JrnlID 11412_ArtID 9105_Proof# 1 - 15/12/2010

Computer-Supported Collaborative Learning
DOI 10.1007/s11412-010-9105-5

CSCL for intellectually disabled pupils: Stimulating interaction by using a floor control mechanism

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Received: 23 June 2010 / Accepted: 10 December 2010

Abstract Computer-supported collaborative learning has an unexploited potential of becoming an effective learning method for pupils with intellectual disabilities. This paper aims at showing how some specific requirements of this target group may be met by structuring a learning situation with the help of *floor control,* which restricts the opportunities of a learning dyad to act simultaneously within the learning environment. It was expected that *floor control* could improve communication between pupils with intellectual disabilities by explicitly structuring and restricting activities in the learning environment and making it necessary for the pupils to communicate. To examine if *floor control* really supports the collaboration process in the hypothesized way, two different versions of a CSCL environment were implemented and compared. The results revealed improved task-related communication and a higher quality of interaction outcomes.

Keywords CSCL · Floor control · Intellectual disability

Introduction

Pupils with intellectual disability usually have profound deficits in communication, which impair not only their ability to learn but also their social inclusion. Because of their limited

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communication skills, they mainly experience asymmetrical communication situations. Teachers and parents often adapt their communication to the child's abilities, so the disabled child is used to receiving a great deal of help and scaffolding. Over time, however, this may lead to a situation in which intellectually disabled pupils have no need to develop their communication skills any further. But this means, at the same time, that their role is more and more reduced to one of mere recipients and addressees of orders, rather than active speakers and senders of orders.

This paper assumes that computer-supported collaborative learning (CSCL) is a suitable means of stimulating communication. A *floor control* mechanism, as an explicit form of interaction script that restricts the opportunities of a learning dyad to act simultaneously within a learning environment, may be helpful to induce more symmetric and deeper communication. To test this assumption, we developed a collaborative-learning environment for dyads of intellectually disabled pupils, and then compared dyads supported with floor control with dyads without floor control.

After defining what is meant by intellectual disability, we will describe some previous attempts to apply principles of collaborative learning to pupils with intellectual disabilities. Moreover, we will review existing research on structuring collaborative learning, and discuss how these insights might be utilized for designing a collaborative-learning environment for pupils with intellectual disabilities.

Intellectual disability

Intellectual disability is prevalent in 1% to 3% of the population, depending on definition (Baird and Sadovnik 1985; Koller et al. 1983). This broad range of estimates may be explained by the difficulty of providing precise definitions, and distinguishing between intellectual and learning disability. There are different approaches to obtain a definition (Harris 2006): According to the *interaction centred* view, intellectual disability or mental impairment is not primarily described in terms of characteristics or fixed attributes of individuals, but in terms of relations between individuals and society, in which the label of an "intellectually disabled" person is assigned to an individual by society. In this view, a combination of *low intelligence*, *disintegration*, *general complication of their lives,* and *psychosocial deviation of their development* leads to *educational disability* for such children. As a consequence they will be sent to special schools, because they are assumed to be in need of special education.

Collaborative learning of intellectually disabled people

Many studies in recent years have confirmed that collaborative learning is effective for intellectually disabled people. On the one hand, it improves communicative and social skills (Hertz-Lazarowitz and Miller 1992; Jones and Issroff 2005), and on the other hand it leads to deeper learning (Hertz-Lazarowitz and Miller 1992; Rogoff 1998; Webb and Palincsar 1996). However, few authors have attempted to apply principles of collaborative learning to intellectually disabled people. This may be because of their smaller cognitive, metacognitive, and communicative skills, which are essential for any form of collaborative work on assignments. Cosden et al. (1990), for example, say, "it seems 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" (p. 222). At first sight, such doubts in the suitability of collaborative learning environments for intellectually disabled people appear to be convincing. But could such environments not be used very specifically for the purpose of *training communication itself?* The aim of collaborative activities would, in this case, not primarily consist of learning content, but learning to interact verbally on that content.

