

INFORMATICS IS COOL: CROSS-CURRICULAR CONCEPTS FOR COMPUTER-SUPPORTED OPEN LEARNING IN SECONDARY SCHOOLS

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Abstract

Informatics is COOL – as a subject and as a tool for interdisciplinary and cross-curricular learning. In this paper COOL refers to three different aspects of learning not only in informatics but also in other subjects: According to the original sense of the word COOL stands for “cool”, interesting, motivating or fun, for 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-supported Open Learning. This paper aims at showing how to use the three meanings of COOL in cross-curricular computer-supported teaching and learning. After presenting the three forms of COOL and cross-curricular learning the paper describes criteria that should be considered in COOL lesson design. It further presents some examples of COOL teaching units for different subjects and reports on experiences with COOL in secondary schools.

Keywords: computer science, informatics, cooperative learning, collaborative learning, computer-supported learning, secondary school.

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 competent. 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 or brain-based learning. Teachers should consider this information to make learning more brain-friendly and thereby more effective [1][2][3].

According to an Austrian initiative “COOL” is a shortcut for “COoperative Open Learning” [4]. 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 methods like “Computer-Supported Collaborative Learning” (CSCL) or also eLearning, which have similar directions but some different elements [5]. During the last years, the Internet became an indispensable source for information and learning material. Web 2.0 changed and improved the communication and interaction massively. After the introduction to COOL and its theoretical background the paper gives examples for all three COOL meanings.

2 COOL AND CROSS-CURRICULAR

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 [6]. In this case the neurotransmitter dopamine is released, which has a reward effect and supports learning and memory [7]. COOL as COoperative Open Learning considers the social brain and helps to “teach” soft skills like communication competence or responsibility. 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 [8]. COOL as CComputer-assisted Open Learning can support and facilitate cooperative learning. Furthermore, it considers the modality or multimedia effect: Information will be better stored and recalled if it is dual-coded, e.g., if it is presented audio-visually [9].

This section describes the three definitions of COOL and their theoretical background.

2.1 COOL = “cool”

Education and learning can be characterized as “cool” from different views: from students or from teachers. This paper will focus on the students’ view. If students are engaged in a subject or have the feeling that learning for a subject is easy, they will describe it as cool. The main motivation for students who are interested in a specific subject is not the grade they receive for it. They want to understand the information and use it in real life [10].

A natural force that causes people and especially children to act is the desire to achieve competence. It is one of the basic motivators for human being. Schools are places where competencies can be developed. To enhance the motivation for academic work it needs a sense of membership and authentic work in the learning institute. Membership means that learners should feel like a legitimate and respected part of the school. The main elements to establish a feeling of connection to the institution are clarity of purpose, fairness, personal support, success and caring. With authentic work the sense of membership can be enhanced. For this reason the academic work should be meaningful, important and worth the effort. Important factors for authentic work are extrinsic rewards, intrinsic interests, a sense of ownership, a connection to the “real world” and fun [10].

These elements from psychological research fields are considered in brain-based approaches. Brain-based Learning, Educational Neuroscience or Neurodidactics (translated from “Neurodidaktik” in German language area) use information from neuroscience and brain-research to improve learning and teaching. The concepts consider how the brain works in education. Neurodidactics for example combines research fields like neuroscience, didactics, psychology, pedagogy and memory research and uses their findings to elaborate principles for brain-friendly learning [1]. If there is a desire to improve learning, the natural resources should be used most efficiently. Some facts about how the brain affects learning would be the following.

- Learning engages the entire person (cognitive, affective, and psychomotor domains).
- The human brain seeks patterns in its search for meaning.
- Emotions affect all aspects of learning, retention and recall.
- Past experiences always affect new learning.
- The brain’s working memory has a limited capacity.
- Lecture usually results in the lowest degree of retention.
- Practice (in the sense of repeating a skill) does not make perfect.
- Rehearsal (repetition and processing of information) is essential for retention.
- Each brain is unique [2].

One of the main messages from neurodidactics is that knowledge cannot be transferred from one to the other but has to be newly created in the brain of each learner. The learning processes can be improved by creating an appropriate environment and by using different methods and material that engage the learners [1].

For most people playing games is very engaging and with every game someone plays learning happens [11]. So games are used to foster and support the learning-process [12]. Some elements from games can be connected to a neurodidactical principle shown in [6]. Further, a relation between game-based learning and the factors for engagement from [10], where fun is an important element, can be recognized. The potential of games is the high engagement players show. A goal is to reach this engagement, which students feel for games in learning [12]. But besides the playing also the designing of educational games can be used for learning. By designing educational games students gain knowledge and their creativity is fostered. It is a form of active learning and students can contribute to their own experiences from other games [6]. Later examples will show how games can be useful in introducing new concepts as well as to repeat already known information.

