INFORMATICS – A CHILD'S PLAY?!

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Abstract

Informatics or computer science[1] contents are often considered as "difficult", at school as well as in University courses. This may be due to different reasons, e.g. to the topics themselves or to the way of teaching. What can be done in order to make it easier to understand for students of all ages? This paper about an Austrian project for primary and secondary schools – "Informatics – A Child's Play" – shows one possible way: the use of games, animations and simulations. The project is partly based on successful projects like "Computer Science Unplugged" or "Informatik erLeben (Experiencing Informatics)". Like these initiatives, it teaches computer science topics in a playful way, where children slip into the role of hardware components, parts of programs or data. But, the new project "Informatics – A Child's Play" goes further: New teaching units and material are developed and, this is the essential novelty, the children themselves design and test games, quizzes, puzzles and riddles. Furthermore, they act as peer tutors or peer teachers and explain different topics to their classmates, to younger children as well as to elderly people. This paper describes the project, which is still in the pilot phase, as well as some experiences and results gained up to now.

Keywords: Computer science, technology, primary education, learning by playing.

1   INTRODUCTION

The promotion of new talent in computer science is a main aim of the Regional Educational Competence Centre (RECC) for Informatics in Carinthia, Austria. This is a cooperation between the regional stakeholders in education: the Department of Informatics Didactics of the Alpen-Adria-University Klagenfurt, the University College of Teacher Education in Carinthia, the Carinthian Educational Board (Landesschulrat) and the Division of Education in the regional government. Our main aims are

- Increasing interest and motivation for computer science as a technical subject, especially in children and girls;
- Fostering teacher education and in-service training in computer science and all related fields on the basis of research in informatics didactics;
- Improving digital competencies of teachers and students;
- Enhancing methodical and didactical knowledge of teachers and teacher students.

To reach these and other goals we cooperate also with extracurricular educational institutions like the hands-on museum "wissens.wert.welt – blue cube & kidsmobil" or a mobile network operator and offer

- Courses and workshops on informatics concepts and the use of technology for elementary, primary and secondary education as well as for teacher education and in-service training;
- A mobile *Informatics-Lab* for schools;
- Consulting and support of school projects related to informatics and technology;
- Development of research-based didactical concepts and materials;
- Internships and traineeships for students of secondary schools and university.

At the moment our focus lies on decreasing the difficulties of students in computer science at school and university as well as on the promotion of young talent in order to encounter the lack of specialists in technical fields. These were the two main motivations for the project "Informatics – A Child's Play". It is partially based on similar projects like CS Unplugged [1] or "Informatik erLeben" (Experiencing Informatics) [2], which introduce core concepts of computer science in a playful way. In the new project "Informatics – A Child's Play" this effective method is continued, but extended by the new neurodidactical teaching approach "COOL Informatics" [3] developed during a habilitation project. Neurodidactics was initially established as an interface between neuroscience, didactics, pedagogy and psy-

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[1] Informatics and computer science are used as synonyms in this paper.

chology in order to help students with learning difficulties. Hence, it might support and enhance the understanding of difficult subjects like computer science, too. Related work in this field is mainly theoretical and contains general proposals for effective teaching and learning [4, 5]. But, as neurodidactics is a relatively young interdisciplinary science, serious empirical research is very scarce. The few projects conducted up to now confirm the hypothesis that the application of neurodidactical principles and concepts in the classroom can improve understanding and the learning outcomes [6, 7, 8].

2 THE PROJECT "INFORMATICS – A CHILD'S PLAY?!"

2.1 Motivation

The motivation for the project "Informatics – A Child's Play" was that students often have problems understanding computer science concepts as the learning outcomes in schools and university shows. Furthermore there is a lack of qualified technical staff and the interest in technology and computer science has to be promoted [8].

