A Quasi-Linear Model Of Design Cognition

N. Phuthi, National University of Science and Technology, Zimbabwe
K. L. Kumar, University of Botswana, Gaborone, Botswana
O. B. Molwane, University of Botswana, Gaborone, Botswana

ABSTRACT

The continuum of human learning has been the subject of research by behaviourists, cognitivists, constructivists and lately by neural scientists among others. The style and order of learning have also been identified, notably by Benjamin Bloom et al (1956) and Gagne and Briggs (1992). Skills-learning has been the subject of attention in competency-based learning strategies. Yet another milestone in the continuum of learning is to be innovative and creative, which enables a learner to conceive and design new objects and concepts. Design cognition is an under-explored faculty of humankind. Human capability to design appears to be a complex phenomenon influenced by several factors, implicitly or explicitly, such as socio-educational background, learning to think innovatively, interaction with innovators and creators, exercising initiative, experimenting with new ideas, creating designs with confidence and finally moving into seeking design patents and making commercial use of design. In this paper the authors develop first a linear model of acquiring design capability and then modify it to a quasi linear model after validation by interaction with a sample of design students and design professionals through analysis and reflection on questionnaire responses with both qualitative and quantitative data. The proposed model promises to be a useful tool for design educators in several overlapping areas of design.

Keywords: Learning theories, Behaviour learning, Cognitive learning, and Constructive learning

INTRODUCTION

In different content areas of design, university students are expected to develop higher order intellectual capabilities alongside basic skills of sketching, computer-aided drawing, modelling and prototyping. Design has been described as 'ill-defined problem-solving' that is mostly an 'invisible mental activity' (Eastman, 2000). The intellectual expertise that students require to navigate design challenges includes critical analysis, researching, problem solving, and innovation, decision-making and practical creativity. While some of the intellectual attributes are beyond the domains of well-known theories of general learning such as behaviourism, cognitivism and constructivism, acquisition of basic skills is, however, possible by the competency-based education philosophy. Neural learning theories are still in their infancy and there is little evidence that they will provide guiding principles for research into the development of innovation and creativity.

Different theories of learning represent a spectrum of principles and strategies for improving knowledge and capability. Ertmer and Newby (1993) in Mergel (1998) believe that the strategies promoted by different learning theories overlap along different points of a learning continuum depending on the focus of the learning theory, that is, the level of cognitive processing required (Fig.1). Behaviourist theories commence with the lowest level of cognitive processing, e.g. knowledge of facts and processes, encompassing analysis, synthesis and evaluation. However they are more concerned with the lower order learning. Mergel (1998) also observes that behaviourists are unable to explain certain social behaviours such as children who will not imitate certain behaviour reinforced to them, or those who will develop new behaviour not quite attributable to prior learning.

The genesis of the proposed model of human design cognition is the hypothesis that 'design learning by university level students depends on a quasi-linear sequence of key identifiable stages, commencing with their socio-educational background, and resulting in design proficiency.'

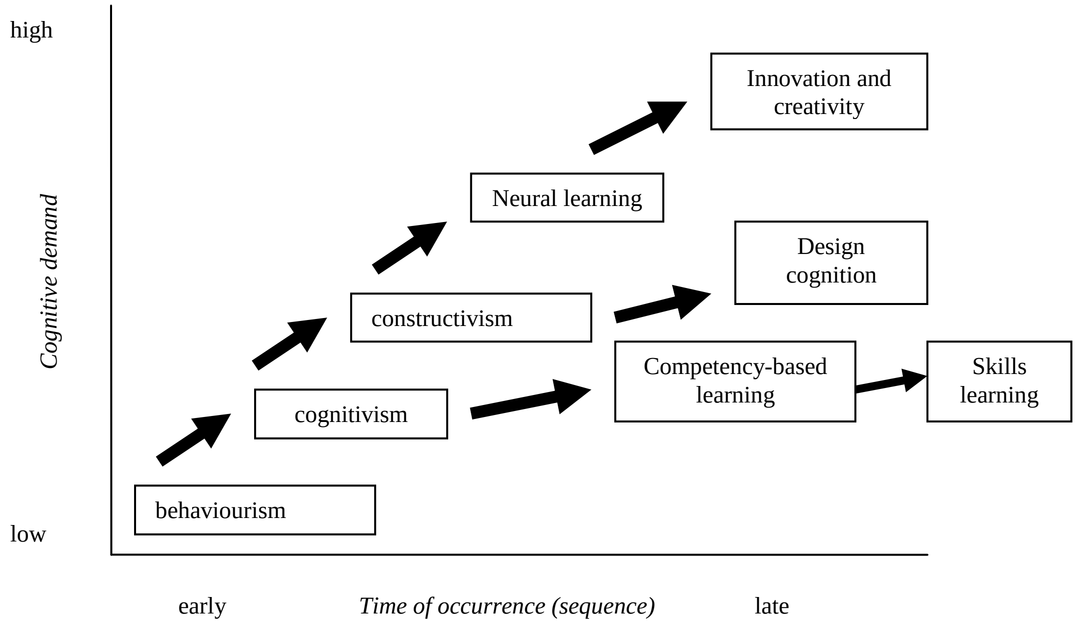

Figure 1: Carpet diagram of the learning continuum (Modified from Ertmer and Newby (1993) in Mergel (1998)

