Constructionist learning Environment (CLE) in the 21st century

Chewachong Akih & Linda Van Ryneveld**

Department of Science, Mathematics and Technology Education (SMTE)

University of Pretoria

Abstract: This paper defines a learning environment in a tertiary institution that enabled the development of 21st century skills, and tries to answer the question: "To what extent can 21st century competencies and character qualities be developed in postgraduate modules that are following a constructionist teaching and learning approach?" A sample size of 27 participants that included seventeen males and ten females. Eighteen students were enrolled for CEL module, and nine for the other CIT module. This study was carried out at the Faculty of Education, Computer-Integrated Education (CIE) at Pretoria University. The study investigated how a constructionist learning environment can support the development of 21st century skills. It implemented a multiple case study strategy. Data for this study was collected using a survey, participant observation, semi-structured interviews and document analysis and was analysed manually. The researcher studied the impact of this learning environment on students who had little or no experiences with learning in such an environment. Students worked individually and in groups and created artefacts that enabled them to develop 21st century competencies and character qualities. A survey was administered at the beginning and at the end of the study to capture students' perceptions about constructionist learning and 21st century skills. They showed positive attitude towards the learning environment with respect to the two modules motivation and understanding, skills and their group work abilities. By integrating Computer as Cognitive tools (CIT) and eLearning (CEL) modules into a constructionist learning environment, students learned to design and developed 21st century competencies and character qualities. The findings of this study provide concrete stimulus for higher education institutions to integrate subject teaching by technology and constructionist way of teaching and leaning into the classrooms in order to prepare graduates to fit into the 21st century society and workplace.

Keywords— *Learning environment; Constructionist learning environment; Constructionism; 21st century skills; innovative teaching and learning; Higher education*

Introduction A learning environment is a place where people can draw on resources to make sense out of things and where they can hypothesize about meaningful solutions to problems (Wilson, 1996). A learning environment typically comprises of a student, a site or space wherein the student actions, tools and devices(Oluwatelure, 2010). It also involves the gathering and understanding of information, as well as networking with others(Charlton, Magoulas, & Laurillard, 2009). Constructionist learning environments inspire and support multiple learning styles and various representations of knowledge (Kafai & Resnick, 2012). The constructionist learning theory recommends a strong connection between design and learning, and it affirms that activities involving building, structuring, or designing, all provide a rich content for learning (Kuhlthau, Maniotes, & Caspari, 2015). Constructionist theory goes beyond Piaget's constructivism (Ackermann (2001)in its emphasis on objects, by stressing that meaningful construction happens particularly well when students are engaged in building external and sharable artefacts (Kafai & Burke, 2015). The constructionist learning environment that was provided in both the modules under investigation, allowed students multiple opportunities to create tangible artefacts. One of the participants confirmed the constructionist nature of the learning environment by stating that lecturers, in the past, use to provide students with slides to study but this learning environment enables students to build their own knowledge. Participants from this study incorporated information and content with abilities and skills and explained constructionism from that perspective by saying

that learning without practical exposure will be meaningless especially when they are asked to apply their knowledge in the workplace (Kirschner, Sweller, & Clark, 2006). The design of this learning environment took this into consideration. These modules were relevant in terms of developing practical knowledge, and the exposure to constructionism that which they got in class. This exposure would enable participants to fit into their found knowledge and skills in the 21st century workplace.

A constructionist approach to learning provides each individual the opportunity to conceptualise their own meaning by building an external object or something that they can share with others (Coffman, 2011). Constructionism is a model for learning and an approach for education. It depends on effective and successful learning, not by pouring information into students' heads, but by giving students the opportunities to construct their own knowledge (Kolb, 2014). Furthermore, constructionism asserts that people learn with particular value when they are involved in building personally significant objects, such as computer programs, animations or robots (Papert & Harel, 1991).

