World Academy of Science, Engineering and Technology
International Journal of Educational and Pedagogical Sciences
Vol:7, No:4, 2013

Learning Paradigms for Educating a New Generation of Computer Science Students

J. M. Breed, and E. Taylor

***Abstract*—**In this paper challenges associated with a new generation of Computer Science students are examined. The mode of education in tertiary institutes has progressed slowly while the needs of students have changed rapidly in an increasingly technological world. The major learning paradigms and learning theories within these paradigms are studied to find a suitable strategy for educating modern students. These paradigms include Behaviourism, Constructivism, Humanism and Cogntivism. Social Learning theory and Elaboration theory are two theories that are further examined and a survey is done to determine how these strategies will be received by students. The results and findings are evaluated and indicate that students are fairly receptive to a method that incorporates both Social Learning theory and Elaboration theory, but that some aspects of all paradigms need to be implemented to create a balanced and effective strategy with technology as foundation.

***Keywords*—**Computer Science, Education, Elaboration Theory, Learning Paradigms, Social Learning Theory.

I. Introduction

IN this paper the different learning paradigms and learning theories are studied in an effort to find a suitable strategy for educating students. The paper starts with a problem statement and the motivation for this study. Background is given on learning paradigms and theories. Then the data collection, analysis and results are described, followed by a conclusion.

II. Problem Statement and Motivation

Many phrases have been used to refer to a new generation of tech-savvy students. Amongst these are the 'T.V. generation' [1], 'Net generation' [2] and 'Millenials' [3]. Perhaps the most interesting term though, is "Digital Natives" [4]. Mark Prensky explains that 'digital natives' refers to a new generation of students who have since childhood been engulfed in technology. The term 'native' indicates that these students 'speak' technology fluently – the digital language of laptops, hand-held computers and, of course - the internet. Prensky goes on to distinguish between 'natives' and 'immigrants', the latter having only adopted the culture of technology later in life. The problem we face becomes clear in this analogy. The older generation, or the 'immigrants', often speaking the language of technology with heavy accents, are tasked with teaching the much younger, and often fluent 'natives'. Prensky concludes that modern students, with such a vastly different upbringing to a generation only ten or twenty years older than themselves, cannot possibly be educated in the same way. Now, we can agree that there exists a generation of 'digital natives' and that the way that we educate this generation must fundamentally change [5].

A study conducted in Australia in 2006 found that a high proportion of first years were very much at ease with established technology like computers, mobile devices and email, but that more complicated technological tools were not so widely used or understood [6]. A similar study conducted in the U.S. found that more than 80% of students owned laptops, 53.8% own personal computers and 33% own one of each [7]. Laptop ownership had risen from 65.9% to 82.2% in the two years between 2006 and 2008. Most students also own internet-capable mobile phones (66.1%). In South-Africa, results mirror these studies conducted in developed countries. 88.9% of first year students have unrestricted access to a mobile phone with a camera, 73.7% have access to a Bluetooth modem via a mobile phone, 61.1% have access to a desktop computer and a further 49.6% have access to a laptop or notebook [8].

Tapscott is quoted as saying in his book that ''the old approach [of didactic teaching] is ill-suited to the intellectual, social, motivational, and emotional needs of the new generation"[2]. This statement can safely be made after evaluating the defining characteristics of the so-called digital natives. These characteristics include sophisticated knowledge of and a high level of skill with information technologies; Prensky might have said it best when he claimed "*Our students have changed radically. Today's students are no longer the people our educational system was designed to teach*." And therein lays the motivation for this study.

III. Literature Study And Background

A. Behaviourism

Behaviourism approaches the psychology of learning by studying human behaviour. The approach is based on the assumption that students learn through reinforcing desired responses. In this paradigm, the key element is rewarding 'good' behaviour. Ultimately, one would want the learner to internalize this reinforcement so that new behaviour is essentially rewarding itself [9]. Behaviourism understands the mind-set behind of learning by observing responses to environmental stimuli [10]. In its most basic form one could almost view behaviourism as a form of programming – instilling students with good habits or behaviour, and administering the ability to continuously produce new, rewarding behaviour. Voluntary behaviour is changed through positive consequences.

Marnus Breed is with the Potchefstroom Campus of the North-West University, South-Africa. (e-mail: 21022887@nwu.ac.za)
Estelle Taylor is with the Potchefstroom Campus of the North-West University, South-Africa. (e-mail: estelle.taylor@nwu.ac.za).

