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Collaborative Writing in a Computer-integrated Classroom for Early Learning

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Abstract

This paper describes a collaborative experiment with a special software application supporting the acquisition of initial reading and writing skills embedded in a computer-integrated environment for young children. The NIMIS project has set up three Computer-integrated Classrooms across Europe with appropriate "roomware" environments, i.e. furniture, hardware and software to support early learning. Here, we present a collaborative writing task facilitated by a shared workspace system, that has been evaluated with first graders using one of the software applications T^3 (Today's Talking Typewriter). Mixed pairs of children used the shared workspace provided by the application to perform a typical first graders writing task collaboratively. The speciality of this experiment lies in the study of domain-specific collaboration in a rich real-world learning environment.

Keywords: collaborative writing, computer-integrated classroom, early learning

1 Introduction

A prominent scenario in CSCL is synchronous cooperation / collaboration through shared workspaces (cf., e.g., Baker & Lund, 1996; Plötzner et al., 1996). Yet, most of the empirical studies using innovative CSCL-specific tools (beyond windows sharing as part of videoconferencing sessions etc.) were usually based on selective experiments, often in the laboratory. In previous experiences, we have seen that co-constructive activities in shared workspaces need a special introduction and that it is appropriate to provide specific training material (cf. Hoppe et al., 2000a). I.e., the "ecological validity" of educational use of shared workspaces is an open issue. In this paper, we describe a study with shared workspace interaction in a real, though quite innovative, classroom setting for young children.

1.1 A Computer-integrated Classroom for Early Learning

The new perspective underlying the idea of Computer-integrated Classrooms (CiC) is to step back from computers as general purpose machines with standard input and output facilities. Integrative approaches with new interfaces and devices are recently gaining an increasing attention, e.g. under the notions of "The Invisible Computer" (Norman, 1998), "Tangible Bits" (Ishii & Ullmer, 1997) or "Roomware" (Streitz et al., 1998). The approach lets the traditional computers go more to the background and invents new specialised devices and interfaces driven by appropriate software architectures. A first version of a CiC was formulated in Hoppe et al. (1993). This vision was implemented as a laboratory prototype. It has now made its way to real classrooms.

To be successful in terms of usability and acceptance with the envisaged users, the setting-up of such environments has to take the existing social interactions and specific needs into account. Our recent experience and most elaborated application of an integrated room is a CiC for young children (5-8 years old). The NIMIS project ("Networked Interactive Media In Schools", cf. Hoppe et al., 2000b) has set up three Computer-integrated Classrooms across Europe with appropriate "roomware" environments, i.e. furniture, hardware and software to support early learning. Fig. 1 gives an impression of an embedded classroom installation with integrated hardware components and a big interactive screen.

1.2 Situation and prerequisites

To make sure that new media technology really supports learning without redefining well-suited pedagogical procedures, we studied existing interactions and curricular activities in the classrooms of three primary schools associated to NIMIS. The CiC that exists now in the German primary school has been setup in close cooperation with teachers and test groups of young children. Furthermore the teachers and children were involved in the design process of the software. By following a rapid prototyping approach, we had the chance to get immediate feedback from the teachers as well as from the pupils. In periodical meetings with the teachers we discussed the experiences and new requirements that have arisen from the daily use of the CiC.

