A technical framework to support implicit structured collaboration

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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 everyday life. Since one main objective of schools for pupils with cognitive disability or learning difficulties is to prepare pupils to manage their everyday life on their own, we expect that teaching pupils how to learn and work collaboratively by sharing tasks, give directions to each other and understand them, will support this process and provide them in becoming more independent. In this paper we will present an environment which supports implicit scripted collaborative task solving without increasing cognitive load.

Introduction
There are only few systematic studies about the potential of collaborative learning for pupils with cognitive disabilities. Wishart, Willis, Cebula, & Pitcairn (2007) showed that collaborative learning can be an effective learning method for this target group. In general computers can be used as effective learning tools to support pupils with cognitive disabilities in acquisition of basic learning skills (Zentel, Opfermann, & Krehwinkel, 2007) and help them to increase self-determination, independence, and integration skills (Cosden, et.al, 1990; Wehmeyer, 1998).

We started with a preliminary study (Lingnau, Zentel, & Cress, 2007) using a collaborative software environment with a shared workspace where two pupils had to solve a puzzle task. This task was designed similar to a problem solving task for early learners described in (Lingnau, Hoppe, & Mannhaupt, 2003) where two pupils had to write words in a shared workspace. Lingnau, et. al. implemented a jigsaw design where one pupil owned the consonants while the other owned the vowels. In our setting puzzle pieces had to be moved to the correct position but without any restrictions which objects may be manipulated by a user and how one could agree or disagree to the co-learners' actions within the workspace.

As a side effect for this basic CSCL setting we observed that not only the higher performing pupil took the leadership and started to give directions to the other learner but that also the lower performing pupil backed off from being an active and mindful contributor. Since the pupils had to act by turns the lower performing pupil mostly just added one of his/her puzzle pieces from the private repository to a random position in the shared workspace or moved a piece to a random but wrong position in the workspace. The higher performing pupil waited his/her turn and undid this action by moving the piece to either the correct position or just outside the working area. Analysing the results of our preliminary study we started to develop a more elaborated environment which aimed at providing a shared workspaces where access to objects could be restricted to objects' owner and where the approach of scripting tasks for collaborative learning (Fischer, Mandl, Haake, & Kollar, 2007) could be implemented.

In this paper we will present the technical environment which has been developed to be used for further studies to explore whether we can stimulate collaboration and/or accomplish and foster communication between learners with cognitive disabilities or learning difficulties.

Designing the Framework
The implementation is based on FreeStyler (Hoppe, & Gassner, 2002), an open and modular simulation and modelling tool which already provides a collaborative workspace in a replicated architecture. Evaluating the results of our preliminary study and from a non computerised collaborative task described in Wishart, Willis, Cebula, & Pitcairn (2007) we concluded that a modified environment should provide the possibility to define scripted tasks without specifying a fixed interaction pattern but giving pupils the freedom to operate with their existing ability to communicate and interact. Furthermore we wanted to avoid the decrease of motivation and the increase of cognitive load caused by an explicit collaboration script.

From our preliminary study we learned that mechanisms are necessary to prevent lower performing pupils from backing off and leaving the task solution to the higher performing pupils. In the first setting the pupils had to take turns but could manipulate every object in the shared workspace. The implementation of a floor control mechanism seemed to be essential for an improvement of the task.

To avoid that the target group of pupils with cognitive disabilities has to handle to much activities at the same time we limited the number of objects the learner has to deal with. Thus, we implemented a confirmation mechanism where both pupils had to validate the final position of an object in the shared workspace (Margaritis, Avouris, & Kahrmanis, 2006) in combination with floor control. The floor control mechanism was realised as a switch. A new object is assigned to one of the learners and the ownership is
represented by different colours. Instead of having an explicit moderator controlling the task, this is done implicitly when the learner who owns an object confirms the position where he wants the object to be placed. Thereby the other learner now has to either confirm or decline the decision which means he is implicitly asked by the system what he thinks about the suggestion. By getting the confirm or decline buttons enabled this is an implicit information for the learner that he/she gets the floor and it is his/her turn now.

Figure 1. Collaborative workspace with floor control and confirmation tool.

