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"CONTROLLED SELF-STUDY" IN THEMATIC EDUCATIONAL COMMUNITY ENVIRONMENT*

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Many different learning styles exist nowadays. In general, they contain a sequence of steps the student has to go through in order to get new knowledge. The truth, however, is that the teacher most often provides students with a problem, a dozen of facts, considered to be an "absolute truth", his own solution to the problem and a subsequent assessment. Such, well known, learning pattern has a couple of shortcomings that many researchers are trying to solve. This paper aims to solve a general drawback of the standard learning approach, where the students accumulate knowledge while remembering set of definitions that subsequently do not know how to use, because they often do not understand how and why they were formulated. As an alternative approach, this paper defines a learning model where the teacher provides just a couple of "learning blocks" considered to be axiomatic set for a particular subject or a lesson, together with a number of problems that students have to solve. While solving each individual problem, the student himself reaches new definitions, which he or she then adds to his "dictionary" of "learning blocks". In other words, the students build new, more complex, "learning blocks" by their own, based on a few core "blocks" or other "blocks", which they have already built by their own. This learning model follows the philosophy that a theorem is composed by several axioms (core "learning blocks") and/or one or more other theorems (newly built "learning blocks"). To demonstrate the relevance of the presented model, a specific domain was chosen, where the model is applied – Computer Science. There, the students are provided with the opportunity to study Computer Science through Computer Science itself, having just a few key "learning blocks" initially.

1. Introduction. In the standard education teachers go through several basic steps to present a lesson to the students in the standard learning approach. They define a problem, provide their definitions of "tools" used to solve the problem, often solve the problem by themselves and, finally, evaluate the decision to choose exactly the selected "tools". The last steps of the process is where the students are having an assessment on whether they understand what they have just learned. Since they remembered the "absolute truth" provided by the teacher, the students often used it by, almost, quoting it, but do not actually understand what they are writing. As a result, the students gain "knowledge" but not "skills" and "experience" to solve problems in different situations. This leads to a major problem – lots of "knowledge" that cannot be applied [7]. "Thanks

***Key words:** Thematic community, learning block, controlled self-study, learning model, computer science, algorithms, self-generated analogies, self-explanation.

to some excellent classroom and cognitive research in recent decades, we know a great deal about how learning happens and how little of it happens in lectures" [10].

As the school moves forward, every professional in the building must engage with colleagues in the ongoing exploration of three crucial questions that drive the work of those within a professional learning community:

- What do we want each student to learn?
- How will we know when each student has learned it?
- How will we respond when a student experiences difficulty in learning?

The answer to the third question separates the learning communities from the traditional schools [13].

The contemporary technologies, the easy connectivity and ubiquity of interrelations between teachers/tutors and learners and the ability to form thematic communities, give a new essence to education. The principles of forming thematic learning communities are given in Section 2.

In this paper we use communal constructivism as unifying theory for the proposed ICT pedagogy, with which we try to capture specific elements of the additional value that various forms of ICT bring to learning environments [14]. The learning model proposed in [14] reflects the different ways in which knowledge is constructed, shared and reconstructed, published and republished by both teachers and learners.

The learning model presented in this paper is explained in Section 3. It describes an approach to learning a lesson or a group of lessons trough arranging a set of small "pieces" in a complete "puzzle". What makes the approach interesting to consider is that just a small part of the "puzzle's pieces" are provided to the student. These pieces are considered as the "core" of all the other pieces of the puzzle. The rest of the "pieces" are created by the student himself or herself. In other words, this model describes a "controlled self-study" process. The student does not have to remember all the definitions related to a subject or a lesson, following this process, but rather to generate them by his own or her own, and thus gain "experience". The "experience" is the key to increasing his or her "skills" and "knowledge".

The illustration of the model is done in Section 4, where it is used to present the proposed learning "Algorithms", as part of "Computer Science" domain , and considered to be a basis for creating software applications. The purpose of this presentation is to guide the reader to the nature of the study area, to its peculiarities and potential problems. The challenges before the model application in different learning areas are presented in Section 5. Two major challenges that need to be analyzed and overcome are considered – 1) determining the core "pieces" for a lesson and/or a discipline; 2) problems that will serve to generate new "learning blocks" by the student.