LITERATURE REVIEW: LEARNING THEORIES

The process of design has been modelled by, among others, Yarwood and Dunn (1986), and Goel (1995). Linear models of the process have been criticised for giving the impression of 'distinct phases' (Lawson, 2004). The learning of design requires both physical manipulative and conceptual knowledge development on the part of the student. While it may be easy and more natural to achieve the physical skills development, conceptual learning may 'be hampered by pressure on learners to design and make products' (Reddy et al, 2005). The diversity of available learning models, and the variances and congruencies among them, suggest that there are probably many different kinds of learning, between and within individuals, as there are many different teaching-learning strategies (Phillips and Soltis, 2004). Welch and Lim (2000) found in their study that significant differences existed between the strategies used by novice designers and the theoretical models contained in many textbooks and curriculum documents, suggesting that teachers must think carefully about the way in which students are expected to explore, develop, and communicate their design proposals, and that teaching any form of linear design process may be counter-productive to students' success in developing a solution to a design-and-make task. Engagements with the real world, Griffiths (2003), have been used by some vocational institutions, and include pre-post and post-only competency tests.

Since the central organ in human learning is the brain, all our actions, including those in which we may be experts in, require mental activity. Jennings and Caulfield (2005) report that, "Some critics argue that we do not know enough to bridge the gap between neuroscience and education. Other critics suggest that brain-based education 'sounds redundant' (Pritchard, 2005). Kornhaber et al (2004) report on Harvard psychologist Howard Gardner's (1983/1993) multiple intelligences, underscoring the uniqueness of brain organisation, adaptability and output. The influence of emotions on thinking has pointed to a link between intellectual and emotional intelligence. Jennings and Caulfield (2005) note that, "Tension, anxiety, and fear override the great thinking brain in all of us and how emotion short-circuits thinking." In learning how to design, a linear and schematic representation is useful; but the whole is greater than the sum of its parts. Mealing (2000) has outlined the characteristics which are useful for aspiring designers; namely, creativity, intelligence, drawing skills, determination, gender and maturity.

According to Mealing (2000), research has consistently suggested that general education does not reward or nurture the creative student, and that we turn out conformists when conformity is inimical to creativity. People with low intelligence are rarely creative, and highly creative people are usually highly intelligent, although intelligence is no guarantee for creativity. *Intelligence* itself is a complex phenomenon, expressed in many ways, such as linguistic and computer literacy, and is dependent on situations and cultures. *Drawing skills*, the foundation of visual literacy, are effective for design representation. However, if we use drawings as our sole benchmarks of design aptitude, we are denying access into our courses for a large number of perfectly capable problem-solvers and visual information communicators who cannot draw well. *Determination* requires much effort, and creativity has been characterised as 99% perspiration and 1% inspiration.

APPLICATION OF LEARNING THEORY

Instructional designer must understand the strengths and weaknesses of different learning theories to optimize their use in appropriate instructional design strategy. Recipes contained in instructional design (ID) theories may have value for novice designers who lack the experience and expertise of veteran designers (Wilson, 1997). Theories are useful because they open our eyes to other possibilities and ways of seeing the world. Whether we realize it or not, the best design decisions are most certainly based on our knowledge of learning theories. (Mergel,1998).

While behaviourism and cognitivism are both objective in nature and both support the practice of analyzing a task and breaking it down into manageable chunks, establishing objectives, and measuring performance. Cognitivism shares some similarities with constructivism such as the analogy of comparing the processes of the mind to that of a computer (Mergel, 1985). However, Phillips and Soltis (1985) argue, a computerised robot cannot sense as much, know as much, and be as insightful as the human being it represents

Very early research produced the classification and purpose of learning in the form of taxonomies of learning outcomes. The works of Bloom and Krathwohl (1956) and others on cognitive, psychomotor and affective domains of performance objectives, and that of Gagne and Briggs (1992) have been useful. These theories, which have survived the test of time and academic scrutiny, show, among other things, the hierarchal nature of learning and skills.

Competency based education and training, CBET gives the student credit for the competent performance of an activity in a work setting following an assessment procedure in the workplace. The claimed virtues of CBET, says Winch (2000), are that it focuses on what trainees need to do in the workplace and not superfluous extras, and gives workers credit for what they already know without having to go through a further, unnecessary, period of training. According to Hyland (1994), CBET is closely associated with national vocational qualifications.

Recent breakthroughs in neuroscience are reshaping the understanding of learning and taking it to a new level. The nervous system and the brain are the physical foundation of the human learning process. Neuroscience links our observations about cognitive behaviour with the actual physical processes that support such behaviour. This theory is still "young" and is undergoing rapid, albeit controversial development, Jennings and Caulfield (2005).

