Enhancing pair learning of pupils with cognitive disabilities: Structural support with help of Floor Control

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Abstract: Computer-supported collaborative learning has the potential to be an effective learning method for pupils with cognitive disabilities, but there is just little research in this area. A computer-supported environment offers several possibilities to handle the specific demands of this target group, for example, by structuring the learning situation with Floor Control. Floor Control explicitly structures the activities in the learning environment and implicitly enhances communication. To examine whether the Floor Control supports the collaboration process on activity level as well as on communication level or not, two versions of a CSCL environment were realized and compared with each other. The results revealed an improved task-related communication and a higher quality of learning results.

Introduction
Collaborative learning (CL) and computer-supported collaborative learning (CSCL) can be effective learning methods (Slavin, 1996), even for pupils with cognitive disabilities (McDonnell, Thorson, Allen, & Mathot-Buckner, 2000; Wishart, Willis, Cebula, & Pitcairn, 2007). But there are just a few systematic studies about CSCL with pupils with cognitive disabilities (Lingnau, Zentel, & Cress, 2007). Accordingly, there exists little guidance for designing a CSCL learning environment and, thereby, structuring the communication and the learning activities of this target group.

The current paper focuses on the question how to use a CSCL environment to promote pair learning of pupils with cognitive disabilities. Building on theoretical and empirical insights from CSCL research in special education, a CSCL environment was developed. The study presented in this paper considered the effect of Floor Control on structuring communication and, thereby, collaboration of the target group.

First, we consider the specific characteristics of the target group and the resulting demands on a CSCL environment. Furthermore, we point out how Floor Control can support collaborative learning of pupils with cognitive disabilities. Afterwards, we introduce our research design and the results of our study. We finish with discussion about the experiences and results.

Designing a CSCL environment for pupils with cognitive disabilities
The challenge in supporting pupils with cognitive disabilities is the variability in manifestations, genesis and development of their abilities. Besides deficient cognitive abilities, restricted communication abilities are a common criterion among pupils with cognitive disabilities (Sondersorge, 1972). Difficulties in communication abilities apply to the organisation of speech (e.g. turn-taking, Sacks, Schegloff, & Jefferson, 1974), to formal particularities (e.g., time-structure, Wagner-Willi, 2001), to understanding, to speaking (Hensle & Vernooij, 2002), and to reading abilities (Conners, 2003).

Wishart et al. (2007) were the first who investigated the effect of collaboration on the core cognitive skills of pupils with cognitive disabilities. In specific, they considered the ability to sort by category. They remark that “one partner with intellectual disabilities often dominated verbal exchange” (p. 370).

This dominating behaviour in communication was also found in the effort ratio. Lingnau and colleagues (2007) showed that the higher attaining pupil of a learning pair did two thirds of the overall action in collaboratively solving a puzzle even if both pupils have had the abilities to solve the puzzle on their own.

The restricted communication and coordination abilities make it necessary to support the collaboration process of pupils with cognitive disabilities. Aim of the support should be twofold: (1) achieving a balanced effort in collaboration and (2) fostering task-related communication. By structuring the collaboration with the help of the environment, the cognitive resources of the pupils are disburdened so that they can be more focussed on the content of the task. An adequate method to structuring in the background is the Floor Control design (Lingnau et al., 2007).

Implicit scripting of communication by Floor Control
As we know from different studies, communication can be influenced by the environment. For example, Suthers and Hundhausen (2003) verified that communication of collaborative partners can be implicitly fostered by the design of an external knowledge representation. Similarly, we expected that Floor Control can foster communication by explicitly structuring coordinative activities. Floor Control coordinates the simultaneous use
of shared resources in a collaborative setting. At a particular time, one pupil is authorized to act with the shared resources. So to speak this pupil has the floor. For pupils with cognitive disabilities, it is important to assign a specified proceeding in order to avoid additional coordinative activities rather than learning activities. Therefore, we chose to implement a confirmation tool. The floor was reassigned when the pupils agreed or repeatedly disagreed. When having the floor the respective pupil was responsible for the shared resources. The other pupil could only affect the actions in the shared resources by communicating about the problem solving. When only disagreeing with the floor holder, this could provoke communication on his side. We would speak of *implicit scripting* (Runde, Bromme, & Jucks, 2007) of communication by explicitly scripting the activities in the shared workspace.