Learning may be gained through a constant practise of students relating new information to their own skills and current understanding (Wasko & Faraj, 2000).The new knowledge is integrated with the students' previous knowledge and understanding so that it can be used effectively in new tasks and moved willingly to different circumstances(Council, 2013). It is important to note that participants were concerned with that too. The current study

brought out some of the aspects of successful teaching and effective learning. When participants were asked which teaching approach, they thought would result in the best learning experience, they all preferred the one where they are actively involved and are responsible for their learning.

Meanwhile they all agreed that the lecturer should still provide guidance and give structure concerning what need to be carry out. Constructionist learning was one of the compulsory learning theories introduced in these modules and was also used to encourage the mastering of the content that was termed learning by doing. Students in a constructionist-learning environment often create objects or artefacts representing a learning outcome that is meaningful learning to them(Han & Bhattacharya, 2001). It adopts not only Piaget's constructivism (Koohang, Riley, Smith, & Schreurs, 2009), but also Freire's ideas on self-determination (Bowers, 2004), and Papert's prediction about the role of technology to foster a more innovative and truly independent society (Kirwan, Costello, & Donlon, 2018). As discussed earlier, many issues occurred in the discussions concerning the modules related to constructionist teaching and learning approach. The learning environment created an opportunity for students to become active participants in their own learning, not like the traditional way of sitting and listening to lectures.

Constructionism is learning by making which means learning is most effective when students actively construct an artefact that is meaningful that they can see a tangible result from their work (Papert & Harel, 1991). Constructionism is when students are given the opportunity to create things that can be used, rather than focussing on study materials that uses the traditional teaching and learning approach where lecturers are the givers and students the receivers of knowledge. A constructionist-learning environment is more student-centred than teacher-centred, and learning is more collaborative, engaging and reflective than the traditional learning environment (Jonassen & Rohrer-Murphy, 1999).

Constructionism has a strong connection with constructivism. Constructivism and constructionism both emphasize active learning, mastery, and hands-on skill presentation that is well matched with the development of employability skills(Mays, 2015). In this learning environment, the lecturer acted as a facilitator and she monitored the students along their tracks of learning(Hmelo-Silver, Chernobilsky, & Jordan, 2008). Students were allocated responsibilities in which they had to implement specific instructional objectives that enabled them to explore, build, and solve problems (Hmelo-Silver & Barrows, 2006).

According to Han and Bhattacharya (2001)constructionist-learning environment is when a rubric is presented to the students which define what is expected from the students in a particular module or task. When the lecturer interprets the assignment to the knowledge of the students. When there are several methods to carry out the assignments. Group work for students to discuss the assignment. An opportunity for students to present their work or assignment to their group members and also to the facilitator before the final submission date.

Students should be able to develop sharable artefacts, an environment where students collaborate with each other and the opportunity to find out information from professionals from the internet. Students being able to engage in honest and trustworthy practical responsibilities. The lecturer engages the students in the constructionist learning environment and provided opportunities for them to know and understand the module content, which can enable them to acquire the required information. In this case, the modules assisted students to develop skills because it was more practical than the old method of teaching that was for students to listen passively and then give the knowledge back to the lecturer.

Constructionist approach of learning has a strong connection with constructivist learning approach that corresponds to learning by doing if the more you practice the more you become perfect in what you do. These two approaches both emphases on active learning through hands-on skills presentation that is in line with employability skills. Constructionist learning is made up of various forms and activities that including active learning, incidental learning, problem-based learning, inquiry learning and pragmatic learning. Nevertheless, this can only happen when students are actively involved and given the opportunities to interact in order to create new knowledge.

The 21st century competencies and character qualities are assumed to be important skills for higher education graduates. When higher education students are equipped with such skills, they construct new knowledge based on their past experiences and involvement in a constructionist learning process. Knowledge is created through observation, reflection and interaction with the learning environment such as their peers, instructors or technology. It depends on learning strategies of effective learning which results to the construction of new knowledge by enabling students to interpret it in a situation. In a constructionist teaching and learning environment the lecturer is a facilitator in order to support students in attaining information through performing actions.