Burrhus Frederic Skinner, viewed as the father of radical behaviourism said that teaching as a technology functions through the arrangement of possibilities of reinforcement under which behaviour changes [11]. Behaviourism, thus, is methodical and organized. Not stretching the imagination too far, one could also imagine a behaviourist approach being computerized. Skinner himself proclaimed – in 1968 none the less that ''we have every reason to expect that the most effective control of human learning will require instrumental aid. The simple fact is that, as a mere reinforcing mechanism, the teacher is out of date.'' Ten years earlier Skinner had already described a 'teaching machine' [12] that provided a physical instantiation of what behaviourism is all about. In the 21st century students come standard with their own instrumental aid in the form of laptops, mobile phones and tablet PC's.

Behaviourism could make the most of this.

Behaviourism is advantageous in that it sets objectives that are clear-cut. Due to the approach being so specific, success is mostly easily observable. Lastly it ensures behavioural practice – not just theory, and works best for helping learners to attain behavioural skills. The Behaviourist theories include classical conditioning, GOMS model, operant conditioning and Social Learning theory. Social Learning Theory will be discussed in more detail later on.

B. Cognitivism

Cognitvism deals with the cognitive processes involved in learning. These processes include induction, deduction, rule finding, law discovering and pattern recognition. Cognitive perspective has to do with schemata development and according to this paradigm, gaining understanding (or cognisance) is all important. This is in contrast with Behaviourism which focuses more on knowledge accumulation [13]. Cognitivism is a relatively newer paradigm than behaviourism and cognitivists believing that higher organisms (meaning humans) could develop expectations criticized behaviourist theories. The new paradigm claimed that individuals could attain and stockpile information that can be united with new types of information to lead to new types of behaviour. These new types of behaviour can come about without repeated response to a stimulus [14]. The upshot of this theory is that learning is not automatic or without awareness, but rather purposeful. Awareness of what is being acquired and active interpretation of stimuli forms the backbone of Cognitivism.

J.C. Smith defines Cognitivism as the view that all mental activity is cognitive [15]. According to his definition of the paradigm, it advocates that perception, understanding, learning and action are all to be understood on the model of fact gathering, hypothesis formation, inference making and problem solving. Our ability to deal with things intelligently is due to our capability to think about them rationally, and our ability to think about things rationally amounts to ability for internal symbol manipulation.

In educating students, cognitivism focuses on the transmission of knowledge of the objective reality of the environment from the lecturer to the students. At the end of the day students should have the same representation of reality in their minds as the lecturer. Cognitivism is concerned with symbolic mental processing systems that focus on learning schemas and how the brain receives, internalizes and recalls information. Therefore the main point of focus in cognitivistic education is finding the best depiction of the human information-processing model and the best way of transmitting schemas from lecturers to students. Lecturers need to build students' knowledge by conveying as best possible the mental construct describing the objects under study [16]. Cognitivist theories include assimilation theory, attribution theory, cognitive load theory, cognitive theory of multimedia learning, component display theory, elaboration Theory and Stage Theory of Cognitive development – among others. Elaboration Theory will be scrutinized more closely later in the paper.

C. Constructivism

Constructivism is a theory of knowledge that asserts two main principles with far-reaching consequences for learning and the practice of teaching, namely a) knowledge is not passively received but actively built up by the cognizing subject and b) the function of cognition is adaptive and serves the organization of the experiential world, not the discovery of ontological reality [17].

Individuals create new understandings through the interaction between existing knowledge and beliefs and newly garnered information [18]. Central to this theory is the concept of an active organism, not just responding to stimuli, but actively seeking to understand. Students are not sponges simply soaking up information; they make tentative interpretations of an experience and elaborate on those interpretations. Learning is inherently constructivist in character, and therefore teaching should support this process of construction [19].

One can make a distinction between two types of constructivism: BIG constructivism and WIG constructivism. These acronyms stand for 'Beyond information given' and 'Without information given' respectively. It is quite intuitive that the latter school of thought advocates that direct information should be withheld to ensure that concepts are truly learned through discovery. Advocates of BIG constructivism believe that one can teach concepts provided there is opportunity for students to test and evolve their conceptions [19].

The constructivist pedagogy involves the following characteristics [20]:

Attention should be given to the background of each student.

Group discussion should be facilitated to explore domain elements with the purpose of creating understanding of a topic.

Formal domain knowledge can be introduced at specific points. Students should be allowed the opportunity to challenge existing beliefs. Students' meta-awareness of their understandings and learning processes should be developed.

Constructivist theories include Case-Based Learning, Cognitive Apprenticeship, Communities of practice, Discovery Learning, Goal Based Scenarios, Social Development Theory and Situated Learning.