The *right brain vs. left brain* theory suggests that the two sides of the brain control two different "modes" of thinking. It also suggests that each of us uses one mode more than the other. Experimentation has shown that the two different sides, or hemispheres, of the brain are responsible for different manners of thinking. Left brain individuals are said to prefer logical, sequential, rational, analytical, and objective thinking, accuracy and looking at parts, while right brained subjects are more random, intuitive, holistic, synthesizing, subjective, look at wholes and focus on aesthetics, feeling, and creativity. Most individuals have a distinct preference for one of these styles of thinking. Some, however, are whole-brained and equally adept at both modes. Pritchard (2005) has noted that mind-mapping, and perhaps to a lesser extent in concept mapping, is to mimic, at a simplified level, the associative nature of the structure of memory patterns in the brain. Ertmer and Newby's (1993) suggestion that theoretical strategies can complement the learner's level of task knowledge, allows the designer to make the best use of all available practical applications of the different learning theories. With this approach the designer is able to draw from a large number of strategies to meet a variety of learning situations. Presenting his Learning Development Cycle which combines learning theories and domains, Siemens (2005) notes that in spite of advances in neuroscience, collaborative technology, and a globalised business climate, learning is still largely based on theories created during the early 1900's to 1960's.

DESIGN CAPABILITY

Like other normally distributed human attributes, it might be postulated that all human beings have an often inert propensity to design and create. Children create things and patterns that did not exist previously, from stones, sticks, sand, paper, play dough or in fact any materials or components that might be to hand, as they shape and create their own models of the world. It appears that later in life the same innovative children get discouraged away from independent exploration by teachers who insist on 'uniformity' of performance and behaviour. The inert and overt design capabilities provide a starting point for inspiring and teaching in young adult students.

METHODOLOGY OF THE PROPOSED MODEL

Review of literature on selected learning theories has motivated the authors to develop a model applicable to the learning of design by university undergraduate students. The applicability of the model was pilot tested through an analysis of views of enrolled students and design professionals in the industry. A total of seventy (70) volunteering students from between year level 300 and 500 of a 5-year design programme participated in the questionnaire survey to authenticate the stages of the proposed model of the creative design learning process. Eight (8) purposively sampled design experts from industry responded to the questionnaire.

The authors used their accumulated experience in teaching design and related subjects in addition to the above review. The first indication to a design career or undertaking is inspiration or motivation. A questionnaire (Appendix 1) was drafted and used on a small sample of design students to determine: (a) their sources of inspiration to embark on a design career and (b) the main activities or experiences that led them from inspiration to design competence. The outcome of the questionnaire survey showed that the sources of inspiration for our respondents could be grouped into two, i.e. family and community. Thus, within the family setting a child may observe, assist, discuss with, or understudy a family member who is an expert or professional designer. In the community the potential designer does the same. The community includes the schools attended, clubs, workplaces and other environments. With inspiration, a future designer begins to observe and interpret the environment around in different ways. The environment and the people in it provide the socio-educational background needed by the learner designer.

The survey initially led us to a ten stage linear model, with stages ranging from exposure to design, to competent commercial use of design knowledge. However the first eight stages were considered suitable for the learning experiences of students at university. To determine the possible chronology of these eight stages, qualifying statements were created for each of the first eight stages under four sections: family inspiration, community inspiration, university experience, and design project activity (Appendix 2). The statements were converted into response items in the questionnaire (Appendix 3) with the four sections in which the order of the stages of the model were randomly rearranged. Respondents were required to re-enact the model by ordering (ranking) the statements from first to last according to their experience and knowledge. All respondents selected between family (section A) and community (section B) inspiration. Student respondents then went on to answer section C on their university experience, while qualified designers went on to answer section D on stages in a design project.

DESCRIPTION OF THE MODEL

Researchers are generally in agreement that, although unique, being a designer or learning to be one is akin to any other learning and can take place in or outside formal settings. Cross (2006) says that in the teaching of 'Design and Technology', primary school children are encouraged to "develop their own ideas, share them and develop initiative while working alone and with others." The following is a stage by stage description of the model.