The project "Informatics – A Child's Play" is mainly intended for primary and lower secondary schools. It aims at raising interest and motivation for informatics and other technical subjects by teaching core concepts of computer science to children from five years on in a way that they can understand. This can be achieved by various methods, e.g. the use of games or animation as successfully demonstrated in projects like "CS Unplugged" [1] or "Informatik erLeben" (Experiencing Informatics) [2]. "Informatics – A Child's Play" is partly based on these projects, but it goes further, as it is developed on the basis of a new neurodidactical teaching approach: "COOL[2] Informatics" including the main principles of discovery, cooperation, individuality and activity (see section 3.1) [3].

As computer science is not part of the primary and lower secondary school curricula it is necessary to integrate it in other subjects as well as to foster projects and cooperation with other schools and universities. This is often difficult due to different reasons. The largest hurdle is, that teachers, mainly in primary schools, show a rather reluctant attitude towards computer science. On the one hand, they are skeptical because informatics is not part of the curriculum and they cannot see the relevance for their lessons. On the other hand, there are still some misconceptions about informatics, which is often understood as "work on computers" and "software use". But, informatics is a technical subject and this is the next hurdle: technology is considered "(too) difficult". Therefore, one aim of this project is to break down these fears respectively to avoid them. This is possible, when we start introducing technology already in elementary and primary education, because misconceptions and fears only arise later in lower secondary schools [2]. Furthermore, the main aims of the project are the following:

- Raising and fostering interest for technology and computer science, particularly in girls;
- Integrating core concepts of computer science in the long-term in primary education;
- Laying the basis for computational thinking and necessary skills like problem solving;
- Fostering activity and creativity of the children;
- Improving understanding of complex contents by considering neurodidactical principles.

2.2 Project Procedure

To reach the goals above, the project started in 2013 and is divided in three phases:

1. the pilot phase for the development of teaching units and materials,
2. the implementation of the project in different partner schools and
3. the completion phase with a final evaluation and the publication of the developed materials.

The *pilot phase* (March 2013 – September 2014) is mainly dedicated to lesson and task design (see section 3). It aims at developing playful teaching units and materials based on the "COOL Informatics" approach, testing and evaluating them regarding their practicability in primary education. The pilot phase includes two sometimes overlapping phases, which are already evaluated in part:

1. In the *preparatory phase* (March 2013 – July 2014) we (the RECC - Regional Educational Competence Centre of Informatics in Carinthia, Austria) firstly prepared an application for fun-

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[2] COOL = COoperative and COmputer-supported Open Learning + "cool" as motivating, playful etc.

ding of the Sparkling Science program of the Federal Ministry of Science, Research and Economy. Furthermore, this phase aims at finding partner schools and developing new teaching units and materials for different informatics concepts. In the development of the teaching units not only scientists are involved, but also teachers, teacher students and students of different secondary schools in the framework of a traineeship at the Department of Informatics Didactics work together. In a first step all participants get information concerning the planned project, the teaching approach "COOL Informatics" and the neurodidactical principles that should be considered in lesson and task design. New units and materials are developed and already existing teaching units of the project Informatik erLeben (Experiencing Informatics) [2, 10] are adapted and extended. During this preparatory phase all RECC-members are involved: The Department of Informatics Didactics at the Alpen-Adria-Universität Klagenfurt is responsible for the development and execution of the informatics workshops, whereas the other partners – teachers and the University College of Teacher Education, Carinthia – promote the workshops, search and inform partner schools.

2. In the *test phase* (February 2014 – September 2014) the developed units and materials are tested in different workshops for schools, during the "Long Night of Research" at our university and for our cooperation partner "wissens.wert.welt – blue cube & kidsmobil", a hands-on museum for children. The workshops have been evaluated (see section 4) and are now extended and/or adapted based on the feedback of teachers and students.

The *implementation* of the project will start in autumn 2014 in different classes of our partner schools as well as in the planned stationary *Informatics-Lab* of our Regional Educational Competence Centre. Certainly the workshops and materials will be continuously evaluated and adapted if necessary.

