Children's potential for controlling their own learning while solving problems with an 'idea organiser'

Emrah Orhun

University of Nottingham

United Kingdom

&

Ege University

Turkey

ABSTRACT

This paper describes a pilot study of how 4th grade children in a Turkish primary school used a computer-based idea organizer for problem solving in social studies. The described study is part of a project aimed at identifying ways in which computers can be used to enhance the quality of primary education in Turkey. The study has attempted to assess the children's potential for controlling their own learning in a collaborative problem solving activity and to identify the requirements for a computer-based cognitive tool to support children's knowledge construction. The successful completion of the project which aimed at improving the local traffic, has given support to the notion of children's potential for self-direction and self-regulation.

Main conference themes: developing countries

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Study topics:

Secondary keywords: case studies, collaborative learning, problem solving, thinking, tools

INTRODUCTION

This paper describes a pilot study concerning children's collaborative problem solving using computers. The study is part of a project aimed at identifying ways in which computers can be used to enhance the quality of primary education in Turkey. This pilot work involved a class of 4th graders as they carried out a project to improve their local traffic. The study attempted to assess the children's potential for controlling their own learning in such a problem solving activity and to identify the requirements for a computer-based cognitive tool to support children's knowledge construction.

Three assumptions have underlain this project. First, that learning is a process of knowledge construction, rather than knowledge transfer. In this process learners use new information and their existing knowledge to construct new knowledge. Successful learning requires effective metacognitive strategies for self-regulation and an ability to reflect upon one's knowledge and management processes [1, 2]. Secondly, that instructional programs can be devised [3, 4, 5, 6] to help learners acquire cognitive and metacognitive strategies which experts in a domain employ for using, managing and discovering knowledge. Finally, in activities of thinking, learning and problem solving children can be supported by computer-based cognitive tools which compensate for their cognitive limitations such as memory [7].

Children's potential to take greater control over their learning in question-answer dialogues has been investigated by Scardamalia and Bereiter [5]. Their study has shown that children can produce and recognize educationally productive questions and can adapt them to their knowledge needs. We similarly wanted to find out the potential of 4th grade children for controlling their learning in a guided and supported collaborative activity while using a computer-based 'idea organizer'.

The term 'idea organizer' refers to a cognitive tool which can be a useful adjunct in organizing and processing ideas and formulating arguments. In an idea organizer ideas, and relations between them, are represented pictorially by graphs composed of nodes and links. Idea organizers offer the opportunity to examine one's own thinking and reflect on it. This may lead to not only enhanced performance in problem solving, but also "to greater insight into, and control over, one's own thinking and learning" [8]. The pilot study attempted to assess the effect of using an idea organizer we have developed at Ege University on the realization of this potential, as well as children's potential for controlling their own learning.

DESIGN OF THE STUDY

We set the following questions to be answered by the study:

- what is the potential of children for controlling their knowledge building in a collaborative problem solving situation?
- what are the effects of using a cognitive tool on the realization of that potential?

We decided that social studies offered rich possibilities for formulating and solving problems relevant to the daily lives of children. Social studies subject matter for the 4th-grade includes topics such as local environment, transportation and traffic, local administration and environmental protection. The local environment topic also deals with directions, maps, plans and graphics.

The study involved the creation of two 'learning environments'. The environments are characterized by the task, the tools, the pedagogical methods and the sociology of learning [4]. As we were interested in the effects of using a cognitive tool on children's realization of their potential for controlling their learning, the two environments differed only in the tools. One environment contained the prototype idea organizer as well as a word processor and a paint program. The other environment contained only the wordprocessor and the paint program.

We formulated three hypotheses concerning the two questions set. The first one concerned the children's potential for controlling their knowledge building in a collaborative problem-solving situation. It was hypothesized that the children were capable of exercising higher levels of executive control over their zones of proximal development [9] and would be able to advance their knowledge by identifying their knowledge needs. The dependent variable selected concerning this hypothesis was the level of domain knowledge to be acquired. The hypothesis was that experience with the two learning environments would lead to higher ratings of the level of domain knowledge.

