INFORMATION COMMUNICATION TECHNOLOGY AND E-LEARNING CONTRA TEACHER

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Abstract

This article presents the results of a pilot research about interaction between e-learning/teaching paradigms and "classical" ones, where a "human" teacher is the central element. With other words, we analyzed relation between e-teacher and the human one. Because the presented results are gained in a pilot research and so the sample was relatively small, we would like to show how, with the help of statistical methods the reliability of the results can be increased. In our research work we developed different tools and with this pilot research we would like to test, if this tools:

- *are precisely enough and specially if they*
- *give us enough reliable results.*

Results of our research in this paper will point out two important conclusions, namely:

1. *the students need (human) teacher and e-material (or e-teacher/tutor) is simply not enough, especially if we would like to reach higher cognitive, long lasting knowledge, and*
2. *with appropriate selected statistical methods, also with small sample, we can obtain enough reliable results.*

Key words: *ICT, e-learning, human teacher*.

Introduction

A wave of innovation is being stimulated by the Information Technology (IT) revolution that promises to revitalise our schools. Outcome-based teaching methods, e-learning at a distance, home schooling and collaborative group work are becoming popular phrases in progressive educational milieu at the end of 20th century (Aberšek & Kordigel, 2005). It looks that these changes are proving so effective that they signal the need for a major reconceptualization of the learning process. The goal of school system must focus on instilling that vital desire of "learning to learn" in today's students. To accomplish this, teachers must involve the student as an active, self-directed learner. Powerful new forms of IT will have to be provided to create an information-rich learning environment in which students and teachers can explore the use on-line knowledge bases, and information superhighways. It looks that in the school of 21st century the human teacher will disappear. But is this rational? In this paper we will try to answer to this question!

Monitoring the international scientific communication about ICT and its importance in the educational process of 21st century one gets an impression, modern teaching technology and adequate computer programs can substitute the teacher (Aberšek, 2010). Of course everybody

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agrees teachers' role in educating moral and social values is indispensable. But considering his role in, for instance science and technology education, not everybody is convinced that the new, *the digital generation,* of students would learn better and would learn more trough digital media. In didactical literature about ICT and its possibilities in science and technology education, teachers are mainly mentioned as a disturbing factor. They do not understand the possibilities, ICT is offering in educational process, they are not enough opened to the progress of computer science achievements and they are not prepared to change their pre-digital routine. In short, hardy anybody is pointing out teacher's role in (science) education in the new ICT age. Should the teacher really take only the role of the manager in learning process? And what does this means? Should he/she only be responsible for organizing students turning on and off the computer and removing disturbing factors in using prepared ICT programs? Or should he do more, because he is needed in learning process.

Examining teachers' role in educational process we should begin with the question: *Where does children's knowledge of the world come from*? *Do children have to communicate with others in the learning process?* And in case, they have to communicate: *can this communication be performed by machine or an interpersonal communication is needed* (Aberšek & Kordigel, 2010).

Concerning the first question, the answer should be searched in constructivist theory of learning, based on J. Piaget's (e.g., 1951, 1952, and 1954) research of universal mechanisms of child's development. He assumed that the human child has a genetically transmitted readiness to construct knowledge from every encounter with the physical world. In Constructivism, universal developmental changes are believed to come about through a general cognitive mechanism for processing information. To be brief, the course of development is understood as a sequence of stage-like changes into higher cognitive structures. After Piaget the debate about child's cognitive development focused on the role of the social environment (Meadows, 1996). To what extent would a child construct knowledge independently? Could the construction process originate to any extent from others' experiences in the society? Lev Vygotsky's (Vygotsky, 1978a, 1978b) theory, according to which education constitutes cognitive growth, was discovered again. This means that the child needs a support at sensitive stages; a so called zone of proximal development, from engagements with more experienced others. In social situations, parents and siblings, and later peers and other adults, would take responsibility for the child's developing mind. In *Thought and Language* Vygotsky put forth his influential conclusion that cognitive growth is socially structured.

Social Constructivism in 90s' pointed out the importance of social context and its influence in learning process and cognitive development and spoke about internalization of knowledge in social events. (Silve'n 2002). A socio cultural framework for the study of cognition has gained increasing acceptance in recent years also with the work of B. Rogoff (Rogoff, 1998). She points out the social context in which cognition occurs. In her research she observes the generic individual as the basic unit of analysis and adds social factors as external influences" (Rogoff, 1998, p. 680). Most specifically, the documentation of what teachers do, say and think along side of children's' interactions is critical for determining how participation changes over time. According to Rogoff research of child's cognition development needs also to include detailed observations of teacher interaction. The research focus may be on how children influence each other, and equally important on how what the teacher says and does influences thinking.