The *completion date* of the *project* is not fixed yet. The final date depends on the funding, which is still not fully guarantied. Actually, the planned closure will be in summer 2015 including a final evaluation and the publication of a booklet containing ready to copy teaching units and materials for primary schools. If the funding of Sparkling Science will be approved, the project will last until October 2016. If the stationary *Informatics-Lab* can be established and funded as planned the project will be extended until 2018.

Currently, the project is still in the pilot phase, where we have already developed and tested some workshops and teaching materials (see section 3). The evaluation methods and results we gained up to now are described in section 4.

3   TEACHING UNITS AND MATERIALS

3.1   About The Teaching Units and Materials

The teaching units and materials are developed on the basis of "COOL Informatics", a new teaching approach developed during a habilitation project. It integrates neurodidactical principles in order to make difficult and complex topics easier to understand and to support the memory process. The first version of the teaching concept "Brain-based Programming" was successfully tested over two semesters in four Bachelor introductory programming courses. [3, 7, 8]

The successful concept was even nominated for the Ars docendi – Award 2013, the Austrian national award for excellent teaching in universities. It was then adapted according to the feedback of students, peer tutors and teachers and extend to the more general concept "COOL Informatics". This concept is not only based o neurodidactical findings but also on empirical research on successful teaching concepts and methods.

Table 1 shows an overview of the four main principles, the corresponding teaching methods with references to related empirical research as well as their relation to neurodidactics.

Table 1 Overview teaching approach "COOL Informatics" [3]

"COOL Informatics" – Overview		
Principle	**Teaching and learning methods**	**Neurodidactical basis**
1. Discovery	Solution-based learning (worked examples) [11] Step-by-step instructions + tasks Observational learning Video tutorials Hands-on, Minds-on Learning with all senses	Pattern recognition Mirror neurons Individual learning rhythm modality / multimedia effect
2. Cooperation	Team and group work [12, 13] Peer tutoring and -teaching [14, 15] Pair programming [16, 17] Cross-curricular learning Project-based learning	"A joy (=knowledge) shared is a joy (=knowledge) doubled." Recall = re-storage in long-term memory Integrating individual needs, talents and competences as well as practical relevance
3. Individuality	Competence-based learning Questioning [18, 19] Self-organized learning with compulsory and optional tasks	Connecting new information to previous knowledge, Considering individual interests, needs, tasks, methods and learning rhythm
4. Activity	Hands-on, Minds-on Learning by doing [18, 20] Learning by animation, simulation and playing [21, 22] Learning by playing and designing games (creative learning)	Knowledge must be newly created (constructed) by each learner (= constructivism) Learning is an active process (=progressive education)

Up to now we have developed the following workshops. The respective computer science concepts are given in brackets.

- 1 + 1 = 10 (binary numbers, addition, subtraction, parity bits)
- CSI Informatics – Find the thief! (secret language, encryption, decryption)
- How to communicate with my computer? (describing directions, algorithms, Lego robotics)
- Playful programming (Scratch, Enchanting)
- Pictures learn to walk (color systems, graphics,
- Top secret (hiding of information, coding, encryption, decryption)
- One switch – many switches – hardware
- All is logic! (Boolean algebra, digital circuits, logic operators)
- Models & Co. (modeling, classes, objects, inheritance)

All these workshops were already tested in different contexts and with different target groups. Depending on the duration of the workshops and the age of the students the topics were elaborated more or less in depth. The next section shows one sample unit in order to demonstrate how the principles of "COOL Informatics" are put into practice.

3.2 A Sample Teaching Unit: "All is logic!"

The unit "All is logic!" shall introduce logic operators, Boolean algebra and digital circuits for children. In the following paragraphs the procedure of the workshop for young children is presented.

At the beginning of the unit the children are asked some questions in order to check previous knowledge (not only in informatics) and to connect the new concept to it. Some sample questions are:

Do you know anything about algebra? What is logic? Where do you need logical thinking? Are you able to think in a logic way? Can computers think logically, too?

