As instructional technologies become increasingly well incorporated into the curriculum at all levels of the education system, and as parents consume increasing amounts of instructional technology for their children to use at home, it becomes increasingly important to assess the actual learning that results from their use. While instructional technology looks promising, much of what we know about its effectiveness comes from research funded by the companies that produce the instructional technologies. In fact, many educational systems incorporate instructional technology into the classroom without examining any research results at all. This is, obviously, unacceptable, because we are talking about the most valuable resource we have: our children’s minds. It is critical that we examine when instructional technology does help, when it does not, and when it has completely unintended effects on learning.

In fact, several research studies suggest that instructional technologies have quite detrimental effects, especially on children. For example, Flanagan and Black (1998) found that watching as little as 15 minutes of educational television could produce symptoms of learned helplessness, a condition in which perfectly able children give up in the face of hard or challenging problems. Since many children watch educational television for significantly longer periods of time, this should be of great concern to parents and educators. A natural response to this research is to argue that of course children should not spend time passively watching television but should interact with computer programs. But a study by Fox and Oakes (1984) found that if a computer program produces arbitrary responses to the user, that interacting with a computer program can also produce symptoms of learned helplessness. So, learning from instructional technology may be affecting motivation, and unmotivated or depressed students are a problem just about every community is familiar with.
But, learning from instructional technologies may be affecting the learning of the content as well. After all, this is what everyone is hoping when they incorporate instructional technology into the classroom, or sit their child down in front of a computer or television screen. Studies show that children do seem to learn counting and the alphabet at an earlier age because of shows like Sesame Street, and that they learn some Spanish words at an earlier age because of shows like Sesame Street and Dora the Explorer. But research by Flanagan and Black (2001) showed that when learning how to do something unfamiliar (use a Chinese Abacus to represent numbers) using a computer simulation or else the physical object itself that children showed exactly the same amount of recognition (or declarative) memory regardless of how they had learned, but that the children who learned to use the abacus using the physical abacus were significantly better at using the abacus (non-declarative knowledge) and were significantly more successful at building on their recently acquired knowledge. In other words, the learning was more robust.

While instructional technologies have clearly improved in the past ten years, it is not clear that the effect on learning has been profound or robust. Most students seem to be struggling as much as (or more than) ever in math, for example.

The proposed research cannot, of course, focus on learning in the abstract, but must focus on learning in a particular content area. It focuses on math skills in female students because there seems to be a lot of room for improvement in this area, and we’d like to try to help our participants learn something useful while they are helping us to learn about learning.

Hypotheses

- Children involved in eight sessions of one-on-one math enrichment will have an overall improvement in math, and attitudes toward school.

- College students involved in eight sessions of one-on-one math enrichment (as tutors) will have an overall improvement in attitudes toward math and technology.

- Children will have equivalent declarative knowledge regardless of having used physical or virtual materials.
• Non-declarative knowledge will be better for those who use physical materials.
• Children will exhibit more frustration when using virtual materials.
• Children will show greater long-term retention and transfer after using physical materials.

Method

Each tutor/researcher will work with an elementary age girl for eight half-hour sessions. The first session will be an introductory session, at which the child and tutor become acquainted, and the child is asked for assent to be in the research project. Basic background information will be established.

The following six sessions consist of two sets of three sessions each, which focus on two activities of the tutor’s selection, provided that one activity is “physical” (uses physical wooden abacus, or physical tangram pieces, or physical scale modeling materials) and the other activity is “virtual” (using a computer screen to simulate the physical activity). Choices, at this point, include pattern block activities, abacus activities, tangram activities, scale modeling activities. At the end of each of the two activities, a brief assessment of achievement in the particular activity will be performed.

The final session consists of a final assessment, of achievement, long-term retention, attitudes, transfer, and feedback, as well as a “thank you”.

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Participants
Participants will include girls from local public elementary and middle schools with the informed consent of the child’s parents, teacher, principal, as well as the child’s own assent. There are no selection criteria beyond gender. All academic achievement levels, attitudes, and socio-economic backgrounds are of interest.

**Materials**

There are two categories of materials used in this research: the physical materials and the virtual materials.

**Physical Materials**

- Chinese Abacus, wooden, approximately 5” x 12”.
- Wooden Tangram puzzle, approximately 5” x 5”.
- Pattern blocks, wooden, in standard colors.
- Scale Modeling Materials include a dollhouse and various materials for creating items that fit into the dollhouse in a 1”:1’ scale ratio.

**Virtual Materials**

- Virtual Abacus, simulated on a Macintosh laptop computer, using HyperCard.
- Virtual Tangram, simulated on a web page using HTML and JAVA.
- Virtual Pattern Blocks, simulated on a web page using HTML and JAVA.
- Virtual Scale Modeling program, using interior design software.

Most of the materials have been pilot-tested to establish equivalence of content available (Flanagan, 1998, 2003; Flanagan & Black, 2001).

**Assessment**

Assessment will take several forms.

Math achievement will be assessed using the arithmetic subsection of the Wide Range Achievement Test Version 3 (WRAT-3). This test is appropriate for participants age 5 - 75, has two alternate forms and has been nationally normed.
Achievement in the particular math activities will be assessed using simple paper and pencil recognition tests such as are typically used in a school setting to assess basic understanding. This assessment will capture the declarative learning involved in the activity. Past studies have shown this type of learning to be about equal in the physical and virtual learning groups (Flanagan & Black, 2001). In addition, non-declarative learning in the particular math activities will be assessed using a simple performance-based test such as is typically used to assess physical or motor skill achievement. For example, learning to use the abacus might be assessed using a recognition test (declarative learning) and then a task involving actual use of the abacus (non-declarative learning). Past studies have shown this type of knowledge to be significantly stronger in the learning group that uses physical materials (Flanagan & Black, 2001).

Attitude toward math will be assessed using an attitude questionnaire. In addition, a persistent, or masterful, attitude will be assessed using a challenging but solvable math puzzle. Past research has shown that this persistence test can pick up changes in attitude after experiences as short as 15 minutes (Flanagan & Black, 1998).

The attitude assessments will also assess the attitudes of the student/tutor/research assistant.
References


