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Supervising Knowledge Sharing in the classroom

Supporting Teachers' Individual Diagnosis and Instruction in a Peer Education Scenario

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Abstract— **Bridging the gap between diagnosis and learning in the classroom is the focus of our software tool PEDALE. It allows the usage of open-format questions, knowledge sharing and peer review of other students' solutions through the exchange of hand-written notes. A pilot study with teacher educators proved the potential for diagnostic support for teachers and at the same time promoting adaptive individual learning and exchange among students. The results indicate crucial design issues and future improvements, as well as the requirement of a teacher panel, providing a supervision of the learning scenario.**

Keywords - Learner-centered Diagnostic Assessment, Technology-enhanced Learning, Knowledge Sharing, Peer Review, Peer Feedback, Supervision, Mastering

I. Motivation: Individual Learning in the Classroom

To support each individual student best with appropriate instructions and tasks, teachers need detailed diagnostic insight into the individual students' learning and misconceptions. Simultaneously teachers need to manage the whole classroom. Here group learning scenarios with peer education are used to support students in knowledge exchange and sharing ideas to address the current task [1],[2]. In order to initiate knowledge sharing processes, the teacher usually assembles groups of learners to work together and identifies the individual's performance by walking from one student group to the next. Thereby the teacher needs to keep track of individual achievements as well as the class' overall progress. Still it is impossible to diagnose thoroughly. Software tools can help teachers to continuously get an overview over the current performance of individual learners as well as the whole class. At the same time they can enable each student to work on his own pace without abandoning the benefits of knowledge sharing among peers. After an overview on related work, our created software tool is described, followed by the setup of the pilot study, leading to the results. Finally, future research targets will be stated in the outlook.

II. Related Work

The combination of diagnosis and learning in a computer-supported peer education environment is an interdisciplinary field. As stated in [3] three major challenges were identified to bridge the gap between diagnostic assessment and learning:

i: The Computer Diagnosis Problem: From the instructional point of view it is suitable to use open-format questions which require students to create own solutions rather than to identify the correct answer out of a given choice. Open-format questions are not only more motivating for students, they also provide more diagnostic information for instructors [4] as they allow for individual approaches and answers. However, those open-format questions are not automatically assessable and therefore current software mainly offers closed-format questions only, e.g. gap-text or multiple-choice answers [5]. The challenge for computer-supported diagnosis and learning is to allow for suitable task formats.

ii: The Individual Group Assessment Problem: For diagnostic purposes usually the individual student is assessed while working solitarily. However, solitary assessment is somehow artificial as classroom learning takes place as a social process [6–8]. In order to conduct learning-oriented formative assessment, situations of social learning need to be comprised while assessing individual achievements.

iii: The Diagnosis Adaption Problem: On the one hand diagnosis needs to provide comparable results [9]. On the other hand the students' motivation for and progress in learning depends on the appropriateness of the task difficulty. If the challenge is adapted to the individual skill level, boredom or anxiety are prevented and optimally a state of "flow" is reached [10]. In order to provide diagnostic support for teachers' digital environments must allow for adaptivity and comparability.

A variety of instructional approaches tried to handle one or more of these problems: Intelligent Tutoring Systems are strong supportive software-systems keeping track of an individual students' progress on tasks and giving sophisticated guidance and feedback for well defined domains [5]. Instructional methods like learning by example, learning by teaching or collaborative learning have been investigated and proved to be beneficial for individualizing the learning challenge and to support knowledge sharing in the classroom [11],[12]. Concerning the learning through exchange of knowledge with other learners, especially peer tutoring and peer assessment, have been investigated in several setups [13],[14]. It is shown that peer assessment increases motivation of students and that they are interested in accessing peers' solutions. Peer assessment can improve social behavior and learning results. Still, it is shown that the intervention of teachers is desired [15]. Furthermore, in peer assessment, the individual and social features of the assessor and the content-quality has a varying impact on perception and performance of the person that is assessed [16]. Social network analysis has shown that not-closely related peers (weak-ties) can be most valuable for new knowledge acquisition and support [17].

The adaption of the task difficulty to learners' abilities for optimal learning is widely used in the field of Serious Games. Here the computer maintains a player- and learner-model that tracks the decisions and selects the best fitting next game scenes accordingly [18]. Especially Multiplayer Games for Learning have already adapted the principles of collaborative learning into computer-based scenarios. Upon this, the concept of Game Mastering, known from former Pen & Paper-Games, has been found usable for instructional control and overview by a teacher [19].

III. Scenario and Solution

To address the three problems stated in section II (i-iii) we created the software PEDALE. It will be used by teachers during classroom instruction for the purpose of diagnostic assessment and instruction during repetition and practice phases and to help students close their gaps in the specific domain. We focus on 15-year-old students in secondary school and the domain of functional dependencies in mathematics as we have an underlying sophisticated diagnostic model as a basis for implementation [20]. Each student uses an individual computer along with a digital pen. Each computer is connected to the network and a central database. The software is used for a fixed time period, depending on teacher's instruction and the scenario configuration.