Based on the answers of the children, the teacher shortly explains what logic and logical thinking means for informatics and for computers. He/she explains that also computers can think logically and make decisions based on certain conditions. In a next step the relation to hardware and digital circuits has to be drawn. A short story like the following example makes the concept understandable for children, because it shows a situation that they may know from their own world:

Maxi has his birthday and invites some of his friends for a small birthday-party. As this date is in the time of carnival the children who come to the party should wear a mask or bring a birthday present. All of them who are wearing a mask or bring a gift get a piece of the cake. The others only get a hot chocolate. How many pieces of cake and how many cups of chocolate must Maxi buy?

Based on this story in a first round the teacher (principle: discovery) and in a second round the children (principle: activity) complete a truth table. They use child-friendly symbols like smileys for the persons and cards with check marks (yes) or crosses (no) in order to indicate if the condition is true or not. During these two rounds the teacher always uses questions and comments in order to explain what is happening. Some sample questions and comments may be: "The first friend (smiley) has a mask and brings a gift. So both conditions are true and we put a green tick into the columns "mask" and "gift". Is the statement that *this friend has a mask OR a gift*" true? Does this friend get a piece of cake? Yes, hence we can put the corresponding card into the last column. Which cards (symbols) can we put into the table regarding the second friend?"

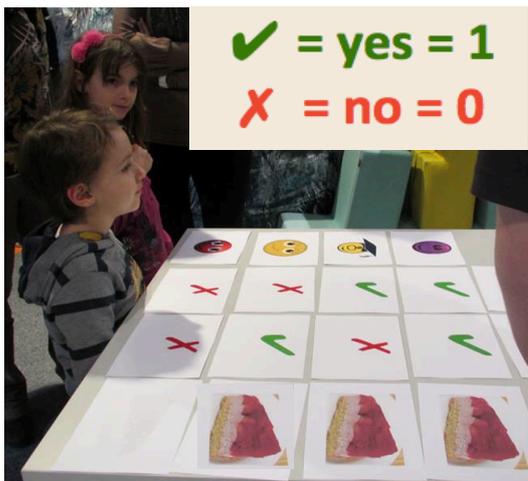Fig. 1 and 2 show possible truth tables for the condition "mask **or** gift".

	Mask	Gift	Mask OR Gift
	1	1	1
	1	0	1
	0	1	1
	0	0	0

Fig. 1 Truth table for "mask OR gift"   Fig. 2 Truth table with binary numbers

In the second turn the children are asked what happens when the condition changes. How many cakes does Maxi need, when only those children eat a cake, who wear a mask **and** bring a gift? The children complete once again a truth table and check the difference between the "and" and "or" operator in Boolean algebra. In the next step the relation between a truth table and a digital circuit is shown. To demonstrate it as clearly and easily as possible, the teacher lays the cards once again (Fig. 1 or 2) and shows a corresponding digital circuit like the graph in Fig. 3.
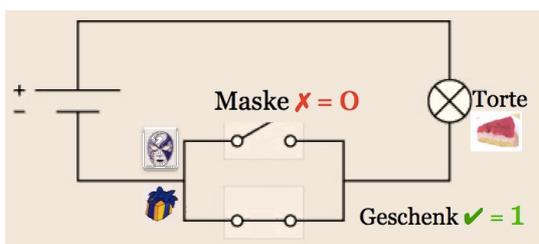

Fig. 3 Digital circuit based on truth table in Fig. 3

Fig. 4 Digital circuit with magnetic toys

Besides that he/she uses magnetic toys and "constructs" a sample digital circuit accompanied by comments and questions (principle: discovery) (Fig. 4). One sample circuit shall be built by the teacher (principle: discovery) and then different variations of "and" and "or" conditions are constructed by the children together (principle: activity).