D. Design-Based Research Models

Design-based research is a combination of approaches that intends to produce new theories and practices that can explain and impact on learning and teaching [21]. The goal is to balance positivist and interpretivist paradigms so that the gap between theory and practice in education might be closed or at least narrowed. Design-based research aims to understand why educational innovations succeed and to unearth the correlations between educational theories, designed artifact and practice [21].

Common features of design-based research include the fact that the purpose is to produce theories on the process of learning, and teaching. Processes of learning are broadly interpreted as knowledge, the evolution of learning-relevant social practices, identity, and interest. The second feature is that the methodology is of an interventionist nature. The intent is to investigate ways to improve education by developing new forms of learning and then studying them. Thirdly, design experiments create conditions for developing theories and then place these theories in the way of harm. Design experiments have two sides: prospective and reflective. The prospective and reflective aspects of design result in a fourth characteristic, namely iterative design. As conjectures are generated and disproven, new conjectures are developed. The result is an iterative process of invention and revision. The fifth characteristic is that theories developed are concerned with domain-specific learning processes [22].

Design experiments aims to address more theoretical questions about the nature of learning in context, the need for approaches to the study of learning phenomena in the real world situations rather than laboratory conditions, the need to go beyond narrow measures of learning and the need to derive research findings from formative [23].

Critical characteristics of design experiments are addressing complex problems in real contexts in collaboration with experts, integrating known and hypothesized design-principles with technological affordances to render plausible solutions, and conducting rigorous and reflective inquiry to test and refine innovative learning environments and define new design principles [24]. Design-Based strategies include the ADDIE Model of Instructional Design and the ARCS Model of Motivational Design.

E. Humanism

Humanism as a paradigm believes that humans are different to other animals in the sense that we possess extended capacities. Humanists study human needs and interests. Humanism assumes that intentionality and values is at the centre of human behaviour. Contrast this with how Pavlov and the other Behaviourists approached education and instruction, and the beliefs of cognitive psychology that the discovery of concepts and information processing are the main components of human learning. Humanists believe that a holistic study of the person is necessary, with special attention paid to how an individual grows and develops. The self, motivation and goal setting are points of interest for humanists [25].

There are five objectives of the humanistic view of education [26]:

Promotion of positive self-direction and independence, development of the ability to take responsibility for learned knowledge, development of creativity, curiosity and an interest in the arts. The main goal of humanism is the development of people who are self-sufficient and self-actualized. In humanism, learning is personalized and student-centered, and the educator plays the role of a facilitator. Emotional and cognitive needs are important, and the objective is to cultivate self-actualized persons in a cooperative, supportive milieu.

Theories included in Humanism are Experiential Learning, Facilitative Teaching and Maslow's Hierarchy of Needs.

IV. Two Models Chosen for Further Study: Motivation and Discussion of Chosen Models

As can be seen from the above discussion on learning paradigms and theories, there is an overwhelming amount of choices available. To limit these for further study, a fourth year student of the new generation - a digital native - was asked to study and compare these choices, and to select two of them for further study. This selection was made using the knowledge gained during the study, but of course not excluded own experience and preferences. The two theories chosen were social learning theory (paradigm: behaviourism) and elaboration theory (paradigm: cognitivism). These two theories will now be discussed, as well as the motivation for each choice.

A. Social Learning Theory

1) Model Study

Social learning theory focuses on the interaction between the environment and the student [27]. Students form models of behaviour from which learning ensues. Learning from models takes on different forms, including new behaviour patterns, judgmental standards, cognitive competencies and generative rules for creating new forms of behaviour [28]. Individuals are thought to be self-organizing, proactive, self-reflecting and self-regulating. Psychosocial functioning is explained in terms of triadic reciprocal causation [29].

In this model of reciprocal determinism, behaviour, personal factors and environmental events are interacting determinants that influence each other bi-directionally [30]. Students are both products and producers of their own environments. The four components of social learning theory are as follows: Attentional processes that determine what students observe and what knowledge is extracted from those observations. Retention processes are processes that involve actively transforming and reorganising information into conceptions for memory representation. Behavioural production process where the conceptions formed during the

retention process are translated into actions where actions are refined until they match the internal conception of the activity. Motivational process makes a distinction between acquisition and performance because not everything that is learned by a student is necessarily performed.

Social learning distinguishes between three types of incentive motivators. These are direct, vicarious and self-produced. It is more probable that students will perform modeled behaviour if the consequences of this behaviour is rewarding to them. Students will also be motivated if they see their peers attaining success. Lastly, students are incentivised by personal standards [28]. Internalization of standards is integral to the achievement of self-directedness and a sense of purpose [31].