The proposed model is closely related to "Learning by doing", where the students are being put in particular situations, which have to provoke them to reach their goals by solving a problem and thus gain knowledge and skills. The difference between the latter and the model presented in this paper is that the paper provides a system for self-studying by incrementing the student's knowledge and going from initial set of "knowledge pieces" to the integrated "puzzle" of learning in a particular domain.

2. Thematic learning communities. Generally, every intentionally formed combination of individuals with an interest in education, focused on maximizing the individual and shared learning of its members and increasing their academic success, is considered as Community in education or *learning community* (LC). There is ongoing interaction, interplay, and collaboration among the community's members as they strive for specified common learning goals. According to [6] there are three types of learning communities – student, professional (faculty, staff), and institutional LCs concerned with student learning. They usually are structured as local, regional, national and international. Building a learning community means creating appropriate collaborative communication and using community resources for learning. On a later stage, a proper collaborative culture is formed. We consider anything that has the potential to improve the "quality of life" in a learning community a community resource. The effectively built learning communities easily solve the often existing – Data Rich/Information Poor syndrome in education, facilitating turnover of data into appropriate learning information [3].

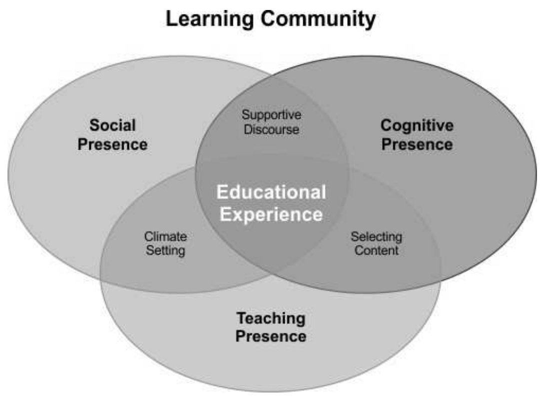


Fig. 1. Elements of Learning Communities

The principle of building a learning community is given below [11].

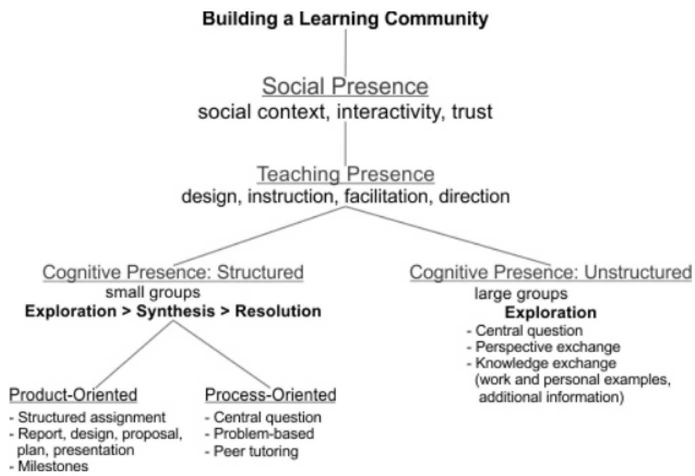


Fig. 2. Structure of a Learning Community

The thematic learning community follow in general the elements and principles of Learning communities. They are focused on a specific learning subject, domain, specific majors, academic interests or other common themes. The thematic communities give new ways for scholars and practitioners to engage together in a disciplined inquiry organized around specified problems of practice improvement. They give to the learner the opportunity to access an open space for the exchange of knowledge, information, best practice, news, opinions, a learning space where you can download tutorials, workshops, presentations etc., a meeting place for professionals (teachers, tutors…) and students of certain knowledge domains and thematic areas.

3. Learning model – "controlled self-study" in thematic community. *Self-learning by solving problems* is a scientific concept studied by many researchers. First Thorndike started working on it with his learning experiments [8]. Subsequently, other scientists such as Kohler [5] and Tolman [9] contributed to this topic. A final coherent analysis was provided by A. Newell and H. A. Simon [1] with their framework for understanding how the problem solving provides the relationship between learning and performance. Although this concept shows remarkable results, Anderson explains in [2] that it will be more effective and with higher performance when a complex problem is divided into a set of small problems and then the small problems are solved one by one. Thus, it will be possible for the concept to be applied in every discipline, for every problem and it will result in a development of a cognitive knowledge. The learning model, presented it this papers, follows the same idea of solving complex problems by dividing them into a set of elementary problems. However, it is further developed by offering a comprehensive learning system. Moreover, it argues that in order to solve even small problems, the student must have a minimal knowledge provided.

