Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia - Social and Behavioral Sciences 47 (2012) 1398 – 1402

Procedia
Social and Behavioral Sciences

CY-ICER 2012

Identifying constructivist methodologies and pedagogic content knowledge in the teaching and learning of technology

Moses Makgato

Department of Eduactional Studies , Tshwane University of Technology,2 Aubrey Matlala Road, Soshanguve, Pretoria, South Africa

Abstract

Constructivism theory which underpin variety of teaching methods such as problem-based learning, inquiry–based learning, project-based learning, case-based teaching, and discovery based learning promote active participation in the classroom. These constructivist methods of teaching and learning were used in this study to identify the attributes of constructivist practices in the teaching and learning of technology in classroom or laboratory. The study incorporated the aspects of PCK theoretical framework which also includes the principles of constructivist theory, particularly on the use of relevant methods (PK) in teaching and learning. This paper report on the difficulties experienced by teachers of grade 9 classroom in applying the appropriate methods of constructivist theory and attributes of PCK in teaching and learning of technology at some schools in Kwa-Zulu Natal, South Africa. Data was collected from eight (8) teachers spread across urban, semi-urban and rural or farm schools. The results showed that teachers don't know how to use the appropriate constructivist methods and principles in the teaching and learning of technology. It was also found that teachers lack the proper aspects of PCK in the teaching and learning of technology. Preservice teacher education and continuous professional development programmes for teachers should include the use of constructivist theory methods and principles in the teaching and learning of practical subject such as technology.

Keywords: contructivist methods,pck,technology subjects;

1. Introduction

Technology is about solving practical problems, thus it involves "creativity rather than an investigatory activity" (Gumbo & Makgato, 2008). Technology subject contributes towards learners' technological literacy by giving them opportunity to develop and apply specific skills to solve technology problems and to understand the concepts and knowledge used in technology (Department of Education [DoE], 2003). It also gives learners opportunity to interact with each other within teams where they develop technological solutions and explore both the positive and negative impacts of technology (DoE, 2003).

The content of technology subject allows learners to understand the concepts and principles used in technology. According to Khumalo (2004) teachers do not have enough content knowledge to teach technology because most were not trained in technology at the time of implementation. Gumbo and Makgato (2008) also found that teachers are being blamed for their apparent inability to prepare learners with the content knowledge and skills of technology. They further argue that technology could be better taught and learnt if teachers have an understanding of what should be taught and learnt. Teachers should also have a thorough understanding of how teaching and learning occurs in technology classroom.

This study was underpinned by the theory of constructivism which promotes active participation and variety of teaching methods such problem-based learning, inquiry –based learning, project-based learning, case-based

 doi:10.1016/j.sbspro.2012.06.832

teaching, and discovery based learning. These constructivist methods of teaching and learning were used in this study to measure the effectiveness of teaching and learning of technology in classroom or laboratory. Furthermore, the study was underpinned by Pedagogic content knowledge (PCK) framework which also encompasses the principles of constructivist theory, particularly on the use of relevant methods in teaching and learning technology subject. Pedagogic content knowledge is considered as one of the pillars of the teacher's knowledge and was first introduced by Shulman (1986). PCK framework "refers to teachers' interpretations and transformations of subject matter knowledge in the context of facilitating student learning" (van Driel, Verloop & de Vos, 1998. Gess-Newsome (1999) defines PCK as a combination of content and pedagogy in a specific context. Schneider and Krajcik (2002) explain how each of PCK is constituted:

Content knowledge

- Accuracy of content presentation for each concept of the unit.

Pedagogical knowledge

- Linking of ideas across lessons
- Use of artifacts to assess students' ideas

There are several approaches to constructivist theory with major branches, those built on philosophical theories of learning and those focusing on psychological theories (Olsen,1999)**.** The constructivist theory of learning is reflected in the developmental theories of Piaget (Piaget,1972) , Dewey (Dewey,1997) , Bruner (Bruner, 1961) and Vygotsky (Vygotsky, 1978). In Cognitive constructivism from the work of Piaget, a student reactions to experience lead to learning. From the work of Vigotsky, social constructivism play important role in the construction of meaning from experience (Prince and Felder, 2006). Teachers should have understanding of constructivist theory, principles and pedagogy in order to provide effective teaching and learning in the technology classroom. Although there are several approaches to constructivism, the common perspective is that construction of knowledge by students is basically a learning process that involves change (Olsen,1999). Thus, knowledge construction is the process of learning. In implementing a constructivist classroom the teacher should (1) influence or create motivating conditions for students (2) take responsibility for creating problem situations (3) foster acquisition and retrieval of prior knowledge and (4) create the process of learning, not the product of learning (Olsen, 1999). Constructivist classroom should reflect active participation and deep learning through inquiry based approach as opposed to surface learning (D'Silva, 2010). Proponents of constructivist theory provide the following principles for effective teaching and learning:

1. Teaching should begin with content and experiences familiar to the students, so they can make connections to their existing knowledge structures. New knowledge should be presented in the context of real-life applications, rather than abstract.
2. Knowledge should be presented in a manner that does not change students cognitive models drastically. In Vygosky's words, it means students should not be forced outside their " zone of proximal development", the region between what they know/can do independently and what they are capable of doing under adult guidance or capable peers (Vygotsky, 1978).
3. Teaching should enable students to fill the gaps and extrapolate information and materials presented by the teacher. The goal should be to empower learners with skills to be independent, and access use relevant information from various sources to answer their problems and challenges
4. Teaching should involve students working in small groups dialoging and arguing to find solutions to the learning activities. This attribute of cooperative learning support all forms and approaches of constructivism and essential in social constructivism

Principle #1 deals more with the content knowledge the teacher possess for a particular subject in the classroom. This principle is regarded as CK in the theoretical framework of PCK. Principles #1, 2, and 3 form PK in the PCK framework. This paper reports on the content knowledge (CK) and principle of constructivism demonstrated by teachers in the teaching of technology. The paper also assesses the ability/inability of teachers of technology to demonstrate the use of appropriate constructivist teaching methods which also reflect PK in the PCK framework.

2. Methodology

Data was collected from eight (8) teachers, i.e 3 teachers from 3 urban schools, 3 teachers from 3 semi-urban schools and 2 teachers from 2 rural or farm schools. Data collection was done by means of interviews with teachers and classroom observations. The purpose of interview was to obtain in-depth information about the teaching methods as well as the quality of content knowledge in technology. The classroom observation was done to obtain information regarding: lesson presentation. About eight schools were observed in their classrooms.

Interview data was transcribed and coded in order to categorise the data into patterns and themes. These data was analysed internally by the researcher and externally by an objective consultant in order to remove any biasness (Vithal & Jansen 1997). Field notes collected during observations were analysed in order to get the patterns that can be categorized into themes.

3. Results and discussions

Results and discussion were categorized in terms of technology knowledge content (CK) and the use of teaching methods.

3.1. Technology content knowledge

During interview most of the teachers indicated that they don't have enough knowledge of the technology content because they were not trained properly. For example one of the teachers in the semi-urban area said that: "We are still not well trained to teach technology subject despite the one week in-service training that the Department gave us. Most of us were teaching mathematics and physical science, at FET at the time of training. SES for technology have started making sense of this learning area."

Other teachers in urban and rural area supported this. For example one of the teacher in urban area also indicated that "the training given by the Department was not of any assistance, because the trainers were struggling to explain the content of technology learning area. Even some Senior Education Specialists (SES) are not yet making sense of what is expected in technology." Similarly teachers in Rural area said that "We were never trained to teach technology…, but we were made to teach technology because there was a shortage of manpower and to balance the work load. The SES for technology calls us in cluster groups and this does not help because those who know overshadow us." Despite inadequate training and lack of content knowledge of technology subject, teachers believe that "teachers have to know many terms that learners need to know and skills that they need to grasp as well". The results of this study agrees with findings in a study by Makgato, Khumalo and Mafisa (2006) which reported that teachers lacked content knowledge to teach technology. Many studies have shown that teacher competence in content knowledge (CK) is crucial for student achievement (Pikulski, 2000; Darling-Hammond, 2000; Rivers & Sanders, 1996; Kent, 2004; Borko, Elliott, McIver & Wolf, 2000).

According to the lessons that took place during observations, teachers seem to have chosen the content that they understood very well. This made it difficult to determine if technology content knowledge was a challenge. For example the teacher in school E prepared a lesson on pulleys. The teacher use text book to explain all the relevant terms that are used to transmit the force and motion from the driver shaft to the driven shaft. The teacher at school B was teaching about Hookes' law. This topic is not a direct content for technology in Grade 9, unless it is linked with the topics of technology. At School C the teacher was teaching about processing of materials using textbooks throughout the lesson. The teacher in school D prepared a lesson in electricity, the reason for the teacher to use this

topic is because is a science teacher and you can find this topic in science. The contents for schools A, F, were 2-D/ 3-D projections and, strength of materials, respectively while schools G and H were both teaching graphs. The observations in these schools also supported the interview data, that teachers lacked sufficient content knowledge. In most cases they were just reading from textbooks or teach wrong content taken from science subjects. .

3.2 The use of teaching methods

Various teaching methods and approaches were used by teachers in the teaching and learning of technology in Grade 9. The teacher at school A used the design approach as stipulated in technology curriculum to assist the learners to design the 2-D orthographic projections. He used the experimental method during the imparting of knowledge of the 3-D and 2-D and the various projections. The teacher also used the same method to enable learners to gain the relevant drawing skills that they needed to draw the front, top, and left views. This approach is more suitable when learners are supposed to design solutions to a problem. At School B the technology concept approach was used to prove Hooke's Law. During the lesson the teacher kept on intervening to give guidance to learners. The teacher at school C used the experimental method when teaching processing and the making of ice cream. Again there was mismatch in the use of teaching approach used. At School D question and answer method was used throughout the lesson in teaching electricity. The teacher at School E used the text book method to explain all the relevant terms that are used to transmit the force and motion from the driver shaft to the driven shaft. At School F the experimental method was used in teaching strength of materials. Furthermore, at Schools G and H teachers used the design approach to teach learners how to draw the graphs.