In order to make use of the potential of collaborative learning and overcome some of the restrictions due to lower intellectual ability, McDonnell et al. (2000) used collaborative learning in mixed groups of disabled and non-disabled children. In this study, groups of one disabled and two non-disabled pupils had to spell words, and the group members had to take turns as the role of a tutor. This study demonstrated a positive learning effect with the disabled child, and no negative effects with the non-disabled children. Wishart et al. (2007) refer to earlier studies by Rogoff (1990) and Bruner (1986) who showed that babies and very young children would benefit from peer learning. Their conclusion is that a very low level of socio-cognitive skills is sufficient for effective collaborative learning. Their assumption is that a collaborative learning environment should also work with intellectually disabled people if they get no support from non-disabled group members. The authors examined the influence of a collaborative assignment on the ability of intellectually disabled pupils to categorize. Dyads were formed of one pupil with higher and one with lesser categorization skills. In the second stage of the study, these dyads worked collaboratively face-to-face on a so-called furniture task: The two pupils had to sort and put away various pieces of furniture and equipment in the model of a house. Before it started and while they worked on it, they were told that they should furnish the house together and were allowed to talk about it. Mistakes were not corrected. After doing the furniture task, the pupils' categorization skill was measured again. Wishart and colleagues (2007) had varied the dyads. They examined dyads of non-disabled pupils, dyads with mixed causes of intellectual disability, and dyads of Down Syndrome's children with intellectually disabled children who had no specific diagnosis. It could be demonstrated that, after doing the collaborative assignment, categorization was better both with intellectually disabled and non-disabled children. In the non-disabled dyads, it was the weaker pupil who benefitted more, in the disabled dyads the stronger pupil. Although the authors provide no precise analysis of the collaboration process, they remark "one partner with intellectual disabilities often dominated verbal exchange" (Wishart et al. 2007, p. 370).

Few studies have used computer-supported collaborative learning environments in such contexts. One exception is the study of Lingnau et al. (2007) who explored the computer-mediated collaboration process between intellectually disabled pupils who were co-present in the same room during the task. Dyads had to solve a graphical puzzle jointly on tablet personal computers. Each pupil had their own tablet pc and the desktop showed a private and a shared workspace. In the *private workspace,* each pupil had half of the parts of the respective puzzle. As a result of this distribution of resources, no pupil could solve the task alone. These pieces had to be moved into the *shared workspace,* where it was possible to fit the pieces together to a complete picture in a collaborative effort. The study revealed that the activities of these dyads of pupils were quite unequal. About two thirds of the overall activities was performed by one learning partner. It was observed that in many cases the lower-achieving learning partner just brought his or her own pieces into the shared workspace, while the more active partner moved them into their right position. This was the case even if a pre-test had shown that both pupils were capable of solving the puzzle on their own. During the collaboration phase, the pupils did not communicate very much. This study points out that a learning environment which supports cooperation between two intellectually disabled pupils is confronted with two challenges: (1) achieving a balanced effort among the collaboration partners, (2) stimulating task-related communication.

Structuring interaction in CSCL: Scripting and floor-control

In recent years, efforts have been made to develop scripts for CSCL (Dillenbourg 2002; Fischer et al. 2007; Kollar et al. 2006; Rummel and Spada 2005; Weinberger et al. 2005). Scripts may be described as scaffolds that provide a structure of interaction between two or more learners. Scripts stimulate specific types of activities, restrict their sequence and assign roles; they are tools that help learners accomplish tasks that they would not be able to accomplish without the tool. In fact, it has been demonstrated that scripts reduce off-task and coordination-related talk and deepen content-related discussion and arguments. In this way, they improve collaborative knowledge construction and knowledge acquisition (Baker and Lund 1997; Kollar et al. 2006; Haake and Pfister 2010; Hron et al. 2006; Hron et al. 2000; Stegmann et al. 2007).

Scripts have sometimes been criticized because of a risk of "over-scripting". Dillenbourg (2002) argues that the idea of collaboration, "with all the fun and richness of real collaboration", is blended here with concepts from instructional design. Scripts tell people what they have to do and when they have to act in a certain way. This may constrain the individual learners' freedom to handle their activities and the spontaneity of their interaction. Kollar et al. (2007) proposed that people work and learn on the basis of their own built-in scripts, so-called internal scripts. Such an internal script may also be more or less structured. An external script that is implemented through software and tells learners to communicate in a certain way will interact with the respective learners' internal scripts. This may be problematic if learners are capable of effective communication and cooperation, or, in other words, if they have effective internal scripts. Intellectually disabled people, however, have poorly developed communication and cooperation skills. So our assumption was that especially intellectually disabled people should benefit from scripts, because the external script supplies them with a very clear structure of interaction.