2.2 COOL = COoperative Open Learning

In 1921 Helen Parkhurst published her concept for education in schools. Her approach was influenced by the approach of Maria Montessori. The so-called Dalton Plan includes three basic principles [4][13]:

1. Freedom: Students should be free to choose when, where and how long to work on chosen exercises from a given work request. At this time they can provide the best mental performance and can overcome difficulties.
2. Cooperation: This point does not prescribe students to learn with each other. How and with whom students cooperate remains their free choice. It means that schools should offer the possibilities for cooperation and remove communication-inhibiting elements.
3. Budgeting time: During free work phases (Dalton phases) students should self-reliantly organize and plan their work for given assignments. The so-called "Special Calls" are short instruction lectures from teachers held for one class.

Further points of the plan would be the abolition of the timetable, no bell-ringing, free room choice and group work [13].

Based on the Dalton Plan a vocational school in Steyr, Austria initiated the "COOL"-project with the idea of a better handling of the strong heterogeneity in the classes and the promotion of soft-skills. For these problems concepts from progressive education could be the solution. Selected elements were adapted for the needs of vocational schools and the term "Cooperative Open Learning" should describe this approach [4]. The term COOL implies two different methods: Cooperative learning and open learning.

Cooperative learning outlines methods including a form of group or teamwork in which the group size does not matter. This should promote and enhance the social skills and the self-related learning [14]. Basic elements of cooperative learning would be [15]:

- Positive interdependence: Students should recognize that they can reach their goals only together. The positive interdependence describes the dependency within the group, between all members.
- Individual responsibility: Although students work in groups and share goals their individual performance should be recognizable.
- Supportive interaction: Within the groups it is necessary that students are encouraged to support, motivate and help each other.
- Reflection on the group process: After the group work the whole process should be discussed.
- Cooperative skills: Working in groups has to be practiced like other competencies. Requirements for it are communicative skills, a trusted environment, skills for group management, and a constructive way to deal with controversies [15].

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 a definition for it. The exact definition of open learning is prohibitive [16]. To practice open learning, some preconditions have to be fulfilled. Especially, it is important to consider that the openness can refer to different dimensions [17].

- Thematic openness means that students are free to choose which content to deal with and how much time and effort to spend on it.
- Methodic openness means that students are free to choose the material and the method to use during the work on a topic. This includes the self-reliant management of time and work.
- Institutional openness means that students are free to choose, for example, where i.e. in which room, they want to work at school. It can be further structured into organizational, social and personal openness. Organizational openness refers to the choice of location and time, social openness to joint decisions about e.g. class management or rule structure, and personal openness to the relationship between involved persons [16].

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) [4]. COOL can be integrated into traditional schools without changing the whole institutional structure for all classes. COOL classes have some basic features:

- Freedom of choice for students: Students get written assignments with tasks they should prepare until a given date. During COOL-lessons they have the choice of when, where, how and with whom they do their exercises.
- Portfolio: Additional to traditional assessment methods students have to submit a portfolio which contains all of their achievements. Students can choose the form and type of their portfolios on their own.
- Evaluation and reflection: Students should frequently give feedback on their working and learning processes. Thereby they should analyze their own behavior.
- A new teacher's role: Teachers adopt the roles of moderators and companions. That means they have more time to help solving out students' difficulties.
- Teacher cooperation: COOL-teachers have to act as a team. This requires a closer cooperation and frequent team meetings.
- Class council: This council should be a regular meeting for the students of one class to discuss problems and to practice discussion rules, logging information and moderation techniques.
- COOL parliament: Teachers and students should work out the rules for a structured use of COOL together. These have to be recorded in so called contracts.
- Involvement of parents: Regular parent's evenings should lead to a closer involvement of the parents [4].

It is obvious that these features contain a lot of the elements from the Dalton plan and from cooperative and open learning.

To make cooperation easier and independent from room and time it can be supported by the use of computers and mobile devices. In this sense COOL stands for CComputer-assisted Open Learning.

2.3 COOL = CComputer-supported Open Learning

In the COOL project working with a computer is also included. "eCOOL" describes the connection of COOL with e-learning and is an additional feature of COOL. Main characteristics of eCOOL would be [4]:

- 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

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 [12]. With the initiation of Web 2.0 also e-learning changed and in [18] was proposed to call it "e-learning 2.0". 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 [12]. The ePortfolios used in eCOOL can have these forms including the content collected and produced by students themselves. These tools 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) or CALL (Computer-assisted Language Learning) in language 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. Today's technologies like Web 2.0 allow cooperative work or learning independent from time and location. Table 1 shows possible constellations for cooperative learning varying in location and time [5].

