Research Relating to TI-Navigator

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As TI-Navigator has just recently been released, there is not yet a full body of research relating directly to this technology. Useful research based upon earlier “response systems” and “classroom communication systems,” however, is available, and the core features of these earlier technologies have been carried over into TI-Navigator. We can summarize this prior research using the rubric of “Evidence-Based Education.” In one definition, evidence-based education is “the integration of (a) professional wisdom with (b) the best available empirical evidence in making decisions about how to deliver instruction” (Whitehurst, 2003).

In addition to prior work collected here, we discuss in the last section emerging research on the new capabilities of TI-Navigator, including ways that expand beyond uses envisioned with earlier classroom response technology.

Research reflecting professional wisdom

Over the past decade, teachers and university lecturers have undertaken classroom-based research with technologies related to TI-Navigator. We have identified 26 such studies that report benefits. The main benefits reported, in order of decreasing frequency, are:

- Greater student engagement (16 studies)
- Increased understanding of complex subject matter (11)
- Increased interest and enjoyment of class (7)
- Promotes discussion/interactivity (6)
- Helps students gauge their own level of understanding (5)
- Teachers have better awareness of student difficulties (4)
- Extending material able to be covered beyond class time (2)
- Students do more thinking in classrooms (2)
- Improved quality of questions asked (1)
- Overcoming shyness (1)
- Saving time (1)
- Simplifying record keeping (1)

This value of this research should be understood within its limits. On one hand, consistent benefits have been reported across a wide range of subjects and grade levels. Further, teachers and lecturers using the technology have written most of the reports, which and incorporate their professional wisdom. On the other hand, none of the studies has a research design that is sufficient for reaching a strong conclusion about effectiveness of this technology for achieving these benefits.

Best available empirical evidence

Four bodies of empirical evidence are available to guide decisions relating to TI-Navigator. While the research we cite in this section is not directly about TI-Navigator, it does closely align with the technical capabilities and envisioned use of TI-Navigator.

Research cited in this section has the backing of stronger research designs. Future research will be needed to validate the full applicability of this literature to TI-Navigator.

Better questioning and feedback

The most obvious thing this technology does is to increase the ease with which teachers can engage all students in frequent formative assessment and provide teachers and students with feedback about how each student is learning.

The connection to formative assessment makes a large literature on questioning and feedback available to guide best practice. When teachers' questions are used to deepen students' higher-order thinking and when feedback is provided to students on how they can improve, significant learning gains can occur (Dillon & Wittrock, 1984; Gall, 1984; Redfield & Rousseau, 1981; Samson, Strykowski, Weinstein, & Walberg, 1987). In addition, higher achievement levels are reported in classrooms where students are involved in checking their own understanding of concepts and assessment data are used to inform and adjust instruction (Black & Wiliam, 1998; Fuchs & Fuchs, 1986).

Support of mastery-oriented goal structures

This technology may facilitate students' adoption of learning or mastery goals by highlighting the differences among ideas but downplaying the individual ownership of those ideas.

Motivational "goal theories" focus on analyzing students' reasons for engaging in achievement activities (Pintrich & Schrauben, 1992). Research on goal theory has focused mostly on two major kinds of goals that students pursue: "performance" goals, in which learners seek to maintain positive judgments of their ability and avoid negative judgments, and learning or "mastery" goals, in which students seek to increase their ability or master new tasks (Elliott & Dweck, 1988). Across a range of studies, researchers have found a consistent pattern: the adoption of learning goals tends to help students of all ability levels sustain engagement in a task, but the adoption of performance goals for low-ability students tends to lead them to avoid challenging tasks and attribute failure to poor ability rather than to their level of effort (Elliott & Dweck, 1988). Students' individual goal orientations, moreover, can be shaped by powerful educational interventions like this technology, especially in cases where students perceive classroom goal structures to be more learning- or mastery- focused (Ames & Archer, 1988; Griswold & Urdan, 2001; Maehr & Midgley, 1991).