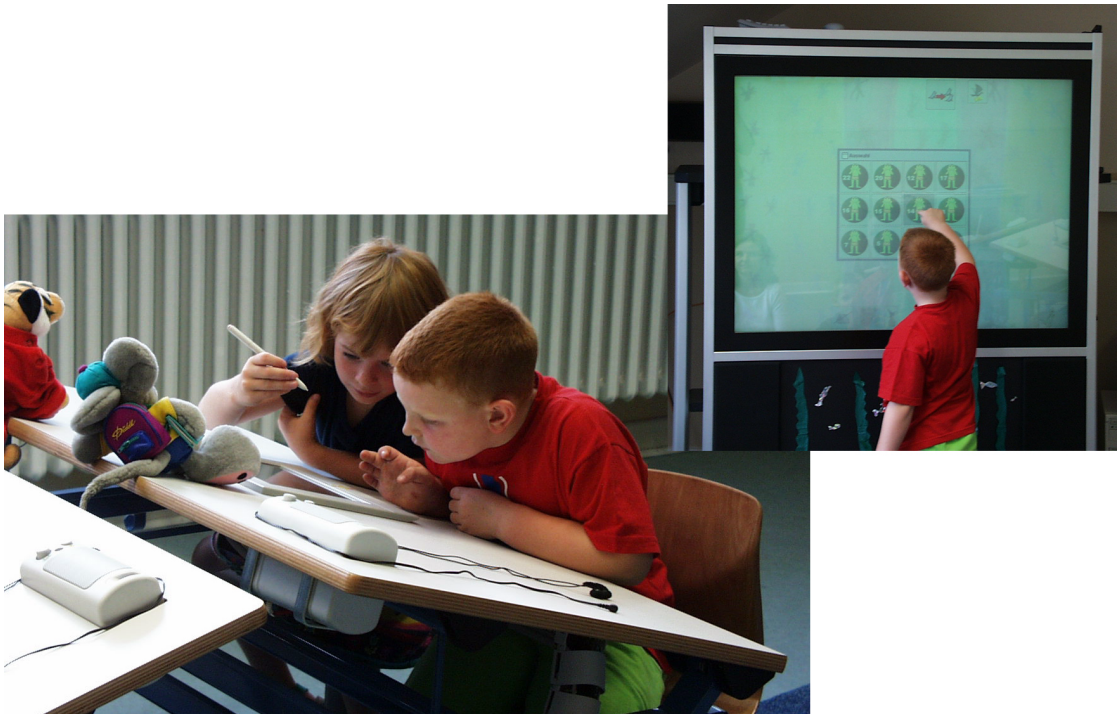


Fig. 1: Pen-based interaction on LC-displays and a touch-sensitive big screen

1.3 Description of the class

Within the NIMIS project, the CiC in Duisburg (Germany) was used every day for at least one hour with the first graders (cf. Kirchstraße, 1998). When working in the NIMIS environment the 27 pupils were divided into two groups of 13 and 14 for the reading and writing lessons. One group then worked within the NIMIS classroom environment while the other was taught following the same "reading through writing" (see below) method in an ordinary classroom environment without technical assistance. The next day, the two groups switched classrooms for this literacy hour. All in all, each group had two to three lessons (à 45 minutes) per week in the NIMIS classroom environment.

In both classroom environments children worked individually or in pairs on workstations solving problems that most of the time had to do with literacy. In the NIMIS environment six interactive Wacom tablets served as "workstations". The pupils could work in pairs or, if they preferred, in turns, since non-computerised workplaces had also been introduced. The tasks from which the pupils could choose changed about once every 6-8 weeks and usually referred to a main theme such as "Autumn", "Winter" or "Christmas".

In order to generalise the learning activities and literacy development of the participating children to ordinary first graders, we assessed their cognitive prerequisites at the beginning of the year using the "Bielefeld-Screening" test (Jansen et al., 1999). The Bielefeld-Screening tests the cognitive prerequisites considered relevant for literacy (e.g. phonological awareness, short term memory span, speed of memory recall, visual discrimination). Results indicate that seven out of 24 children were at risk of developing literacy problems. This percentage of 30% is considerably higher than in ordinary groups of first graders (average 17%). It might be explained by the fact that the percentage of children with German as second language is higher than in ordinary schools and by the high number of broken-home families in the examined sample.