2) Motivation

The Social Learning theory, with emphasis on learning through observation should fit Computer Science classes well. Computer science has strong theoretical and practical components, both in introductory and advanced courses. Because the world already embraced technology and Computer Science in all facets of life, it is not difficult to draw comparisons between real-world behaviour and study material that has to be taught. According to Social Learning theory, students learn through observing behaviour and eventual outcome. Using technology to construct a visually attractive lecture, the educator has ample opportunity to demonstrate behaviour that will be effective in the field of Computer Science, both in the practical and theoretical arena. For instance, if a programming language is being taught, the lecturer has the opportunity to demonstrate the processes of critical thinking that needs to be followed to solve a certain problem and the language specific intricacies that goes along with constructing an algorithm that will deliver the desired outcome. If the lecture is constructed to be both interactive and attractive to the students they will pay attention and learn not only from the behaviour of the lecturer, but also from that of the students that interact within the lesson. Now, the material has to be retained. Observed behaviour is retained through either an imagil or verbal representation system. If the lecturer demonstrated the correct use of syntax in coding an algorithm the student will form a model of behaviour in his mind containing the visual and verbal instructions and processes that was demonstrated in the classroom. This can be reinforced with interaction by questions answered or a student demonstrating problem solving in the class. Also, memory is reinforced by transforming symbolic representations into suitable actions- that is practicing the study material at home through homework assignments. These assignments should be similar to what was discussed in the classroom but may be a little more complex. The lecturer must also provide encouragement and motivation for the students to replicate modeled behaviour. The most obvious form of motivation is grades. Social learning theory places a high value on self-regulation though, so lecturers should encourage students to take an interest in the field of study and take some initiative in conducting research and deepening their knowledge. As far as social influences and interaction goes in shaping behaviour and ultimately learning, Computer Science offers ample opportunity. In terms of group work and presentations or demonstrations by students there would be a solid base to work from to achieve education through altering perceptions of the students' environment, and ultimately changing behaviour.

B. Elaboration Theory

1) Model Study

The main goal of elaboration theory is to select and sequence learning material to optimize the process of attaining the learning goals that have been set. It is intended for medium to complex cognitive and psychomotor learning [32]. Elaboration theory seeks to provide a holistic alternative to parts-to-whole sequencing. The approach aims to sequence the content by identifying real-world versions of the task or content [32]. The premise is that different sequencing strategies are based on different kinds of relationships within the content, and the different relationships relates to different kinds of expertise. Distinctions are made between task expertise and domain expertise [33].

Task expertise refers to students mastering a certain task, such as writing program code to solve a specific type of problem [33]. Elaboration theory deals with tasks of more complex nature. It is based on the view that complex cognitive and psychomotor tasks are executed differently under different conditions. What the theory offers is a simple-to-complex sequence by starting with simpler tasks and gradually moving to more complex versions as each level is mastered by the student. The learning of the tasks takes place in the Zone of Proximal development as discussed in Social Development Theory [32].

Domain expertise refers to the student becoming an expert in some content such as the history and origin of Artificial Intelligence [33]. Domain expertise ranges from simple to complex, but also from general to detailed. The holistic sequence unsurprisingly goes from simple to complex and starts with the broadest, most general ideas and gradually progresses to more complex, detailed ideas. There are two types of domain expertise, namely conceptual and theoretical [32].

The conceptual domain expertise deals with concepts and conceptual structures to effectively understand "what". Concepts are groupings of ideas that can't be broken down into narrower concepts and are stored under a broader, more inclusive concept within the student's cognitive structures. So conceptual elaboration sequence starts by teaching new broad concepts and then proceeds to more detailed, less inclusive concepts that fall within the broader concepts. This narrowing of concepts continues until the desired level of detail has been reached [32]. The theoretical domain expertise deals with principles, causal models and theoretical knowledge structures to effectively give the student an understanding of "why". It is used in courses with interrelated sets of principles which are elaborations of one another [32].

2) Motivation

Elaboration theory approaches education by first taking a 'wide-angle' view of the study material so that students may see the 'big-picture' or holistic view of what must be mastered. Each segment is then elaborated on to provide a more detailed view. The most important thing is to sequence the material to optimize the process of attaining goals set in learning. To attain these goals, they have to be identified beforehand and communicated effectively to the students. Because students are presented with this holistic view of study material and learning goals beforehand, they are empowered to make decisions about how they sequence their learning beforehand. Applying this theory to Computer Science one could envision that this approach could benefit an educator trying to teach a theoretical course. Once the students have a firm grasp on how each component of the theory to be learned fits together in the bigger picture, one could elaborate on each component in turn. This elaboration continues until the desired amount of detail has been conveyed to the students. An easy example in Computer Science would be the theory relating to Databases. Taking a holistic view of how databases and database systems work and fit will provide context to the students before launching into more detail about how a single database should be constructed, normalizing databases etc. While Social Learning theory might be more suited to the practical side of Computer Science, elaboration theory could effectively deal with learning the theory. Even more practical applications might be taught in this manner. Consider the theory behind object orientated programming. Elaboration theory would provide the students with a holistic view of how problems will be solved using the object oriented approach before elaborating on the more complex details of how to program a specific component.