Engaging students with cognitive contrasts

This technology appears to focus students on two kinds of important contrasts:

- Contrasts among ideas that are strongly related to the target concept.
- Contrasts between an individual student's idea and the ideas of the group.

The "perceptual learning" literature, particularly as articulated within the "Preparation for Future Learning" framework (Bransford & Schwartz, 1999), highlights the power of presenting students with a few, well-selected contrasting cases. Without contrasts, any number of conclusions can be drawn from a presentation of concepts. The contrasts help guide interpretation and create a basis of readiness for future learning. Experimental results show that contrasting cases prepare students to learn more from subsequent elaborations (Bransford & Schwartz, 1999).

The second kind of contrast may complement the first and result in better self-regulation—students are more able to engage with and make sense of feedback when it is feedback on something they have thought about first and when they have a personal stake in the outcome (Butler & Winne, 1995). Indeed, engaging with cognitive conflict (or making prior knowledge problematic) is known to be an important prerequisite to conceptual change (Posner, Strike, Hewson, & Gertzog, 1982; Webb & Palincsar, 1996). Evidence shows that the appropriate use of "constructive controversy" in the classroom has powerful positive effects. Since teachers have a poor sense of students' misconceptions, drawing out students' ideas is crucial to creating awareness of the relationships between commonsense prior knowledge and the target domain ideas (Clement, Brown, & Zietsman, 1989; diSessa & Minstrell, 1998; Van Zee & Minstrell, 1997).

Facilitating collaborative learning

This technology may facilitate collaborative learning by establishing "positive interdependence" (a goal structure that promotes interaction and commitment to group learning goals) and enabling the teacher to maintain both individual and group accountability (Johnson & Johnson, 1989; Slavin, 1990; Webb & Palincsar, 1996).

Research has demonstrated that appropriate technology-based representations can significantly affect both the quality of students' discussion and what they learn from the discussion (Cohen & Scardamalia, 1998; Hsi, 1997; Pea, 1993; Ryser, Beeler, & McKenzie, 1995; Suthers & Hundhausen, 2003). Tools that support manipulating dynamic notations and models are particularly important in mathematics (Kaput, 1992) and science (Penner, 2001). These tools were not available in simple response systems, but they are available in TI-Navigator because of its calculator heritage. TI-Navigator may thus catalyze the base conditions known to be necessary for successful group learning while integrating mathematical and scientific modeling tools. When the right conditions are established for collaborative learning, strong achievement gains can result (Slavin, 1990; Webb & Palincsar, 1996).

Exploratory research on TI-Navigator

There has been recent exploratory research with the new capabilities of TI-Navigator. Although this work was performed with prototypes or pre-production versions, the results are useful in illustrating the potential of the current system.

Work by Owens et al (2002) suggests that teachers can use TI-Navigator to benefit both classrooms and individual students in significant ways (see also, Abrahamson et al 2003). This research, which included teacher professional development, attempted to measure changes in the middle- and high-school classrooms of ten teachers after they had been using a system for between one and three months. . They discovered that TI-Navigator classes were indeed perceived by students to be more responsive to individual learners' needs, more focused on knowledge building and assessment, and more community-centered. In a separate study, Davis (2002) explored how learners' and teachers' perceptions of the classroom change with the use of TI-Navigator in high school classrooms. Students in TI-Navigator classrooms report being more attentive, less anxious, and more focused on tackling their problems of understanding (Davis, 2002).

Some of the new research on TI-Navigator explores uses of technology and benefits that are distinct from those reported in research on earlier classroom response systems. Investigators such as Wilensky and Stroup (2000) and Kaput and Hegedus (2002) are presently developing ways that classroom networks can be used to create more participatory environments for mathematics and science learning. For example, they have involved creating simulations of physical situations to which individual students have input, such as an inner-city traffic grid, or the spread of an infectious disease through a population. Such situations are described to the class in the context of a story with a goal that often can only be accomplished through class-wide cooperation. Thus, mathematics and scientifically informed ideas become elements in a space-creating play (Stroup and Kaput et al, 2002).

<u>Reference: Evidence-Based Education</u>

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