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"Old" Learning Theories in the E-learn Environment

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Abstract: In this presentation, based on the Stage-by-Stage Development of Mental Action Theory as developed by T. Talizyna (Talizyna, 1975) and applied by M. Bouniaev (Bouniaev, 2004) to incorporating technology in teaching collegiate mathematics, we analyze what problems should be resolved while organizing on line (e-learn) teaching. Although the experimental basis of our analysis is collegiate mathematics, we strongly believe that other disciplines could also benefit from it.

Introduction

Practical experience shows that learning is most effective when based on the general pedagogical principles of instruction whether it is organized in the traditional classroom or in the e-learn environments. Some well-known psychological-pedagogical theories such as behaviorism of B. Skinner (Skinner, 1954 &1986), J. Piaget's concepts of instruction (Piaget, 1972), modern constructivist theories (Griest, 1993; Papert, 1993; Dubinskiy & McDonald, 2001; Connell, 2001), activity theories (Leontiev, 1979; Galperinn & Talizyna, 1979; Bouniaev, 2004) have been actively incorporated in e-learn education.

The scenario for the development of an instructional strategy, as a rule, has the following components: objective psychological laws; general pedagogical principles; methods of teaching the subject; instruction tactics. The first two components are always implicitly present in every scenario, although some instructors believe that they skip them in their own work.

Objective psychological laws remain the same for every learning environment. General pedagogical principles are more subjective to change, in particular, to using technologies or to online teaching. Some principles become not applicable (not wrong!) to the new learning environment, reflecting new instructional modes (for example, lecture-seminar-recital-lab versus online teaching). Methods and strategy of instruction are determined not only by general psychology and pedagogy, but are conditioned to a great extent by the learning environment. It is the specifics of the learning environment that determine an effective instructional strategy reflecting all the new changes and adjusting to them.

In this presentation, based on the Stage-by-Stage Development of Mental Action Theory as developed by T. Talizyna (Talizyna, 1975) and applied by M. Bouniaev to incorporating technology in teaching collegiate mathematics (Bouniaev, 1999,2000, 2004), we analyze what problems should be resolved while organizing on line (e-learn) teaching. Despite the fact that the activity theories belong to socio- cultural psychological theories and, as a rule, are viewed as opposing to constructivism, we came to the conclusion, while performing a comparative analysis of constructivism versus SSDMA, that recommendations of both theories how to organize teaching and learning process are very similar (Connell & Bouniaev, 1997).

P. Cobb (Cobb, 1992) compared the theoretical theses of modern constructivism (Steffe, Cobb&Glasersfeld, 1988) with the recent research of B.Rogoff (Rogoff, 1990) and G.B.Saxe (Saxe, 1991) who are activity theory followers. P.Cobb contends that these two perspectives are complimentary. The close scrutiny reveals that probably the differences between these theories are mostly of philosophical character, and recommendations how to design an e-learn environment based on constructivism, would be very similar to our recommendations. Although the experimental basis of our analysis is collegiate mathematics, we strongly believe that other disciplines could also benefit from it.

Organization Instruction at Different Stages of Developing Mental Actions

The First Stage of Instruction

According to the SSDMA theory, the major goal of instruction is developing mental actions with objects in the studied field. Instruction is viewed as controlling and organizing students' actions and activities.

The SSDMA theory singles out five stages in the process of instruction. At the first stage the student gets necessary information about the goals and objects of the action to be developed. The structure of the action is defined, which includes orientation, executive and control parts. Also links, connections and relationships with actions and studied previously objects are determined.

Major forms of organizing instruction in the traditional environment are:

1. Class presentations
2. Visual aids
3. Laboratory experiments
4. Reading textbooks or manuals

The question arises how to organize the learning process at the first stage of instruction in the e-learn environment. Although we do not have a complete answer to this question, we can make some suggestions. The key word of our suggestions valid for the first stage of instruction, as well as for the rest of them, is technology. To be effective, the organization of instruction at the first stage in the e-learn environment should involve at least the following components:

1. Multimedia incorporated in the on-line presentation of material.
2. Computer modeling
3. Internet search
4. Students' work with hypertext

Neither the first nor the second component is principally new. Nevertheless, even in this case, the use of technologies significantly enhances the presentations enabling to connect the studied notions and actions with computer created models.

The notion of a model is very comprehensive; it could be a model of a jet with changing wing angles, or a model of a grammar form in studying a foreign language. It could also be a group of commands of a programming language. This approach was implemented in the experiment by Ed. Dubinsky, J. Dauterman, U. Leron, R. Zazkis (Dubinsky, Dauterman, Leron, & Zazkis, 1994), in teaching abstract algebra, by M. Bouniaev (Bouniaev, 2000) in teaching linear algebra and by M. Connell in teaching elementary mathematics (Connell, 2001)

U. Leron and Ed. Dubinsky (Leron & Dubinsky, 1995) did it to develop the action of verification that an object is a group. A group of commands of programming language ISETL was presented as a model of that action. M. Connell as described in M. Connell and M. Bouniaev (Connell& Bouniaev, 1997) made it in the form of a program created in ToolBook for teaching the action of fraction comparison.