V. Data Collection, Analysis and Results

As mentioned earlier in this paper, Prensky [4] said that "*Our students have changed radically. Today's students are no longer the people our educational system was designed to teach*." The older generation is tasked with teaching the much younger and often fluent 'natives'. Because of this, it is important to get feedback from the new generation of Computer Science students themselves.

A. Data Collection

Questionnaires were e-mailed to 80 third year Computer Science and Information System students of the Potchefstroom Campus of the North-West University, South Africa. The questionnaire was answered and returned by 46 students.

The questionnaire covered aspects such as the availability of technology, current methods of education and receptiveness towards certain aspects of Elaboration Theory and Social Learning Theory. The questionnaire consisted of multiple choice questions, and some subjective, open-ended questions were included to provide context to the data collected.

B. Data Analysis

Mixed methods were used to analyze the data. The multiple-choice questions were analyzed statistically (positivistic paradigm). The open questions in the questionnaire were analysed using coding aspects of grounded theory (interpretive paradigm). All the phases of grounded theory were not followed, as the purpose of the research was not to develop a theory, but to identify important factors.

C. Results

For the multiple choice questions students had five options: 1 –I strongly disagree, 2 (I disagree somewhat), 3 (I have no strong opinion) either way, 4 (I agree somewhat) and 5 (I strongly agree).

The results of the multiple choice questions can be seen in table I.

TABLE I
MULTIPLE CHOICE QUESTIONS

Questions	1[a]	2[b]	3[c]	4[d]	5[e]
I participate in classroom discussion	2%	11%	30%	48%	9%
I volunteer to answer if I know the answer to a question.	7%	15%	24%	43%	11%
I prefer a lecture with PowerPoint slides.	4%	7%	20%	43%	26%
I prefer to do practical assignment in groups.	20%	30%	26%	11%	13%
I prefer lectures containing visual presentations as opposed to strictly verbal lectures.	0%	7%	15%	41%	37%
I would learn a concept more effectively if I did some research on it by myself.	0%	9%	30%	41%	20%
I would enjoy the opportunity to watch instructional videos on platforms such as YouTube to assist me in completing a task.	0%	4%	28%	24%	43%
I feel that I would remember a concept effectively if I did a group presentation on it to the class.	24%	30%	22%	15%	9%
I would understand processes and ideas better if they were demonstrated to me by someone I consider an expert.	0%	4%	24%	46%	26%
I think that if students are given the chance to present course material to the class that everyone will remember the information presented very effectively, especially the student that presented said material.	15%	22%	28%	22%	13%
I like to know the structure of the course material we will be covering beforehand.	2%	7%	33%	46%	13%
I remember concepts better when I know how they fit into the 'big picture'	0%	4%	7%	54%	35%

I would like to have a say in which concepts the lecturer should elaborate on.	0%	15%	43%	22%	20%
I learn and remember concepts better when they are first explained in a more general fashion and then in more detail.	2%	2%	11%	50%	35%
When I see my fellow students perform a practical task I feel I learn something, whether they perform the task correctly, or whether they perform it incorrectly and are corrected by the lecturer.	4%	7%	26%	48%	15%

[a]1: I Strongly Disagree, [b]2: I Agree, [c]3: No opinion, [d]4: I agree, [e]5: I strongly agree.

To augment the categorical data gathered from the multiple choice questions open questions were asked to provide context. The open questions can be seen in table II.

TABLE II
OPEN ENDED QUESTIONS

Would you like access to sound bites and video material from classes that you could review at home?
How do you react when asked a question in class?
How can a teacher motivate you to participate in class discussions?
Do you find your current lectures interesting, engaging and effective? Please explain.
How do you think the lecturer could use technology more effectively to teach the course?
What motivates you to do a good job when handing in assignments or studying for tests?
Do you think your background and personal history influence the way you learn? Please motivate.

In section II of this paper statistics were quoted about the number of students in the US and in South Africa who own laptops, computers and internet-capable mobile phones. Questions were asked in this study to get up to date statistics for this group of students. The results can be seen in table III.