Constructivist model of teaching is based on cognitive conflict between child's existing scientific concept and problem in learning environment, which can not be solved with the content of existing scheme. In social cognitive model a teacher with his mediation in learning situation draws child's attention on the facts which generate a cognitive conflict and on the facts, which can generate a possible solution of the problem. This means with social factors as external influences are meant not just children and their interactions with each other and the learning environment, but also mediation by other cultural tools, such as the teacher (O'Loughlin, 1992). Or in other words: *teachers' mediation* generates students' cognitive processes and is an important factor for results of learning process.

Problem of Research

The primary problem of our research is the previous questions:

- Is self learning philosophy, philosophy *learning to learn without human teacher* real imperative or a dangerous mistake? Is the teacher useful in didactic process, in case this process is based on ICT technologies, or can he/she be spared?

And the secondary one:

- How to interpret results if we don't have sample big enough, if we don't have a significant sample for making reliable conclusion?

Research Focus

Our main research goal was to study interaction between e-learning/teaching (self learning) paradigms and "classical" ones, where the human teacher is the central element, by comparing the results of their "teaching". With other words, we analyzed, in which learning environment students learn more. The central question of our research was to find out, if the quantity of knowledge, quality of knowledge and duration of knowledge is higher, when students are taught in classical teacher-student situation or when they are guided by the "e-teacher?

We developed different tools and with this pilot research we wanted to test, if this tools:

- are precisely enough and specially if they
- give us enough reliable results.

The main research doubt, connected with e-learning and on the base of e-material self learning, origins from social constructivism and its paradigm, according to which students need engagement with more experienced others (Meadows, 1996), a human teacher, and his mediation in the zone of proximal development (Vygotsky, 1978a, b). This is perhaps not so important in the case, when only knowledge is expected. But in the case we want to gain knowledge on higher cognitive levels, as interpretative understanding and adaptive critical understanding, is teacher's mediation especially important. Further we were interested, how long students keep the gained knowledge. Which knowledge do students remember longer, the knowledge, they gained in teacher-student situation or that they gained by their work with e-teaching material?

Methodology of Research

General Background of Research

The presented stage of our research is only a pilot research. Our sample was 120 students and the whole sample in Slovenia is approx. 18.000 students/per generation. So if we would like to talk about reliability of results in our case we must do something, for example, we must introduce statistical tools (Hubbard, 2007). In our research we used statistical numerical approach for increasing reliability of prediction – simulation method Monte Carlo and probability analyses (Hammersly, 1988). Next phase of our research will be full scale experiment with cca. 20–30% of generation.

Students, participating in this study, were 12–13 years old. In Slovenia this means the 7th year of education in the compulsory school. The experiment was conducted in the framework of school subject *technical education.* This didactical environment was selected to eliminate the factor of "fear" from new technologies on the teachers' side and the factor of excitement at exposing to new teaching media on the students' side. We assumed teachers of technical education use ICT in their daily work quite often and consequently students are used to work with ICT too.

The topic, chosen for assessment of chosen teaching models, was *material properties.* We divided the sample in 3 groups. The first group was taught in a classical way, students were exposed to 80% of teachers lecture and 20% of self learning. The second group was taught in a modern way: they were exposed to 60% of teachers influence, 40% of the time they learned by themselves, using ICT. The third group experienced pure e-learning. 80% of the time they independently worked with e-material, in 20% of time, they were exposed to teachers introducing the e-material and his assessing the results.

Progress of each group was assessed by a special for this experiment prepared assessment tool. It was made on the base of the revised Bloom taxonomy. We used first three levels: knowledge, comprehension and application, and assumed:

- Progress on the 1st level (knowledge/literal understanding) is reached, when student can remember, what was explicit mentioned in the text.
- Progress on the 2nd and 3rd level (comprehension) is reached, when students can show understanding on interpretative or adaptive, critical level.
- Progress on the 4rd level (application) is reached when students could prove they can apply their knowledge in new situation.

On the level of **knowledge** informative/*literal understanding* was expected, the assessments tool asked students to recall the definitions.

Comprehension was divided in two levels, a level of *interpretative understanding*, where students could find the answer by combining different data from the text, and a level of *adaptive, critical understanding*, where the answers could be found only by comparing data from the text with previous existing mental schemes. For example, as reached level of interpretative understanding was counted, when a student could answer on the question as: could you connect the specific material with prescribed property. As reached level of adaptive, critical understanding was counted, when a student proved understanding of connection between specific properties of material, as tensile strength and hardness or between hardness and brittleness.

