Fostering collaborative problem solving
for pupils with cognitive disabilities

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Abstract: Verbal communication, particularly the ability to give directions and understand them, is a key not only for learning but also for every day life. Since one main objective of schools for pupils with cognitive disability is to prepare them to manage their every day life on their own as much as possible, we expect that teaching pupils to learn and work collaboratively by sharing tasks and give directions to each other will support this process and provide them in becoming more independent. In this paper we will present a short study and approaches we have elaborated to increase quality and quantity of users' contributions and foster verbal communication between pupils in collaborative problem solving tasks.

Introduction

"Technology as a teaching tool immediately, profoundly, and positively impacted the education of individuals with mental retardation … The introduction of the computer as a teaching tool … can be viewed as the greatest agent of change …for individuals with mental retardation." (Jeffs, et al., 2003). This euphoric description is representative for the appraisal of the use of computers in schools for students with cognitive disabilities. A Computer can be used as an effective learning tool to support the acquisition of basic learning skills (Zentel, Opfermann, & Krewinkel, 2006). In addition, the work with this medium supports the increase of self-determination, of independence, and integration skills (Wehmeyer, 1998) and allows for "positive changes in inter- and intrapersonal relationships, sensory abilities and cognitive capabilities, communication skills, motor performance, self-maintenance, leisure, and productively." (Parette, 1997).

Whereas most of these positive effects are measured in the context of individual learning we would like to enhance the focus on the potential of the computer to support processes of collaborative learning (CL) among pupils with cognitive disabilities. As part of a project for the development of a software toolkit for pupils with cognitive disabilities funded by the Federal Ministry of Education of Baden-Württemberg (Germany) we are conducting an explorative study to receive a first impression whether CSCL can be beneficial for this target group or not.

The software development within the project is done using the FreeStyler framework (Hoppe & Gassner, 2002) developed by COLLIDE research group at University Duisburg-Essen, Germany. Its capability has been proven in several projects with primary and secondary schools and in academic education (Lingnau et al., 2003b).

Collaborative learning & cognitive disabilities

According to Slavin (1999), CL is one of the greatest success stories in the history of educational innovation. The use of this instructional method has been proved in numerous studies in the traditional classroom as well as in computer based settings. However, only a few efforts have been made regarding the research of CL and CSCL on pupils with cognitive disabilities. Three research reviews (Tateyama-Sniezek, 1990; Stevens & Slavin, 1991; McMaster & Fuchs, 2002) stated mixed results in studies in which CL was used to improve the academic achievement of students with cognitive disabilities. Stevens and Slavin (1991) suggested that the reasons for the equivocal results can be seen in the variety of CL and the fact that some emphasise the academic achievement of pupils with cognitive disabilities to a much greater extent than others. The main result of their review is that the achievements of students with disabilities will be greater if CL includes individual accountability and group awards.

Beyond these methodological difficulties Cosden, Goldman, and Hine (1990) described fundamental problems of pupils with cognitive disabilities engaged in small group activities: pupils with cognitive disabilities are less effective communicators than non-handicapped, they are less effective in expressing their own point of view as well as in responding to the needs of the listener. They have problems taking over leadership during group activities and demonstrate considerable inconsistency in level and appropriateness of their communicative skills. Cosden et al. state that "it seemed plausible to expect that students with learning disabilities would have difficulty making

effective use of collaborative groups to the extent that their communicative problems inhibit effective group participation." (ibid., p. 222). Although these global attributions may not apply to all individuals, they are describing potential problems that might occur in CL settings for this target group.

Preliminary studies

In our first study, we tried to explore which kind of setting might be reasonable for the target group of pupils with cognitive disabilities. In Lingnau, Hoppe & Mannhaupt (2003a) a study is reported where two primary school learners with heterogeneous ability solved a problem collaboratively in a jigsaw design. The study showed that even two low attaining children produced better results when working together instead on their own. Beyond they where stimulated to collaborate not only in the shared workspace but also by verbal communication discussing their actions and contributions to the shared workspace.

