JOURNAL OF EDUCATIONAL AND INSTRUCTIONAL STUDIES
IN THE WORLD
February, March, April 2013, Volume: 3 Issue: 1 Article: 23
ISSN: 2146-7463

IMPLEMENTATION OF CONNECTIVISM IN SCIENCE TEACHER TRAINING

Josef Trna
Masaryk University, Czech Republi
trna@ped.muni.cz

Eva Trnova
Masaryk University, Czech Republi
trnova@ped.muni.cz

Abstract
The pedagogical theory of connectivism was born as a response to very fast ICT development which strongly influences education. The study presents our research outcomes of connectivist influences on science education which is focused on the following issues: identification of connectivist factors and their influence on science education; development of connectivist educational methods; implementation of connectivist educational methods into teaching/learning and teacher training. Connectivist teaching/learning methods have to be implemented in science teacher training. We are presenting research outcomes of the implementation of connectivist teaching/learning methods in science education and teacher training. The research has been carried out in the European project "Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science" (7FP). The important objective of our research is upgrading of the self-efficacy of science teachers to take ownership of effective ways of science teaching. Students should benefit from connectivist learning methods for their better motivation and understanding science.

Keywords: connectivism, motivation, science education, science teacher training

INTRODUCTION

Very fast ICT development strongly influences education. ICT technology has reorganized also learning and teaching. D. Oblinger and J. Oblinger (2005) describe today's students as the Net Generation (Net Gen), who has grown up with widespread access to ICT and all tools of the digital age. Members of the Net Gen have some features which are different from previous generations and which can affect their education. The most important changes are:

- They are well visually literate, but their text literacy is not developed enough. Most of the Net Gen students (73 %) prefer to use the Internet to libraries for research and they know how to find valid information on the Web (Online Computer Library Center, 2002).
- They intuitively use a variety of ICT without an instruction manual; therefore their understanding of the technology may be sketchy.
- They prefer speed to accuracy.
- They do multitask, move quickly from one activity to another and sometimes perform them simultaneously.
- They prefer to learn by doing rather than by being told what to do.
- They learn well through inquiry by themselves or with their peers. This exploratory style enables them to retain information better and to use it in creative, meaningful ways (Tapscott, 1998).
- They often prefer to learn and work in teams. A peer-to-peer approach (help each other) is common.
- They consider peers more credible than teachers in terms of determining what is worth paying attention to (Manuel, 2002).

These changes necessarily have an impact on science education and teacher training.

Connectivisim in Science Education

Behaviourism, cognitivism, and constructivism are the three main teaching/learning pedagogical theories still used in science education. Findings about the Net Generation have led to the origin of a new pedagogical theory. This new theory is connectivism as "a learning theory for the digital age". G. Siemens (2005) as its founder states that learning is a network phenomenon, influenced by socialization and technology. "Learning is no longer an internal, individualistic activity. Education has been slow to recognize the impact of new learning tools and the environmental changes. The ability to learn what we need for tomorrow is more important than what we know today. When knowledge, however, is needed, but not known, the ability to plug into sources to meet the requirements becomes a vital skill. As knowledge continues to grow and evolve, access to what is needed is more important than what the learner currently possesses" (Siemens, 2004).

According to Siemens (2005, p. 4) "learning (defined as actionable knowledge) can reside outside of ourselves (within an organization or a database), is focused on connecting specialized information sets, and the connections that enable us to learn more are more important than our current state of knowing." Siemens established the first principles of connectivism (Siemens, 2005, p.5):

- Learning and knowledge rests in diversity of opinions
- Learning is a process of connecting specialized nodes or information sources
- Learning may reside in non-human appliances
- Capacity to know more is more critical than what is currently known
- Nurturing and maintaining connections is needed to facilitate continual learning
- Ability to see connections between fields, ideas, and concepts is a core skill
- Currency (accurate, up-to-date knowledge) is the intent of all connectivistic learning activities
- Decision-making itself is a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decision.

Connectivism is nowadays widely discussed (Downes, 2005, 2012). It would be suitable to examine possible connectivistic influences on science education. Our research is focused on the identification of connectivistic factors and their influence on science education.

Connectivist Influences on Science Education

Thus a need occurred to examine possible connectivist influences on science and technology education. Our research (Trnova & Trna, 2012a, and 2012b) is mainly focused on the following issues: identification of connectivist factors and their influence on science education; development of connectivist educational methods; implementation of connectivist educational methods into teaching/learning and teacher training

To identify connectivist factors, we used a method of a design-based research. It is a development research which is a new trend in educational research. The used methodology can be described as a cycle: analysis of a practical problem, development of solutions, iterative testing of solutions, reflection and implementation (Reeves, 2006).