1.4 General software environment

To provide networked interactive working and collaboration, the NIMIS Desktop has been developed as a multifunctional tool for pupils and teachers (see fig. 2). The NIMIS Desktop gives access to the main functions without the need for technical instruction or deeper knowledge about computers. Children easily archive data (ownership!), they can pass data to others, share data with others, move, print, send or delete their data.

As a child-oriented metaphor for handling and visualising data and different media, we have introduced a *companion* or *computer friend* as a virtual representative of the child (for more details cf. Hoppe et al., 2000b).

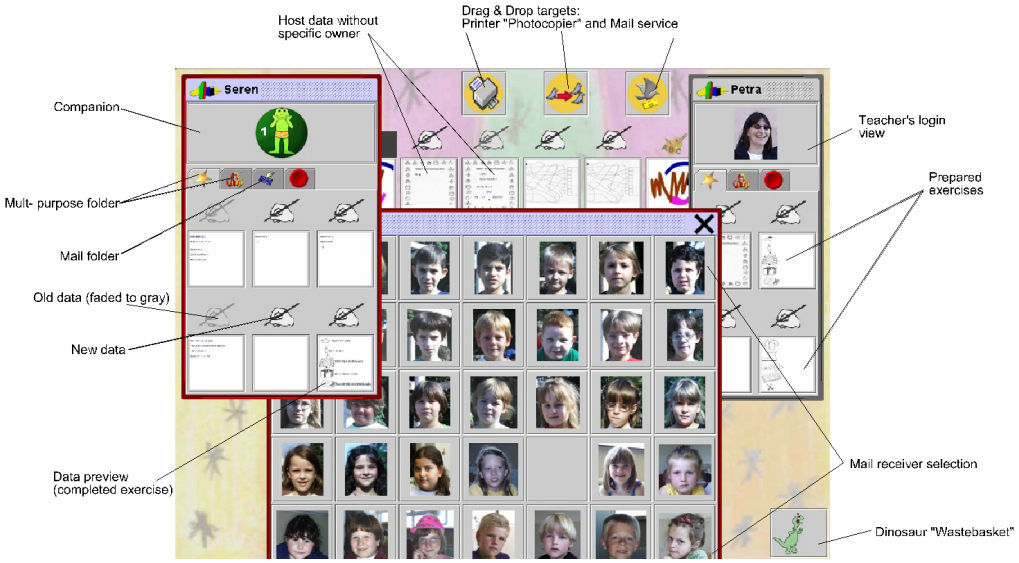


Fig. 2: Elements of the NIMIS Desktop

2 T³: A Collaborative Writing Tool

The main focus of the NIMIS project concerning the content of learning was to provide different means for a wide range of experiences with literacy. Among the NIMIS applications, T³ is the one that concentrates on the very first step in acquiring literacy-related skills, i.e. learning to read and write (see fig. 3).

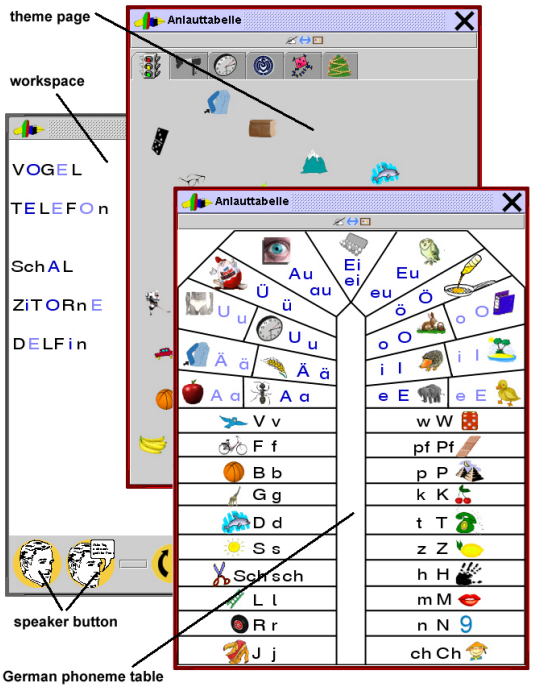


Fig. 3: Main parts of T³'s user interface. The German phoneme table on the right side (uses different colours for consonants, short and long vowels), a page of prepared words together with their visual representation, and the child's result (most of the words are already phonetically correctly spelt) in the writing board on the left.

