RETHINKING TRADITIONAL SCIENCE TEACHING THROUGH INFUSING ICT LEARNING EMBEDDED BY A *'LEARNING-AS-DESIGN'* APPROACH

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The South African Department of Basic Education (DoBE) has been promoting constructivist learning principles, the development of higher order thinking, the implementation of ICT (Information and Communication Technology) (Department of Education, 2004; Du Plessis, 2014) and the development of critical outcomes such as problem solving, critical thinking, collaboration, self-management, finding and analysing information, developing effective communicating skills, assisting learners to use science and technology effectively as well as promoting effective learning strategies (Department of Education, 2004). The use of ICTs to promote teaching and learning has also been high on the agenda of the DoBE (2004; 2007). However, it appears that the use of ICT within South African schools is *'bolted-on'* on to the curriculum as an added extra, resulting that integration with school subjects is minimal (Du Plessis, 2010). The above is probably prevalent outside the South African context too in many other schools all over the globe.

It appears that what happens within the computer laboratory and classroom is in many instances not well discussed and collectively planned for between the computer laboratory teacher and the subject teacher – resulting in additional computer literacy without integration. The above predicament presents an opportunity for the science teacher(s) and computer laboratory teacher to re-examine existing practices and to re-think how they could work more closely together to implement and promote short or long term project-based science learning by means of the *'learning-as-design'* (Du Plessis, 2014) or knowledge-as-design (Perkins, 1986) approach, an approach where links between what happens in the classroom and computer laboratory become more visible to the learners and teachers.

There also seems to be many *'forces'* that prohibit the experimentation with and implementation of new ideas towards science learning, including ICT integration in alternative ways. The way teachers has been taught and lectured, the factory bell driven school model and a too fully packed curriculum are some of the forces that prohibit alternative ways of learning. This results in the presentation of science and traditional teacher talk dominating the teaching space, *i.e.* a transmission model, as well as subscribing to a textbook knowledge teaching approach. The belief is that *'If I have transmitted it, I have covered it and if I have taught it then my learners have learned what was taught'* which translates into a focus on teaching instead of learning. As a result of all of the above, I would argue that the above has lead in many instances to limited time for science learning where learners become actively engaged in science project-based learning, or as to what Pearson, Moje and Greenleaf (2010) alluded to very little real science engagement (Pearson, Moje & Greenleaf, 2010) or as Osborne (2010) and Pearson, Moje and Greenleaf (2010) referred to as focusing too much on *'what to know'* instead of *'how we can know'*.

I have deliberately NOT used the concept *teaching* above and referred to *information* and not knowledge. This is based on my opinion that there should be less science teaching, teacher presentation and transmission in the science learning space, as the transmission of information does not necessarily results in understanding. Hence, we do not transmit knowledge, we transmit information and this information only becomes knowledge when there is real understanding and application, not mere rote regurgitation. I therefore posit that real science learning cannot be presented; it requires that learners (students) have to experience science learning through active learner engagement, discussion and argumentation. As such, the focus of newly developed ICT approaches to promote science learning at school level should incorporate active learner engagement, *i.e.* learning that requires the creation of a

product or artefact by learners to demonstrate the learners' thinking and presentation of what they have learned in a meaningful way. This learner created science products or artefacts could then also be presented to their peers not only to obtain their viewpoints about the quality of their product to assist with science learning, but also to critique it with a view that it can be further improved.

In order to promote science learning (not science teaching), it is suggested that several aspects have to be considered when conceptualising science learning, for example exploratory talk, reading and writing, metacognition, constructionism, learning-as-design or designing-to-learn, artefact creation presentation and questioning as well as posing questions on different cognitive levels, learning as complex activity and distributed leadership, reflection and sharing of learning experiences, revisiting the role of the teacher from transmitter to facilitator and co-learner, higher order thinking through posing questions on different cognitive levels, motivational theory and project based learning (Du Plessis, 2014, p. 126). The above aspects resonate with Jonassen, Howland, Moore, Marra and Crismon's (2008) meaningful learning, learning that constitutes actively involved learners in the learning process.

Du Plessis and Webb (2011; 2012) and Du Plessis (2013; 2014) proposed heuristics or science learning approaches that can be implemented by using ICTs where learners become actively involved in science learning by means of using a presentation tool for example PowerPoint. The reason for developing these heuristics was to address the concerns that there seems to be a lack of information that clearly present to teachers the *'how to'* dimension (Hodgkinson-Williams, 2005; Leach & Moon 2000). However, there is a twist in *'how'* PowerPoint is used as it appears that PowerPoint is usually utilised by the teacher as a presentation tool, in many instances a mere replacement of the chalkboard or whiteboard embedded by an instructivist approach. The purpose of our the proposed heuristics is to make a 180 degree turn that requires re-thinking of the traditional conceptions of teaching in comparison to the *'learning-as-design'* approach. The proposed heuristic requires learners-students to utilise functions in PowerPoint such as the design of custom animations, creation of images and explanations as well as voice recording (including creation of their own science videos) to portray scientific literacy investigations or science learning about science topics. The use of story boarding as planning, research, search, talk, note taking and science writing are only some of the aspects that can be developed as a result of implementation of the heuristic (See Du Plessis, 2014). However, one could also utilise the proposed heuristic without using PowerPoint, *i.e.* using different ICT related tools to achieve the above.

In a recent paper (Du Plessis, 2014, p. 132-138) a heuristic and its proposed implementation part of has been presented. In brief, the implementation part of the heuristic suggests that the following process is embarked upon: Provide a stimulus and motivates learners, (2) Provide question or topic, (3) Describe the process & elements of the project, (4) Planning, (5) Inquiry: Searching for information & note taking, (6) Plan the design to be created, (7) Product creation & testing of product, (8) Articulation of learning & thinking, (9) Product presentation: Formative assessment and feedback, (10) Reflection and sharing, (11) Revising and (12) Formal presentation: Summative assessment.

This implementation part of the heuristic requires that learners embark on science related topic linked to the science curriculum using the internet and/or textual sources to present their understanding of scientific literacy related investigations or scientific concepts and topics by using PowerPoint in an alternative manner where learners become the designers and presenters of engagement, research and/or science topics. The participants (learners-students) have to know what the outcomes are, the object is, the rules and division of labour including what is expected from learning in community. It is proposed that activity theory as framework could be used to provide answers to the above (Engeström & Miettinen, 1999; Roth & Lee, 2007).

Our learners/students are digital natives (Prensky, 2001) that demand that we as science educators/lecturers not only use ICT for science teaching, but that we afford our learners/students the opportunity to utilise ICTs for the presentation and representation of their thinking about science (Du Plessis, 2013, 2014). It appears that simplicity, trialability, observability, relative advantage and compatibility are keys to adoption and implementation of new approaches (Rogers, 2003). I hope that science teachers and lecturers will trial our proposed heuristics in their learning spaces and report how they and their learners experienced them as science learning tools. Our proposed *'learning-as-design'* heuristic could hold promise not only to develop various critical outcomes, but to develop various critical thinking, planning, design, presentation and meta-cognitive deep thinking-learning (Du Plessis, 2013, 2014). It appears that activity theory could be a useful lens to research how teachers/lecturers and learners/students experience the proposed. Lastly it is important to note that what I am proposing is not that all science learning should follow this approach, but that this approach is one approach that could be used as a long term project-based learning approach that could not only promote possibly positive attitudes towards science as

subject, but also an approach that assist to fill the void that exists between what happens in the computer laboratory and in the science classroom, hence closer collaboration between the computer teacher and science teacher in order that we move from science teaching to science learning. Any takers?

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