One way of implementing such scripts is the use of *floor control* (Lingnau, and Bientzle 2009). It means that only one user at a time has the right of using and acting with shared resources. The user who has the *floor* is the *floorholder*. A technical implementation of *floor control* will need to be based on precise criteria for passing the *floor* and assigning rights to the *floorholder*.

Hron et al. (1997) developed an explicit script in which one person of a learning dyad was asked to propose a solution, explain it and come to an agreement with the other partner. Only on the basis of this agreement, the workspace will be made available to the other person. *Passing the floor* requires confirmation of the activities of the active participant by the observer (using a confirmation tool). As soon as the person without floor control has confirmed the other person's action, the next assignment starts and a new agreement on floor control has to be reached. The danger of one person dominating activities within the shared workspace is reduced, as far as possible, by passing floor control on to the other person. Boyd (1996) and Dommel and Garcia-Luna-Aceves (1997) have shown that floor control is not only capable of coordinating activities, but may also have a positive influence on the quality of communication. Floor control will improve the process of communication, reduce redundancy, assist coordination and balance the participation of individuals within a group during group work.

In the light of these findings, floor control appears to combine all those features that make it a promising method of effective collaboration between intellectually disabled people.

In the following study, we considered whether floor control is a suitable method for assisting communication between and collaboration of intellectually disabled people. We expected that floor control promotes *task-related communication* and leads to *more evenly balanced activities* of the partners of collaborative assignments.

Method

Sample

Thirty-nine pupils at a German special school for intellectually disabled children took part in the pre-diagnostic session of the study. They were between the ages of 12 to 17. Finally, 20 out of them fulfilled the criteria required for handling the experimental task (cf. *Procedure*).

CSCL environment

With FreeStyler (Hoppe and Gassner 2002), an open and modular simulation and modelling tool, we designed a collaborative learning environment that is aligned to the needs of pupils with intellectual disabilities. In this environment, the pupils had to sort various pieces of furniture and equipment in the respective rooms of a house (e.g., kitchen) or, if this was more appropriate, outside the house (based on the furniture task from Wishart et al. 2007). Each of the partners worked on a tablet PC. The shared workspace showed a house with different rooms. The task started by displaying just one symbol in the private workspace of one partner. This pupil first had to move this symbol from his or her private workspace into the shared workspace, using a pen. There the other partner could also see it on his or her tablet PC. To mark ownership of a symbol, each symbol had the colour that had been assigned to the respective pupil before starting the task. The pupils were given coloured bracelets in order to remember their colour.

Two versions of the CSCL environment were implemented. In the *floor control condition*, only the pupil who was the owner of a symbol had the right to move it within the shared workspace. After deciding on the final position of the symbol, the non-owner had to confirm or decline the position (by pressing a respective button). This person was not allowed to move the symbol in the shared workspace. Consequently, the only way to affect the position of the symbol for the non-owner was discussing with the other pupil about its position. The owner could then relocate that symbol. If the other child confirmed that position, the next symbol appeared in the private workspace of one partner randomly chosen by the system. This random assignment was introduced in order not to give that child the impression of always automatically being the next one who could move a symbol.

In the *control condition without floor control*, both partners had the right to move a symbol within the shared workspace. So the non-owner declined a position of a symbol by just moving it to another position. Consequently, pupils had two options for coordinating their actions: They could discuss with one another and/or move a symbol to the room that they thought was the right one. Only if both partners confirmed a position, the symbol was finally located, and the next symbol appeared in the private workspace of one partner (see Lingnau and Bientzle (2009) for more details).

Graphical material

In the shared workspace, the house was presented as a schematic and two-dimensional image. The six rooms of the house were labelled with symbols as kitchen, bedroom, living room, bathroom, children's room, dining room, and workroom.

The furniture symbols that the pupils were supposed to assign to the rooms were taken from Widgit Software™ (German Version 2.061). In order to vary the difficulty of the task, we used different symbols. Twenty three *standard symbols* (e.g. chair, bed, toilet, TV) were introduced to the pupils before the task, so they knew their meaning. There were also four *difficult recognition symbols* (CD; curtain; refrigerator; building blocks) and four *non-furniture symbols* (rain cloud; dog, moon, bird). Both types of symbols were not introduced to the pupils before the experiment (this was analogous to the study of Garton and Pratt 2001). We expected that these items would increase the need for communicating during the experiment. Figure 1 shows some examples.