This unit about Boolean algebra is relevant not only for informatics but also for different other subjects, e.g. native of foreign language lessons, math or technology. It can train general and cross-curricular competencies like reading carefully, text comprehension, extracting essential information, logical thinking etc. already in primary schools. Furthermore, starting from this sample unit, children can write their own short stories in different languages and use them for designing even more complex truth tables and digital circuits (principles: individuality and activity).

3.3 Teaching Materials

Teaching materials appropriate to the principles of the "COOL Informatics" approach support discovery learning, activity and creativity. In order to make lessons more active, the teacher might push pupils to test their new knowledge for instance by designing games (principles activity and individuality).

To revise the concept of Boolean algebra and digital circuits the children get the cards used in the example and some magnets in order to "build" digital circuits corresponding to the truth table in Fig. 2. Then they shall invent their individual stories and statements for which they complete corresponding truth tables and build digital circuits. Depending on the age of the children further logic operators like the XOR (the exclusive OR) can be introduced and more conditions can be defined, e.g. "Children who bring a gift OR a cake AND wear a mask drink a chocolate".

The materials presented here were developed as examples for the children and complete the units about hardware and software described in [23]. These tasks correspond to the principle of discovery and shall animate the children to create their own activities and games (principles: activity and individuality). For this purpose, computers are not necessary as Fig. 6 shows.

Fig. 5 Memory game "Hardware" designed by children of a primary school [Els]

But also applications like LearningApps[3] and educaplay[4] are easy to use and support the development of different games, quizzes and puzzles. The matching game (Fig. 7) can be played (drag and drop) after having learned the main concepts of hardware, but also in order to introduce the topic (principle: discovery) and to check previous knowledge.
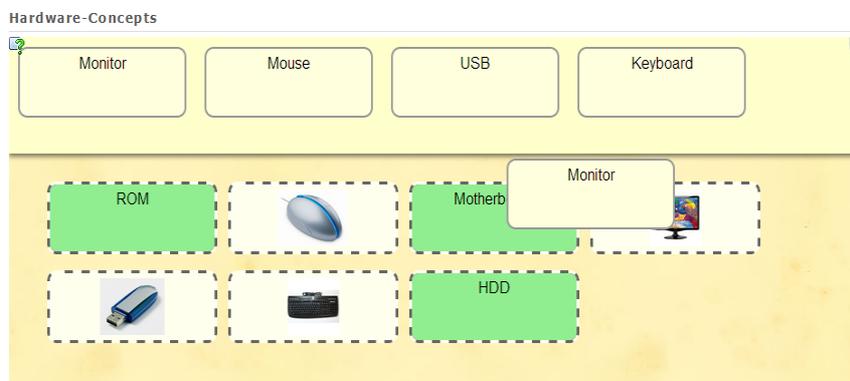

Fig. 7 LearningApps: Hardware concepts matching game.

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[3] http://learningapps.org/

[4] http://en.educaplay.com/

Another form of playing (and simultaneously learning) the hardware concept is the word-search puzzle (Fig. 8) or the crossword (Fig. 9).

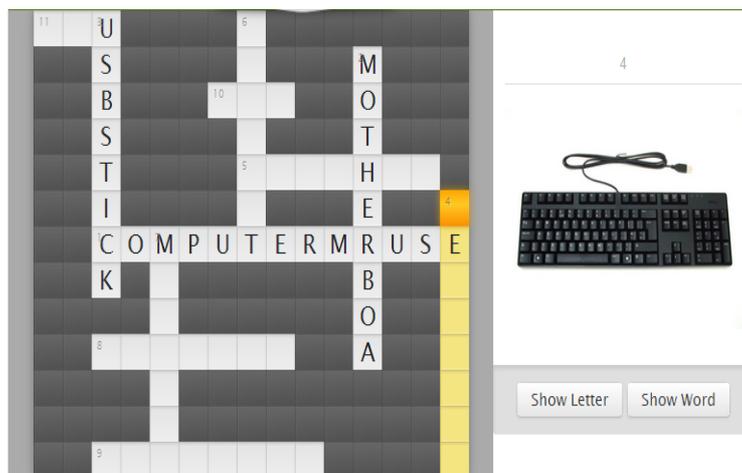**Fig. 8 LearningApps: Hardware concepts word-search puzzle.**

Fig. 9 The LearningApps for crossword.