It was also hypothesized that the problem-solving strategy modelled and scaffolded by the researchers would be transferable to similar tasks and the children who would have learned the strategy, would achieve higher ratings in a transfer test.

The third hypothesis concerned the effect of the cognitive tool on the learning outcome. The following dependent variables were selected: the quantity and quality of steps taken in problem solving, questions/problems posed, solutions generated and constructive comments made. It was hypothesized that the learning environment with the idea organizer would lead to

higher ratings in the measures of these variables as well as in the level of domain knowledge and of performance in the transfer task, compared to the environment without the idea organizer.

Environments

Task

The task was taken from the text book and defined as: how can we improve the traffic around our school? Write a report which contains your suggestions for improving the traffic.

The children were thus required to formulate, elaborate and revise subgoals, identify, plan and solve problems. They also needed to make practical decisions about the allocation of time and resources to various subgoals.

Tools

The set of tools in the environment with the idea organizer consisted of the organizer itself, a commercial wordprocessor (Hal-Word) and a paint program (Hal-Paint) for MS-DOS. The set of tools in the environment without an idea organizer consisted of MacWrite and MacPaint for the Apple Macintosh. All software in both environments had interfaces in Turkish.

Fig. 1 (a) A network of ideas generated by the children (labels translated)

The idea organizer allowed text nodes with attributes such as keywords, name, authors, type and status, similar to the CSILE system [5]. One could create nodes and link these to others. In order to allow scaffolding during the initial phases of problem solving the idea organizer provided the following labels for node type: question, answer, goal, plan, issue, problem, solution, idea, comment, reference and summary. Editing functions and a string search mechanism were also provided. Fig. 1 shows a network created by the children during the study.

Fig. 1(b) The contents of the node labelled 'Plan' (translated)

Social Setting

In collaborative problem solving the social setting provides a zone of proximal development [9] for the learners in which they can exercise activities—which they are not able to perform alone—under adult guidance or in collaboration with peers. The group contributes to the zone of proximal development by sharing the cognitive load during problem solving.

In the study conducted two levels of collaboration were organized. Children participating in the study formed two groups, each assigned to one of

the learning environments. Teams were formed according to the task division and allocation decisions made at the group level.

At least three different roles are requested in successful small-group problem solving [2]: that of moderator or executive, that of generator of alternative paths and that of critic of alternatives. The differentiation and externalization of these roles in collaborative problem solving provides models which an individual needs to internalize to be a successful problem solver. In the present study the roles of generator and critic were taken by teams in inter-team collaboration. No role structure was imposed on the children during intrateam collaboration.

When the teams comprising the groups met, they engaged in articulation and reflection. They explained what they did as a team. They examined what the other team had done. So they alternated as a team between the roles of producer and critic. As each team worked on a different subgoal, they were not only able to get practice in both roles, but also had an opportunity to grasp different aspects of the overall problem.

The Pedagogical Methods Employed

The pedagogical interventions followed the notion of expert scaffolding in the cognitive apprenticeship approach [2]. The strategy modelled by the researchers was reminiscent of the means-ends heuristic which is based on the general procedure for breaking problems into sub-problems and which was intended as a general procedure for guiding children's collaborative problem solving. Such a weak method can be relevant when little is known about a task. It can also provide a framework into which other methods (e.g. using an analogy) can be incorporated.

Children

The 35 participants (out of a class of 50) were 4th grade (age 9) children who had taken part in the previous year's Logo project. The children were mostly of middle-income families. They had studied the topics covering local environment, transportation and traffic, local administration and methods of graphical data representation in the preceding semester.

The children were accustomed to the pedagogical method of question-answer whereby the teacher hands out a list of questions about a topic and discusses the answers prepared by the children.

In Turkey, children start getting prepared for the secondary school entrance examinations usually in the 4th grade. The 5th grade is almost entirely left for the examination preparations. The class teacher was offering three hours of extra mathematics lessons on Saturdays in order to prepare the students. She was able to participate in the project only partially. Many children were attending preparatory courses before or after class hours.