Procedure

In order to familiarize the pupils with the person who conducted the experiment, the experimenter was present in the school for several weeks and worked with the children as a co-teacher. For each dyad of pupils, the experiment took place in three sessions on three different days.

Session 1: Introduction In the first session, the topic of "furnishing" was introduced in the school class. The pupils were shown a three-dimensional model of a house (Fig. 2a). The house had the same allocation of rooms as the two-dimensional house that was used later. The labels of the rooms and the *standard symbols* were introduced. Together with the experimenter the pupils learned the assignment of symbols for the respective rooms. In the next step, the dyads received a paper with a two-dimensional schematic representation of the house, analogous to the image used in the virtual environment. The pupils had to assign the symbols to the different rooms.

During this introductory session, the pupils got to know the experimenter and became familiar with the task and the symbols. This was important because pupils with intellectual disabilities may find it difficult to cope with unknown people and new situations.

Session 2: Pre-diagnostics In the second session, we collected some diagnostic data. First, the intellectual skill of sorting by category was tested for each pupil with the block sorting task used by Wishart and colleagues (2007). In this task, the participants are confronted with 12 symbols which they have to sort by colour, form or magnitude, or by two of these categories. In this task, participants got one (or two) points for each correct categorization, and a maximum of 15 points.

Second, the class teachers were interviewed about the physical, intellectual, socio-emotional, and communication ability as well as the learning behaviour of their pupils. Because of the small class sizes in special schools, the teachers are very familiar with the pupils supervised and so are good sources for these assessments. In these interviews, we additionally used a questionnaire based on *Heidelberger Kompetenz Inventar* (Holtz et al. 2005) and *Vineland Social Maturity Scale* (Doll 1965). The following criteria had to be fulfilled for participating in the experimental session:

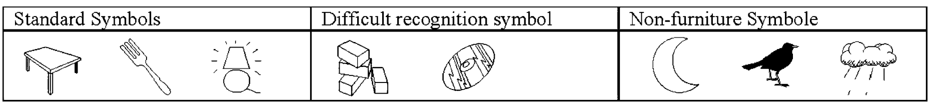

Fig. 1 Examples of symbols used in the task

Fig. 2 **a** (*left*). Three-dimensional model of the house. **b** (*right*). One partner of a learning dyad working with the virtual house

- Sight or hearing impairments, if these existed, had been corrected sufficiently.
- Motor skills had to be sufficient to use a pen for moving symbols on the screen of a tablet PC to a desired position.
- Verbal instructions had to be understood and the pupils had to be able to speak sufficiently to make simple statements and give simple instructions.
- The pupils had to be able to spend 10 min on an assignment continuously.
- The pupils had to have sufficient emotional stability, social competence and self-control in order not to react to minor conflict situations by physical violence.
- The pupils had to be able to work on the block sorting task independently, displaying at least medium ability of categorization.

The 20 pupils who had fulfilled these criteria were paired and randomly assigned to one of the two experimental conditions.

Session 3: Core study with CSCL task The core study was done in single pair sessions. It began with refreshing the labels of the rooms. Afterwards, the CSCL environment was introduced to the pupils. Each partner of a dyad received a tablet PC and was shown how to move symbols on it. This was learned by solving the block sorting task collaboratively. The experimenter helped the children to understand the handling of the CSCL environment. Private and shared workspaces and (in the experimental condition) the floor control mechanism were explained. When both learning partners had fully understood how the CSCL environment works, the experiment started, and the pupils had to accomplish the furniture task collaboratively. The virtual house in the shared workspace (Fig. 2b) had the same rooms as the house in the model and the one in the paper version, both introduced in session 1. The experimenter only intervened when technical problems occurred or when a group needed help in order to proceed with the task.

Dependent measures

Activities in the shared workspace All activities on the tablet PCs were automatically logged during the furniture task: moving a symbol into the shared workspace, declining the position of a symbol, confirming the position of a symbol, or relocating a symbol (i.e., changing the position of an already positioned symbol in the house). The most relevant activity was the number of relocations, because it indicates either a reaction to verbally expressed disagreement of the other pupil (possible in both conditions) or a reaction to disagreement of the other pupil (only possible in the control condition without floor control, because, in the floor control condition, only the owner of a symbol could disagree).