**Research questions**

The presented study aimed at investigating the following research questions.

1. How far does the Floor Control Design affect the acting of both pupils in the shared workspace? Is it possible to balance the actions of the pupils in the shared workspace?
2. How far does the Floor Control Design affect the communication of the pupils?
   1. Does the Floor Control Design cause task-related communication aiming at controlling the action of the floor holder?
   2. Does the Floor Control Design cause task-related arguing about declined objects?
   3. Does the Floor Control Design minimize the coordinative communication of the pupils?
3. How far does the Floor Control Design enhance the quality of the collaborative learning?

**Method**

We designed a CSCL environment (Lingnau & Bientzle, in press). The software development is done by using FreeStyler (Hoppe & Gassner, 2002), an open and modular simulation and modeling tool. This environment was aligned to the needs of pupils with cognitive disabilities, e.g. the whole learning environment is not constrained by scripture. To examine whether the Floor Control design can support the collaboration process of pupils with cognitive disabilities or not, two version of the environment were realised and compared with each other.

**Sample and design**

Thirty-five pupils of a school for cognitive disabled children in Tübingen (Germany) took part in this study. The pupils were at the age of 12 to 17. To ensure coping with the demand of the task, preconditions for participating in the study like basic physical, cognitive, socio-emotional, and communication abilities as well as capability to concentrate on the task, were collected. Therefore, a pre-diagnostics concerning the abilities of the pupils were conducted at the beginning of the study. Out of the 35 pupils, 20 met the preconditions and were combined in learning pairs. The Floor Control condition was compared with a control condition with equal rights to act with the shared resources at any time. The pairs were randomly assigned to one of the two conditions.

**Learning task and learning environment**

The collaborative task based on the furniture task (Wishart et al., 2007). In our CSCL setting the task follows the idea of a jigsaw design. The learning pairs were seated in the same room and each pupil got an own tablet pc. The pair got several symbols of furniture and other things that they had to assign to the adequate room of the house represented in the shared workspace. The task started with one symbol in one of the private workspaces. Thus, the respective pupil first had to move this symbol from the private workspace into the shared workspace. To show the ownership of the symbol, it got the colour assigned to the pupil before the task started.

In the Floor Control condition, only this pupil had the right to move the symbol from room to room. After confirming the position of the symbol, the non-owner got the right to confirm or decline the position but was not allowed to move the symbol in the shared workspace. Consequently, the only way to affect the position of the symbol was arguing with the other pupil about the position. When agreeing on the placement or when disagreeing several times, the next symbol appeared in one of the private workspaces randomly selected.

In the Control condition, the pupils had the same rights at any time with exception of moving a symbol from the private workspace into the shared one. So pupils also had to agree on the placement of a symbol via the confirmation tool, but they both could move all symbols in the shared workspace. Consequently, pupils had two possibilities to coordinate their actions: On the one hand, they could argue with one another and, on the other hand, they could move a symbol to the room they thought to be adequate. The possibility to act simultaneous in the shared workspace demands coordinative skills from the pupils that could otherwise be used for task-related exploration.

**Graphical material**

The house was presented as a schematic and two-dimensional image. The rooms of the house were labelled as kitchen, bedroom, living room, bath room, children’s room, dining room, and workroom. The symbols that the
pupils should assign to the rooms were taken from Widgit Software™ (German Version 2.061). Some of these symbols were introduced to the pupils before data collection.

**Procedure**

Pupils took part in three sessions on three different days. The setting will be explained in the following.