TABLE III
USE OF AND ACCESS TO TECHNOLOGY

Technology:	Percentage of students with regular access:
Laptop	81.82%
Personal Computer	77.27%
Internet Capable Mobile Phone	100.00%
Tablet PC	25.00%
Internet & Email	97.73%

D.Discussion of Results

Students need to be stimulated both visually and verbally. Cognitive theory of multimedia learning assumes that students have two channels through which they process information-one channel for auditory processing and one channel for visual stimulus. These channels have limited capacity for active processing [34], so the need for both verbal and visual stimulus in a classroom becomes very clear. Therefore it is not surprising that 78% of students in the study indicated that they do prefer lectures that include visual presentations, while only 7% of students indicated that they do not enjoy an added visual presentation. At the moment the preferred method of visual aid in the classroom is without a doubt Microsoft PowerPoint, and 69% of students indicated specifically that they prefer the use of PowerPoint in a lecture.

One aspect of education that has stayed decidedly static is the way in which students access study material. Written notes, textbooks and, in some cases, PowerPoint slides made available to students are all that a student has to come home to. Once the lecture is over the student loses some dimensions of the pedagogical process, namely the verbal and interactive components found in a classroom. One way to negate this loss of dynamism is to make videos or sound clips available to students online. A factor that came up even though it was not directly asked is that lecturers sometimes do not speak clearly enough. Two students indicated that lecturers speak too softly, and a further 10 students complained that lecturers sometimes talk too fast in the classroom. In a diverse country such as South-Africa this problem is compounded due to a wide array of languages being spoken at home. The language that is used to instruct in the classroom might be only the second or third language for many students. Therefore these multimedia tools placed online could be very useful in taking steps to engage students of a new generation. Two questions were posed to the sample group of students. The first was aimed at measuring how open students would be to use sound bites and videos to assist them in performing tasks or completing assignments. When asked whether they would enjoy the opportunity to watch instructional videos on platforms such as YouTube to assist in completing a task, 67% of students agreed while 28% had no strong opinion on the subject. Only 4% of students did not agree that this would be a good idea. The second question tried to gauge the feeling regarding videos and sound bites recorded in class being made available. When asked this more open ended question whether they would like access to sound bites and video material from classes that they could review at home, all but one student said that it would be very helpful, especially in doing revision. The reaction to this proposed use of technology was almost overwhelming with students using copious amounts of exclamation marks and adjectives such as “great”, “amazing” and “fantastic”.

Social Learning theory advocates self-regulation and the internalization of motivating factors. One way to get students interested in the work being taught is to have students do some research on a subject. Of course this idea overlaps somewhat with the theory of Discovery Learning which states that learning is an information processing activity, by which students try to understand their environment. Students do this by organizing and categorizing information using a coding system. The most effective way to develop a coding system is to discover it, and what better way to discover information than to do some research and then summarize it? Large proportions, namely 61%, of students feel that they would memorize a concept more effectively if they did some research on that subject themselves. 30% of students had no strong opinion either way and, only a measly 9% of students felt that they would not learn a concept more effectively if they did research on it.

Another big aspect of Social Learning theory is observing the behaviour of others and forming conceptualizations from these observations. The easiest way to engage students in activities that enable them to learn from others is group work. Students don't seem to have a great affinity for group work however, with 50% of students indicating that they would not like to do practical assignments in groups. Extending this question to whether students would like to do a presentation to the rest of the class in a group increased the negative reaction to 54% of all students. This exposed a very interesting pattern and one that is greatly connected to social learning theory. 37% of students felt that they would not remember material effectively if it were presented to the class by another student while 35% felt they would. 28% had no opinion either way. In contrast to this, 63% of students felt that they would definitely learn something from seeing another student perform a practical task in class – whether that task is performed correctly or whether it is performed incorrectly and then corrected by the lecturer. This anomaly might be explained by the next two statistics. Only 48% of students indicated that they ever participate in classroom discussions. Only 54% of students indicated that they would volunteer to answer a question in class, even if they knew the correct answer. So while students feel that they would be able to learn from their peers in an interactive classroom, not many students are very keen to participate themselves. Many students, when given the opportunity to openly voice their opinions, had reservations on participating in the classroom due to fear of ridicule or a fear of talking in front of others. Many also felt that when classroom discussions do take place there is always a minority of students that take over these discussions. It is clear that there are definite advantages to an interactive classroom, but that the onus is on the lecturer to ensure that students feel safe to voice their opinions, and that all students are given the platform to be heard.