Communication acts The dyads were videotaped. For each dyad the number of communication acts per partner was identified. Because we were especially interested in task-related communication, the communication acts were coded into categories: We differentiated between *coordinative communication acts* (e.g., "It's your turn"), *content-related communication acts* (e.g., "Do we need a wardrobe in the children's room?" or "Children need clothes."), and task-unrelated communication acts.

Quality of collaborative outcomes Quality was assessed by counting the number of accurately positioned symbols.

Results

The results will be presented in four parts. We will report (1) about how well the pupils understood the task and the tool, (2) about activities in the shared workspace, (3) about communication acts and (4) about the correct location of symbols as a measurement of quality of the collaborative outcome. Due to the small sample size (five dyads per condition) and the high variance between the dyads (as was to be expected with intellectually disabled pupils), inferential statistics were not suitable. Consequently, we present values of all dyads and add some observations from the video records. We complement these results with additional observations. The numbering of the dyad per condition from 1 to 2 will be used consistently throughout all results presented here.

Understanding the task and the tool

Each symbol had to be moved from the private workspace into the shared workspace with the house. This was the same for all dyads. The videos show that in both conditions the pupils fully understood the task. They understood that they could see their own activities and the activities of their partners in the shared workspace. They understood that both partners had to agree on the position of a symbol (by clicking on a box) before they could continue with the next symbol. This was shown (among other things) by verbal utterances like "Do you agree?" after one partner had placed a symbol. In the control condition, it happened sometimes that both pupils tried to move a symbol at the same time. In the floor control condition, the two pupils never attempted to move the symbol simultaneously. They waited until it was their turn.

Activities in the shared workspace

Dyads with floor control had, on average, 21.6 relocations, dyads without floor control, on average, 43.8 relocations. Table 1 shows the number of relocations caused by the dyad partners respectively. The relative amount of relocations by each of the partner shows that the relocating activities were heterogeneously distributed among the dyad partners. This was the same in both conditions: The mean proportion of relocations among the partners was on average 1:2 in both conditions.

Table 1 Number of relocations in the shared workspace

	With floor control		Without floor control	
Dyad	Less active pupil	More active pupil	Less active pupil	More active pupil
1	4	9	14	18
2	9	9	0	0
3	9	10	32	57
4	7	15	10	21
5	11	25	17	50
Mean numbers	8	13.6	14.6	29.2
Mean number per dyad	21.6		43.8	

Communication acts

In order to give the reader a rough idea of the communication that took place, we will first present three typical extracts from dialogues, translated into English. The first one is about locating a standard symbol, the television set, in the floor control condition (Dyad 4). The owner of this symbol is Pupil 2. He asks a question, answers it himself, locates the TV and asks Pupil 2 about acceptance.

Pupil 2: where does the television belong?
Pupil 2: the living room ... [Pause] yeah [Pause] you agree?
Pupil 1: yes

The second dialogue is about locating a more difficult recognition symbol, the refrigerator, in the floor control condition (Dyad 1). The owner of that symbol is Pupil 1. The pupils do not recognize the symbol. They just have some coordination talk, and finally agree on the position without any discussion.

Pupil 1: hmmm
Pupil 2: what is that?
Pupil 1: don't know
Pupil 2: let go for a moment
Pupil 2: let go!
Pupil 2: [name of Pupil 1], look!
Pupil 1: fits

The third dialogue is one of the longest ones in the experiment. The pupils discuss about locating a non-furniture object, the rain cloud, in the floor control condition (Dyad 4). Pupil 1 is the owner of the cloud. He first locates the cloud in the bathroom, and pupil 2 declines. The experimenter helps a little by asking if the cloud belongs to the house at all. Then Pupil 2 proposes a new position (outside the house), Pupil 1 relocates the cloud, and Pupil 2 agrees.

Pupil 2: What have you got?
Pupil 1: [laughing]
Pupil 2: this is not okay ... [Pause] wrong
Pupil 2: but not for washing hair
Experimenter: [name of Pupil 2], any idea?
Pupil 2: What is it, [name of Pupil 1]?