T³ takes up and extends a well known method "Lesen durch Schreiben" (Reading through Writing), advocated mainly by J. Reichen (Reichen, 1991). This method is used in Switzerland and currently is becoming more and more popular in German primary schools, too. The most important benefit of this method is, that children acquire reading and writing skills at their own pace and can freely apply their pre-knowledge. Independent of the different stages of cognitive development of the children in a class, each child can immediately start writing words or even small sentences. At some point in the later

development reading emerges spontaneously from the synthetic writing experience. This may happen after a week or after five months, and it is not specifically triggered by the teacher.
The crucial feature of T^3 is, to provide almost immediate auditory feedback of the children's written work. Children start with the writing of words before they have the ability of reading what they have produced. Initially, it is quite frequent that a child cannot read what he or she has written a few minutes ago. Although not emphasised in the original approach, the important feedback cycle starts in the non-computerised classroom practice with the exact pronunciation of the written phonemes by the teacher. This has been taken up and implemented in T^3 (Tewissen et al., 2000a).

3 Classroom Collaboration

Collaboration takes place in a classroom, also without computer support. However, computerised material, particularly shared workspace systems, introduce new forms of collaboration mediated by technology. Collaboration in our class of first graders takes place in asynchronous and synchronous mode: Children create simple written dialogues by sending each other text parts (i.e. small questions and answers written with T^3) via the NIMIS desktop's email function. For synchronous collaboration of two or more children, we use shared workspaces. In the case of the T^3 application, the writing area (see left workspace in Fig. 3) is synchronised by means of a software library for coupled objects ("MatchMaker", see Tewissen et al., 2000b). The users cooperate in shared workspaces based on a replicated software architecture. Specific applications are built in first place as single user applications, prepared for later synchronisation by a set of flexible and independent modules. Collaborative modes are technically introduced by coupling (or synchronising) multiple application instances at runtime.

3.1 A study on collaborative writing of first graders

Within our research framework in the NIMIS classroom the question arose whether the first graders were able to make use of synchronous collaboration through shared workspaces offered by the T^3 application. Although the basic task of acquiring reading and writing skills is an individual one, the T^3 application also provides a mode for collaborative work in a shared workspace.
Our experimental study of collaboration with T^3 was embedded in the everyday classroom environment. This setup allows us to avoid well known problems in collaborative learning studies (cf., e.g. Fischer et al., 1999) that have to do with the fact that often learners are familiar with the learning content but not with technical tools and computer-mediated collaboration.
Children were given a computer collaboration task that was in their "zone of proximal development" (Vygotsky, 1981). Therefore the task building the basis for the collaboration task should be familiar to the children, i.e. it should consist of the every day word construction. Secondly, the computer application should be known by the children, i.e. that they have used the T^3 software environment. Consequently, in the collaboration setting the new learning demand consisted of coordinating the children's actions to solve a common problem.
From a set of possible and reasonable collaboration modes (i.e. distribution of material, roles and goals), we focussed on a mode, where the participants were allowed to use different material but had intentionally the same goal and role. To realise this "jigsaw" design (cf. Aronson et al., 1978 for the origin of the idea) the T^3 environment was changed. The task for each of the 12 pairs of children was to write together five words presented on a working sheet within ten minutes. In order to have the children cooperate, the phoneme tables were split up. One of the partners had to work with the vowels, while the other could only make use of the consonants. Therefore, to complete a word, both partners had to work together. As the children were familiar with the application they got a very short introduction by the teacher about the collaborative task. The two writing boards were linked to each other on opposite tables so that each of the children could see the actions of the partner (see fig. 4).