Gaining knowledge based on personal experience has proven its efficiency. The opposite of this approach is highly embedded into the tutoring systems used by the educational institutions, where the knowledge is simply provided to students as an "absolute truth" and they are expected to memorize it [12].

The learning model presented in this paper follows a well-known sentence "Give a man a fish, and you feed him for a day. Teach a man to fish, and you feed him for a lifetime." In order to apply the offered model, however, the teacher has to provide the student with a set of basic knowledge – a core set of concepts that supports the student to gain new knowledge but this time – of his own. As a result, the student will be able to use this new knowledge, group it together and gain even more knowledge. In other words, by aggregation of a couple of "learning pieces" (core and/or generated by himself or herself) the student will be able to create a new "learning piece".

The model, presented in this paper, contains two components – a group of axiomatic truths ("core blocks") stored in a "dictionary of knowledge" and a set of problems, by solving of which new truths (new "learning pieces") are reached and, in turn, added in the "dictionary of knowledge". In other words, the students increase their knowledge.

There are two participants in the learning model – a teacher and a student with their respective. roles and responsibilities. On one hand, the teacher should select only a set of basic elements for a particular topic, subject, or a discipline. Furthermore, the teacher has to develop appropriate problems, so that the student could reach a new definition/knowledge ("learning piece"). On the other hand, the students have to solve the problems carefully by using either just the "core pieces" or the ones gained by themselves. Finally, the teacher has to check the solution of every problem and provide a feedback to the student. Thus he or she will ensure the student about having reached the correct definition/knowledge. In other words, we can call this learning model "controlled self-study" as the student himself or herself generates new definitions/knowledge, but the teacher manages the process.

According to Wong [12], the method of "self-study" is effective because students without any background knowledge needed to solve a problem by using their analogue knowledge and experience in other topics or the same topic. He calls this principle "self-generated analogies" in his study. Using this method of "self-explanation", the students are able to develop their knowledge with higher productivity.

The mathematical expression of the model, presented in this paper, looks like this:

(1) $$Pc_i - \text{ the set of "core pieces of knowledge"}$$

where "i" may vary from "$1..r$" and "r" gives the number of the last piece of the set of "core pieces of knowledge";

(2) $$P_j = \sum_{i=1}^{r} B_i.Pc_i$$

for a problem P_j – the sum is provided virtually, meaning that the new piece of knowledge derived is made of building blocks containing a combination of the previous pieces of knowledge;

(3) $$B_i - \text{ an integer coefficient,}$$

showing how many times (if at all) the core piece of knowledge is used as building block, j is equal to "$r + 1..n$" $(n > r)$, meaning that a new piece of knowledge, based on the core pieces of knowledge, has been derived, n gives the last piece of knowledge from the set.

Remark. It is up to the user of the model to decide if the new piece of knowledge may gain the status of a "core piece of knowledge" – k, initially $k = r$ and it may vary from "$r..n$". If it gains such status, then k becomes $k + 1$ and the new "core pieces of knowledge" is $Pc_k = P_j$ and the new $r = k$, thus starting the building of the new pieces of knowledge, but with more "core pieces of knowledge".

(4) $$P_j \text{ forms a set of "new pieces of knowledge".}$$

So at the end we have the full set of pieces of knowledge, which contains the initial set of "core pieces of knowledge" Pc_i combined (joined) with the derived set of new pieces of knowledge P_j.

Thus a student creates his learning space with dictionary of "learning pieces", which he can use as a tool base for deriving and creating new "constructs" of knowledge, enriching his personal domain of knowledge in the subject he learns.

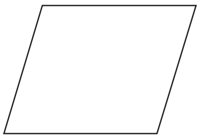
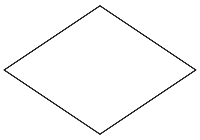
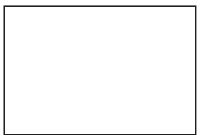
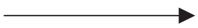
This example could be extended by defining a problem, whose solving will result in a new definition.