We have discovered the first set of connectivist factors:

- Sharing and acquisition of new science knowledge and skills
- Exchange of experience among students and also among teachers
- Creation of learning/teaching network structures
- Development of communication competencies of students and teachers
- Development of cooperation competencies of students and teachers
- Motivation of students and teachers by communication and cooperation with colleagues, use of ICT etc.
- Teachers' and students' improvement of skills to use ICT and English language

We have also developed a set of special connectivist teaching/learning methods in science education (Trna & Trnova, 2012). These methods include:

Educational games

Common use of ICT, advanced visual literacy and multitasking are reflected in the popularity of educational games from different themes of science for different age categories. These games provide educational space, in which students may explore and solve science tasks assigned by the game instructions. Connection of classical games features with connectivist factors highly motivates students and brings significant educational outcomes.

JOURNAL OF EDUCATIONAL AND INSTRUCTIONAL STUDIES
IN THE WORLD
February, March, April 2013, Volume: 3 Issue: 1 Article: 23
ISSN: 2146-7463

Comics creation

Students of the Net Generation have developed visual literacy and they easily express themselves with the help of images but have difficulties reading long texts with comprehension. If a theme is not interesting for them, they skip passages and try to get to the end fast (Grunwald, 2003). *Comics advantageously combine text with images and therefore they contain connectivist factors. It is appropriate to include students actively in the creation of comics.*

Creation of multimedia presentations

Students of the Net Generation are able to integrate images, audio and text quite naturally. They are able to move very fast between the reality and virtual environment. They have knowledge of a wide assortment of ICT applications, which allow them to create their own multimedia presentations. They are joined in online communities where they present the results of their work to others; they express their opinions and advise each other on problems etc. We have utilised their skills and needs in the creation of multimedia presentations of science experiments and publishing them on the Internet.

Use of simulation experiments

Connectivist approach to problem solving is based on the use of simulation animations, in which students change parameters and verify or seek the problem solving. Here, their need of intuitive searching is applied by the heuristic method, further; image assignment of information without long texts is applied. After a series of simulation experiments, the students verified their results with a calculation and a real experiment.

Connectivist teaching/learning methods based on connectivist factors have to be implemented in science teacher training.

Implementation of Connectivism in Teacher Training

Science teachers need to be equipped with new competences and innovated professional skills based on connectivism. Teachers are not satisfied with just prepared new methods and techniques but they need to understand the scientific reasoning of these innovated educational methods and instruments. Thus research-based teacher training is a new dimension of science teacher continuous professional development.

Connectivist educational methods (Trna & Trnova, 2010) have to be included in the actual pre-service and in-service science teacher training. To strengthen connectivist teacher education we used connectivist methods also in their training. These teacher training methods include:

- Teamwork of trained teachers
- Networking by creation of information and cooperative ties among members of a team of trained teachers
- Various use of ICT

Implementation of connectivist teaching method in teacher training can take various forms, which combine different training methods.

We are presenting as an example the output of training teachers in the connectivist teaching method "Use of simulation experiments". A part of the training was to create a set of simulation experiments using plastic bottles which demonstrate behaviour of the human body in the pressure above atmospheric (swimming, bathing and diving under water). Trained teachers used teamwork, networking and ICT when developing these experiments. The results of their work are the following experiments:

Human Body in Experiments

Eardrum under water: *The test tube covered by a rubber membrane arches by overpressure in the plastic bottle. The rubber membrane simulates behaviour of the eardrum during swimming, bathing and diving. The water in the ear canal pushes the eardrum. The result is the deflection of the eardrum.*

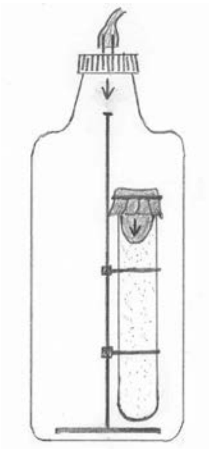

Figure 1. Eardrum under water

Eardrum rupture under water: *The deformational effect of the overpressure force is demonstrated by the rupture of the covering membrane on the test tube made out of a piece of a plastic bag. The plastic membrane simulates the terminal behaviour of the eardrum during swimming, bathing and diving. The water in the ear canal pushes the eardrum by great force. The result is the rupture of the eardrum. The implication of the rupture is cutting pain and loss of spatial orientation. This means danger of death for the diver.*