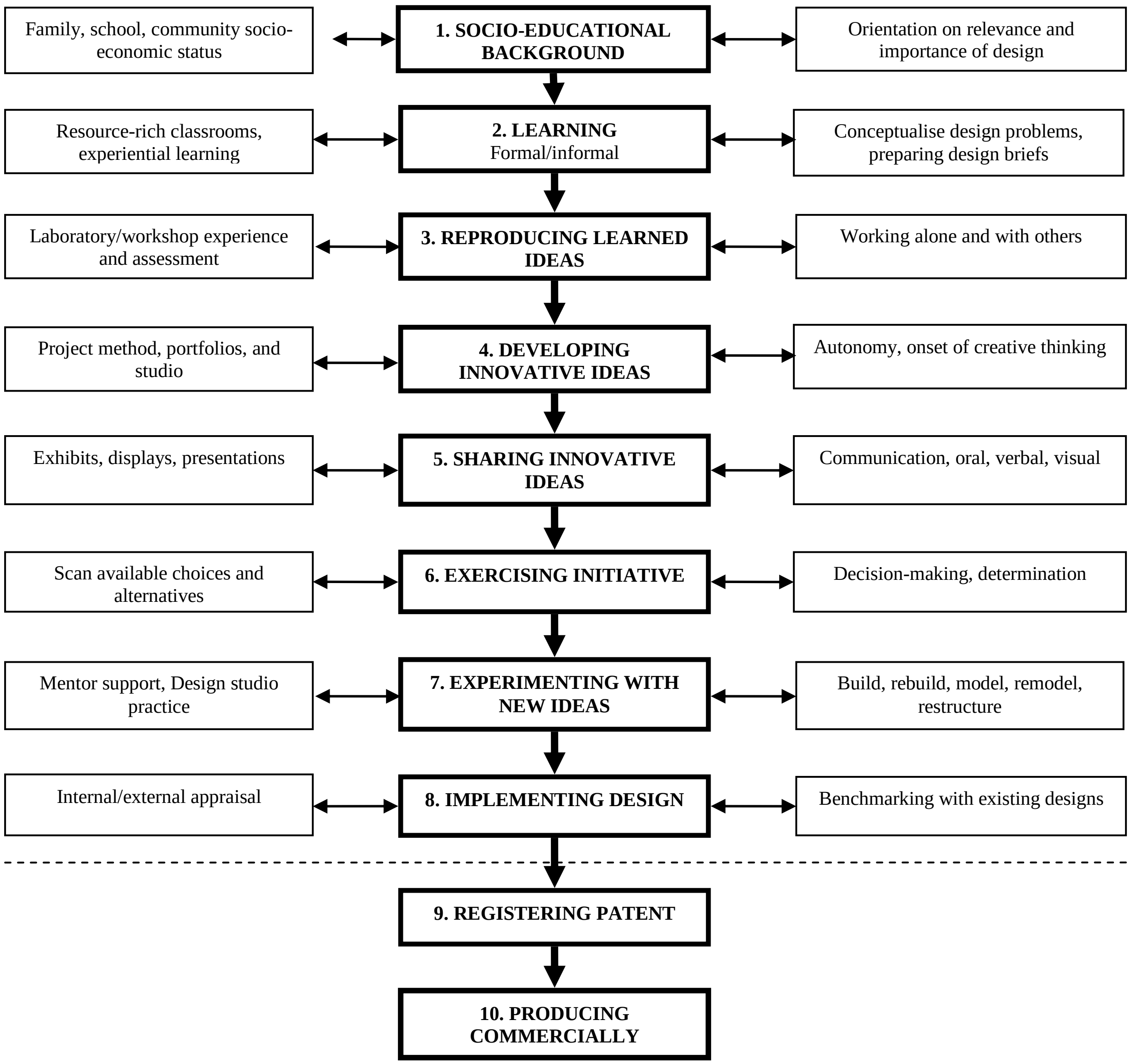

Fig. 2: A model of the innovative and creative design process

(i) Socio-educational Background - All students, in the first instance are groomed by the prevailing cultural, political, economic and technological milieus.

(ii) Learning to design - Through formal schooling and other everyday life experiences, they acquire essential mental, practical and emotional capabilities, sensitising them to problems around them.

(iii) Reproducing learned ideas - In formal learning situations, the use of assessment methods such as tests, exercises, assignments, projects, examinations and others, demonstrates what learners have acquired from 'experts' and internalised.

(iv) Developing innovative ideas - It is based upon a personal mental construction process that brings together concrete past experiences and current imaginations.

***(v) Sharing innovative ideas* -** This is manifested in dialogue, debates, exhibitions and public presentations

***(vi) Exercising initiative* -** It is about making bold choices and being self-assertive, relying on a high measure of self-assessment and self-reliance working alone, while building confidence and managing criticism and praise through working with others.

***(vii) Experimenting with new ideas* -** The experimental phase involves cycles of build-destroy-rebuild, or make-and-modify, or even design-redesign so as to improve the original main idea.

***(viii) Implementing design* -** At this stage the 'concrete' design is ready to go further, in the form of drawings, models, artefacts, prototypes, or finished products.

***(ix) Registering design patents* and *(x) commercial use of design* -** These two last stages are mainly for the professional designers although some young students do. The interplay between and among the preceding steps determines how far an individual can go on the route from a novice to become a professional creative designer.

RESULTS OF PILOT TESTING OF THE MODEL

A total of 70 students and 8 professional designers responded to the questionnaire (Appendix 3) which sought to capture both the source of inspiration and the sequence of experiences which respondents went through from first being inspired into design learning to the stage where they became proficient or expert.