Students also respond to figures of authority. When the lecturer is considered an expert in the field of study that he or she is teaching students tend to listen more attentively and place a higher value on what the lecturer says. 72% of students indicated that they would understand concepts better if the lecturer were an expert in the field.

Elaboration theory places high emphasis on first presenting a holistic view of the material before 'zooming in' on specific parts. Students tend to agree with 59% of students saying they would like to know the structure of the whole course to be studied beforehand. A massive 89% of students said that they like to know and see during lectures how the current material fits into the big picture. Students were less enthused about having a say in what section of work has to be elaborated on with only 42% indicating interest. The main concept of Elaboration theory is sequencing the work in such a way that it is explained in a more general sense before focusing on specifics of the various components thereof. 85% of students indicated that they would remember concepts better when they are first explained in a more general fashion and then in more detail. This bodes very well for Elaboration theory as a method of education going forward.

Most students found the current method of teaching engaging and interesting citing facts such as the lecturers being experts in their field, lecturers being helpful, the students having a great interest in the subjects presented and lectures being well organized as the greatest positives. In fact, only 6 students did not answer emphatically in the positive, with only two students saying that they do not find the lectures engaging at all. There is room for improvement however. Six of the students felt that technology could be used to show practical examples and applications in the classroom. Due to the obvious need for interaction but the unwillingness of students to stick their necks out in a classroom environment there is a definite need for technological assistance in making lectures more interactive. In today's fast paced, internet based world where information is available at the click of a button, students are looking for faster and more effective feedback from lecturers. They want prompt replies on their emails, quick feedback on tests and assignments and immediate answers to their questions. This is where technology could streamline the education process and keep students interested.

Another interesting topic that arose is the one of motivation. Where does motivation come from? What makes students want to work hard? The questionnaires showed that these students, who have already reached the final year of their studies toward a degree, are mostly motivated by personal goals. The question of what motivates them was asked directly and the results showed that 60.87% of students felt that their motivation is internalized. The factors that these students listed as motivation include personal goals, attaining good marks, securing their futures or financial incentives like bursaries. The other 39.13% of students felt that their motivation comes from more external sources like their families, spiritual motivation or the way that they were raised. 23.91% of these students specifically cited interesting work and effective lecturing techniques as motivation. When questioned more directly about how they feel their backgrounds affect their studies, students indicated that they felt their personal backgrounds such as life at home and especially their academic history played a big part in driving them to deliver good work. They are motivated by securing their own futures and implementing the discipline that they learned from their parents and teachers while growing up. Students learn by observing and then imitating – a process called modeling, and a key concept of Social Learning theory.

In the U.S. more than 80% of students owned laptops, 53.8% owned personal computers and 33% own one of each, while 66.1% owned internet-capable mobile phones [7].

A study in South-Africa showed that 88.9% of students have access to mobile phones with cameras, 61.1% have access to a desktop computer and 49.6% have access to a laptop or notebook [8].

In this study the results are somewhat different. This might be due to the rapid increase in availability of technology, the fact that Computer Science students have, on average more access to technology or that the demographic of the sample population is somewhat different from those used in previous studies. 18.18% of students owns or has access to a personal

computer, 22.73% of students own or have access to a laptop and 59.09% of students have access to both. That means the whole sample population of Computer Science students have access to either a laptop or a desktop computer. This statistic is supported by the fact that 100% of these students own an internet-capable mobile phone. 25% of the students own a tablet PC, 97.73% of students have regular access to the internet and email. These figures are not totally unexpected when considering the motivation for this study. Modern students live and learn in an era where technology is the norm, and for Computer Science students this is compounded.

VI. Conclusion

Students have fundamentally changed with regards to their intellectual, social, motivational, and emotional needs. The modern student not only uses technology on a daily basis, but has become dependent on it. The motivation of this study outlined the characteristics of a new generation of students that need to engaged effectively in sensory-rich and interactive learning situations to ensure that their interest is arrested. The norm in higher level educational institutes is an hour-long lecture [1], but studies have found that the attention span and learning ability of students decline after 20 minutes [35]. This results in students only recording about 500 words out of a lecture consisting of 5000 [1]. Studies in Australia, the U.S. and South-Africa confirmed that students have plentiful access to many forms of technology including internet capable mobile phones, laptops, desktop computers and the internet. The motivation for this study is therefore quite clear.

A literature study was conducted to examine the major learning paradigms, namely Behaviourism, Constructivism, Cognitivism, Design-Based and Humanism. Two models, namely Social learning theory and Elaboration theory was identified as having the most potential for fulfilling these needs of the new generation of Computer Science students. The choice of these two models was motivated, and the models were studied in further detail.