**Session 1: Introduction.** In the first session, the pupils were informed about the area “furnishing” within their classes. First, they worked with a three-dimensional model of a house. Then the labels of the rooms and the standard symbols were introduced. Afterwards, the assignment to the adequate rooms was trained. In the next step, they transferred the learned knowledge to a two-dimensional schematic representation of the house, analogue to the image used in the virtual environment. Aim of this introduction session was that pupils got to know the experimenter and became familiar with the task and the symbols. This was important because pupils with cognitive disabilities have difficulties to handle with unknown people and new situations. Besides this, the session was used to inform about the schedule of the study.

**Session 2: Pre-diagnostic.** In the second session, the pre-diagnostic were collected. First the core cognitive skills to sort by category were individually tested (following the blocksorting task used by Wishart et al., 2007). Second, the class teachers were interviewed about the physical, cognitive, socio-emotional, and communication abilities as well as learning behaviour of their pupils. Therefore, we used a questionnaire based on Heidelberger Kompetenz Inventar (Holtz, Eberle, Hillig, & Marker, 2005) and Vineland Social Maturity Scale (Doll, 1965).

**Session 3: Core study.** The core study began with the refreshment of the labelling of the rooms. Afterwards, the learning environment was introduced by collaboratively solving a categorisation task. The experimenter supported the understanding concerning the handling of CSCL environment while a pair coped with the learning environment. Subsequently, the furniture task was collaboratively accomplished. In this phase, the experimenter had only intervened when technical problems occurred.

**Dependent measures**

**Actions.** All actions in the shared workspace were automatically logged during the furniture task. In specific, the following actions were logged: moving a symbol in the shared workspace, declining the position of a symbol, and confirmed position of the symbols.

**Communication.** To investigate the communication the pupils were videotaped. The communication acts were coded in order to investigate our research questions. The following communication acts were categoriazed and compared with the overall communication acts:

- Task-related communication aiming at controlling action (e.g., “Put the bed in the bedroom.”)
- Coordinative communication (e.g., “It’s your turn.”)

In addition, communication acts after every declining the position of a symbol were coded in whether they consist of arguing or not (in the following called task-related arguing after declining).

**Quality of collaborative learning.** The quality was assessed by counting accurate positions of the symbols.

**Results**

**Pre-diagnostic.** The investigation of the child characteristics shows that Floor Control condition and control condition conditions are comparable in all categories (see table 1).

<table>
<thead>
<tr>
<th>Ability</th>
<th>Floor Control condition</th>
<th>Control condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Categorisation</td>
<td>118</td>
<td>126</td>
</tr>
<tr>
<td>Communication</td>
<td>226</td>
<td>217</td>
</tr>
<tr>
<td>Cooperation</td>
<td>223</td>
<td>222</td>
</tr>
<tr>
<td>Socio-emotional</td>
<td>133</td>
<td>135</td>
</tr>
<tr>
<td>Learning behaviour</td>
<td>136</td>
<td>137</td>
</tr>
</tbody>
</table>

**Research question 1: How far does the Floor Control Design affect the acting of both pupils in the shared workspace?**

First, we were interested in whether the Floor Control Design balanced the actions of the pupils in the shared workspace. We expected that in the Floor Control condition both pupils reveal similar amounts of moving and rejecting symbols in the shared workspace because Floor Control equally distributes action possibilities among the pupils. Therefore, we considered the distribution of the moving and rejecting actions between pupil 1 and
pupil 2 in the shared workspace. The descriptive statistics shows that there is no difference in the distribution between both conditions (see table 2).