Table 1: Source of Inspiration towards design career by respondents

Respondents	Year level	Family	Community	Total
Students (N=70)	300	12	21	33
	400	5	12	17
	500	8	12	20
	Sub-Total	**25**	**45**	**70**
Design Professionals (N=8)		5	3	8

Overall the students' responses indicate that forty-five of them (64%) were inspired into the design career through the community (64%) rather than the family (36%), citing their former primary and secondary schools and their teachers as the most influential. This is typical since the predominant socialising agent for children is the school. On motivation to enrol for a university degree in design and technology, different student respondents in the sample, a mixture of industrial design trainees and aspiring teachers, stated reasons contained in the following representative responses:

I always wanted to be a designer; UB was the only place (to go).

I was motivated by the introductory seminar/presentation made (by) Prof Kumar and Mr A. Clark at G12 main campus…. (it) made me change from the pre-medical programme to design (and technology).

I enrolled as a designer because I thought it is a course which has (a job) market and you can be able to feed yourself on it.

The design professionals reported 63% inspired by the family and 37% by the community.

The responses from students' questionnaires show some significant confirmation of the model's stages. For example, in year level 300 the 12 students who reported family inspiration had mean rankings that confirmed stage one and eight as expected, with 25% and 58% actually matching stage one and eight respectively. They ranked stage 2 third and stage 7 sixth, which was close to expected, indicating that they considered those stages as coming early or late respectively. Those who reported community inspiration in year level 300 confirmed only stage one (socio-educational background) and stage eight (design), with the rest of the stages in between mixed up. The closest confirmation was with the 5 respondents in level 400 who reported family inspiration, and who confirmed all eight stages in the order given. The rest of the results in Table 2 show little agreement between observed and expected rankings on the community inspired design learning and on university experiences, implying that it was more difficult to define stages of design learning with these modes of inspiration.

Table 2 : Expected and obtained rankings of design stages

Year Level & No. of respondents (N)	Stage		Expected Ranking	Obtained Ranking (Family Inspiration) A	Obtained Ranking (Community Inspiration) B	Obtained Ranking (University Enrolment) C	Obtained Ranking (Design project) D
				n=12	**n=21**	**n=29**	**n=0**
300 N=33	Socio-educational b/ground	**Early**	**1**	1*	1*	7	
	Learning		**2**	3*	4	1*	
	Reproducing learned ideas		**3**	5	2	3*	
	Developing own ideas	**Mid**	**4**	2	7	4*	
	Sharing innovative ideas		**5**	7	6	6	
	Exercising initiative	**Late**	**6**	4	5	5	
	Experimenting with ideas		**7**	6*	3	2	
	Implementing design		**8**	8*	8*	8*	
				n=5	**n=12**	**n=17**	
400 N=17	Socio-educational b/ground	**Early**	**1**	1*	5	1*	
	Learning		**2**	2*	4	2*	
	Reproducing learned ideas		**3**	3.5*	7	5	
	Developing own ideas	**Mid**	**4**	3.5*	6	6	
	Sharing innovative ideas		**5**	5*	2	7	
	Exercising initiative	**Late**	**6**	7*	1	4	
	Experimenting with ideas		**7**	6*	3	3	
	Implementing design		**8**	8*	8*	8*	
				n=8	**n=12**	**n=17**	
500 N=20	Socio-educational b/ground	**Early**	**1**	2.5*	4	4	
	Learning		**2**	1*	1*	1*	
	Reproducing learned ideas		**3**	5	8	6	
	Developing own ideas	**Mid**	**4**	4*	5*	3	
	Sharing innovative ideas		**5**	8	3	7	
	Exercising initiative	**Late**	**6**	6*	2	5	
	Experimenting with ideas		**7**	2.5	6	2	
	Implementing design		**8**	7*	7*	8*	
				n=25	**n=45**	**n=64**	
All Students N=70	Socio-educational b/ground	**Early**	**1**	2*	2*	5	
	Learning		**2**	1*	3*	1*	
	Reproducing learned ideas		**3**	4.5	6	6	
	Developing own ideas	**Mid**	**4**	3	7	3	
	Sharing innovative ideas		**5**	6.5	5*	7	
	Exercising initiative	**Late**	**6**	6.5*	1	4	
	Experimenting with ideas		**7**	4.5	4	2	
	Implementing design		**8**	8*	8*	8*	
				n=5	**n=3**	**n=1**	**n=7**
Designers N=8	Socio-educational b/ground	**Early**	**1**	2*	5.5	2*	7
	Learning		**2**	1*	3.5	4	4
	Reproducing learned ideas		**3**	4	2	1	2*
	Developing own ideas	**Mid**	**4**	5.5*	7	8	3
	Sharing innovative ideas		**5**	5.5*	5.5*	5*	6*
	Exercising initiative	**Late**	**6**	3	1	7*	8*
	Experimenting with ideas		**7**	7*	3.5	6*	5
	Implementing design		**8**	8*	8*	3	1

* Agreement between respondents' average rankings and model

Professional designers in the field who reported family inspiration were in agreement with the model stages more than those who reported community inspiration. There was also not much agreement with the model on its applicability to the real life design process in industry. This suggests that the expert designer may not be as tied to a preset procedure as the learner, since more of them were inducted into design by family ties (a much more complex learning experience) rather than through their own motivational effort.

