commented in his post-unit interview that "…the first day, we were confused. Because we didn't really know what to accomplish. I know our whole group was…confused on what we were supposed to really do." When asked what could be done to alleviate the problem, the student suggested:

> …if we had kind of like…a roadmap type thing, like, we needed to explore this so that we, you know, come to this conclusion and this is the problem we have to solve or something like that, and that way we have like a clear picture in our mind, like what needs to be done. (Brush & Saye, 2000, p. 91)

Observations and interviews suggested that both the storyboard scaffolding process and the hyperlinked contextual essays may have affected better presentation outcomes for DP groups. In student interviews, most respondents found that the storyboard scaffolding was helpful in conceptualizing presentations (Saye & Brush, in press). One student explained, "When you presented and [demonstrated] how to go through it, that helped a lot, 'cause that helped us see how to do it." A second student rated the presentation as her favorite aspect of the project: "That was the best presentation thing I have ever done…we had to write it down and actually show what we learned…it was an easier process [than previous presentations]…"

Analysis of data supports the hypothesis that scaffolded encounters with conflicting accounts encouraged students to reconceptualize the nature of historical narrative. During a post-unit interview after the third implementation of the unit, a student discussed how the diverse views available in the DP database enriched her understanding: "You saw what the press saw and what everyone else in the world saw about it at the time, you know, and see what you think about it. Even though you can't always, you know, tell if it's true…you just kind of got to see that story from all different sides…'cause usually we just go by the side that's in the book..… It's more interesting, and I think it's a little bit easier [to understand history], I guess, 'cause you can see it from all different sides…" (Saye & Brush, in press).

When post-unit essays of students who completed the DP unit are compared to those of students who participated in a more traditional civil rights unit, the DP essays were significantly stronger in (a) stating factual unit knowledge relevant to the posed social issue, (b) making persuasive arguments using unit content knowledge as evidence, and (c) making dialectical arguments that addressed at least one line of support for a counterargument in defending their position about the social issue (Saye & Brush, 1999).

How can we support teachers in providing more effective soft scaffolding for students? Throughout the three implementations of the DP unit, the teacher continued to struggle with soft scaffolding support. She reviewed storyboards and provided brief feedback to groups. During the unit she held brief small group meetings to clarify students' procedural understanding of unit tasks. However, she did not use the meetings to monitor and probe thinking as students attempted to synthesize data (Brush & Saye, 2000). As she stated in one of her post-unit interviews, "I think they needed more direction from my part, especially from the beginning.… So I really think the biggest change [I would make] would be the guidelines that I would give them without doing it for them, without saying…step by step this is what you do" (Brush & Saye, 2000, p. 92)

Both the data synthesis charts and student storyboards appeared to provide the teacher with summarizing information that allowed her to reflect on student work before providing feedback. Thus, these student scaffolds may have also provided the teacher with support for the soft scaffolding she administered to students (Saye & Brush, in press). During the third implementation of the DP unit, the teacher reported that the storyboards helped her with feedback because they "gave me something to come back to with them." However, the feedback she provided students tended to address issues of factual error more than student reasoning.

Some hard scaffolds may serve as intermediate structures that support teachers in the task of soft scaffolding by creating time for reflection before their response is required. In this way, we scaffold teacher thinking by providing a thinking space between the student's initial response and the teacher's supporting response. The storyboard process was intended to be such a device. Other intermediate feedback devices might be designed to give teachers a preview of the conceptualizations that students are forming before they meet with students to probe and redirect student thinking (Brush & Saye, 2000, October; Saye & Brush, in press).

Summary

This paper has provided an overview of research conducted over the past five years dealing with design and implementation of technology-enhanced student-centered learning activities in K-12 classrooms. We are currently in the process of refining the unit based on the findings of our research to this point. Further studies with other classes will focus on providing teachers with additional supports to facilitate soft scaffolding, examining the implementation of student-centered units by teachers with experience in problem-based and student-centered learning, and using the database for students attempting to solve more bounded, structured problems. These studies will provide further information to assist with the successful implementation of student-centered activities in K-12 classrooms.

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