A. Separating Scenario Authoring and Player Software

PEDALE has a two-tier concept. On one side there is an authoring tool (StoryTec) that allows teachers to setup the classroom characteristics and the specific scenario without any programming skills required. On the other side there is a player software (StoryPlay[1]) that allows for student interactions with the software and the tasks. Both components, authoring tool and player, use the XML-based format for narrative game-based learning objects to exchange all dependencies and rules of the scenario elements [21]. They are flexibly extendible and proofed their validity as authoring and player software already for learning scenarios in the research field of Serious Games [22], [23].

B. Scenario phases and task types supported

In StoryTec the flow of activities is visualized by a graph of connected scenes of different types, e.g. one for solving several tasks, one for giving feedback, one for displaying received feedback etc. Teachers can easily create, arrange and modify these scenes. Based on our research we found the following setup recommendable for our evaluation: 1. solving two closed-format tasks on a comparably easy level, followed by automated diagnosis of the performance, 2. solving two open-format tasks and sending them to the system, 3. giving four times feedback to such open-format tasks' solutions of peers, 4. reviewing received feedback, 5. re-editing formally not correctly solved tasks (or skipping in case of all correct), 6.-7. again steps 1.+2. and finally 8. a last review like 4.

C. Digital Pen Support

To allow for open-format tasks PEDALE supports the use of digital pens and regular paper. The pen movements are recorded and stored as an image. These images are then embedded in the respective task and are re-displayed to the peer students for giving peer feedback, to the teacher when she accesses the solutions and to the same student when he revises wrongly solved tasks.

D. Providing and Receiving Feedback

When students are requested to give feedback to a peer's solution the best fitting candidate is selected. The selection is based on the previously received feedbacks to balance the knowledge exchange. For giving peer feedback the student is provided with the task, the hand-written notes and a feedback panel with structured feedback criteria. The student assesses the solution and ranks his own certainty of the given feedback. Using the judgment the software can update the learner models of both assessor and the person assessed. While receiving feedback students can browse their feedbacks in a list or drop-down selection in order to compare different hints easily.

IV. Evaluation Setup

In our first evaluation we aimed for an expert judgment of the usability and utility of PEDALE. The evaluation focus was twofold: on the one side the use in classroom setups from the teacher's perspective (i.e. diagnostic and instructional support and supervision) and on the other side from the student's perspective (i.e. task-solving and peer review). Therefore ten teacher educators were consulted to participate as experts in a pilot study (N=10). They used the player software with the setup as described in section III.B. The participants were then asked to fill in a questionnaire with crucial design and implementation aspects and about the requirements and potentials for classroom use and to evaluate the design in a group discussion. The data was analysed and grouped by similarity.

V. Evaluation Results

Interpreting the evaluation results we see a great support for our solution. For an instructional purpose the main potential is seen in the supervision of the class' as well as the individual's progresses. Furthermore the experts valued the possibilities for differentiation and automatic adaptation of future tasks depending on the students' performance. They suggested to broaden the application scenarios to homework and web-based learning communities. The real benefit for

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[1] Formerly known as the software BatCave

learning might truly come from a teacher-assistance. The peer review was seen as big potential for student understanding. The participants discussed the issue of anonymity vs. display of names. Whereas the display of names might promote an extra effort to provide helpful and good feedback, anonymity might prevent feeling uncomfortable while sharing erroneous solutions with classmates. Furthermore the mapping of feedback partners was mentioned as a crucial aspect of success. Several variables might be worth considering, for instance gender and performance. Additionally no two feedbacks should come from the same feedback partner as the feedback might be wrong or destructive. In order to fully use the potential of the peer review the whole feedback procedure needs to be understood as a learning process which must be practiced and improved in the classroom. For the diagnostic purpose the potential was mainly seen in the collection of rich information content and it's reusability. The management of these data can help to diagnose thoroughly. However the teacher's benefit for diagnosis and supervision depends on an interface to comfortably handle and filter the earned data.

Based on the results of the pilot study we enhanced the player software with a teacher supervision panel which allows for better supervision of the class' and the student's progress. It provides a filter-based search interface to see the students' solutions and feedbacks and filter it by student or by task, with or without feedbacks.

VI. CONCLUSION AND FUTURE WORK

The evaluation with teaching experts brought valuable hints for improvement and towards a better support for diagnosis and learning together. The results indicate some further research questions concerning specific design issues. The matching of feedback partners according to performance, gender and feedback history shifted into the focus of the next evaluation as well as the exposure of personal data during the feedback process. A teacher supervision panel is integrated in the software's next version.

Finally the most recent step after improvements of the software itself is the evaluation in real classroom setups. The details of such a classroom evaluation setup were focus of an earlier publication [3]. At the time this paper is published the evaluation should be already realized. We expect to prove the positive impact on motivation and learning for students while providing a software tool for instructional and diagnostic support in the classroom.

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