An analysis of the responses indicated that the eight learning stages of the design learning process could be combined to form three major linear phases; early (stages 1 – 3), middle (stages 4 and 5), and late (stages 6 – 8) shown in Figure 3. To drive home the observation that the stages within each phase are closer to each other than between phases, and that they sometimes overlap, a further modification of the model was created (Figure 4).

Early Phase	**1. Socio-Educational Background**	**2. Learning Formal/informal**	**3. Reproducing Learned Ideas**
Middle Phase	**4. Developing Innovative Ideas**	**5. Sharing Innovative Ideas**	
Late Phase	**6. Exercising Initiative**	**7. Experimenting With New Ideas**	**8. Implementing Design**

Figure 3: The three-phase representation of the design cognition model

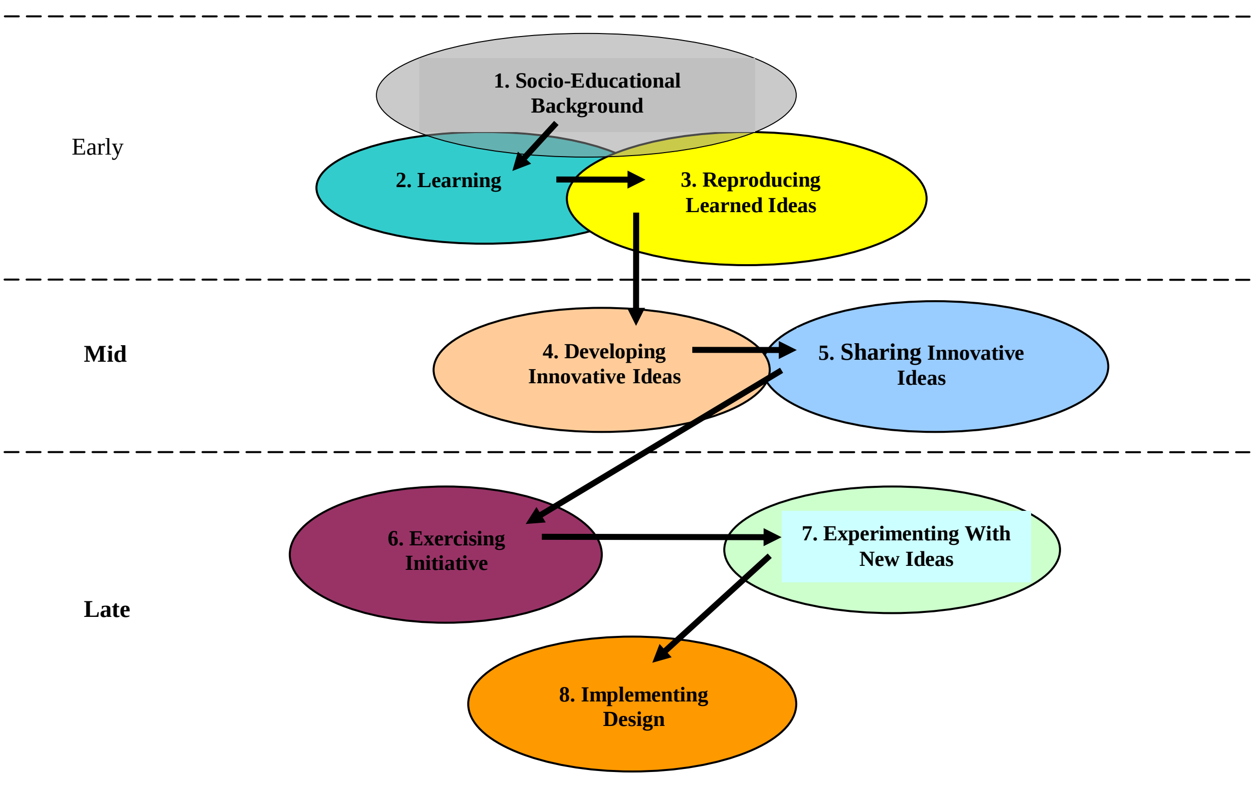

Figure 4 : The quasi-linear Design Cognition Model

CONCLUSION

University educators in Design are crucial in providing the necessary scaffolding and the climate for the student designers to develop their creativity and problem-solving skills towards competence required for high performance in industry. In presenting yet another model for the learning of design and technology, we attempt to provide some challenges to the educator who is free to use the model or to modify it appropriately to suite their purpose and circumstance. We acknowledge that tacit design skill and knowledge cannot be satisfactorily taught, but need to be conceptualised and practised by the learner. Alongside the extrinsic motivation to qualify for a career, university students can benefit from an internal motivation generated by the learning process they go through in preparing for a design career. This latter motivation would assist in the advancement of design and technology knowledge and practice, and in the general uplifting of people's living standards in developing countries.