4 METHODS AND RESULTS

For the evaluation of the project "Informatics – A Child's Play" we use a quantitative and qualitative research design. Currently the project is in the pilot phase where the qualitative feedback from open interviews, observation and dichotomous questions prevails.

Among others, the following research questions of the project can already be answered cautiously:

1. Can the interventions of *Informatics – A child's play* increase interest for technology in general and computer science in particular?
2. Is it possible to integrate computer science concepts in the long-term in primary and lower secondary education without changing the existing curricula?
3. Which informatics concepts are useful and practicable in elementary and primary education?
4. Can the new teaching approach "COOL Informatics" enhance also general skills like logical thinking or problem solving?

Up to now we have held already six workshops of one hour were held for different schools (students' age: 10-14). Furthermore, parts of the workshops were presented in different stations at the "Long Night of Research" at the Alpen-Adria-Universität Klagenfurt. Participants and teachers evaluated the teaching units and materials in open interviews, by observation and smileys. The smileys are a very easy system for getting a fast evaluation from the students after the workshops. This was necessary, because there was not much time available for evaluation. The participants have to pick a green card with a "happy" smiley or a red card with an "unhappy" smiley and throw it in separate boxes for boys and girls. With a green card they indicate, that they have understood the content and the red ones stand for the opposite. This system was developed for stressful situations with a lot of students or interested people, when it is not possible to ask everyone for a feedback.

In a workshop for 59 students between 12 to 14 years old the Boolean algebra unit was evaluated with the help of the smiley-cards as visualized in Fig. 10.
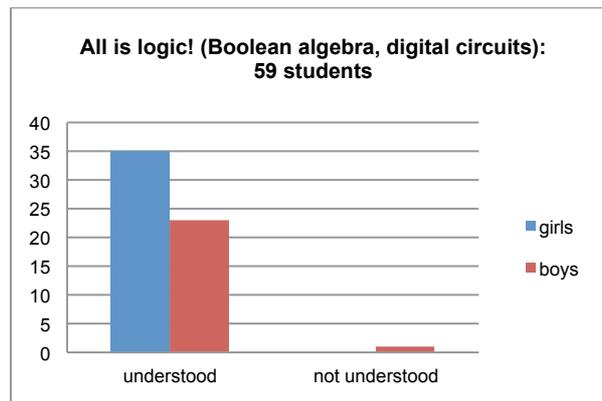
All is logic! (Boolean algebra, digital circuits):
59 students

Fig. 6 Evaluation results for the Boolean algebra workshops.

As expected, the majority, 58 of the 59 students, understood the content. Only one male student threw a red card into the feedback box. Further results from other workshops show similar tendencies, which is shown in Fig. 11, where evaluation results from different workshops with different content and numbers of students are included.
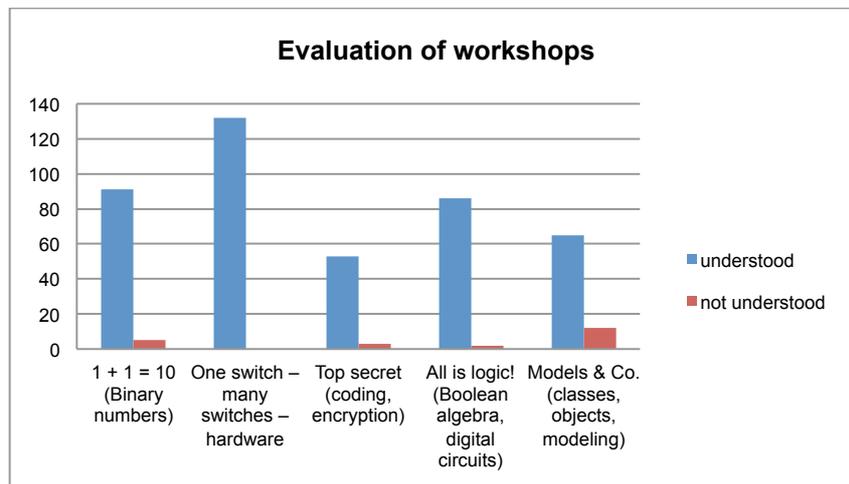