Application of knowledge, for example, was proved by students when they could correctly decide which material could be appropriate for choused product as a function of material property.

The **duration of knowledge** was assessed after 1 to 6 months.

And now few words about analyzing data and base terminology (Hubbard, 2007, Little, 1981). Statistics is a set of methods used to collect and analyze data. Those statistical methods help us to make good decisions about uncertain situations. A **probability** is a numerical measure of the likelihood of the event. It is a number that we attach to an event, which reflects the likelihood that we will get expected results. A probability is a number from 0 to 1. If we assign a probability of 0 to an event, this indicates that this event **never** will occur. A probability of 1 attached to a particular event indicates that this event **always** will occur. An outcome is the result of an experiment or other situation involving uncertainty. The set of all possible outcomes of a probability experiment is called a sample space. The sample space is an exhaustive list of all the possible outcomes of an experiment. Each possible result of such a study is represented by one and only one point in the sample space, which is usually denoted by S. An event is any collection of outcomes of an experiment. Formally, any subset of the sample space is an event.

Sample of Research

If we talk about reliability of the test results, we can gain this or with significant big sample (let say 20-30% of whole generation) or with appropriate statistical methods. Because our research sample is small, 120 students, and the whole one year generation in Slovenia is approx. 18.000 students, some of the major issue of this paper is show how to come to grips with the discrepancies between the idealization of test planning and mathematical analyses and the realities of practical procedures of actual test conduct so that ultimately test variability may be assessed reliably. Certain aspects of this problem are presented in this paper.

Instrument and Procedures

Instrument and procedures in our research were:

- Questionnaires for testing the level and duration of knowledge,
- statistical methods described below and probability calculus for analyzing the obtained results and
- Monte Carlo method for mathematical/numerical increasing sample data and the reliability of results.

Data Analysis

The selected and statistically analyzed test data of presented research (self learning, intelligent learning environment in front of classical school system with teacher – human teacher) contain 3 tests groups:

- Group A: 20% self learning with ICT and 80% human teacher.
- Group B: 40% self learning with ICT and 60% human teacher.
- Group C: 80% self learning with ICT and 20% human teacher.

Because this is pilot research each group contain “only” 40 students. The scatter characteristics of test results were statistically analyzed by using selected data. The data were selected on following basis:

- Only adults of the students were considered.
- The students were not be considered to be part of the same population (we introduce randomness in the sampling).

A series of linear regression analyses was performed to determine if the standard deviation of the test data fit the proposed normal distribution function (Little, 1981). The standard deviation was calculated from the following equation:

$$\text{standard deviation} = \left[\frac{1}{n-1}\sum_{i=1}^{i=n}\log X_i^2 - \left(\sum_{i=1}^{i=n}\log X_i\right)^2\right]^{\frac{1}{2}}$$

$$\text{standard deviation} = \left[\frac{1}{n-1}\sum_{i=1}^{i=n}\log X_i^2 - \left(\sum_{i=1}^{i=n}\log X_i\right)^2\right]^{\frac{1}{2}} \quad (1)$$

$$standard\ deviation = \left[\frac{1}{n-1}\sum_{i=1}^{i=n}\log X_i^2 - \left(\sum_{i=1}^{i=n}\log X_i\right)E2\right]E0.5$$

With X_i being the i^{th} results in a test group composed of $n = 40$ samples. The probability P was evaluated by ordering the values of logarithmic standard deviation sequences from the lowest to the highest value. Consider the probability expression

$$Prob\left[z_{low} < Z < z_{up}\right] = \gamma \; Prob\left[z_{low} < Z < z_{up}\right] = \gamma \tag{2}$$

in which z_{low} and z_{up} are data, Z is a random variable and $0 \leq \gamma \leq 1$.

The probability corresponding to each value of logarithmic standard deviation was then computed by using the following equation:

$$P = \frac{i - g}{m - (2g + 1)} \tag{3}$$

Where

i =count number,
g =1/2 and
m =total number of logarithmic standard deviations begin analyzed

For this type of sequentially ordered data, the median value of logarithmic standard deviation has a count number of $[(m/2) - g]/m$ if m is odd. If m is even, the median is the average value of $[\{(m/2) - g\}/m]^{th}$ and the $[\{(m/2)\,g + 1\}/m]^{th}$ ranked values of logarithmic standard deviation.

The linear regression analysis of the normal distribution of logarithmic standard deviations led to an equation of the form expressed in Equation 4

$$Y = A + BX \tag{4}$$

With

Y = logarithmic standard deviation

and

$$X = z \tag{5}$$

Equation 4 was also used for the linear regression of a logarithmic distribution with $Y = \log_{10}$ of the logarithmic standard deviation and $X = z$.