AUTHOR INFORMATION

Mr Nduduzo Phuthi is a lecturer in the Department of Technical Teacher Education, Faculty of Industrial Technology at the National University of Science and Technology in Zimbabwe. He has been a Head of Department for 6 years in the same Department and faculty. Mr Phuthi spent a year as a sabbaticant in the Department of Industrial Design and Technology at the University of Botswana and researched in the areas of design cognition and student learning behaviours and patterns. He has a vast amount of experience in the area of Teacher Education. Currently he is pursuing his PhD studies at the University of Pretoria in the area of Assessment and Quality Assurance in Higher Education.

Professor Krishan Lall Kumar is currently the Professor in the Department of Industrial Design and Technology at the University of Botswana, Africa. Prior to this, he has been at the Indian Institute of Technology Delhi, formerly as Professor and Head of Applied Mechanics and later as Professor and Head of Educational Technology. During the intervening years, he served as UNESCO Expert and Chief Technical Advisor in Middle East. He is the author of three text books by international publishers and he has presented papers, refereed and reviewed papers in International conferences and reputed journals. His background includes a Bachelor's degree from the University of Delhi, a Master's degree from the Indian Institute of Technology Roorkee and a Ph. D from the Imperial college of Science and Technology, London.

Dr Olefile Bethuel Molwane is a Senior Lecturer at the University of Botswana in the Faculty of Engineering and Technology, Department of Industrial design and Technology. Dr Molwane is currently the Head of Department of Industrial Design and Technology. Prior to joining the University of Botswana he taught for so many years at Molepolole College of Education where he held several positions including the post of Head of Design and Technology Department and chaired Admissions Committee. Dr Molwane has several years of teaching experience in the subject of design and technology and conducted several researches related to that. He has also conducted some consultancies, to date 4 consultancies including the Ministry of Education, Skills and Development in Botswana, Ministry of Labour and Home Affairs in Botswana, and jointly with Professor Richard Kimbell and Team from the University of London they did a consultancy for the South African Government co-sponsored by the Government of South Africa and DIFD - UK. He has authored a book with one colleague published by Cambridge University Press and has published in international journals and several conference proceedings. He is the external Examiner for Lesotho College of Education and External Verifier for Francistown College of Technical and Vocational Education.

REFERENCES

1. Eastman, C.M. (2000) New Directions in Design Cognition: Studies of Representation and Recall, in Design Knowing and Learning: Cognition In C. Eastman, M. McCracken, W. Newsletter, eds. *Design Education,* Elsevier Science, Amsterdam (2000)
2. Griffiths, C. (2003). Accountability systems in Vocational Education: Performance standards and core measures. In R. Nata (Ed). *Vocational Education: Current Issues and Prospects*. Nova. NY. 63-82.
3. Hyland, T. (1994). *Competence, Education, and NVQs.* Cassel, London.

4. Jennings, W. and Caulfield, J. (2005*). Bridging the Teaching/Assessment gap: Showcase Teaching*. Scarecrow Education, USA.
5. Johnsey, R. (1995). The Design Process – Does it Exist? *International Journal of Technology and Design Education,* 5(3) 199 – 217.
6. Kornhaber, M., Fierros, E. and Veenama, S. (2004). *Multiple Intelligences: Best Ideas from Research and Practice*. Pearson, USA.
7. Lawson, B. (2004). *What designers know*. Architectural Press, Oxford.
8. Logan, C. (2008). 'Metaphor and Pedagogy in the Design Practicum. *International of Technology and Design Education.* 18(1). 1 – 17.
9. Mawson, B. (2003). 'Beyond the Design Process: An Alternative Pedagogy for Technology Education. *International Journal of Technology and Design Education, 13(2), 117 – 128.*
10. Mealing, S. (2000). Ud2k – designing the design student. In Esther Dudley and Stuart Mealing (Eds) *Becoming designers: Education and Influence*. Intellect, England.
11. Mergel, B. (1998). Instructional Design and Learning Theory. http://www.usask.ca/education/coursework/802papers/mergel/brenda.htm
12. Phillips, D.C. and Soltis, J. F. (1985). *Perspectives on Learning*. The College Press, NY and London.
13. Pritchard, A. (2005). *Ways of Learning: Learning Theories and Learning styles in the classroom*. David Fulton Publishers, London.
14. Reddy, K., Ankiewicz, P.J. and de Swardt, A.E. (2005). Learning Theories: A conceptual framework for learning and Instruction in technology Education*. South African Journal of Higher Education.* 19(3), 423-443.
15. Siemens, G. (2005). Learning Development Cycle: Bridging Learning Design and Modern Knowledge Needs. http://www.elearnspace.org/Articles/ldc.htm
16. Walker, J.M.T., Cordray, D.S., King, P.H., and Fries, R.C. (2005). 'Expert and Student Conceptions of the Design Process': Developmental Differences with Implications for Educators'. *International Journal of Engineering Education.* 21(3), 467 – 479.
17. Welch, M. and Lim, H. S. (2000). The Strategic thinking of Novice designers: Discontinuity between Theory and Practice. *Journal of Technology Studies*. Volume XXVI, Number 2. http://scholar.lib.vt.edu/ejournals/JOTS/Summer-Fall-2000/welch.html
18. Winch, C. (2000). *Education, work and social capital: towards a new conception of vocational training*. Routledge, London.