Lung compression: *The deformational effect of the overpressure force is demonstrated by changing volume of an inflated small rubber balloon. The overpressure under water during diving reduces the lung volume. We are able to breathe spontaneously only about one metre under the water surface. The air must be pumped into our lungs by overpressure during diving. At a depth of ten metres the lung volume is reduced to a half. If the diver emerges too quickly, his lungs can be fatally damaged.*

Figure 2. Lung compression

Air dissolving in blood: *The air is dissolved into the water in the overpressure plastic bottle. The air (nitrogen) is dissolved into blood during diving. Air embolism is a frequent reason of death after fast emergence.*

CONCLUSIONS AND IMPLICATIONS

Our research results verify that implementation of connectivism factors and teaching/learning methods in science education is the necessity. We identify the set of connectivistic factors and teaching methods which influence science education.

The international dimension of connectivist science education provides an opportunity for the development and dissemination of ideas and curricular materials among teachers. A web-based environment can be a very effective educational technology for science teachers' and students' cooperation leading to upgrading of science education. Connectivistic teaching/learning methods have a positive influence on students and teachers. We have implemented our research results into pre-service and in-service science teacher training.

WJEIS's Note: This article was presented at 4th International Conference on New Trends in Education and Their Implications - ICONTE, 25-27 April, 2013, Antalya-Turkey and was selected for publication for Volume 3 Number 1 of IJONTE 2013 by WCEIS Scientific Committee.

Author's Note: The study was initiated within the project "Quality of Curriculum and Instruction across School Subjects"(Czech Science Foundation, GAP407/11/0262).

REFERENCES

Downes, S. (2005). *An introduction to connective knowledge.* Retrieved March 12, 2013, from http://www.downes.ca/cgi-bin/page.cgi?post=33034

Downes, S. (2012). *Connectivism and Connective Knowledge.* National Research Council. Canada. Retrieved March 12, 2013, from http://www.downes.ca/files/Connective_Knowledge-19May2012.pdf

Grunwald, P. (2003). *Key Technology Trends: Excerpts from New Survey Research Findings, Exploring the Digital Generation, Educational Technology.* U.S. Department of Education, Washington, D.C., September 23-24.

Manuel, K. (2002). *Teaching Information Literacy to Generation Y.* NY: Haworth Press.

Oblinger, D., & Oblinger J. (2005). *Educating the Net Generation.* EDUCAUSE. Retrieved March 12, 2013, from http://www.educause.edu/educatingthenetgen/

Online Computer Library Center. (2002). How Academic Librarians Can Influence Students' Web-Based Information Choices. OCLC white paper on the information habits of college students. Retrieved March 12, 2013, from http://www5.oclc.org/downloads/community/informationhabits.pdf

Reeves, T. C. (2006). Design research from the technology perspective. In Akker, J. V., Gravemeijer, K., McKenney, S., & Nieveen, N. (Eds.), Educational design research. (pp. 86-109). London, UK: Routledge.

Siemens, G. (2004). Connectivism: A learning theory for the digital age. *International Journal of Instructional Technology and Distance Learning.* Retrieved March 12, 2013, from http://www.itdl.org/Journal/Jan_05/article01.htm

Siemens, G. (2005). *Connectivism: A Learning Theory for the Digital Age.* Elearnspace. Retrieved March 12, 2013, from http://www.elearnspace.org/Articles/connectivism.htm

Tapscott, D. (1998). *Growing Up Digital: The Rise of the Net Generation*. NY: McGraw Hill.

Trna, J. & Trnova, E. (2010). ICT-based collaborative action research in science education. In *IMSCI'10. The 4th International Multi-Conference on Society, Cybernetics and Informatics. Proceedings. Volume I.* (pp. 68-70). Orlando, USA: International Institute of Informatics and Systematics.

Trna, J., & Trnova, E. (2012). Inquiry-Based Science Education in Science and Technology Education as a Connectivist Method. In *Proceedings of the 8th International Conference on Education* (pp. 831-837). Samos, Greece: Research and Training Institute of East Aegean.

Trnova, E., & Trna, J. (2012a). Connectivism in Science and Technology Education with Emphasis on International Cooperation. *Journal of Social Sciences*, USA, New York, Science Publications, 8 (4), 490-496.

Trnova, E., & Trna, J. (2012b). Influence of connectivism on science education with emphasis on experiments. In Bruguiere, C., Tiberghien, A. & Clément, P., (co-ed. Marzin, P. & Lavonen, J.). E-book proceedings of the ESERA 2011 conference: Science Learning and Citizenship. Part 4 (pp. 83-89). Lyon, France: European Science Education Research Association.