Because we have not enough big samples for reliable interpretation of collected results we use Monte Carlo methods to increase the number of data; with Monte Carlo method we simulate our experiment with the total number of generation (Hammersly, 1988). Monte Carlo methods are numerical methods that use random numbers to compute quantities of interest. This is normally done by creating a random variable whose expected value is the desired quantity. One then simulates and tabulates the random variable and uses its sample mean and variance to construct probabilistic estimates. Monte Carlo methods are useful in all uncertain situations. Because of their reliance on repeated computation of random or pseudo-random numbers, these methods are most suited to calculation by a computer and tend to be used when it is unfeasible or impossible to compute an exact result with a deterministic algorithm or when we have not enough data. More broadly, Monte Carlo methods are useful also for modeling phenomena with significant uncertainty in inputs. The Monte Carlo method can be illustrated as a game of Battleship. First a player makes some random shots. Next the player applies algorithms (i.e. a battleship is four dots in the vertical or horizontal direction). Finally based on the outcome of the random sampling and the algorithm the player can determine the likely locations of the other player's ships.

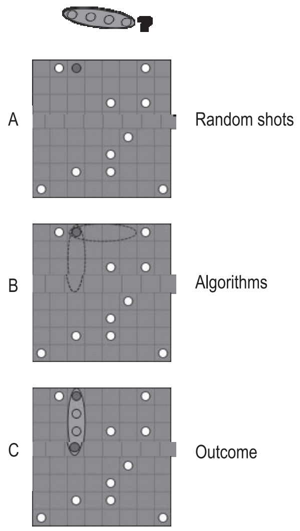

Figure 1. Monte Carlo simulation of the game of Battleship.

Results of Research

In the next figures we point out only final results of our calculation. For interpretation of experimental (simulating) data we use standard 90% probability, which means, that our results could bi significant and correct for whole generation of Slovene students with reliability of 90% (Hubbard, 2007, Little, 1981).

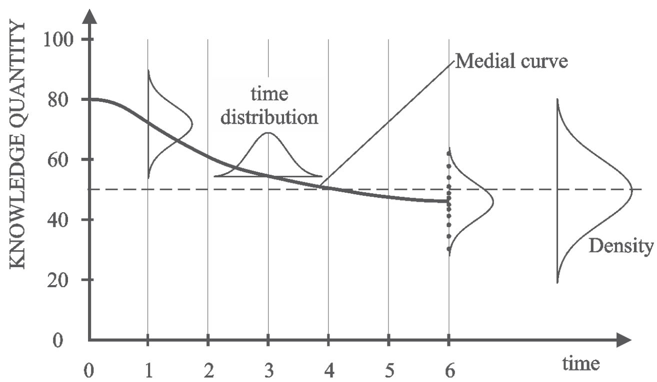

Figure 2. Typical data scatter in experiment results (interpretative understanding).

So the Figure 2 presents the way how we analyze research data. The Figure 3 shows the comparison of results for all three groups A, B and C in connection with 4 levels of knowledge, comprehension and application. And figure 4 show the duration of knowledge for informative (literal) understanding (group A). Almost identical are also the diagram for groups B and C.

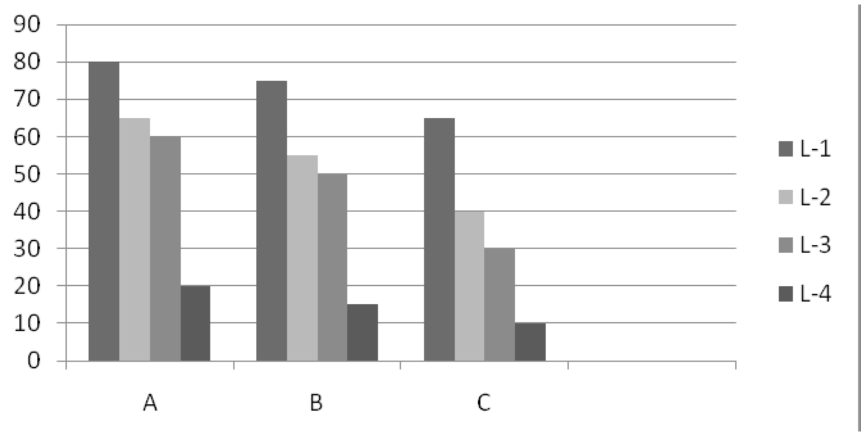

Figure 3. Research results.