Fig. 7 Evaluation results from different workshops.

In addition to the smiley cards the following statements were given during the interviews with students, teachers and workshop leaders.

- For a lot of people this content is very interesting.
- It makes sense to show where the content can be used.
- The examples like the one with the birthday party are good.
- Informatics can be fun.
- These workshops are well-suited for children and adolescence.

The non-informatics teachers of our partner schools, who participated in the workshops with their students, could also see the relevance of some topics for their subjects, particularly coding, encryption, logical operators and modelling.

The success of the workshop and the level of understanding depend very much on the way of explaining. This could be observed at the station "Models & Co." during the "Long Night of Research". At this station two persons acted as teachers: The first teacher (one of the authors, who is used to work with children and to explain topics in a playful way) got only green smileys as feedback. The second teacher, an 18 years old student of a technical high school without teaching experiences, used

a more technical language in his explanations and got some read smileys only from female visitors. This effect will be studied more in detail in the following workshops.

5   CONCLUSION

As the interim results of the project "Informatics – A Child's Play" show, all presented computer science contents could be understood easily and are appropriate also for younger children. All interviewed participants independent from age and gender liked the workshops and the majority found them easy to understand. Certainly it depends on the way of explaining, the teaching methods and the used materials. The results suggest that considering the principles of "COOL Informatics" – discovery, cooperation, individuality and activity – and the use of games and game design can help to under-stand difficult concepts and to relate them to the world of the students. Non-informatics teachers who participated in the workshops could confirm this as well. They recognized the practicability and meaning of different informatics concepts for their subjects and general skills like problem solving, text comprehension and creativity. Summarizing all experiences and results up to now plead for continuing and extending the project. In the next phase not only the practicability and satisfaction with the workshops but also the effectiveness of such interventions will be evaluated in different schools. Furthermore, a long-term study should be started in order to follow the way of the participating students and to see, if the interventions have an impact on general learning skills like problem soling etc. as well as school and career choices.

REFERENCES

[1]   Bell, T., Lambert, L., and Marghitu, D. (2012). CS unplugged, outreach and CS kinesthetic activities. In Proceedings of the 43rd ACM technical symposium on Computer Science Education (p. 676). ACM.

[2]   Bischof, E. (2011). Interventionen im (Informatik-) Unterricht. Ein Versuch bei SchülerInnen das Bild der Informatik zu erweitern. Dissertation. Alpen-Adria Universität Klagenfurt.

[3]   Jensen, E. (2008). Brain-based learning: The new paradigm of teaching. Thousand Oaks: Corwin Press.

[4]   Sousa, D. A. (2006). How The Brain Learns. Third edition. Thousand Oaks, California: Corwin Press.

[5]   Ozden, M. and Gultekin, M. (2008). The Effects of Brain-Based Learning on Academic Achievement and Retention of Knowledge in Science Courses. In Electronic Journal of Science Education, 12(1), 2008. Retrieved on 19/07/2013 from: http://ejse.southwestern.edu /article/download/7763/5530.

[6]   Sabitzer, B. and Strutzmann, S. (2013). Brain-based Programming. In Proceedings of IEEE Frontiers in Education, Oklahoma City, Oklahoma, US.

[7]   Sabitzer, B. and Pasterk, S. (2014, in press). Brain-based teaching: Neurodidactical Proposals For Effective Teaching in Computer Science. In Proceedings of 19th Annual Conference on Innovation and Technology in Computer Science Education, Uppsala, Sweden.

