Informatics is COOL
COoperative and COmputer-assisted Open Learning

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ABSTRACT
Informatics is COOL – as a subject and as a tool. In this paper COOL refers to three different aspects of learning: First of all, COOL stands for "cool" in the sense of interesting, motivating or fun, topics that students like to learn and methods that enhance learning, e.g. brain-based teaching. Furthermore, COOL can be the abbreviation of COoperative Open Learning, an Austrian teaching model based on the Dalton-Plan or COmputer-assisted Open Learning. This paper first describes all three forms of COOL learning and gives examples for COOL Informatics lessons. The evaluation results of two pilot projects, one in a primary school and one in a university programming course at our university, suggest that COOL is worth being implemented and refined in all levels of school and university.

Categories and Subject Descriptors
K.3.1 [**Computers and Education**]: Computer Uses in Education – *Collaborative learning*

General Terms
Human Factors, Theory.

Keywords
Cooperative open learning, computer-supported learning.

1. INTRODUCTION
The term "cool" is frequently used by young people and mostly associated with something positive. It can stand for beautiful, great or anything similar. In relation to teaching in schools or universities teachers, lessons or subjects can be cool. The different meanings "COOL" can have in this context will be discussed in this paper.

Firstly, COOL can describe lessons that are cool in the sense of interesting, good, diversified, and effective. The question what is necessary for learning so that students would call it "cool" comes up. What is cool for the brain of the students, can be answered by the research field of neurodidactics. Teachers should consider this information to make learning more brain-friendly and thereby more effective [1].

According to an Austrian initiative "COOL" is a shortcut for "COoperative Open Learning" [2]. The idea behind this project, which started in 1996, is to take the heterogeneity in classrooms more into account. Further, the integration of so-called "soft-skills" in school-education should be more intense. For this purpose different progressive education approaches and especially the Dalton plan from the US-American Helen Parkhurst is referenced.

Additionally COOL can be interpreted as "COmputer-assisted Open Learning". This method uses technology to increase and facilitate the cooperation of students. It can be compared to "Computer-Supported Collaborative Learning" (CSCL) or eLearning, which have similar directions but some different elements [3].

After the introduction to COOL and its theoretical background the paper gives examples for all three COOL meanings: It talks about COOL and playful informatics in primary schools, computer-supported lessons in secondary school as well as a COOL teaching concept for a university programming course based on neurodidactical principles.

2. WHAT IS COOL?
COOL lessons and methods – in all three senses – have in common that they consider brain and memory functions, which improve the learning process.

Teaching is *cool* when it affects the students' innate curiosity and when they have fun, like in learning by playing as offered in the project "Informatik erLeben" (Experiencing Informatics) where children act as computer components, programs or data [4]. In this case the neurotransmitter dopamine is released, which has a reward effect and supports learning and memory [5]. Education and learning can be characterized as "cool" from different views: from students or from teachers. For teachers cool can stand for effective, e.g. by considering how the brain works. Students will describe learning as cool when they are engaged in a subject or have the feeling that learning for a subject is easy and/or fun. For most people playing games is very engaging and with every game someone plays learning happens [6].

COOL as *COoperative Open Learning* considers the social brain and helps to "teach" soft skills like communication competence or responsibility. This was the aim of a vocational school in Steyr, Austria, that initiated the "COOL" project with the idea of a better handling of the strong heterogeneity in the classes and the promotion of soft-skills. The result was a new teaching concept called "COOL", the abbreviation for Cooperative Open Learning, which

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is mainly based on the principles of the Dalton Plan [2]. The basic elements of the Dalton Plan are

- *freedom*, students should be free to choose when, where and how long to work on chosen exercises from a given work request,
- *cooperation*, students and teachers should have the possibilities to work together in teams or groups, and
- budgeting time, students should self-reliantly organize and plan their work for given assignments. The term COOL implies two different methods: Cooperative learning and open learning.

Cooperative learning contains methods including different forms of group or team work. Cooperative learning methods can support the long-term memory because they require continuous recall, which starts the whole memory process from the beginning and leads to a better storage of information [7]. Furthermore, cooperative learning promotes and enhances the social skills and the self-related learning [8].

Open learning underlies different interpretations in literature. The basic elements were developed by a combination of principles from progressive pedagogic approaches like Freinet and Montessori. That makes it hard to find an exact definition for it. Especially, it is important to consider openness that can refer to different dimensions: to thematic, methodic and institutional openness [9]. This means that COOL offers freedom of choice concerning topics, contents, learning methods as well as location and time.

The connection of these two independent education methods to "Cooperative Open Learning" aims at fostering self-reliance, personal responsibility and cooperation for the secondary education (from 5th school grade onwards) [2]. COOL can be integrated into traditional schools without changing the whole institutional structure for all classes. To make cooperation easier and independent from room and time it can be supported by the use of computers and mobile devices.