Table 2: Distribution of the moving and rejecting actions between pupil 1 and pupil 2

<table>
<thead>
<tr>
<th>Pair</th>
<th>Floor Control condition</th>
<th>Control condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9 : 4</td>
<td>18 : 14</td>
</tr>
<tr>
<td>2</td>
<td>9 : 9</td>
<td>0 : 0</td>
</tr>
<tr>
<td>3</td>
<td>10 : 9</td>
<td>57 : 32</td>
</tr>
<tr>
<td>4</td>
<td>15 : 7</td>
<td>21 : 10</td>
</tr>
<tr>
<td>5</td>
<td>25 : 11</td>
<td>50 : 17</td>
</tr>
<tr>
<td>Ø</td>
<td>13.6 : 8</td>
<td>29.2 : 14.6</td>
</tr>
</tbody>
</table>

Research question 2: How far does the Floor Control Design affect the communication of the pupils?
Second, we were interested in whether the Floor Control Design affects communication. We expected that the proportion of task-related communication aiming at controlling action on the overall communication acts is enhanced by Floor Control. In contrast, the proportion of coordinative communication on the overall communication acts should be reduced by Floor Control. And that is exactly what we found. Pupils in the Floor Control condition revealed 14 percent task-related communication aiming at controlling action, whereas pupils in the control condition revealed only 7.5 percent. In contrast, pupils in the control condition showed 34 percent coordinative communication, whereas pupils in the Floor Control condition showed only 14 percent.
Moreover, we expected that the proportion of task-related arguing after declining is higher in the Floor control condition. As expected, pupils in the Floor Control condition revealed 82.3 percent arguing after a decline has taken place, whereas pupils in the control condition revealed only 48.8 percent.

Research question 3: How far does the Floor Control Design enhance the quality of the collaborative learning?
Third, we were interested in whether the Floor Control Design enhances the quality of collaborative learning. We expected that Floor Control improves the quality of the task solution by structuring acting and communicating. As expected, pupils in the Floor Control condition placed more symbols in the accurate room than pupils in the control condition (Floor Control: \( M = 28, SD = 1.7 \); Control: \( M = 26.4; SD = 7.3 \)).

Discussion
Overall, the Floor Control design affected communication of pupils with cognitive disabilities as well as the quality of their learning results. Against our expectations, Floor Control did not balance the activities in the shared workspace.
Concerning the activities, the overall moves were lower in the Floor Control condition than in the control condition. This is not surprising because in the Floor Control condition the right to move the symbols was restricted to the floor holder. Although the logged actions revealed no more balanced participation of the pupils in the Floor Control condition than in the control condition, we found hints that more balance in the Floor Control condition: In the majorities of pairs, the higher attaining pupil revealed more task-related communication acts aiming at controlling action. This explains the unbalanced moves because the lower attaining pupil reacted to the controlling of the higher attaining pupil in making more moves. This counter-balanced effect could not be observed in the control condition.
The results of the study point out that the Floor Control design allows to structure the collaboration process of pupils with cognitive disabilities because it can reduce coordination in favour of task-related communication. However, there are some limitations of the presented study. First, the sample size is rather low. This is especially problematic because the sample is a very heterogeneous one. Consequently, the results should be replicated in further studies. Second, two pairs revealed no communication. But this is rather unproblematic because they were equally distributed among the conditions. Nevertheless the pre-diagnostic should be tighter in further studies. Third, because of the small sample size it was not possible in any case to match pupils according to their abilities, although this was proposed by the results of Wishart and colleagues (2007). Nevertheless, we found a strong effect so that this effect should even stronger when pairing higher attaining pupils with lower attaining pupils more systematically.
The pairing of higher and lower attaining pupils is then especially important when the Floor Control design is implemented for learning new stuff and not only practicing. Then the higher attaining pupil is structured in his teacher role and the lower attaining pupil can profit from content-related guidance. Moreover, we would expect that a computer-mediated communication instead of a face-to-face communication enhances
the effects of the Floor Control design because non-verbal communication is excluded. In the current design, pupils could use gestures to underline their intentions. These gestures have to be substituted with communication acts.

**Conclusion**

The presented study is the first that implemented Floor Control in a CSCL environment for pupils with cognitive disabilities. The aim was to explicitly structure the activities in the shared workspace and, thereby, to also foster task-related communication. By communicating more about the task, the quality of learning should be enhanced. As expected, Floor Control can improve communication and learning quality of this target group. Further studies would be helpful to elaborate the applicability of Floor Control to support learning of pupils with cognitive disabilities.

**References**


