Conceptual Patterns for Student-centered Computer Science Education at Secondary School Level

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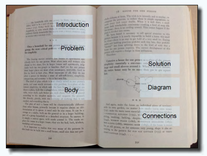
Pedagogical Background

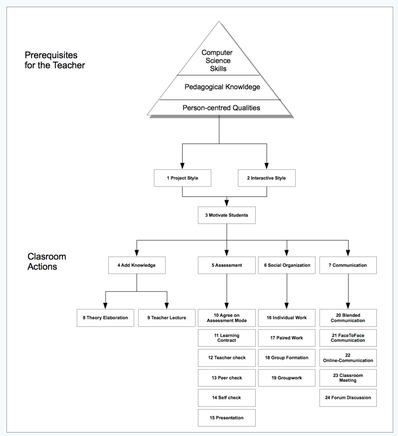
The well known American psychologist Carl Rogers (1902-1987) introduced first the humanistic person-centered approach in psychotherapy and counseling and further in educational settings. It is based on the hypothesis that students who are given the freedom to explore areas based on their personal interests, and who are accompanied in their striving for solutions by a supportive, understanding facilitator not only achieve higher academic results but also grow with respect to their personal values, such as flexibility and self confidence. This approach builds the pedagogical background for modeling a pattern network for secondary school computer science.

Patterns



In the years 1977 and 1979 the Architect Christopher Alexander published in "A Pattern Language: Towns, Buildings, Construction" and "The Timeless Way of Building" his idea of how patterns can be formulated, described and structured for the field of architecture. This approach was taken for this work to capture successful computer science lesson sequences. In this spirit, a pattern network for computer science lessons at secondary school level was described. The prerequisites for the teacher are necessary to apply the network appropriately.

The computer science pattern network is depicted bellow:



Pattern Examples

The two patterns bellow give an example how such a pedagogical computer science pattern looks like in detail. Each pattern has the same structure in order to allow comparability for an easier reuse and implementation in practice.

The problem is stated in bold font face followed by the section about forces where the way to the solution is described in detail.

Another important part of a pattern is the semi-formal description of the pattern itself and possible relations to other patterns. Each pattern is connected to other patterns where some patterns complete other patterns and some patterns get completed. For example is the pattern Teacher Lecture a smaller part of the pattern Add knowledge.

The end of each pattern describes a practical example how the pattern has impact in computer science lessons.

8.2.9 TEACHER LECTURE (9) **

Intent

A teacher lecture is a way to transfer knowledge to the students.

Dependencies

One way to ADD KNOWLEDGE (4) can be carried out with this pattern. However, this is not understood as a traditional way of lecturing but rather as a lecture where the teacher interactively takes care about how the information is assimilated by the students. Hence COMMUNICATION (7) has to be considered for this pattern.

Problem

Sometimes things can be explained in a few sentences by the teacher better than by other methods.

Forces

At schools students frequently can't follow teacher lectures. Simple and understandable information transfer is hence required and possible if appropriately prepared and communicated by the teacher. This supports the learning process of students significantly (Tausch and Tausch, 1998, p.267). First of all, a teacher lecture in the person-centered sense has nothing in common with a teacher lecture as one way information flow.

The teacher rather has the role of information resource and provides content in a verbal explanation in constant interaction with students. The teacher starts his lecture with assessing the current knowledge level of students in order to find the appropriate entry point. Next, the teacher lectures in a constant interaction with students. During this interaction, the teacher has to consider the students' level of knowledge acquirement and adjusts his lecture if necessary. At the same time is the teacher aware of the learning objectives and keeps the focus on where he knows to go.

Diagram

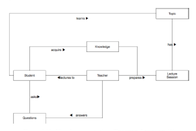


Figure 8.12: Visual representation: TEACHER LECTURE (9)

Solution

Even though a teacher lecture is structured as a teacher centered talk it is important to keep the connection to the audience. This means, that during an explanation, the teacher doesn't loose the connection to the students and tries to understand the intellectual processes within them. Keeping students involved with questions and motivate them to ask questions helps to understand the current knowledge state of the students.