COOL as *COmputer-assisted Open Learning* or "eCOOL", as it is called in the COOL concept, can support and facilitate cooperative learning. Furthermore, it considers the modality or multimedia effect when applied in an appropriate form: Information will be better stored and recalled if it is dual-coded, e.g., if it is presented audio-visually [10]. Main characteristics of eCOOL are:

- Usage of learning platforms;
- Assignments including e-learning-elements (eCOOL);
- Larger, individual feedback in digital form;
- Less online-time, but more direct communication;
- Usage of ePortfolios [2].

What e-learning exactly stands for is difficult to say because literature offers many definitions for it. Mostly, e-learning is understood as a collective term for all forms of technology-supported learning [11]. With the initiation of Web 2.0 also e-learning changed. For teaching and learning the Internet switched from an information and material source to a modifiable environment. Students, alone or in cooperative work, can actively create content and publish it easily in different ways without special prior knowledge. Examples are Weblogs, Wikis, Websites, Podcasts, Media sharing, or Social Networks [11]. The ePortfolios used in eCOOL can have these forms including the content collected and produced by students themselves. These tools as well as mobile devices can improve cooperation between students during lessons at school and beyond. That leads to approaches, which come closest to the interpretation of COOL = Computer-assisted Open Learning: CSCL (Computer-supported Collaborative/Cooperative Learning). CSCL can be described as cooperative learning with the help of current information and communication technology. Although it is an approach for cooperation it does not exclude time for individual learning, which is essential for good cooperative work.

3. COOL INFORMATICS IN PRACTICE

Unfortunately, in schools Informatics or computer science education are often equated to "work on computers"; so it seems obvious that it is also "computer-assisted". But Informatics is much more than using computers and than user training. It has to teach also the concepts behind computers like coding, encryption, Boolean algebra or object orientation. Then computers are not necessarily needed (e.g. in Informatik erLeben [4]) but they can support learning, understanding and practicing these topics in different ways described in numerous books and articles about computer-supported learning or e-learning, e.g. in [3] or [11]. A review of the possibilities would go beyond the scope of this paper. At this point we will only give some examples used in our own courses that can be seen in the sense of "cool" and COOL as COoperative or COmputer-assisted Open Learning.

3.1 Computer-assisted: Online Courses & Co.

Online courses, video lectures, podcasts or step-by-step tutorials, for example, can support and supplement the teachers' lectures at school or university. There is a huge amount of online offers, e.g. from different open universities, iTunesU, a free platform with courses and lectures from more than 1,000 universities, or YouTube. Every student knows YouTube well, so why not use it for educational purposes? The online courses are a varied and valuable information source for students as well as for teachers who can publish their own video files or tutorials e.g. on YouTube, too. Step-by-step video tutorials that can help students e.g. to learn how to program or how to use a certain application can easily be created with online capturing tools like "Faststone capture" [12] or "Hypercam" [13] which record all activities on the screen and save them as video files.

These tutorials can be a good help for students, but for effective learning, more important than the passive consumption of all the information, is an active use of these platforms or tools. As we know from neurodidactics, learning is always an active process where knowledge has to be constructed [14]. Therefore students should be motivated to elaborate the learning contents actively and to make their own video lectures, courses, podcasts or step-by-step tutorials. This allows not only revising the learned topics. Talking about them and explaining them to others is an effective learning method. As described e.g. in [14], compared to other methods teaching others and/or the immediate use of learning lead to the highest retention rate of 90%, followed by practice by doing (75%) and discussion groups (50%).

Besides, it requires cooperation and self-reliance, two of the main principles of COOL as COoperative Open Learning. Furthermore, students find it "cool" to create and publish their own videos or podcasts as verified in a project in the course of the Carinthian teacher support program "Informatik kreativ unterrichten" (Teaching Informatics creatively).

This project called "Lassen wir die Jugend sprechen" (Let's make the adolescents talk) was carried out in two classes of an Austrian vocational school for computer scientists. The COOL Informatics lessons aimed at designing micro learning modules that should

help other students to understand different informatics concepts. The students had to create short creative podcasts or webcasts about different topics like algorithms, object orientation or databases. Besides the aspect that learning by teaching others is very effective [14] the project leader assumed that it might be easier for adolescents to understand the explanations of their peers who use the "same" language than those of the teacher. During the design and the production of these micro learning modules the students were very motivated and active, discussed about the topics and tried to help each other to really understand the concepts. With each step in their work they could also increase their self-esteem, an important factor in learning [15], because they were proud of their products [16]. Furthermore the multimedia learning modules can also support the memory process by taking benefit of the modality effect [10].

3.2 Cooperative Learning: Peer Tutoring

Computer-supported teaching and learning also facilitates cooperation between students and/or teachers, as it is required in COOL as COoperative Open Learning. Besides that, cooperative learning methods, e.g. teaching others (e.g. peer tutoring), discussion groups [14] or pair programming, are effective [17].