Where:

L-1 = informative (literal) understanding
L-2 = interpretative understanding
L-3 = adaptive, critical understanding
L-4 = application

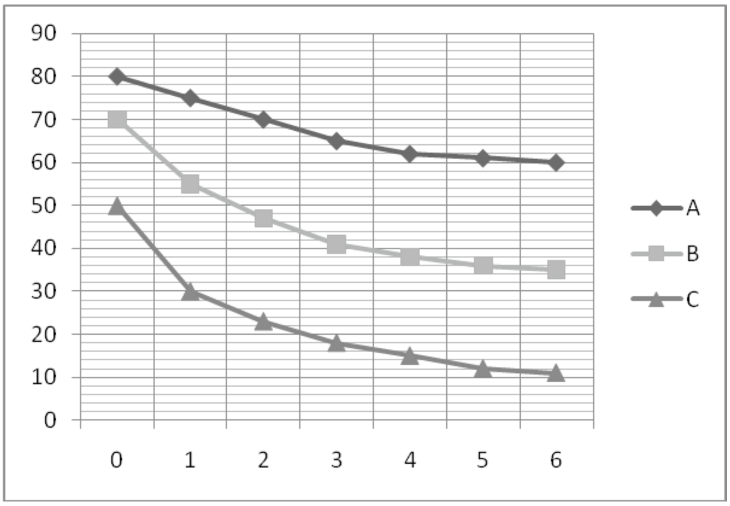

Figure 4. Duration of informative (literal) understanding.

Discussion

The results of our experiment confirm our doubts, concerning the question of the necessity of teacher in natural science and technology educational/learning process. Examining teachers' role in educational process from the perspective of social constructivist cognitive model draws our attention to the fact that, *children* simply *have to communicate with others in the learning process.* Cognitive development and learning occur in the process of (written or oral) communication. And teachers' role in this communication is at least double:

- he/she (can) be a source of knowledge and at the same time
- he/she must be a mediator; his/her mediation in learning situation must draw child's attention on the facts which generate a cognitive conflict and on the facts, which can generate a possible solution of the problem.

Comparing results of experimental groups A and C can be interpreted as a fact that ICT obviously does not fulfill both of this tasks good enough. The difference in assessment results speaks clearly for presence of real teacher in learning process. A group A, which was exposed to the teacher's influence for the longest period of time, reached better results on all four levels, where progress was assessed and the duration of reached progress was longer. But this is not all that matters: as figure 3 shows, the difference between reached results was important bigger on the level of adaptive, critical understanding (level 3) than between informative/literal understanding and interpretative understanding (levels 1 and 2). If we recall, that literal understanding (knowledge, according to Bloom) and interpretative understanding can occur with the process of thinking in the frame of information, given in the text (oral or written, verbal or visual) and that for adaptive understanding student has to compare information, given in the text, with previous existing mental schemes, this is especially dangerous. It can lead to the conclusion, students, exposed mainly to ICT, didn't get enough help in form of 'drawing their attention on the facts which would generate a cognitive conflict and on the facts' (O'Loughlin, 1992), which would generate comparing new data with existing mental scheme. One could conclude: teacher's mediation was missing.

Because we have not enough big samples for reliable interpretation of collected results we use combination of different statistical methods to increase the number of data, to simulate our experiment with the total number of generation. With such approach we got more reliable results, and with comparisons with similar research we find out good agreement. But if we would like to be sure if we choose appropriate statistical combination it is necessary to compare our results also with some similar research or data. For this reason we will continue our research in future with bigger sample, approximate with 20 - 30% of whole population.

Conclusions

In conclusion we should answer the question, we asked at the beginning. Do students need a (human) teacher and e-material (or e-teacher/tutor) is simply not enough, especially if we would like to reach higher cognitive, long lasting knowledge. Or in other words: is it possible to perform education by machine or an interpersonal communication is needed.

There is no doubt ICT (and other sources of knowledge) will very likely overtake teachers role as transmitter of new knowledge. But there is still an open question how far ICT (and self teaching paradigm) can overtake teachers' role as mediator, which is indispensable, because such mediation generates students' cognitive processes and is an important factor for results of learning process. For this second task ICT is not yet good enough. We do not know, what future will bring, but we can be sure, if somebody wishes to replace human teachers with computer

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devices and computer programs (because this would be economically wise and he would save money) he has carefully explore, how to "teach computer to detect the zone of proximal development and how to perform the mediation role, which generates student' cognitive process and is an important factor for results of learning process (Aberšek, 2010).

Results of our research in this paper will point out two important conclusions, namely:

1. the students need (human) teacher and e-material (or e-teacher/tutor) is simply not enough, especially if we would like to reach higher cognitive, long lasting knowledge, and
2. with appropriate selected statistical methods, also with small sample, we can obtain enough reliable results.

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