Supposing that the whole process is done in appropriate thematic community, the used pedagogy is communal constructivism and the method – learning by doing.

4. Illustration of the model in a study of Computer Science. The design of problem-solving algorithms is a major part of the Computer Science. It can be considered as the first step in creating more sophisticated software applications. For this reason, it is a good case study to apply the proposed model of self-study. The learning environment assumes the student to be a member (part) of thematic community.

We can assume “initial values”, “process”, “decision”, “go to” and “end values”to be the basic elements of a simple algorithm.

Table 1. Core learning pieces needed to study algorithms as part of Computer Science

	• **Initial values** –What is the initial state before solving the problem • **End values** – What is the state after solving the problem
	• **Decision** – What decisions do we have to make in order to solve the problem
	• **Process** – What action do we have to make in a particular moment
	• **Go to** – Where do we have to go after we have done some action (making a decision or taking the initial value, etc.)

The goal is to reach the element “repeatability/cycle”.

The problem that is defined in order to reach the goal is:

Ivan has a basket of 10 apples, 9 of the apples are green and just 1 is red. He likes to eat only red apples. What should Ivan do to be sure that he will eat the red apple from his basket?

The problem should provoke the student to use the already defined basic elements and understand that in order to solve the problem he has to return to the decision step several times with every apple until he finds the right one.

As it can be seen from the above example, the student should have reached the definition of “repeatability/cycle” by solving the problem.

The tutor should check the student’s solution and confirm if it is correct, providing him or her with a feedback. Then the tutor should explain to the student that this is a “cycle” and give him a definition of a “cycle” as it is written in the paper. According to Schank [7], this kind of feedback will be effective even if the student fails to solve the problem, as by “feedback and pointing the error by the teacher the student will create new knowledge”.

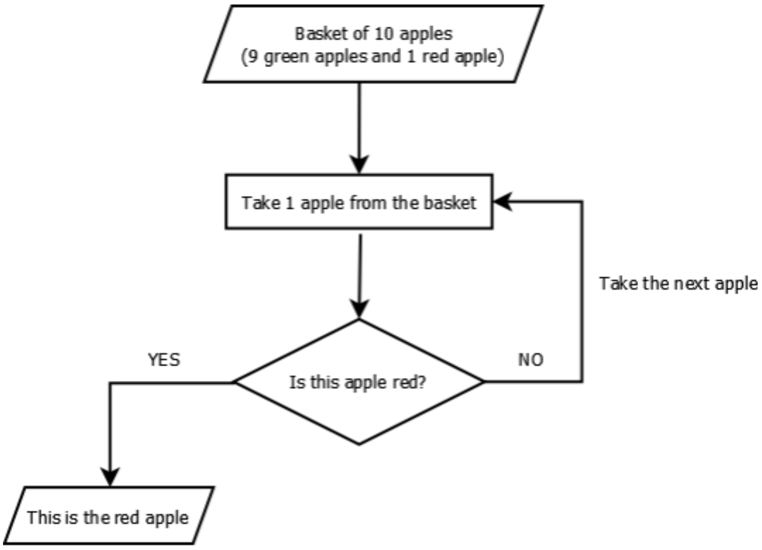


Fig. 3. Solving the problem

The result of this exercise is that the student has reached a new knowledge ("learning piece") that he has added in his "dictionary of learning pieces", using just "core learning pieces". Moreover, he or she has acquired both an "experience" and a "skill", which may be used in solving further problems. Now the "cycle" "learning piece" can be added to the "dictionary of learning pieces" and if decided by the student added also to the dictionary of "core learning pieces".

This example could be extended by defining a problem, the solving of which will result in a new definition.

The role of a tutor could be played by the teacher or by other member of the thematic community.

5. Challenges before the model's application. There are two major challenges before the model's application into different study areas that need to be overcome – 1) Determining the core "pieces" for a lesson and/or a discipline; 2) Problems that will serve to generate new "learning blocks" by the student.

"Core learning pieces" should be determined and carefully selected by the tutor in order to optimize the number of such basic pieces. The simpler the initial set of axiomatic "operators", the easier it will be for the student to use them and discover (derive, achieve) new pieces of knowledge and enrich his thematic dictionary of "knowledge pieces". The aim is not to provide as much information as possible to the student, as the standard learning model does, because then it will be difficult for the student to find out which part to use. Instead, the student should be provided with the opportunity to gather new definitions by solving problems on his own or her own. A teacher with a deep knowledge of the subject matter can overcome this challenge. In this case, it will not be a problem for him or her to get just the essence – "If you are not able to explain something in easy words, you just do not understand it" (common sentence in software development area).