Effective learning happens through personal students' involvement in their learning experiences. It requires students to work in groups and interact on the principle of Vygotsky social constructivism. When students interact amongst their peers it motivates them to be able to bring out new ideals and foster their development intellectually. Bruner's (1960) indicate that pedagogies is when students carry out activities and hands-on instructions when they are expected to use their own direct experiences and observations to get information to complete a task. In a constructionist teaching and learning environment, lecturers are supposed to be academic leaders and facilitators of students. The lecturer must be able to recognise students' potentials and support their learning. A

constructionist learning approach is based on construction of artefacts either by the support of the lecturer and their peers.

Constructionist learning environment enable students to be able to construct their own knowledge through group work and individually by the assumption that effect can be constructed when students are involved in active learning process. Knowledge is mostly constructed in learning environment were interaction or group work is an important factor for effective learning process. In this learning environment, the role of the lecturer is not underestimated rather it is more important because the lecturer become a coach to the students in order to enable them select appropriate activities for learning.

In a traditional learning environment, the teacher plays an active role in transferring knowledge to passive students. In a constructionist learning environment, the environment is design in a way for students to play an active role in their learning process through the activities they have been given to carryout. The students feel relax and confidence in becoming active participants. In this learning environment, the lecturer guides the students by posing a question and allowing them to work in small groups in order to discover one or more solutions to the problem. Students carryout experiments in order to reach their conclusions.

The lecturer assists the students in developing new insight and connecting them with prior knowledge but allows them to discover and discuss the solution to their group. Questions are posed on the virtual classroom and students assign in groups to discuss and reach agreement on their answers or artefacts, which are then shared with the whole class. Students can develop their own understanding of the subject matter based on their peers' ideas. Students in a constructionist learning environment shows interest in the subject matter as indicated in student's course evaluation. Constructionist learning environment enable the lecturer to design activities and projects to be offered to the students and these activities may be carryout individually or in groups.

The use of constructionist approach in education has a positive effect on postgraduate's students learning. Students are active participants in the learning environment. They claim responsibility on their learning by giving their own meaning in their own respective understanding. Constructionist learning environment gives students the opportunities of incidental, cooperative and collaborative learning. Constructionism involve students to participant actively in teaching and learning achievement. Students spend more time in carryout activities that required critical thinking, grit and creativity. Therefore, constructionist learning environment is an efficient instructional approach for developing 21st century skills.

Theoretical Framework

Activity theory uses the word "activity" as a unit of analysis. The activity is broken into systematic components of subject, tool and objectives. The subject is the person under investigation, or groups of players engaged in the activity. The objective is the proposed product, and the tool is the assisting device by which the action is executed (Hashim & Jones, 2007). In the context of this study using Computer-Integrated Education modules, the subject were students in the Postgraduate Certificate in Higher Education (PGCHET) CEL 420, and B.Ed. (Hons) CIT 720 modules. The objective of the activity is the physical or mental product that is required. The subjects act on the objective. The objective represents the meaning that stimulates the activity(Leontiev, 2005). For this study, the objective was to develop postgraduate students who will be able to demonstrate 21st century competencies and character qualities. The object undergoes transformation during the course of the activity (Hashim & Jones, 2007).

Tools can be anything used in the learning environment as a renovation method. The use of particular tools shape the way people act and think (Morf & Weber, 2000). For this study, the tools consisted of the constructionist teaching and learning environment, which included a variety of hands-on activities that were meant to transform the subjects. For example, it was envisioned that using a constructionist teaching and learning approach could potentially result in dramatically different graduates. The outcome was to produce graduates who are fully functional and highly valued in the 21st century living and working society.