Coming from these results we analysed three different settings using the shared workspace of FreeStyler in a face-to-face situation with 2 tablet pc's. The test persons were 8 adolescents aged 17 to 19 from a school for students with cognitive disability with different aetiology. The speech of all of them was understandable. Participation was voluntary. In the first setting pupils should solve a puzzle collaboratively using the standard puzzle we implemented. The number of pieces can be varied and if a puzzle piece is dragged to the correct position on the puzzle frame, it will snap into the frame and be fixed. In the second setting, we had a maze as a background image. The pupils where asked to plot the way out of the maze in the shared workspace by using different colours. In the last setting the pupils where asked to paint a picture in the shared workspace by choosing from a list of objects e.g. a car, a house or a tree. We evaluated different pairs of pupils working on one or more of the three settings in an informal way but using video recording and FreeStyler log files which can be replayed, parsed and analysed. As a result, we concluded that the task description should provide a scaffold to guide the pupils through the task and that the pupils must be encouraged to communicate and coordinate themselves.

Collaborative puzzle solving

For the second study, we defined a setting following the idea of a jigsaw design i.e. one pupil cannot solve the task without the other. Two pupils from the same school mentioned above had to solve a puzzle collaboratively using 2 tablet pc's in a face-to-face situation. To measure their skills in this particular task in a short assessment the two candidates had to solve four puzzles with increasing difficulty (from 12 to 24 pieces) individually. Their performance was quite different. One of them was three times faster than the other. Furthermore he used goal-oriented strategies. The slower one had problems to find a starting point. After finding some correct pieces he continued solving the task by trial and error.

In the study each pupil got half of the puzzle pieces in a private workspace while the target image was presented as a preview icon in the shared workspace. The task was to bring together the puzzle pieces while taking turns in adding pieces to the shared workspace or re-arrange them. We identified four main types of action:

(1) Adding a piece from private to shared workspace to a random/wrong position
(2) Adding a piece from private to shared workspace to the correct position
(3) Moving a piece within the shared workspace to a random/wrong position
(4) Moving a piece within the shared workspace to the correct position

Table 1: Evaluation result from the FreeStyler log file

Task	overall actions		actions leading to correct solution	
	pupil 1	pupil 2	pupil 1	pupil 2
12 pieces (6 each)	4 (28.6%)	10 (71.4%)	2 (20.0%)	8 (80.0%)
12 pieces (6 each)	7 (35.0%)	13 (65.0%)	4 (33.3%)	8 (66.6%)
16 pieces (8 each)	13 (32.5%)	27 (67.5%)	0 (0.0%)	14 (100.0%)
20 pieces (10 each)	16 (26.2%)	45 (73.8%)	3 (15.0%)	17 (85.0%)

The analysis of the log files (see Table 1) provides evidence that the type of actions of the two pupils differed significantly. The results show a ration of approx. 1:2 in the contributed actions of the two subjects, i.e. the higher attaining pupil did two thirds of the overall actions. Although there were differences in their performance during the initial assessment both pupils were able to solve the puzzles. In the collaborative setting, we observed that not only the higher attaining pupil took the leadership but that also the lower attaining pupil backed off from being

an active and mindful contributor. Since he had to contribute at least one action in the shared workspace when it was his turn he mostly just added one of his puzzle pieces to a random position or moved a piece to a random but wrong position in the puzzle. The higher attaining pupil waited his turn and undid this action by moving the piece to either the correct position or just back.

Conclusion and Outlook

Since we observed indications for a more collaborative behaviour, we will modify the puzzle setting to guide the pupils to problem solving through acting in shared workspaces and verbal communication. Margaritis, Avouris & Kahrimanis (2006) and Vassileva (2004) showed that enabling learners to reflect on their participation in collaboration through awareness mechanisms can change and increase the quantity and/or quality of contributions to CL. Margaritis et al. found out that providing the user with a *state of collaboration* index "… is easy to interpret, not requiring high cognitive load and focusing ability of the partners concerned …". We assume that such awareness information will stimulate and increase collaboration between pupils with cognitive disabilities too.

Following the approach of scripting tasks for CL (Fischer, et. al., 2007), we will modify the setting using different layers in the workspace. This mechanism is implemented in FreeStyler, i.e. the pupils are using a shared workspace but each pupil is using his own transparent layer where objects can be manipulated only by him but changes are visible to the other. In such a setting the puzzle task can be accomplished avoiding that one pupil can solve the task without the others help when all pieces are in the workspace. Combining these two variations of our setting we want to study whether we can stimulate collaboration and accomplish and foster verbal communication between the learners. Similar to examples of collaborative problem solving with early learners described by Lingnau, et. al. (2003a) we expect that even learners with cognitive disabilities will benefit from collaboration.

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