Not before both learners confirm the position of an object the next object appears in the private workspace of one of the learners. Figure 1 shows the collaborative workspace with floor control and confirmation tool. There are already few objects sorted into the corresponding rooms in the house and fixed by confirmation from both learners. The sofa in the living room is the object which has to be placed next. In figure 1 the owner of the object has already confirmed the location and by doing so the confirmation and decline buttons appeared to the other learner. A detailed description of the steps is given below.

Collaborative learning environments per se do not guarantee that interaction in collaboration will be maximised or at least increased. Collazos, Guerrero, Pino, Ochoa, & Stahl (2007) showed exemplary that if certain design aspects are taken into account the likelihood that interaction takes place can be increased. As a result they propose a design model which grounds on three coherent parts. The initial condition defines the setting under which collaboration shall take place. In our case we want pupils with cognitive disabilities which do not have strong communication skills to work together on a sorting task.

In the model of Collazos, et. al the initial conditions are constituting the possibilities of structuring the collaboration. Therefore it is not sufficient to instruct the learners with a collaboration task. The expected collaboration process must directly refer to the task itself, to the roles assigned to the learners, to the environment in which the learner is acting and to the resources provided to the learners.

In our case the main goal is to stimulate communication and interaction between pupils with cognitive disabilities which are normally unaccustomed to solve tasks in pairs and without intervention of non disabled people. From our preliminary study we learned that although we directed the pupils to take turn and try to contribute in a meaningful way the pupils did not behave as expected. Even more then normal learners it is likely that pupils with cognitive disabilities will not be able to follow the rules at any time, even if they are observed by a teacher. In addition it is also even more likely that learners do not understand directions given to follow a script or they need to concentrate too much on the directions instead on the task.

In our preliminary study either of the learners usually took over the leadership, even if both pupils where able to solve the task on their own. This minimised communication and one of the pupils often just acted by chance when he/she had turn and the other pupil solved the task on his/her own. These results point out that many pupils with cognitive disabilities have difficulties to coordinate learning activities in a collaborative situation on their own. The restricted communication and coordination abilities make it necessary and reasonable to support the collaboration process of pupils with cognitive disabilities with technology. With our floor control and confirmation tool approach we try to avoid an unnecessary increase of cognitive load by guiding the pupils through the task with an implicit script but without changing or restricting the pupils' familiar way of communication.

In our preliminary study each approach was designed in a way which allows the implementation of an implicit script to structure the learners' activity and contribution and help them to organise and coordinate the solution finding process. The software achieves a balanced effort in collaboration and foster 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 focused on the content of the task.

**The software environment**

As a result of the requirements we detected the collaborative workspace of FreeStyler has been enhanced by two features: floor control and a confirmation tool. Although FreeStyler provides collaboration between unlimited workspaces in our case we decided to design the floor control and confirmation functionality for just two learner. An expansion for more learner is foreseen but currently not yet done.

To visualise the ownership of objects within the floor control mode every learner has his/her own colour. The background of the private workspace, where new objects appear for the first time, is coloured with the learners assigned colour and after he/she has dragged an object from his/her private workspace into the shared workspace it appears with a frame in the learners' colour.

In the floor control mode, objects can only be moved by the owner of an object as long as he/she did not confirm the position of an object. Table 1 shows the different steps the learner are going through while they are working on one object. In step 1, the owner of an object (learner 1) has positioned a new object in the shared workspace. It has a coloured frame representing the ownership of learner 1. In this step, the object can only be moved by learner 1 since he is the owner and has the floor for this particular object. If learner 2 wants learner 1 to move the object to another position he/she has to tell him/her what he/she wants since there is no possibility for the non-owner to manipulate the object.