3.2 Observation

The observation procedure involved two stages: the first was to simply observe the interaction of the children and to note this down. After the observer had written down the event that he had observed (for example: Peter asks Jim a question and gets help), he was asked to encode certain predefined events by help of a coding sheet. The coding sheet contained a number of categories, each of which reflected, how the partners may or may not interact. After each observation the observer was asked to give an overall estimation of the quality of the interaction on a number of key criteria (collaborative working – individual working, dominated work – equal rights work, motivated work – unmotivated work, observation affected the pupils' interaction – unaffected interaction). The observation procedure followed the event-sampling paradigm, i.e., observers were requested to count the occurrence of predefined events, while neglecting undefined events. From extensive observations in class we derived a classification of events of interest reflecting the degree of interaction between partners (e.g., individual work, giving affirmation, non-task behaviour; see table 1 and NIMIS, 2000, for more details). To standardise

the judgement, we conducted an extensive 20-hour observer training. The observation categories were explicitly defined to rely heavily on observable and overt behaviour to minimise interpretative freedom. Based on videotaped sessions from the classroom, the observer was instructed in using the coding sheets. Potential ambiguities were resolved. Since we could only use one observer, we could not statistically calculate measures of reliability. Nonetheless, by the end of the 20-hour training, the correspondence of the observations between the observer and the instructor exceeded 0.8.

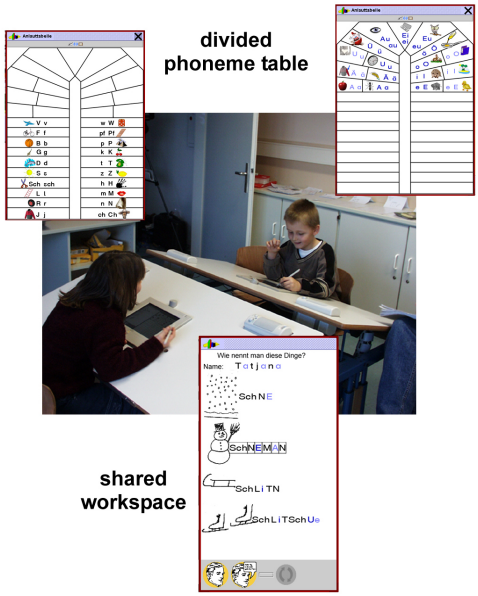


Fig. 4: Collaboration of two first graders using T^3

The overall impression of how the children managed this task was very positive. The children became skilled in using the collaborative working scenario quickly. The notion that two computers would be "connected" was easily grasped by the children. During the first 1 or 2 minutes of the 10 minute observation interval, the partners usually needed to adapt to the new mode of usage. Most of the mutual tutoring occurred in this phase. Children were explaining to each other what this software scenario was for and how they could use it. After one or two letters were moved to the working section of the desktop the "warming up" period was usually over and the children started to work more quickly on the words they would have to write.

One partner usually started by simply moving a letter to the working window of the screen and then waited for the partner to continue. When the partner was unsure how to continue, the children usually engaged in a collaborative dialogue: The weaker partner sometimes asked the stronger for assistance, which was almost always provided. More often, the higher-attaining pupil gave advice unasked, which was usually accepted. Occasionally there was dissent, as to whether the word was spelt correctly. Astonishingly, children sorted this out rather constructively, for example by reading the word aloud (thereby checking the phonetics), asking the computer to read it for them or simply by "consent over dissent". Disagreement was seldom settled in a rather destructive or dominating way. Usually the children had no difficulty in working on all five words that were depicted on the digital work sheets. After the ten minutes were over, still most children were willing to spend some more time on the refinement of the words in the task.