	Same location	Different location
Same time (synchronous)	e.g. computer-supported classroom	e.g. Chat, instant Messenger
Different time (asynchronous)	e.g. digital post-it in mobile learning	e.g. discussion forums, wikis

Table 1: Location-time-matrix for CSCL [5].

At school these different scenarios can be applied in combination. So it is possible that members of a group can work on the same file cooperatively from home.

A further approach, which is based on technology, is Mobile Learning and should also be included in this interpretation of COOL. It is a specialization of e-learning but with own requirements, possibilities and potentials and focuses on the use of mobile devices for the learning process. Students can learn with their own mobile devices, which are mainly Smartphones or tablets today, everywhere and at any time they like to [12]. Thereby, new possibilities and challenges for teachers occur. Mobile learning can appear in different learning-scenarios like

- Miniature but portable e-learning,
- Connected classroom learning,
- Informal, personalized, situated mobile learning,
- Mobile training/performance support [19].

Especially language lessons can benefit from the usage of mobile devices because of a lot of good available applications. It supports open and self-organized learning and can improve the learning outcomes [20].

3 COOL CROSS-CURRICULAR TEACHING UNITS

During the last semester two courses at our university, called “COOL Informatics” and “Fächerübergreifendes Projekt Studium (Cross-curricular projects)”, dealt with COOL as their main topic. Student teachers with different subjects tried to develop projects or material for school lessons following at least one definition of COOL. This chapter will present some of the outcomes and the view of students concerning COOL units for different school grades and subjects.

3.1 COOL Informatics

3.1.1 PowerPoint for primary school

The first result of a working group we want to present comes from the course “COOL Informatics” and describes two to three school units (about 100 minutes) for primary school [21]. In this project pupils should get a first view of presentation software, in this case Microsoft® Powerpoint®. The main aim of the project is that students learn to create a simple presentation by their own and recognize the utility of it. Therefore the class should have previous knowledge in the usage of a computer with keyboard and mouse and of basic word-processing software. In an open, self-reliant and cooperative way students have the task to build their own presentation following a given assignment. The topic of the presentation and the content it should include can be chosen by the teacher and come from every subject. Instead of an introductory lecture or a demonstration over a beamer the teacher provides learning videos that explain how the pupils can work with the software. These videos can be created easily with the help of screen-capture tools like Hypercam [22], Faststone Capture [23] or Jing [24]. Thereby the teacher can record the screen of a computer he/she is working on and explain the steps with some words that can also be recorded over a microphone. Of course the videos should not direct what to be done, but only the basics of using the program. One advantage of such videos is that the pupils can view them as often and fast as they want or need to. So they can work in their own speed, stop the video and go on later or view a specific section again. During the working phase teachers can act as coaches and help where help is needed [21].

3.1.2 COOL Games

Following the idea that games are useful and can bring an improvement of student’s motivation to learn as well as the learning outcomes the project called “COOL Games” was developed [25]. Its aims were not that the students play educational games but that they create them by different means because also designing of games has a learning effect [6]. The selected means depend on the school

level and can be digital or non-digital. With students of higher school grades and programming knowledge the Pygame [26] framework can be used. Pygame uses the programming language Python and offers elements like computer graphics and sounds, which are needed to write video games. If the programming knowledge is not given the games can also be developed in Scratch [27], which is educational software to learn programming. In the early secondary school grades LearningApps [28] would be a nice online tool to create the games. It contains a lot of sample educational games, which also can be modified and is very intuitive to apply. However it needs some time to become acquainted with it.

The variation, which needs least pre-knowledge and can be held in high primary or early secondary school classes, gets by without using computers. So less preparation time is needed and the project can be passed in one day or 4 units. During the whole process the students should work in groups of three to four people and self-reliantly distribute the tasks. Concerning the content of the game there are two restrictions: it has to deal with one or more school subjects and contain familiar information. This version of the project took place in a first secondary school class with 23 pupils. During the first lesson they had to form groups and to choose the subjects and the kind of the game. An early description should be the result at the end of the unit. Then the students had two units to create the game by handicraft work. In the last unit the students had to present their results and explain to the whole class how the game can be played. After this they could take a look at all games, and test them because they had to find their "winner" game in different categories like best game, best looking game, most interesting game, game with the best idea and best presented game. So the students could take part of this evaluation process and they did this in a very engaged and honest way. At the end of the fourth unit each group had a playable and more or less creative game [25].