APPENDIX I

Taking up Design Studies/ Career

You are kindly asked to anonymously give your input on how you have reached your current competence as a design student. This will help us to conceptualize the process of design and how to improve its teaching and learning. Please answer all questions as honestly as possible.

Q1 Who/What inspired/motivated/encouraged you to enrol as a design student at UB?

____

Where: ______________________ **When:** ______________________ **How**: ________________________________

Q2 After being inspired, what events have happened to help you develop to reach your present level of design competency? (List at least 4)

____
____
____
____

APPENDIX II

Descriptive Statements to represent design cognition stages

	Stage	**Descriptive Statements**			
		Family inspiration A	**Community inspiration B**	**University studies C**	**Design project D**
1	Socio-educational background	Living with or keeping contact with a family member who is a designer	Living in a heavily built environment with many human-made products	Have appropriate qualifications, interest, or get adequate orientation	Have adequate training, varied experience and motivation
2	Learning	Learning simple designs by assisting the family member doing design work.	Observing or assisting a designer, or learning design subjects	Acquire adequate knowledge and skills through lectures	Study relevant specifications and consult where necessary for latest ideas
3	Reproducing learned ideas	Successfully emulating a family member's design skills	Getting praised for possessing design talent	Pass all theory and practical courses with good grades	Check materials, prices, and make comparisons with previous jobs
4	Developing own ideas	Seeing gaps in existing designs, making variations or own new designs	Challenging existing designs and realizing that new ones are possible	Develop a critical mind, objectively analyzing other people's creative outputs	Create new innovations to include in the final design
5	Sharing innovative ideas	Explaining to someone your own new innovative design ideas	Sharing your creative design ideas with friends and others	Excel in individual projects, get selected to display at exhibitions, etc.	Make and publicize proposed working drawings
6	Exercising initiative	Make a firm commitment to become a professional designer.	Making a decision to take designing as a career	Show enjoyment and motivation to continue as a design student	Decide to go ahead and bid for the contract
7	Experimenting with ideas	Trying out several of your own new design ideas to solve a problem	Experimenting with your own simple product designs	Explore your own design skills through small projects	Experiment between appropriate similar designs
8	Implementing design	Become a professional designer	Becoming a professional designer	Graduate with a high performance in design studies	Carry out the design work

APPENDIX III

University of Botswana
Department of Industrial design and Technology

Questionnaire On Design Theory And Processes – 2008 ***Year Level:*** ☐

This questionnaire requires you to make an input into perceiving the creative design process experienced by you in the course of your learning and/or working experience. It has four (4) sections A, B, C, and D. You are requested to complete **two** sections, *either A or B*, **and** *either C or D*, whichever applies to you.

In each section, there are eight statements written in random order. ***Please RANK the statements on a scale from 1 to 8 in order of what you perceive to be the appropriate sequence of events, beginning with what happens first (1) to what happens last (8)***. Place your rankings in the boxes to the right of the statements.

Section A

The section applies to a learner designer who was inspired from within the family and close relatives to become a designer.

Statement	**Your Rank**	
Explaining to someone your own new innovative design ideas		
Successfully emulating a family member's design skills		
Living with or keeping regular contact with a family who is a designer		
Become a professional designer		
Learning simple designs by assisting the family member doing design work.		
Seeing gaps in existing designs, making variations or own new designs		
Make a firm commitment to become a professional designer.		
Trying out several of your own new design ideas to solve a problem		

Section B

This section applies to a learner designer who gets inspired from the community in which he/she lives, including the early school

Statement	**Your Rank**	
Experimenting with your own simple product designs		
Living in a heavily built environment with many human-made products		
Challenging existing designs and realizing that new ones are possible		
Becoming a professional designer		
Observing or assisting a designer, or learning design subjects		
Making a decision to take designing as a career		
Sharing your creative design ideas with friends and others		
Getting praised for possessing design talent		

Section C

This section applies to the university student enrolled in a design programme who becomes a successful top rated performer.

Statement	**Your Rank**	
Show enjoyment and motivation to continue as a design student		
Pass all theory and practical courses with good grades		
Graduate with a high performance in design studies		
Have appropriate qualifications, interest, or get adequate orientation		
Acquire adequate knowledge and skills through lectures		
Excel in individual projects, get selected to display at exhibitions, etc.		
Explore your own design skills through small projects		
Develop a critical mind, objectively analyzing other people's creative outputs		

Section D

The section applies to a qualified designer who is invited to bid for a contract to do a big design job

Statement	**Your Rank**	
Carry out the design work		
Decide to go ahead and bid for the contract		
Have adequate training, varied experience and motivation		
Create new innovations to include in the final design		
Make and publicize proposed working drawings		
Experiment between appropriate similar designs		
Check materials, prices, and make comparisons with previous jobs		
Study relevant specifications and consult where necessary for latest ideas		

Add Any Additional Comments On Your Learning The Creative Design Process

____

____

____

____

____

Thank You For Your Input

NOTES