<table>
<thead>
<tr>
<th>Table 1: Step by step visualisation of the floor control procedure.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Learner 1 (object owner)</strong></td>
</tr>
<tr>
<td><strong>1</strong></td>
</tr>
<tr>
<td><img src="image1" alt="Object movable" /></td>
</tr>
<tr>
<td><strong>2</strong></td>
</tr>
<tr>
<td><img src="image1" alt="Object locked" /></td>
</tr>
<tr>
<td><strong>3A</strong></td>
</tr>
<tr>
<td><img src="image1" alt="Object movable" /></td>
</tr>
<tr>
<td><strong>3B</strong></td>
</tr>
<tr>
<td><img src="image1" alt="Object fixed" /></td>
</tr>
</tbody>
</table>

When the owner decides that the object shall stay at a certain position he/she confirms the position by pressing the check button. After that, he/she cannot move the object any more and learner 2 gets the buttons to either confirm the decision or decline it. Since learner 1 still has the floor the only possibility for learner 2 to change the objects position is to decline the decision of learner 1 and communicate where he/she wants the object to be moved to. Step 3A shows the situation after learner 2 has declined the decision of learner 1. Now learner 1 can again manipulate the object and when he/she is sure about the position he/she can press the check button once again to ask for confirmation by learner 2. After an optional number of unsuccessful tries the
system assumes that the learners are unable to agree on a position and the object is removed from the shared workspace.

When learner 2 confirms the position (step 3B) the object is finally fixed which is visualised by a thumbnail. Now either the other learner or a randomly selected learner gets the next object in his/her private workspace and can drag it into the shared workspace. The possibility of having only one active object at a time is optional but for pupils with cognitive disabilities it guarantees that they concentrate on only one object and do not loose the focus. To provide control group settings for evaluation purpose and data ascertainment in studies the confirmation feature can be used without using floor control. In this second setting the different steps to find a joint solution vary for the two learners.

In Table 2 the different steps of this modified setting are visualised. In step 1, learner 1 has moved a new object from his/her private workspace into the shared workspace. Again, the colour of the frame represents the owner of the object in the shared workspace. But in this setting without floor control both pupils can move the object around and confirm the position of the object if they wish to do so. In step 2 learner 1 has already confirmed the position of the object which means he/she cannot move the object any more and learner 2 now can either confirm the position as well or move the object to another position. By moving the object, learner 2 declines the decision of learner 1 to fix the object and both pupils have to confirm the new position again, as shown in step 3A. If also learner 2 confirms the position by pressing the check button, the object will be fixed as shown in step 3B.

<table>
<thead>
<tr>
<th>Step</th>
<th>Learner 1 (yellow)</th>
<th>Learner 2 (blue)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Learner 1 dragged a new object from his private into the shared workspace. Both learner can now move the object around and have to confirm the final position.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Learner 1 confirmed the position of the object as final. Now learner 2 has either to agree or he can move the objects if he wants to decline the decision.</td>
<td></td>
</tr>
<tr>
<td>3A</td>
<td>Learner 2 declined the decision by moving the object to another position. This leads back to step 1.</td>
<td></td>
</tr>
<tr>
<td>3B</td>
<td>Learner 2 agreed to the decision of learner 1.</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Step by step visualisation of the confirmation process without floor control.

Conclusion and Outlook
The design process of the collaborative floor control environment has been mainly influenced by the preliminary study and further hypothesis. Thus, a more elaborated study Bientzle, Wodziki, Lingnau, A., & Cress, U (2009) has been done where learners from a German school for pupils with cognitive disabilities worked in pairs on a collaborative task. For this study we adapted the furniture task, which has been successfully applied by Wishart, et. al. (2007) in a non computerised collaborative learning scenario with pupils.
with intellectual disabilities. In the computerised scenario, using our floor control and confirmation tool environment, the pupils were placed in a face-to-face situation using pen-based interactive screens in front of each learner. Figure 2 shows the screen of one learner from a pair working on the furniture task. Further information and results can be found on Bientzle, et al. (2009).

Figure 2. Collaborative workspace with floor control and confirmation tool

As postulated by Collazos et al., we believe our environment can be used to define tasks which will increase communication and collaboration between learners with cognitive disabilities. The results of our second study revealed an improved task-related communication and a higher quality of learning results. The floor control design allows for implicitly structure the collaboration process of pupils with cognitive disabilities because it reduces coordination in support of task-related communication. Thus also other learners, e.g. with learning difficulties or special educational needs, might benefit from implicit scripting when working on collaborative tasks.

References