Learning together: The effect of materials on individuals and pairs

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With the increased availability of computers for schools, educators and researchers have begun to develop tutoring systems and training programs to improve students' learning experiences. However, due to limited resources, students must often share a computer with other students. Although some work has been performed on collaboration when students are doing problem solving, no systematic study of differences due to materials has been performed.

The experiments performed address the hypothesis that different types of materials (topics and not just complexity) may produce different learning results for individuals and pairs. More specifically, as the material to be learned moves from declarative to procedural, more problem solving is required to learn that material. With more problem solving should come more interaction and since pairs provide an opportunity to interact together, an increased amount of learning should be found for pairs as the material becomes more procedural in nature.

Experiment 1 focused on groups versus individual learning from an economics hypertext. Using a hypertext as opposed to a linear text was hypothesized to provide a problem solving context for subjects because they would need to figure out where to go in the text. Students read a hypertext either alone or with a partner. Pairs were tested together or individually for the post-test. (Experiment 1a limited the reading time for subjects whereas Experiment 1b allowed subjects to take as much time as they wanted. Similar results were obtained with higher variance for Experiment 1b.) Results for Experiment 1 showed that individuals improved more between pre-test and post-test than groups (tested alone or together) even though groups read more of the text itself. Reading may be an activity which is not conducive to collaboration. Although pairs were not facilitated for a pure reading task, they may perform better on a task which requires first reading and then problem solving.

Experiment 2 focused on groups versus individual learning from a genetics tutoring system. The tutoring system first presented basic information about genetics and then specific information about how to solve pedigree problems. Subjects solved 4 sets of problems with feedback. Results for Experiment 2 indicated that groups showed more improvement than individuals but this difference may be partially due to the greater improvement of the students taking the test together (for one of the sets of groups). Groups seemed to talk more in Experiment 2; they seemed to talk when problem solving started and did not talk during the initial reading parts of the genetics tutor. Some additional knowledge may be gained by working with another individual, but this is hard to differentiate from the ability to retain information when tested with another person. However, more discussion and interaction does seem to occur in a problem solving situation.

In summary, these results imply that a purely procedural task could be learned most easily by groups as compared with a purely declarative task. This work also indicates that there is not an overwhelming advantage for pairs using computers for learning relatively difficult materials (although these materials were not more difficult than what could be expected from college level students). Text itself may not induce students to discuss the material; whereas, problem solving activities embedded in text may promote students' discussion and better performance. From the work of Chi and colleagues (Chi, et al, 1988), better students often self-explain when material is ambiguous or difficult and the possibility exists that textual material that includes questions may produce better results. We are currently performing experiments to explore both of these issues.

The indication that pair learning may show greater improvement as the type of material becomes more procedural (problem solving) in nature requires some caution. First, although the economics text did not appear to be complicated or difficult, the genetics problem solving material became progressively more challenging as the student progressed through the tutoring system. Thus, the genetics material may have been considered complex by many students. As noted in the introduction, extremely easy and extremely complex materials may be difficult for pairs to handle. While extremely easy material results in floor effects where differences between individuals and pairs may be small, extremely difficult material may cause pairs' performance to be less than optimal depending upon how tenacious the pair of students are at tackling the material. If the students both decide that the material is too difficult, they may both stop working or develop strategies to "outsmart" the computer. On the other hand, if both students decide to tackle the material, incredible performance can be observed. Thus, type and complexity of material may interact. In addition, individual differences may result in very different approaches to the same material.

In conclusion, our study demonstrated that pairs do not outperform individuals in all computer learning tasks. In fact, for purely declarative reading tasks, reading as part of a pair may actually hurt a student's performance. Thus, the type of activity may be a very important factor in determining success of group learning using computer tutors.