Example for Computer Science Lessons

When the teacher explains for example the entity relation ship model it usually can bore students if this is carried out as teacher monologue. But if the teacher alternately involves students in helping drawing models on the white board by modeling issues of their life, the lesson can become quite fun and exciting.

The image bellow shows the result of such a process when students get involved in creating an entity-relationship model of 'Cinema'. The teacher made the model together with the student group during the lesson.

Figure 8.12: Entity-relationship model 'Cinema'

As students of this group liked to go to cinema very much, the example of modeling a cinema was very motivating for students. For the students this example was very authentic and hence it was easy for them how the entities with their attributes of a cinema are related to each other.

8.2.23 CLASSROOM MEETING (23) *

Intent

This pattern implements a sort of a person-centered encounter group and the aim is to establish a trustful climate for a dialogue in the group.

Dependencies

This pattern carries out FACE-TO-FACE COMMUNICATION and could also partly carried out with BLENDED COMMUNICATION (20).

Problem

Classroom Meetings provide a space for an explicit group dialogue where students can share anything what is important openly, whether it is subject related or not.

Forces

During computer science lessons, student-teacher and student-student communication frequently takes place simultaneously to computer work. This is, because many tasks have to be accomplished with the computer and even during face to face communication, the computer stays in the focus. Further, in a person-centered classroom climate students work in groups, on themselves or on projects and the teacher facilitates them in doing their progress. However, sometimes it is required to talk from person to person in the group apart from computers. This setting can be used for organising new projects, smoothing conflicts or any other issue. The classroom meeting as a kind of person-centered encounter offers the possibility to carry out such a setting. Person-centered classroom meetings cannot be established as open dialogue space immediately. It needs time to develop such a climate. At the beginning, students usually show insecurity and it can take a while until students open up their personal feelings (Motschnig and Nykl, 2009). Hence it can occur that even if the person-centered teacher facilitates classroom meetings, students keep closed and only would like to talk about organisational things. It is important to let the process flow and not to push students as they have to decide what they think is important to share in a classroom meeting. It takes time for students to open up.

Solution

Establish a climate of trust and hold the role as facilitator. At the first meetings give the open dialogue enough space by talking about things, which emerge from the students - even it is not about computer science. When the group has arrived on a higher level, dialogues will be more meaningful and open.

Diagram

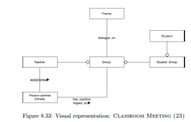


Figure 8.23: Visual representation: CLASSROOM MEETING (23)

Example for Computer Science Lessons

During project phases a classroom meeting can be carried out for different intentions. At the beginning of the project, the meeting can be about organisational issues, during the project phase it could be that conflicts are in the focus of a classroom meeting. However, the classroom meeting is the place where any communication in the group is carried out whatever students think is important to talk about.

The classroom setting on the picture bellow shows students sitting in a circle talking about assessment issues.

Figure 8.34: Typical setting of a classroom meeting

Application in Practice

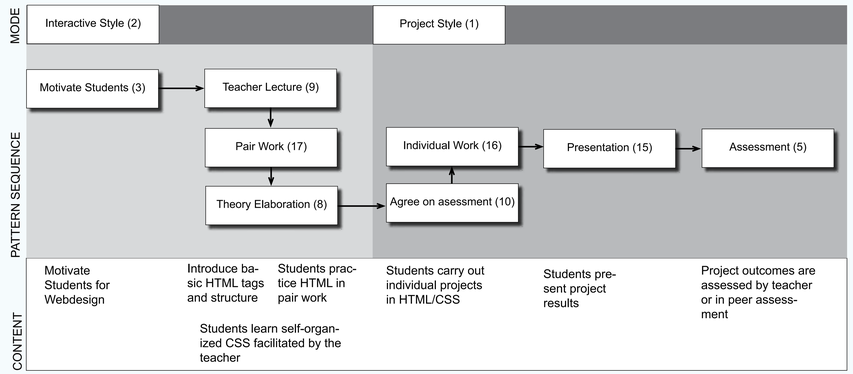
This lesson plan shows how the patterns can be assigned to the corresponding content of learning HTML and CSS. The table gives a rough overview on six weeks when assuming that the computer science lesson takes place once a week.