Figure 1: One of the games created by pupils in school [25].

3.1.3 COOL Apps

A vocational high school was the location for a further project [29]. In a class of the 11th grade the students should create their own Smartphone App, which would be tested and evaluated by younger pupils from a lower secondary partner-school. The problem was that none of the students had any programming knowledge. Therefore the teachers decided to apply the App-Inventor from the MIT (Massachusetts Institute of Technology) [30]. With this software Apps for Android-devices can be created easily and without programming experiences. Like in other educational software for example Scratch [27] the code can be built out of predefined parts including some concepts of programming. So the students could get a first view of these concepts and how programming can work. Preparative the students had to learn how to format pictures so that they could use them in their Apps.

During one lesson both cooperating classes from the vocational high school and from the lower secondary school met to get known each other. An introduction to the App-Inventor with some exercises and adequate solutions marked the next phase of the project. After this the main part of the project started. The students had to design their own Apps, plan the working process, collect or create materials and use the App-Inventor to realize their Apps. This was very challenging for students and teachers because for both sides it was a premiere and they had to overcome a lot of difficulties. Finally

all Apps worked well and could be presented in the evaluation class where all students were excited about them. For the vocational school students it was a very positive feedback, which proved that it was worth the effort and they could be proud of their own self-made products. Thus they went through a shortened software engineering process like designing, producing and testing and learned some basics about programming [29]. Because of the free and creative working process with the usage of a computer and also mobile devices this project fits to all COOL interpretations.

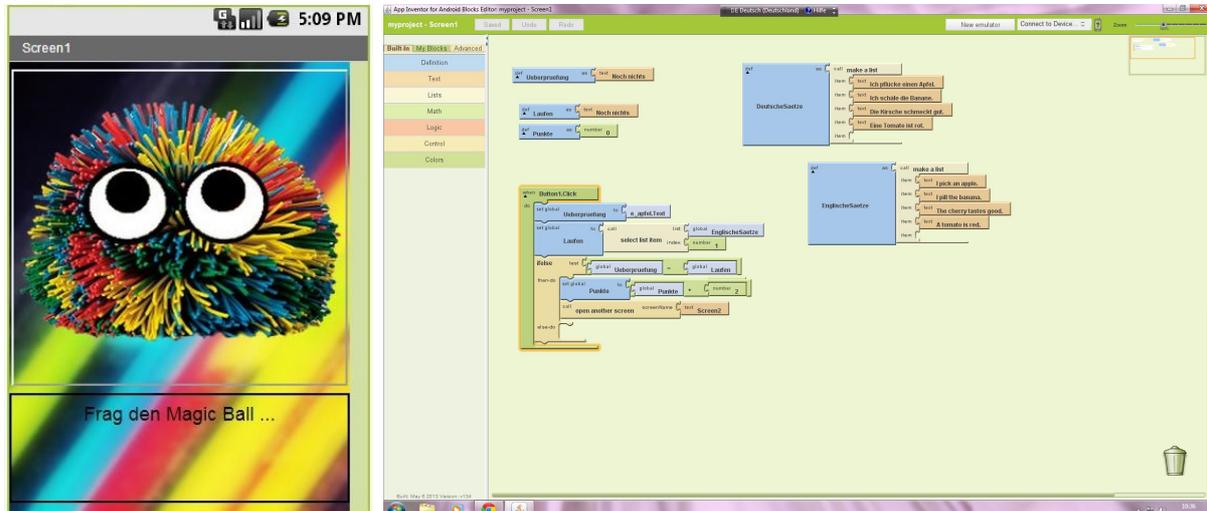


Figure 2: One of the Apps and an App-Inventor Program example [29].

3.2 COOL Language Lessons

The project “Mein Klagenfurt. Ein digitaler Minireiseführer (My Klagenfurt. A digital mini-tourist guide.)” was planned for six cross-curricular school units with the goal to create a bilingual webpage with information about the hometown of the students. It should help exchange and foreign students without German language skills to find interesting places in this town. Students could include their own experiences and favorite places into their work. Every text on the website should exist in German and in English. So the students had to describe the locations in both languages and therefore they had to yield their knowledge of both of them. That should lead to an improvement of their language awareness. The website was built with Jimdo [32], an online tool which is free and easy to use. Students also had to plan the structure of the website and work with new media [31].



Figure 3: The resulting Webpage [31].