In all these cases much less time than in a traditional environment was spent on the actual presentation of material that requires a reading assignment. Thus in teaching the technique of solving linear equations, only the notion of reducing linear equations to row echelon form was assigned to read. We expected that students had to develop the action itself independently in the interactive computer regime and, what is important, in operation-by-operation form.

It goes without saying that even a traditional form of presentation with multimedia is much more efficient than without it. It is especially true for the present generation of students that were brought up with hours of daily internet browsing and playing computer games.

At the first stage of organizing instruction in humanities, modern information technologies make possible extensive use of on-line information that increases manifold almost daily. The work of the student organized in this form solves numerous problems of motivation, attention and concentration. This work makes the learning process more effective by connecting mental activities with manual ones, and objects of action with visual images and its models.

In designing an e-learn environment, we do not exclude traditional forms such as reading textbooks or manuals, if it is possible to incorporate those forms to the new environment. Moreover, we consider reading as one of the most important skills to be taught. By this, of course, we do not mean literacy, but the ability to read a text containing a lot of new information in a condensed form. This skill seems to be the one that many students even at the advanced stage have not developed to a high enough degree for a successful study. However, as the experience of teaching in the traditional environment shows, just reading the textbook and manuals is not a sufficient activity for students to master a subject.

Reading a textbook is made more effective with a corresponding available hypertext since it helps to understand better the printed material using the support of visual images , reducing the time for search of the already studied material (sometimes well forgotten by that time), which is necessary for understanding a new topic.

At the first stage of instruction technologies could be used as a tool and an auxiliary means to help students visualize dynamics of different phenomena and processes that cannot be observed in reality. A graphic interpretation of the studied process to model and imitate it should be provided if possible. .

There are three factors that determine the crucial role of technologies at the first stage of instruction in the e-learn environment. First, the studied material should be visually interpreted. Second, motivation problems should be resolved. Third, students should get additional means (besides a traditional textbook) to reproduce the action, its components and objects on their own, without the instructor.

The Second Stage of Instruction

The second stage of developing an action focuses on students performing actions in the material or materialized form. In the framework of traditional instruction development of actions in the materialized form, as a rule, is associated with creating certain material models of instruction objects.
Proponents of modern constructivism such as Dubinsky & McDonald (2001) in collegiate mathematics or M. Connell (2001) in elementary education mathematics while developing theories of mathematical abstractions, in fact, discuss what particular actions and in what form students should perform to reach a certain level of math knowledge. This approach is most evident in the works of A.Leontiev (1972) and his disciples and followers, such as P. Galperin & T Talizyna (1979).

Any action presupposes an object at which it is directed. If the action is manual, then the object should be material. If the action is mental, then the object of action should exist in the student's mind, whatever we call this object, for example, a "reflective abstraction, " (Dubinsky & McDonald, 2001), "abstract concepts" (Drefus, 2002) or "mental construction" (Connell, 2001), or something else.

These physical objects may be different and various and they are commonly used at elementary level. However, the necessity exists also at advanced stages of instruction dealing with complex and abstract notions. Naturally, at this stage the problem of creating materialized models is much more difficult and complicated. And in this case the use of technologies is difficult to underestimate. Actually, in many cases it is the only feasible way of constructing these models whether in a traditional or an e-learn environment.

Modern technologies provide some means for creating models of materialized objects that the action under development is aimed at. For example: graphics, drawings, tables, figures, diagrams, text blocks, group of commands of a programming language, etc. Computer models of action to be developed may incorporate sound, dynamics and color. Even the most primitive use of computers like pasting objects-blocks and transferring them to a different place with a mouse, enables students to perform transformation actions with models of objects. These actions usually lead to creating a new image, changing a part of the already existing or created at a previous stage image, moving certain blocks, pasting a part of the image and working with the pasted part, etc.

Designing "objects to work with" (Bouniaev, Connell) probably is the most challenging task for both traditional and e-learn learning environments. However, to design the object to work with is only half of the problem.

The second half is to organize the learning activity aimed at the properties of the object that students are supposed to learn. From our point of view, this is the most challenging problem facing online teaching. In most cases, e-learn environments do not even try to solve this problem, suggesting writing assignments as a substitution of the solution.

Meanwhile, the solution could be in the thorough structuring and detailed organization of students' homework. The first step in this direction in the traditional teaching setting is detailed syllabi that in most cases are ignored by students and have been developed by instructors to the pleasure of their department chairs and deans.

However, Learning Management Systems (LMS) such as WebCT and Blackboard provide good tools to organize on line and blended courses. There are more and more faculty who admit that LMS's are great tools for organizing courses. Miner & Topping write "One approach that has gained momentum over the last several years is the widespread use of learning management systems (LMS) such as WebCT,

Blackboard, and e-College. Such systems provide a generic framework for web-based courses, and even some functionality aimed specifically at math and science, such as math-enabled message boards." (Minar & Topping, 2003).