IMPLEMENTATION

The pilot study was conducted one hour a day before class hours in the Spring of 1992 at Emlak Bankasi Elementary School in Izmir, Turkey, and lasted for three months. The implementation involved the following activities:

- children were asked to prepare questions which they thought would contribute to the improvement of the traffic;
- an official from the municipality visited the classroom to answer their questions;
- the meaning of 'improving the traffic' was discussed;
- it was decided to make suggestions for hypotheses concerning dangerous points;
- some of the suggestions were selected as goals to pursue;
- plans were prepared to achieve the goals selected;
- plans were implemented and revised;
- issues were identified and solutions were proposed;
- group reports were written to describe the issues identified and the solutions proposed.

The teams were asked a few times to hold inter-team meetings in order to critique the other team's proposals and plans. At the end of the study each team made a presentation to the whole class and parents of their reports which included the question posed, how it was pursued, what problem was identified and the proposed solution. A subject test was prepared with the help of the teacher which was aimed at measuring the knowledge children had acquired during the study. The test had questions concerning the responsibilities of the municipality, awareness of danger for pedestrians, traffic rules, what to do in case of an accident, etc. The questions were intended to require higher order thinking and could not be answered directly by the textbook information. A transfer test was prepared to determine the extend of the acquisition of the problem solving strategy. The task required children to write a plan for a given goal and to examine a given situation as a problem to be solved.

Children's reports of their progress were collected. Pre- and post-tests for achievement motivation and cognitive ability were given in order to investigate the relationships between these psychological factors and the dependent variables being tracked.

An observation form was designed and used during the last seven weeks of the study. The form considered social interaction, psychological state and problem solving progress.

RESULTS AND CONCLUSIONS

The study described in this paper has not been intended as a rigorous test of the hypotheses stated, but rather as a pilot experiment to guide further research and development. The results should be considered with that intention in mind and with caution, as tests were informal and intersubjective agreement was not sought in the rating of the tests and reports.

The results of the subject matter tests showed that the children who participated in the study, were able to achieve a deeper understanding of the domain compared to the children who did not participate. As the instructional interventions by the researchers were limited to modelling and scaffolding this achievement appears supportive of the notion that the children have a potential for controlling their knowledge building with adult guidance in a problem solving situation. The results of the transfer test gave support to the hypothesis which stated that the problem-solving strategy would be transferable to similar tasks and that the children who would have learned the strategy, would achieve higher ratings on the transfer test.

It has been more difficult to find evidence to support the hypothesis concerning the effect of the cognitive tool on the learning outcome. The ratings of the final reports showed no differences between the two groups in terms of the quantity and quality of the steps taken in problem solving, acquisition of domain knowledge or performance in the transfer test.

The study has given some support to the notion that children have a potential for higher levels of executive control over their learning. Yet current educational practices in Turkey neglect that potential and emphasize the transfer of factual knowledge with little opportunity for children to develop their skills for learning, problem setting and solving, communication and collaboration. It is the author's opinion that current educational practice prevents the children from growing into a habit of viewing knowledge as something they can build. In the present practice there is no need to think about and discuss what to do next. The following excerpt from the 'think-aloud' protocols supports this opinion:

Researcher: How are we going to learn something we do not know?

Child: I cannot know.

Researcher: What are we going to do if we cannot know?

Child: We will try to learn.

Researcher: All right, from where or whom?

Child: Somebody has to teach.

Researcher: Who?

Child: The teacher or you.

The study has shown that children can easily learn how to use such computer based tools. The main question still open is: how can we extend the learning environments which support children's knowledge building to real classrooms with 50-60 students? The potential of teachers for going beyond the given task to facilitate constructive interaction among children appears much more crucial than the potential of children for controlling their own learning. The study has shown that the current curriculum offers possibilities for creating such opportunities. It is, however, very unlikely that such opportunities will be exploited in a system in which the quality of education is measured only by the performance on the secondary school entrance examinations.

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