Perfectly acquainted with the taught subject is the overcome to another challenge in front of the tutor – designing the problems in such a way that they force the student find and create a new element in his “puzzle” with knowledge. In addition to properly defining problems, the tutor must be careful about their proper organization and consistency. When defining a new problem the tutor should make sure that there is no problem, which the student cannot solve with the current set of “learning pieces”. Here one must think of proper verification of the pieces of knowledge derived by the student. Whenever possible, it would be most appropriate for any subsequent problem to be wholly or partly interrelated with the solution of the previous one.

A very important condition for the correct integration of the learning model into a specific science area is the availability of a solution validation and the provision of feedback from the teacher/tutor to the student. This will make sure that the student acquires correct knowledge and does not make a wrong interpretation.

6. Conclusion. The existence of different learning styles does not overcome the major problem for most of the students – they accumulate a lot of knowledge without understanding its essence and accepting it as an “absolute truth”. This does not allow students to apply the gained knowledge in solving problems. Moreover, the students suffer from lack of “experience” and “skills”.

The model for “controlled self-study” performed in thematic community learning environment, provides a new approach to the students for knowledge gathering and skills development. It describes a way of learning where the “puzzle” of knowledge in a particular topic or lesson is formed by the student himself or herself. The students solves various problems using just “core pieces” defined by the teacher/tutor, and hence generates new knowledge and skills – new ”pieces” of the “puzzle”.

Although, this learning model looks particularly close to the needs of pragmatists and activists, according to Honey & Mumford’s learning styles, it could implement each of these learning styles [4]. Firstly, the teacher may implement a different learning style when he or she changes the set of problems that have to be solved by the student. Thus, a personalized profile may be integrated for every kind of learning style. Secondly, the student himself may implement his preferred learning style while solving any problem.

Computer Science is an important part both of the schools’ learning plans and the students’ everyday live.

The implementation of the model has been demonstrated in learning Computer Science through the Computer Science itself. The student is provoked to create and learn new definitions using only a small portion of simple “pieces”. Going through the problem, the student starts gathering more and more sophisticated definitions related to the subject.

The future work of this research could include the design and development of a software that integrates the presented model in a manner accessible to students and teachers. Another direction for further work is the design of the so-called “smart system” that can “learn” by itself while solving predefined problems and completing its set of “learning pieces”.

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„КОНТРОЛИРАНО САМООБУЧЕНИЕ“ В СРЕДА НА ТЕМАТИЧНА ОБРАЗОВАТЕЛНА ОБЩНОСТ

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Съществуват различни стилове за обучение – последователност от стъпки, през които ученикът следва да премине, за да достигне до ново знание. Най-често преподавателят предоставя на учениците проблем, дузина факти, представени като абсолютна истина, собствено решение на проблема и последваща оценка. Този добре познат модел на обучение показва недостатъци, които редица научни трудове се опитват да решат. Тази статия има за цел разрешаването на един основен проблем в стандартния подход на обучение, където учениците по-скоро натрупват знания, запомняйки дефиниции, които впоследствие не знаят как да използват, тъй като, често не разбират значението на тези дефиниции - как са получени и за какво служат. Като алтернативен подход разглеждаме модел за обучение, при който обучаващият дефинира малка част „обучителни блокове“, приети от ученика за „абсолютна истина“, и редица проблеми, които учениците трябва да решат сами. Решавайки всеки отделен проблем, ученикът сам достига до нови дефиниции, които впоследствие добавя към своя „речник“ от „обучителни блокове“. С други думи, учениците сами изграждат нови, по-сложни, „обучителни блокове“, на базата на няколко основни „парченца“ или на други, изградени от тях „блокчета“. Този модел на *обучение чрез самообучаване* следва философията, че една теорема е съставена от няколко аксиоми (основни „обучителни блокове“) и/или една или няколко други теореми (новоизградени „обучителни блокове“). За да бъде доказана релевантността на модела, е използвана областта *Компютърни науки.*