The Third Stage of Instruction

The third stage of developing an action is that of the speech form. Describing this stage of action development T. Taliziyna wrote:

At this stage when all the elements of the action are presented in the speech form, the action is becoming more generalized but still remains non automatic and not compressed... It is imperative that the speech form of the action should be developed in the operation-by-operation mode. All the involved operations should not only take the speech form but also be assimilated in this form. (Talizyna, 1975, p.107).

As research has proved, the speech form has both oral and written forms. In the traditional instruction, the development of action in the speech form is associated first of all with writing assignments and oral presentations.

It is clear that writing assignments could be also used in e-learn environments. In such systems like Breeze, oral presentations could also be incorporated into the on line teaching, though it requires synchronous instruction. Meanwhile there are some features inherent in e-learn environments that make us believe that the e-learn environment could be competitive with traditional teaching. They include asynchronous and synchronous chart boards.

Experiments show that organizing cooperative work in small groups and involving students into discussion works best to master an action in an oral/written form. Chart boards and archives could be used as means to record and store ideas generated by the group, share these ideas with other groups and present them to the instructor. The instructor gets opportunities to control, monitor and correct students' work, which is extremely important at this stage of instruction (Bouniaev, 2005).

The possibilities provided in this case by word processors and various editors incorporated to LMS are hard to overestimate. They enable students to express their thoughts in a written form, as well as connect them with models of the action constructed at previous stages of instruction.

The Fourth Stage of Instruction

At the fourth stage the action should be developed in the inner speech form. The inner speech form is the first stage of the mental form of an action, though while performing an action in this form, an individual is "whispering "to himself what he/she is doing. Probably all of us are familiar with this phenomenon. Sometimes we feel that we know what we are doing, but since we are not confident or proficient in it, we help ourselves by describing every step (operation) of the action to ourselves. In most cases it happens when the individual performed the action long time ago, or when this individual is trying to perform the action for the first time.

At the fourth stage operations of the action are still performed in the operation-by-operation mode with all the operations performed separately. Thus, it is essential in organizing the instruction to provide students with the opportunity to describe in a compressed form the performed operations or to do them in a dialogue regime, where the software performs the executive part of every operation of the developed action at student's command. In this respect again, the opportunities provided by chart boards and message board in combination with specialized editors are hard to overestimate. As we have already stated, these opportunities could compensate at least some flaws and difficulties of e-learn environments. However, the students' activities at his stage should be thoroughly planned and organized.

These activities should be organized in synchronous as well as asynchronous modes. The exercises that require participation of all students in the group should be developed. As far as mathematics is concerned, some examples of these activities developed in the NetTutor's environment could be found in M. Bouniaev (Bouniaev, 2004 & 2005). At this stage of instruction it is still essential to provide control (and correction if needed) at every operation that constitutes the action under development.

The Fifth Stage of Instruction

The fifth stage is development of an action in the mental form. The action at this stage becomes an inner mental act with only the product of this action explicitly evident and observable. Assimilation of the action at a given level of compression and generalization becomes a matter of top priority in developing an action at this stage.

The problems that have to be resolved at this stage are mostly related to motivation and control over the final result of students' works. For some disciplines like mathematics, it is essential to encourage students to do more drill and practice exercises.

Probably there is no need to discuss the fifth stage of e-learn instruction in more details, because the analysis of the on line (e-learn) teaching shows that in most cases the stages two through four are skipped, the stage one is substituted by only reading assignments, and the instruction process focuses only on stage five.

Prompt Control of Action Development in On Line Teaching

One of the problems with traditional face-to-face teaching is prompt control and feedback at the first stage of instruction. It is very important that students do not develop misconceptions or "misdoings" while studying new material. Individual control is essential for this. Though in the traditional environment it is hard to do, the SSDMA theory recommends that at the initial stage of action development, control is provided after every operation of the action. Failing to do so may cause developing misconceptions and "misdoings".

Organizing work groups of students is one of the plausible solutions to this problem. The same thing could be done while teaching online. Work groups online could be a compulsory component for both traditional and online instruction. Since online discussion could be a time and effort consuming process, the instructor should determine the measurable objective of each session, what interactive exercises will be done online, what the role of each participant is, and how students will get feedback on the results of their session.

It follows from the recommendations of the SSDMA theory, that online discussions are essential at the initial level of the action development. The action should be disintegrated into elementary operations such that, first of all, students do not have problems performing any operation of the action and, secondly, the possibility that the majority of the group will make a mistake with any particular operation is fairly small. Even if a member of the group makes a mistake at this point, the mistake will be corrected by the rest of the group.

Synchronized online discussion is a very powerful tool in online teaching; it can also be used in the traditional face-to-face teaching. But since it requires a good amount of time, every session must be very efficient and should help students to save overall time mastering the subject. When students feel that they spend a lot of time in synchronized discussion without visible results, they lose interest in online synchronized sessions. Therefore, the instructor should carefully design online discussions keeping in mind the goals that need to be achieved during every session. The SSDMA theory provides a good theoretical framework for setting up these goals. The most efficient way to use the synchronized online discussions is to develop the orientation part of action and to provide a step-by-step control at the original stages of the action development.

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