4 Evaluation

After the observations of the 12 couples, we calculated the frequencies of each of the 14 categories. Table 1 shows the mean frequencies and standard deviations. The category with the highest frequency was – as expected – category 1.1 (individual work). Since the children had to move letters individually on their own desktop, these actions were coded in this category. Among the interaction categories 2.2 (coordinating actions) scored highest, reflecting the children's need to mutually decide on the next steps to take, e.g. which words or letters to write next, deciding on whether or not to use the computer's auditory feedback device. Comparing the frequencies of the categories 2.1 (asking for / receiving help) and 2.4 (giving / executing suggestions) reveals the pupils' tendency to give orders/advice rather quickly instead of giving the other child time to find a solution on his own. Also, within a pair both partners at times avoided asking each other for help, presumably because they tried to avoid giving a negative impression of their own.

An interesting issue is also the low number of affirmations given to the partner. This was observed throughout all attainment-levels and seems to reflect the long known notion that most children develop this social skill later. On the other hand, giving affective affirmation is rarely observed when adults work on problems like this (Fischer at al., 1999). As can be seen in the two categories labelled "teachers involvement" (3.1, 3.2) teachers were rarely asked for assistance or guidance. This further underlines the strong impression we developed – that the combination of computer / partner successfully replaced the teacher in this collaborative working scenario.

		M	SD
Individual work	1.1 Student works on a (sub)problem individually	12,17	4,09
	1.2.Student takes on a (sub)problem of his partner without being asked	1,08	1,51
Interaction among partners	2.1 Asking for / receiving help	1,25	2,86
	2.2 Partners coordinate their actions	4,00	2,63
	2.3.1. Partners solve disagreement constructively	2,25	1,91
	2.3.2. Partners solve disagreement in a destructive way	,42	,90
	2.4. Partners give and execute each others' suggestions.	4,33	2,77
	2.5. Partners give / receive affirmation	,83	,72
	2.6. Partners use auditory feedback function	5,25	3,52
	2.7 Partner offers cooperation, the other refuses it.	,17	,58
Teacher involvement	3.1 Teacher gives partners advice	,00	,00
	3.2 Teacher interferes in a different way	,42	,90
non-task behaviour	4.1 Partner(s) involve in disturbing non-task oriented behaviour	,25	,87
	4.2 Partner(s) involve in passive non-task oriented behaviours	,33	,65

Tab. 1: Mean (M), standard deviation (SD) for each of the used categories for the 12 pairs of children.

To simplify illustration for the four main categories individual work, interaction, teacher involvement, and non-task behaviour we summed up the mean frequencies for each of them. The results are depicted in fig. 5. It is evident that collaborative activities prevail over non-collaborative activities. Further, it can be noted that the collaborative work scenario was motivating, since the number of non-task oriented actions remains rather low in all different groups. It is also quite interesting that, despite the words the children had to write being of medium difficulty, the children refrained from seeking the teacher's help.

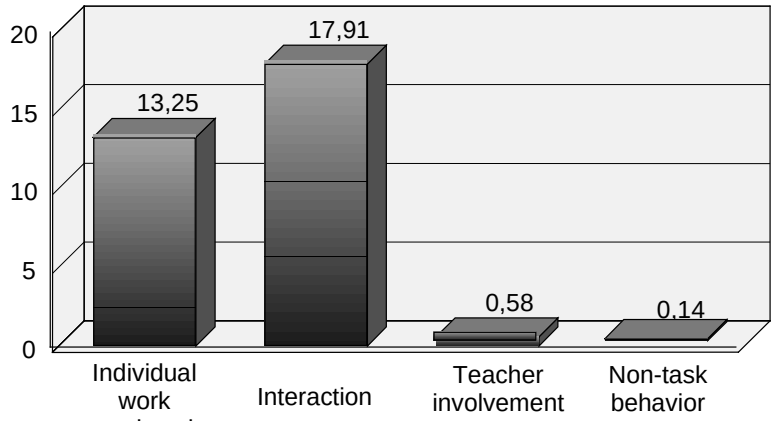


Fig. 5: Sums of the mean frequencies for the four main categories

It can be noted that most pairs did come up with phonetically correctly spelt words. Some of the high-attaining children were even able to implement syntactical rules in their spelling. For the low-attaining children, we observed that the partners came up with higher quality solutions than each of them would have produced alone (there are some task-specific quality measures such as number of correctly spelt graphemes, number of orthographic elements, etc.).