[8]   Schmied, K. (2011). Fachkräfte 2020 - JUGEND BEGEISTERN – CHANCEN SCHAFFEN – Ausbildung sichern. Retrieved on 26/05/2014 from http://www.iv-net.at/iv-all/publikationen/file_571.pdf

[9]   Mittermeir, R. T., Bischof, B. and Hodnigg, K (2010). "Showing core-concepts of informatics to kids and their teachers." *Teaching Fundamentals Concepts of Informatics*. Springer Berlin Heidelberg, 143-154.

[10] Sabitzer, B. (2014, in press). A Neurodidactical Approach to Cooperative and Cross-curricular Open Learning: COOL Informatics. Habilitation thesis. Alpen-Adria-Universität Klagenfurt. = 3

[11] Renkl, A.; Atkinson, R.K. (2002). "Learning from examples: Fostering self-explanations in computer-based learning environments." in Interactive learning environments, 10(2), 105–119, 2002.

[12] [11]C.J. Roseth, D.W. Johnson, R.T. Johnson (2008). "Promoting early adolescents' achievement and peer relationships: The effects of cooperative, competitive, and individualistic goal structures." in Psychological bulletin, 134(2), 223.

[13] B. Gokkurt, S. Dundar, Y. Soylu, L. Akgun (2012). "The Effects of Learning Together Technique Which is based on Cooperative Learning on Students' Achievement in Mathematics Class." in Procedia-Social and Behavioral Sciences, 46, 3431–3434.

[14] V. Miller, E. Oldfield, M. Bulmer (2012). "Peer Assisted Study Sessions (PASS) in first year chemistry and statistics courses: insights and evaluations." In Proceedings of The Australian Conference on Science and Mathematics Education (formerly UniServe Science Conference) (Vol. 10).

[15] Porter, L., Bailey Lee, C., & Simon, B. (2013). Halving fail rates using peer instruction: a study of four computer science courses. In Proceeding of the 44th ACM technical symposium on Computer science education (pp. 177–182). ACM.

[16] N. Salleh, E. Mendes, J. Grundy (2011). "Empirical studies of pair programming for CS/SE teaching in higher education: A systematic literature review." in Software Engineering, IEEE Transactions on, 37(4), 509–525.

[17] C.M. Lewis (2011). "Is pair programming more effective than other forms of collaboration for young students?" in Computer Science Education, 21(2), 105–134.

[18] J. Hattie (2009). Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement. Taylor & Francis, London, New York.

[19] S.D. Craig, J. Sullins, A. Witherspoon, B. Gholson, "The deep-level-reasoning-question effect: The role of dialogue and deep-level-reasoning questions during vicarious learning." in Cognition and Instruction, 24(4), 565–591, 2006.

[20] H.W. Reese (2011). "The Learning-by-Doing Principle." in BEHAVIORAL DEVELOPMENT BULLETIN, 11.

[21] A. Bollin. E. Hochmüller, R. Mittermeir. L. Samuelis (2012). Experiences with Integrating Simulation into a Software Engineering Curriculum. In: D. Chen, M. Baker, L. Huang (Ed.): Proceedings of 25th IEEE Conference on Software Engineering Education and Training CSEE&T 2012, 17-19 April 2012, Nanjing, Jiangsu, China. Los Alamitos (CA): IEEE Computer Society Press, April 2012, pp. 62-75.

[22] Bell, T., Lambert, L., & Marghitu, D. (2012). CS unplugged, outreach and CS kinesthetic activities. In Proceedings of the 43rd ACM technical symposium on Computer Science Education (p. 676). ACM Digital Library.

[23] Elsenbaumer, S. 2013. Neurodidactics in Practice. A Practical Approach to Introducing Informatics into a Primary School in a Brain-based Way. Unpublished Diploma Thesis, University of Klagenfurt.