Pupil 1: a cloud with rain, is it?
Pupil 2: yes, not for the bathroom [Pause] so I don't agree
Experimenter: should it be in the house?
Pupil 2: no
Pupil 1: no
Pupil 2: outside [Pause] out of the house
Pupil 1: wait a moment
Pupil 2: yes, I really agree

The total mean number of communication acts was about the same in both groups (64.8 vs. 69.2; see Table 2). The dyads within each experimental group varied to high extent: In each condition, one dyad had no communication at all, and another dyad had more than 100 communication acts. The communication acts, however, were slightly more equally distributed between both pupils in the control condition without floor control than in the floor control condition.

Taking a closer look at the types of communication acts, however, it turned out that dyads in the floor control condition performed fewer coordinative and more content-related communication acts, both in absolute numbers and in proportion to the total number of communication acts (see Table 3). That means that floor control may have reduced the need for coordination, and enabled more content-related speech acts. This was especially the case after a pupil had declined the position of a symbol which the other pupil has chosen: In these situations, a content-based communication act occurred in 82% of all cases with floor control, but in only in 49% in the control condition. So floor control stimulated content-related communication when the dyads met a new challenge that they could not solve easily. This was also the case with the non-furniture symbols. These symbols were difficult to locate, because the pupils had not exercised with them before, and sometimes these symbols had to be located outside the house. These non-furniture symbols led to an average of 9.6 content-related communication acts in dyads with floor control, but only to 2.6 content-related communication acts in the control condition (Table 3 in brackets).

Quality of collaborative outcomes

Dyads in the floor control conditions located slightly more symbols in their correct position than dyads in the control group (Floor control: M=28; SD=1.7; Control group: M=26.4;

Table 2 Distribution of communication acts (total numbers)

	With floor control		Without floor control	
Dyad	Less communicative pupil	More communicative pupil	Less communicative pupil	More communicative pupil
1	39	58	22	34
2	0	0	0	0
3	14	31	37	46
4	43	88	39	47
5	11	40	48	73
Mean numbers within the dyad	21.4	43.4	29.2	40
Mean number per dyad	64.8		69.2	

Table 3 Coordinative und content-related communication acts (number of content-related acts after non-furniture symbols in brackets)

	With floor control		Without floor control	
Dyad	Coordinative	Content	Coordinative	Content
1	14	54 (13)	9	23 (4)
2	0	0 (0)	0	0 (0)
3	4	23 (11)	27	9 (1)
4	15	88 (16)	13	55 (4)
5	6	27 (8)	27	60 (4)
Means number per dyad	7.8	38.4 (9.6)	15.2	29.4 (2.6)
Percentage of total communication	12%	59% (15%)	22%	42% (4%)

SD=7.3). But we have a ceiling effect here, because in both conditions more than 80% of the symbols were placed correctly. A considerably greater challenge, however, was the location of the non-furniture symbols *raincloud* and *moon*, which had to be located outside the house, but were unknown to the pupils. Only one dyad in the control condition without floor control, but three dyads in the floor control condition positioned the raincloud and moon correctly outside the house.

Additional observations concerning complementary activities of partners in dyads

One dyad in the floor control condition (Dyad five) demonstrated that relocation activities of one partner in the shared workspace might have been reactions to communication acts of the other partner. The two pupils' previous performance was very different: Pupil one was clearly better in the block-sorting task than pupil two. Moreover, pupil two was described by his teacher as a less communicative boy. The distribution of relocation activities in the shared workspace between the two pupils (11:25) makes pupil two appear the more active and dominant one, so there may have been little mutual involvement in the task. But the quantitative distribution of content-related and coordinative communication acts between the two pupils (28:5) is reverse, so that pupil one was more dominant in communication. In the video, we could see that pupil two often reacted immediately in the shared workspace to verbal utterances of pupil one. So this dyad really interacts with each other: Pupil one used speech for guiding his partner's behaviour, and pupil two reacted in the form of activities in the shared workspace.

In contrast, Dyad one in the control condition also had an uneven distribution of coordinative and content-related communication acts (9:23), whereas its relocation activities in the shared workspace were more balanced (14:18). But the video showed that the activities of pupil two were only in some cases directly related to some utterance of this pupil's partner. Activities in the shared workspace and verbal communication were less related to each other in the case of this dyad, with the result that these two pupils could not agree on the position of two of the symbols.