5 Summary and Outlook

The results show new opportunities and necessary conditions to organise computer mediated learning even from the beginning of school onward. Obviously, these very young students are able to productively collaborate on a task and the weaker students even benefit from this learning situation together with stronger students. Working with the technology of such computer mediated collaborative learning situations often appears as an auxiliary task and thus was often the explanation for difficulties in managing these multiple demands: The involved learners had to solve the content task (i.e. constructing a word) while becoming familiar with the new collaboration demand. Actually, the observed learning task was no double task for the children in the above sense. The children even made use of the social learning setting to support their work on the content task. Also, it should be mentioned that, for these young children, to stay on a coherent collaborative task for ten minutes (and more) is a non-evident result as such.

Nevertheless, these positive effects could come out only if the necessary conditions sketched above are met in such learning arrangements:

- Firstly, learners must be familiar with the content level task. If they are confronted with a unknown or unusual task the success of the computer mediated task might be uncertain.
- Secondly, the tools presented by the computer application must be known to the learners or there must be an intensive training period before starting with the collaboration phase. Otherwise, the collaborating partners cannot focus on collaboratively solving the common task, but must acquaint themselves with the computer application (interaction problem dominates over content problem).
- Thirdly, the structure and demands of the common task must be appropriate to the social and cognitive developmental state of the learners. Especially, for the young ones taking part in the NIMIS classroom the common task had to consist of one objective that could be reached together, but with distributed means. This jigsaw arrangement can be seen as one of the easiest ways to organise social learning.

The significance of this exploration study for the whole computer integrated classroom activities shows that computer mediated collaboration is possible and effective even among first graders if, and this is at least as important as the positive effects, the arrangement of the collaboration are prepared properly. The conditions outlined above might be guidelines for that.

These positive results were not reached with students that showed initially good prerequisites for literacy skills as the results of the Bielefeld Screening indicated (see above). But the overall literacy development of the students in the first grade turned out quite positive in terms of standardised spelling test ("Hamburger Schreibprobe 1+"; cf. May, 1998). The distribution of students' performances at the end of the first grade was within average range. Obviously, a considerable part of the one third of the children facing problems at the beginning of the school year showed an accelerated literacy development.

The findings presented here are mainly based on the observations and evaluation of a specific collaborative writing task. Beyond that, all activities of the children working with the NIMIS software are logged in a database. The rich body of data that has been collected from the very beginning of classroom activities is used in ongoing research activities:

- to elaborate our findings of the children's positive development and to reveal more detailed information about the process of learning reading and writing,
- to implement learner models for more sophisticated forms of adaptive intelligent support for individuals,
- to enhance dynamics and flexibility of comprehensive overviews on ongoing classroom activities for the teacher, (e.g. in an HTML format, see fig. 6) and
- to learn more about the aspects of initializing collaborative tasks embedded in normal classroom situations (e.g. based on the comparison of classmates' results, see fig. 7) .

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5.4.2000/9:12:36	|		Schal
5.4.2000/9:13:5	|		Schal k
5.4.2000/9:13:11	|		Schalk
5.4.2000/9:13:32	|		Schalke

Fig. 6: Extract of writing results from the log database prepared as a teacher view.

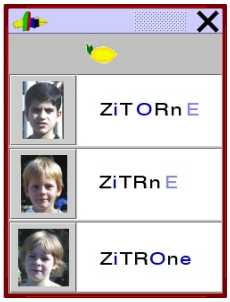


Fig. 7: Presentation of former results and potential collaboration partners

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