A further project connected with new media was “Reiseführer Prag (Tourist-guide Prague)” [33] in a secondary school class, which planned to visit Prague for one week. Before this journey the students should create an own tourist-guide for their target city Prague following the instructions of a Webquest. A Webquest is a collection of investigative tasks for which the students have to find information in the internet and work with it as specified. Additionally Webquests provide some links where to find more information or examples. Time was limited by four units, which could be freely used. The first exercise was to build working groups of four to five students. Within a group the tasks could be distributed but

each member had to be aware of the content and also agree to it. Also there was no sequence, which the students had to follow to work on the exercises. Therefore they had free choice of when, on what or with whom to learn. A text-file should collect all results of one group and represent their tourist-guide. It had to be formatted to be clear and concrete. To have a cross-curricular character the exercises covered different subjects. A geographic description had to be written containing position, size, amount of population, currency, language and the temperature for the month of the journey. Concerning literature the students had to write a poem about the life of Franz Kafka or a text in the style Kafka used in his books. For a historical view of Prague every group had to choose five places of interest and describe them including information for tourists like the history, opening hours or admission price. Further the students should get an introduction and learn some basics of the Czech language. So they had to complete a list of vocabularies with the help of the Internet and listen to sound recordings with the right pronunciation and match them to the corresponding German word. As the last point the students had to find out some insider tips and explain them in English language. These should contain festivals, food and means of transportation. After the groups completed all of these exercises they could add some information they would like to find in a tourist-guide [33].



Figure 4: The LearningApp for Czech pronunciation [33].

4 COOL EXPERIENCES

University students who accomplished their projects in schools had to reflect on their experience with COOL. For most of them it was an interesting task because on one hand they had to work during the course very openly and cooperatively and on the other hand they had to plan and execute their COOL projects as teachers. Therefore their reflections can be interpreted to come from students as well as from teachers. In this chapter some of their answers will be summarized and some of their opinions concerning cool will be presented.

From the teachers view the groundwork and the planning was a big effort but it was worth because thereby the lessons could happen without any bigger problems. The good preparation had the further advantage that the teachers had time to walk around in the class and help where help was needed. Some teacher students were surprised how well the open learning phases worked and that there occurred no problems at the formation of the groups. They supposed that clear instructions and also giving deadlines were necessary for it. In lower school levels sometimes support by teachers was needed at tasks like scheduling time or defining and assigning duties. A very important factor of open and especially cooperative learning is that the social competence is improved. Students like to work in groups and the discussions within them are very good for the learning process. Some opinions were that it was hard to plan open learning units with a specific time limit [21][25][29][31][33].

The experiences with COOL from a student's view come from the university students and from the school students. They like the open way of learning very much but perceive it sometimes as exhausting and difficult. Most students liked to be creative and to bring in their own opinions. Working in groups was great for most of them but others said that it was boring or too much to do. That can occur when group members do not participate or finish their tasks. Such problems can be avoided by practicing working in groups, cooperating and open learning. A further important point for students was the schedule of time. For some of them it was insufficient time or too many tasks for the given time. The use of new technology, like creating a webpage, following a Webquest or building an own app

was motivating for the students. At the end of the project work all of the students were proud of their results.

Finally the university students were asked "What does COOL mean to you?" and the following answers appeared:

- It is a very good alternative to common teacher-centered lessons and COOL-learning can be applied perfectly in schools to motivate students and improve self-reliant working.
- Very helpful, new experiences, online learning.
- COOL means open learning where students can decide what they want to "produce", freedom of choice, use of e-portfolio and computer-supported learning.
- A cool und funny way to teach and learn.
- Cooperative open learning, self-organized learning, group work, student-centered education.
- New learning strategies like open learning.
- To me cool lessons are lessons, where the focus lies on each individual student and how he can learn on its best (own) way.

5 CONCLUSION

COOL can be interpreted in different ways. In the first one cool lessons mean lessons that are motivating, interesting, funny for students and held in a brain-friendly way. Therefore teachers should keep neurodidactical principles in mind. The second interpretation of COOL is cooperative open learning and tries to include the ideas of progressive education in common school classes. Basic elements for cooperative open learning would be freedom, cooperation and budgeting time and come from the Dalton Plan. For the third variation of COOL the use of computer and new technologies like tablet-PCs or Smartphones is essential. Through these technologies new possibilities arise which can be motivating and helpful for students. All of these interpretations try to give ideas for improving school lessons and can be applied in common schools without big structural changes. The presented projects should give examples for each of the three COOL variations and explain ways how they could find use in schools. Experiences from teachers and students should illustrate advantages as well as problems that can occur. All participants enjoyed the different learning situation and it could be seen that the motivation at teachers and students increased. Therefore the adoption of COOL is definitely worth the effort.

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