It was clear in most schools that the use of appropriate pedagogic knowledge (PK) in the teaching and learning of technology was a challenge in many teachers. This is consistent with the findings in Makgato and Mji (2006), that teachers do not know how to teach science subject (PK) to create an enabling environment for effective teaching and learning. Shulman (1986) argues that a particular way of teaching the subject makes it comprehensible to others ...[it] also includes an understanding of what makes the learning of specific topics easy or difficult. Teachers should have relevant theory, principles, and pedagogy of constructivism in order to provide effective teaching and learning (Olsen, 1999).

4. Conclusions

In this study, teachers said that they were not adequately trained to teach technology, and this was evidenced by the interview and observation data. Research findings had reported that when technology was introduced, teachers were co-opted from other related subjects (technical subjects, home economics and sciences) without specific technology teacher training. Most studies in teacher development have found that many teachers are seriously unprepared in both CK and PK to in order to enhance effective teaching and learning of technology. Continuous professional development for teachers is crucial in the process of school curriculum changes. Adequate time should be made available for teacher studies and planning if effective curriculum implementation is to succeed. Generic workshops and meetings cannot equip teachers with the required subject knowledge and skills for classroom practices. It has been shown in this study that teachers are not very competent in using teaching methods that incorporate constructivist theory in their classroom. We require teacher education programme that focus on the applications of models of constructivist theory in the teaching and learning of technology. Preservice teacher education and ccontinuous professional development programmes for teachers should pay much attention on the use of constructivist theory methods and principles in the teaching and learning of practical subject such as technology.

References

Borko H; Elliot RL; McIver MC & Wolf SA (2000). "that dog wont hunt": examlary school change efforts within the Kentucky reform. American Educational Research Journal, 37 (2), 349-393.

Bruner, J.S. (1961). The act of discovery. Harvard Educational Review. 31 (1).

Darling-Hammond L (2000). Teacher quality and student achievement: a review of state policy evidence. Education policy Analysis Archives, 8 (1), 1-49.

Department of Education.(2003). Revised National Curriculum Statement Grades R-9: Teacher's Guide for the Development of Learning Programmes. Technology: Pretoria. Government printers.

D' Silva, I. (2010). Active learning. Journal of education administration and policy studies, 2(6). 77-82.

Dewey, J. (1997). How we think, Mineola. New York: Dover.

Gess-Newsome, J. (1999). Pedagogical content knowledge: An introduction and orientation. In N. G. Lederman (Ed.), Examining pedagogical content knowledge: The construct and its implications for science education (Vol. 6, pp. 3-20). Boston: Kluwer Academic Publishers.

Gumbo, M.T. & Makgato, M. (2008). Dealing with the relational aspects of Technology education: Study Guide. Pretoria.

Kent A.M. (2004). Improving teacher quality through professional development. Education: Spring. Retrieved on October 23, 2010, from http://findarticles.com/p/articles/mi_qa3673/is_3_124/ai_n29092860

Khumalo, S. B. (2004). The implementation of Technology Education as a Learning area. Tshwane University of Technology D.Ed Thesis.

Makgato, M. & Mji, A. (2006). Factors associated with high school learners' poor performance: a sportlight on mathematics and physical science. South African Journal of Education, 26 (2), ISSN 0256-0100.

Makgato, M., Khumalo, S.B and Mafisa, L. (2006). The implementation of technology education: A South African experience. A paper presented at the SAARMSTE Conference 2006 the University of Pretoria , Pretoria from 9-12 January 2006.

Olsen, D. (1999). Constructivist principles of learning and teaching methods. Education. Vol 120.

Piaget, J. (1972). The psychology of the child, New York: Basic books

Pikulski J.J (2000). Increasing reading achievement through effective reading instruction (Tech.Rep.No. 19716). Newark, DE: University of Delaware, School of Education.

Prince, M.J. & Felder, R.M. (2006). Inductive teaching and learning methods: definitions, comparisons, and research bases.

Rivers J.C & Sanders W.L (1996). Cumulative and residual effects of teachers on future student academic achievement: Knoxville: University of Tennessee Value-Added Research and Assessment Center.

Schneider, R. M. & Krajcik, J. (2002). Supporting science teacher learning: The role of educative curriculum materials. Journal of Science Teacher Education, 13(3), 221-245.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15, 4-14.

Van Driel, J. H., Verloop, N. & de Vos, W. (1998). Developing science teachers' Pedagogical Content Knowledge. Journal of Research in Science Teaching, 35(6), 673-695).

Vygotsky, L.S. (1978). Mind in society, Cambridge, M.A. Harvard University Press.

Vithal. R. & Jansen, J. (1997). Designing your first research proposal. A manual for researchers in education and the Social Sciences Cape Town: Juta