Moreover, the videos showed that the pupils did not only interact verbally, but also non-verbally, especially by pointing at things. The left person in the pictures (see Fig. 3) is a boy who was described as "rather autistic" by his teachers. He did not communicate verbally during the experiment, but he found a different way of controlling his partner (Dyad two of the floor-control condition). The picture shows that one time he moved his partner's hand

Fig. 3 Nonverbal action control by leading the partner's hand

on the partner's tablet PC in order to move the symbol to the desired position. This is also a form of nonverbal communication in which this boy explicitly interacts with his partner. Such interaction is only necessary in the floor control condition—without floor control the boy could easily move the symbol to the position he wanted.

Discussion

The activities in the shared workspace as well as the video-recorded communication acts and behavioural interactions showed clearly that the pupils were able to understand the floor control design. They understood that only the owner of a symbol had the right to locate a symbol in the shared workspace. They realized that in the floor control condition verbal or non-verbal interactions were the only way of moving a symbol to a desired position. Nevertheless, the three dialogues which we have quoted—which were very typical examples of such dialogues during the interaction of the learning partners—showed that the ability of our participants to express themselves, to ask and answer questions, or to utter requests was very restricted. It is only a rudimentary form of communication, and an exchange of arguments is particularly difficult for this target group. So long and coherent dialogues on where a symbol should be placed were rare in all dyads.

Activities in the shared workspace showed, however, that the floor control condition led to a smaller number of relocations, even if floor control did not balance the participation of both pupils: On average, one pupil did two-thirds of the relocation activities in this condition. Although the total amount of communication acts did not differ between the two conditions, pupils in the floor control condition performed fewer coordinative and more content-related communication acts, compared to pupils in the control condition without floor control. So it seems that higher activity in the control condition without floor control is a result of just moving symbols, instead of communicating about their right position. In other words, by reducing the need for coordinating communication, floor control may lead to a greater extent of content-related communication. This is analogous to findings on the effects of other scripts: Collaboration scripts reduce coordinating activities between learning partners and, consequently, the learners can use the additional available resources for discussing content (Kollar et al. 2006). Floor control also seems to have this positive effect.

More specifically, the requirement of obtaining confirmation for the position of a symbol by the other learning partner stimulated some negotiation when pupils differed in their preferred solution: When a partner had declined a position of a symbol, more contend-related communication appears in the floor control condition than in the control condition without floor control. Some difficulty of locating a symbol also affected the frequency and quality of communication: Non-furniture symbols, which were more difficult to allocate, led to more content-related communication in the floor control condition, compared to the control condition without floor control.

The described observations show that participation of the two partners of the learning dyad is not only reflected in their activities in the *shared workspace,* on the one hand, and their communication on the other, but also throughout the entire process of verbal and non-verbal interaction. Dyad 5 in the floor condition, for example, demonstrated that despite imbalanced activity in the *shared workspace* it was possible to achieve a balanced extent of participation in solving the task by using verbal communication. Moreover, Dyad 2 in the floor control condition demonstrated that pupils may compensate their low communication ability by using non-verbal interaction with their partner (i.e., showing them what they mean). Further studies should therefore examine two aspects in more detail: (1) how activities in the shared workspace are related to verbal communication, and (2) to what extent verbal and non-verbal activities may be complementary in cooperation between intellectually disabled pupils.

From the researchers' perspective, we should, however, mention that this particular target group confronted us with some specific challenges for conducting our studies and interpreting their results. First of all, the design-based research process was very time-consuming, because the task and the tool were developed together with the teachers, and one researcher had to be present in the class for several weeks to get to know the pupils and to make them familiar with her. Moreover, organizational difficulties and the low level of intellectual ability of many of the available pupils made it impossible to take a larger sample; and those pupils who were finally included still differed greatly in their intellectual ability. So we could only apply descriptive statistics. It was very difficult in some cases to understand what the pupils said and to categorize all their communication acts, because the considered pupils had a very poor verbal expression (although the most competent pupils had been chosen).

Nevertheless, we would like to underline the necessity to apply CSCL tools in such settings. According to our results, intellectually disabled young people will really benefit from such tools in specific ways: A CSCL tool with floor control can improve the quality of the pupils' verbal communication and, thereby, may even help intellectually disabled pupils to practice their communication skills. So a CSCL tool with floor control might be an intuitive way of scaffolding interaction by provoking the need to communicate about the task at hand (rather than giving explicit prompts for content-related communication). In this way, intellectually disabled people can be guided in cooperating with each other by implementing a CSCL tool with floor control. Practicing communication and cooperation skills in this way may even enhance their social inclusion in the long run.

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