This study makes used of Activity Theory (AT) as its conceptual framework. The research topic relates to the development of 21st century skills in a constructionist teaching and learning environment. This study contends that Activity Theory provides an appropriate framework for analysing the needs, tasks, and outcomes of this study (Jonassen & Rohrer-Murphy, 1999). This study argues that a framework for developing 21st century skills, needs, tasks and outcomes in a constructionist-learning environment, is achievable with activity theory as a lens. It is useful because the assumptions of activity theory agree with those of constructionism. It is also important because activity theory is used in designing many human-computer interactions (Nardi, 1996), to provide a clear operational framework for developing a constructionist learning environment. This study elaborates on the assumptions that underlie activity theory, describe the components of an activity system and indicate the use of activity theory to analyse activities and settings for designing a constructionist-learning environment which develops 21st century competencies and character qualities.
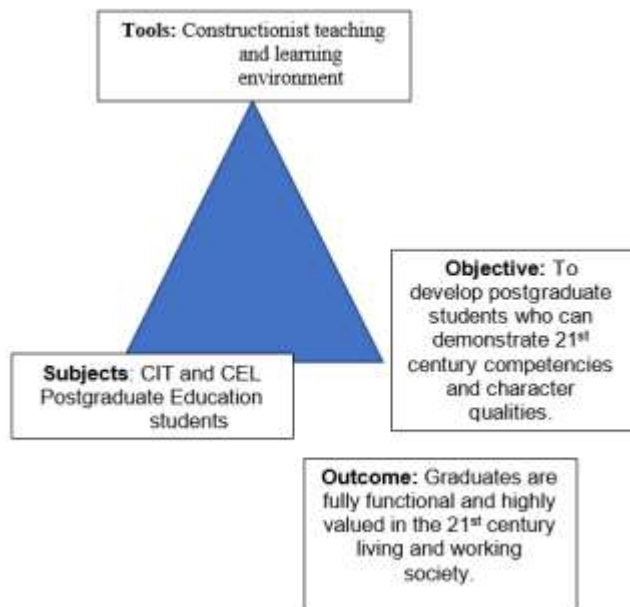
Figure 1: Conceptual Framework for the study

Using the Activity theory for the development of the 21st century skills, the study as indicated on the framework shows that the tools will be a constructionist teaching and learning environment that will make use of hands-on activities. Hands-on constructionist activities regenerate the love of learning for students and connect theoretical observations to the real world with the goal to attain expected learning results (Türk & Kalkan, 2018). When educators use hands-on instructions for constructionist activities, it enables students to develop the 21st century skills needed to be successful in a 21st century era. Student-centred hands-on activities are essential so that real learning can take place, because it helps students to connect ideas to the great image of the programs (Horn, 2009).

According to Haury and Rillero (1994), hands-on constructionist learning is learning by doing. Hands-on learning activities are not only that students should be able to operate structured classroom activities, but that they are able to be involved in detailed research with objects, material events, designs and are able to construct meaning and understanding from those experiences. In a hands-on constructionist learning environment, the focus is on being student-centred, in which the role of the students is not only to find the right answers to create an overview, but also to find designs (Wright, 2011).

When hands-on constructionist activities are integrated well, they can help students to be able to learn difficult concepts (Horn, 2009).Hands-on learning can be beneficial to students regardless of age and intelligence. To summarise the concepts from the activity theory from which this study adapted its conceptual framework: the subjects were the students who participated in the two modules; the constructionist-learning environment represented the tools and the hands-on learning activities. The objective of the study was that by the end of the two modules, students would be able to display the required 21st century skills. The outcome was that students were fully functional graduates who were able to flourish in the 21st century workplace.

Approach and Methodology

This study is descriptive by nature. A qualitative case study methodology was used to enable the researcher to obtain details description and narratives from postgraduate education students who selected CIT and CEL as elective modules. For the purpose of this study, I used the term participant to refer to the students who enrolled for the two modules at the higher education institution. In the context of this study, students enrol in CIT and CEL modules in order to meet up with the requirements to graduate with a BED honours degree and a degree in postgraduate education. Thus, the idea of a constructionist learning environment was to enable participants develop 21st century skills that are required at the job market.