Day	Content	Pattern
1	Web-design	Motivate Students
	HTML Basics	Interactive Style, Teacher Lecturer, Paired Work
2	HTML Basics	Theory Elaboration, Paired Work
3	CSS	Add Knowledge, Communication
	HTML and CSS practice	Individual Work
4	Student projects	Project Style, Agree on assessment mode
5	Student projects	Individual Work
6	Assessment of projects	Assessment, Presentation

The model on the right side demonstrates along the week and content plan as described above, how the patterns could be arranged for these intentions.

As each pattern above is described in an abstract way in order to give the teacher freedom to design lessons on his own style, the following arrangement of patterns for this solution is just one way of arranging them. Another teacher maybe chooses another way to arrange patterns for the same learning objectives. This would be also valid as person-centered course scenario if the teacher fulfills the perquisites.

In this case, it is important to start at Motivate Students (3) as this is important to get students excited for the topic. After this, the lessons will be organized along the pattern Interactive Style (2) where the teacher first presents in a Teacher lecture (9) the basics of HTML. Then, students should in Pair Work (17) practice some of the HTML tags. For the lesson Advanced HTML Tags students apply basic HTML tags in practice and elaborate new tags with 8 Theory Elaboration also in Pair work (17). Next, the lessons about CSS and image editing continue with a mix of smaller patterns as Add knowledge (4), Social organization (6) and Communication (7) along the pattern Interactive style (2). It is important to mention that learning should be carried out with a variety of methods. This means, even if Pair work (17) is carried out a couple of times, different ways to do this is possible. When students are ready to go into their chosen projects, the larger pattern for lesson structure switches to Project style (1), where important connected patterns are described. The project phase hence will be carried out along this structure and the chapter HTML then finished with the Assessment (5) phase and the Presentation (15) of the students products.



Further Work

Application and testing in practice

Another concern of this work is to promote the pattern approach for computer science education at secondary school level. As the suggested patterns can and should still be improved, it is important to promote this approach for other computer science teachers. When more teachers can test and apply this system, it can be refined further from practice experiences.

Integration of Computer Science Content

Basically this suggested pattern system does not include patterns which describe computer science content eplicitly but rather build a pedagogical framework for lessons.
As next step it could be considered how content related patterns can be integrated in this network model. A pattern as "Computational Thinking" could describe the relevance for secondary school and is connected with smaller patterns as "Sorting Algorithms" where the explecit implementation for lessons is described.

Development of Common Cartridge Webtool

In order to make the patterns reusable, a web application is currently under development. The web application is supposed to assist the teacher in creating a common cartridge file for computer science lessons along the pattern network. First the teacher selects a topic, then he can modify the suggested course scenario and finally the web application creates an archive file, which can be downloaded and imported into a learning platform. This tool could also provide a communication center for sharing and improving insights from practice.

References

Alexander, C. (1979). The Timeless Way of Building (p. 552). Oxford: University Press.
Alexander, C., Ishikawa, S., & Silverstein, M. (1977). A Pattern Language: Towns, Buildings, Construction (p. 1171). Oxford: University Press.
Derntl, M. (2006). Patterns for person centered e-learning. University of Vienna.
Motschnig, R., & Standl, B. (2012). Person-centered technology enhanced learning: Dimensions of added value. Computers in Human Behavior, 28.
Rogers, C. (1983). Freedom to Learn for the 80's. Columbus, Ohio: Charles E. Merrill Publishing Company.
Standl, B. (2013). A Web-Application for building Common Cartridge Learning Objects. Proceedings of EDMEDIA 2013 (pp. 1461–1466). Chesapeake, VA: AACE.

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