This could also be verified in a pilot test of a new teaching concept for programming courses based on cooperative learning and neurodidactical principles [18]. It was carried out in an introductory programming course at our university. In order to implement cooperative methods as effective as possible the students were divided up into three groups: *professionals* with already good programming competences who acted as peer-tutors, *amateurs* with some competences and real *beginners*. Each lesson was divided in three phases: the *question* phase and the *discovery* phase - the students worked together in groups, each supervised by one of the professionals. They tried to revise the learned contents by asking questions and elaborating worked-out examples and short competence-oriented exercises with solutions. In the third phase, the *lab*, they had to solve problems in the form of pair programming. The results of the pilot project showed that the students mainly appreciated the methods of peer tutoring and pair programming as well as discovery learning with the help of the peer tutors or their partners in the phase of pair programming. The students' feedback on the course and the learning outcomes – the grades of the students in the final exam – were better than in the last three years. This supports the hypothesis that cooperative learning based on neurodidactical principles is more effective than traditional lessons. Certainly, this hypothesis has to be verified in a larger empirical study [18].

3.3 "cool" Informatics: Games and Animation

The adjective "cool" describes lessons that are fun, interesting, creative, engage learners and consider one of the two COOL methods mentioned above: cooperative and computer-assisted open learning. Informatics offers a lot of possibilities to design "cool" lessons, certainly depending on the age of the students.

Mainly for primary schools projects like "Computer Science Unplugged" or "Informatik erLeben" (Experiencing Informatics) are "cool" because they teach core-concepts of Informatics in a playful way that is easy to understand. The pupils cooperate in groups and, depending on the topic, they act either as part of the computer, serving as data or as objects being manipulated by algorithms, or adopting some role of a program. Computers are not specifically used during the lessons. The pupils learn, based on activities, simulations, and animations [4]. Certainly theses playful units can also be integrated in secondary schools in order to make complex topics easier to understand. Playing and animating hardware elements, data or parts of algorithms is not only fun. Through this way of "Learning by Doing" the contents will be better stored in the memory [14].

"Games can aid in the understanding of a difficult concept or idea" postulated Cliburn [19]. But not only playing, also designing games can be cool and motivating as shown by Cliburn [19] who studied the effectiveness of games as assignments in programming courses. This doesn't refer only to playing games, but also to the design of games. Most of his students preferred game assignments to non-game assignments. Even though the game assignments didn't seem to improve the student scores overall, at least motivation was higher and the students enjoyed the type of tasks.

One example of combining all three meanings of COOL for primary schools has been developed, tested and evaluated by one of the authors during a project called "Exploring and discovering Informatics". The COOL teaching unit about PowerPoint and the results of the evaluation in a primary school are given in [20]. It is created for very young learners of primary schools, though for the third or the fourth form. The general assumption is that these students are beginners, who are not familiar with standard software, but at least know how to handle a computer mouse or the keyboard. Instead of simply showing students how this application works, with the help of a projector and the principal of 'I click then you click', the students get the task to discover the tool by themselves. For this purpose, they are provided with a worksheet, which explains the main steps of what they are supposed to do, and learning videos.

The students have the task to work in groups of two to three people and create a PowerPoint presentation on what they have learned in Informatics so far. The teacher slips into the role of a coach or consulter, who only provides the students with the necessary requirements: technical requirements (computer, software, etc.), the worksheets and of course the learning videos. In the first step, the teacher should only divide the class into groups, handout the worksheet and makes sure that all computers are working and the students know where they can find the necessary software and files. The students have the task to, first of all, read through the worksheet and follow the instructions. Nevertheless, the instructions are very generally formulated and only roughly tell them what the aim and the outcome of this unit should be and instruct them to start with their presentation. In case they need help they are supposed to watch the videos, which describe the proper handling of PowerPoint step-by-step. However, the videos only show the basics of PowerPoint but do not answer textual or stylistic questions. The students need to be creative, work independently in groups and create individual presentations.

Following the results of the feedback for these lessons in [20] students were interested in the content, as well as engaged and motivated. That would correspond to the interpretation as "cool", considering the functions of the brain and memory. Thus these lessons in primary school can be an example of cool informatics lessons.

4. Conclusion

COOL Informatics refers to three different aspects of learning not only in informatics but also in other subjects: COoperative Open Learning, COmputer-assisted Open Learning and "cool" in the sense of interesting, motivating and fun. The aim of the paper was to give an overview of the theoretical background of COOL Informatics including the Austrian teaching concept of COoperative Open Learning as well as the neurodidactical background. Fur-

thermore, some examples of COOL Informatics in practice were presented. They include different methods like discovery learning, peer tutoring and peer-teaching (learning through recall) or game-based learning.

Regarding the experiences of the described examples and projects in primary and secondary schools as well as in a university programming course it can be said that COOL in all senses is worth to be considered in all levels of education. Games, animations and simulations are not only fun, mainly in primary schools, but satisfy the requirements of neurodidactics as they consider how brain and memory work. This is also the case when cooperative learning methods, like pair programming or peer-tutoring, are applied and when students have the possibility to learn actively, e.g. when discovering new topics or explaining them to others.

As the presented examples and pilot projects are not really statistically relevant further studies are needed to verify the acceptance and effectiveness of COOL methods including neurodidactical principles.

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