Constructionist learning environment supports the development of 21st century skills. Majority of the students that enrol in the CIT and CEL postgraduates' modules were teachers but were not exposed to constructionism and 21st century skills. The constructionist learning environment supported the development of some 21st century skills. The learning environment enabled students to work in groups and individually to produce artefacts from the hands-on-activities given by the lecturer who acted as a facilitator in the two modules. Twenty-seven CIT and CEL students participated in the survey and in answering the reflection questions after each contact session. The sample size was made up of seventeen males and ten females. Four students participated in the face-to face interview two participants from CIT and two from CEL modules.

The data collection instruments used for this study was through a survey, participants observation, reflections, document review and semi-structured interviews. The constructionist and 21st century survey and the reflection questions were uploaded on the virtual blackboard of the class. Participants were observed during contact sessions and students' assignments were review on the virtual classroom created by the lecturer. The interview questions were audio recorded and was transcribe word verbatim. The researcher read the data over and over and codes in the transcription which related to 21st century skills. The data was analysis manually. Two main codes stood out strongly from the data as it was in the literature chapter. Table 1. Competencies and character qualities in a 21st century.

Table 1: The 21st century competencies and character qualities

The meaning drawn from the survey and reflections supported the development of such skills through the interpretive lens provided in the constructionist learning environment as outlined in table 2.

Table 2 Common elements of a constructionist-learning environment (adapted from (McLoughlin, 2002).

Elements	Explanation
Introduction	A way to establish the platform or assist as a presenter for the activity.
Task, guiding questions or driving questions	The main task of the examination is that it should be attainable following the study process.
Investigation	A procedure that culminates in the design of one or more shareable artefacts.
Resources	Question and problem specialists, workbooks, hypertext links, laptop computers, spreadsheet software.
Scaffolding	Lecturer seminars to help students evaluate their development, computer-based questioning, project templates,
Collaboration	Opportunities for groups, peer reviews, outside content experts.
Reflection and transfer	Classroom quizzing sessions, journal entries, extension activities.

Findings and Discussion

The data collected from all the participants indicated that the constructionist-learning environment helped participants to develop and foster some of the key 21st century skills. The positive reflection of participants in the survey, observations and interviews demonstrated that the engagement in this learning approach made a useful contribution to the attainment of 21st century competencies and character qualities. Generally, the participants in the two modules acknowledge that the learning approach assisted them to improve their lives and helped them to apply some of the key 21st century skills to the tasks. The students were a key element of this study and their self-reflection was the central focus of this research. Participants developed in their technological skills through the incorporation of technology in the IT laboratory.

Technology being a support tool of the CIE programme, all participants of the study indicated that they had at least a basic level ICT literacy at the beginning of the study. Diverse answers were collected through administering the survey to CIT and CEL participants inquiring about their growth in technological skills, both basic computing and internet skills. About 56% of the CIT students reported that they were good at basic computing skills like typing, word processing, and advanced technological skills including the use of social networking and the Internet. In dissimilarity, only 21% of the CEL participants possessed advanced technological skills with about 42% testifying that they are at the level of being competent. However, participants all mentioned a distinct level of improvement in their ICT skills during their engagement in the study. Furthermore, they also demonstrated the ability to solve problems as they faced them throughout the modules and seemed to have developed a 'can do' attitude that showed grit and tenacity.

In the CIE modules, the contact sessions were held in an IT laboratory, which was equipped with the necessary technology and connectivity. These labs supported the constructionist nature of the modules. The constructionist-learning environment provided participants the opportunities to use technology applications for their learning. Each student was provided with a desktop computer, as the use of technology is an important part of students' lives in these programmes. Agreeing with Anastasiades et al. (2010), the use of technology modifies the way people learn in ways that improve their 21st century skills. During the participant's involvement in the constructionist-learning environment, they used information and communication technologies (ICTs) in order to connect with their peers, to carry out-group or individual activities, and to complete their assignments. Participants used various digital tools in order to develop their artefacts, which is an indicator of their attainment of more advanced technological skills.

The participants' reflections indicated that they improved several aspects of their technology skills. Some of the participants believed that the virtual collaboration with their classmates was equal to face-to-face contacts in terms of the objectives that they wanted to achieve through this teamwork. A CEL student mentioned that their class' WhatsApp group allowed him to be able to ask questions to their classmates or activity group members even when out of the classroom. Participants developed other 21st century skills while completing their class assignments and activities. At the same time, some of the participants mentioned that the experience of working in groups challenged them, but that the empowering social constructivist nature of the learning environment allowed them to adapt to such an extent that they

were now more comfortable working in groups and they actually enjoyed it.

The data specified that the learning environment also made it possible for the students to consider using the multitude of Open Educational Resources (OER) that are available on the Internet, mostly free of charge. They indicated that they did not know about these resources before. One of the participants said that there were many free OERs available that they did not know about. They discovered these as they were searching information needed to carry out their assignments and class activities. This kind of incidental learning is priceless.

Additionally, the data revealed that participants in CIT and CEL modules developed new technology skills such as the ability to design a website, which was a combination of knowledge and skills. Designing a website requires careful collection of pictures and videos along with decisions about what important material to include and what to exclude. Then, participants needed to use multiple digital tools to build a digital story and display the meaning in a very different and powerful way, requiring creativity in their work. Most of the participants mentioned that the designing of a website was one of the best skills that they acquired during this learning environment. The flexibility to individual needs was noticeable from the constructionist concept that students make sense of the world in their own way, each building a website that related to their own world of work.

In addition, the participants showed that they learned about WhatsApp not only as a social networking site, but also as an environment to use for academic purposes. The participants learned how to write blogs, upload videos and photos, create profiles, and manage their virtual work during their engagement in the constructionist-learning environment. According to one of the participants, they learned to do various things on YouTube, like photo and video sharing, blogging, chatting, discussion and collaborating in the times between the contact sessions. Students must prepare themselves in such a way that they will become useful and productive global citizens. It is difficult to be skilled in all world cultures, but it is necessary to be open to new and different philosophies in this globalised world (Guo, 2014). It is important for students to make a quick evolution from indigenous to worldwide education procedures in order to develop a universal nationality. For this goal, they must acquire key 21st century competencies and character qualities. The findings from this study indicated that a constructionist-learning environment showed great potential for the development of these graduate attributes.

Conclusion

To conclude, it is important to restate the purpose of this article. The purpose of this article is to describe the design specifications for a constructionist-learning environment. Educators and higher institutions commonly affirms that simply making available hardware and software will not

necessary result in ICT integration and also effective learning to follow naturally , but actually influences effective learning is the pedagogical design not the availability of technology (Mandell, Sorge, & Russell, 2002). When you visit most universities lecture Halls across South Africa and particularly at the University of Pretoria where study was done, you will still notice that nothing has changed about the design of the learning environment and that the lecture halls are still designed for a teacher to stand in front of the lecture hall of about 100 to 500 students sited in a well arranged rolls list taking notes if possible competing worksheets. However, you may notice some computer wiring and interactive whiteboards at the head of the lecture halls but still with that nothing has change.

Technology is just a tool that makes instructional design feasible (F. Wang, Kinzie, McGuire, & Pan, 2010). In this study the pedagogical design of providing reading materials allowing students to add extra resources, writing online reflections and assignments in groups, promoted students learning and knowledge construction. The students indicated that they liked the learning environment because it was flexible and negotiable. Students appreciated the learning environment involved in the modules, as it met their various needs and expectations.

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