According to Social Learning theory, students learn through observing behaviour and eventual outcome. Using technology to construct a visually attractive lecture, the educator has ample opportunity to demonstrate behaviour that will be effective in the field of Computer Science, both in the practical and theoretical arena. This makes Social learning theory well suited for utilizing technology to educate modern sensory learners. There are four processes involved in applying observational learning. These are attention, retention, production and motivation.

Elaboration theory approaches the pedagogical process by first taking a ‘wide-angle’ view of the study material so that students may see the ‘big-picture’ or holistic view of what must be mastered. Each segment is then elaborated on to provide a more detailed view. The fact that 60% of students are sensory learners [36] and like concrete information, a structured approach to learning, and process information best when it is presented linearly makes elaboration theory quite well suited to the task of educating modern students.

According to this study, the two theories most suited to educate a new generation of students, is the Elaboration theory that can be used to structure and sequence material to make it logical and appealing to students, and Social Learning theory wherein students can observe the behaviour of a lecturer and their peers and learn from the consequences of that behaviour.

Results obtained from a questionnaire aimed at examining the attitude of a class of Computer Science students toward certain aspects of both identified theories were examined. While these two theories complement each other immensely, they cannot stand alone. Elements of all theories need to be incorporated into a paradigm that will be sufficient to educate the Computer Science students of today. Without factors of other theories Social Learning theory will fail to engage, interest and motivate students to learn the course material that has been sequenced so brilliantly according to Elaboration theory in an effective way. Aspects of Humanism such as creating the right environment are vitally important. Elements of Constructivism like setting goals, getting students to discover information and skills and Cognitive Apprenticeship not only overlaps with the fundamentals of Social Learning theory but supports and enhances it in a big way. Other theories in Cognitivism also run parallel with Elaboration theory such as creating schemas and connecting new information to old knowledge. No one theory can succeed on its own, but a combination of Social Learning Theory and Elaboration Theory can be optimal when supported by aspects of other theories.

Students have changed and are now both equipped with and dependent on technology. Computer Science students are even more enraptured with the latest technological tools available due to their interest in the field. Technology must be used in the most optimal way to engage with students and to keep them interested. In an age where time is money and information is power, technology should be used to communicate with students quickly and efficiently by lecturers that understand how the latest gadgets work and are truly experts in their fields. Lecturers have to become ‘digital natives’ themselves and speak the language of technology fluently and without accent. Once students have respect for and trust in a lecturer, the fundamentals of Social Learning Theory and Elaboration theory can be applied to deliver optimal results in the Computer Science classroom. It’s a brave new world that has such students in it, and technology is the tool with which they will be taught.

References

[1] A. K. Beerman, “Computer-based Multimedia: New Directions in Teaching and Learning.” *Department of Food Science and Nutrition*, pp. 15-18, 28 June, 1996.

[2] D. Tapscott, *Growing up digital: The rise of the Net Generation*. New York: McGraw-Hill, 1998.

[3] D. G. Oblinger and J. L. Oblinger, *Educating the Net Generation*, Date of access: 28 February 2012. http://www.educause.edu/ir/library/pdf/pub7101.pdf, 2005.

[4] M. Prensky, “Digital Natives, Digital Immigrants” *On The Horizon*, vol. 9, no. 5, October, 2001.

[5] S. Bennett, K. Maton and L. Kervin, “The 'Digital Natives' debate: A critical review of the evidence.” *British Journal of Educational Technology*, vol. 39 no. 5, 2008.

[6] G. E. Kennedy, T. S. Judd, A. Churchward and K. Gray, "First year students' experiences with technology: Are they really digital natives?" *Australian Journal of Educational Technology*, vol. 24, no. 1, pp.108-122, 2008.
[7] J. B. Caruso and G. Salaway, *The ECAR Study of Undergraduate Students and Information Technology*, EDUCAUSE, 2008.
[8] H. Thinyane, "Are digital natives a world-wide phenomenon? An Investigation into South African Students' use and experience with technology." *Computers & Education*, vol. 55, pp. 406-414, 2010.
[9] T. Kramlinger and T. Huberty, "Behaviorism Versus Humanism" , pp. 41-45. December 1990.
[10] N. Friessen, "Mind and Machine: Eithical and epistemological implications for research." *AI & Society*, vol. 25, no. 1, pp. 83 – 92, 9 December 2009.
[11] B. F. Skinner, *The Technology of Teaching*, New York: Appleton-Century-Crofts, 1968.
[12] B. F. Skinner, "Teaching Machines." *Science*, pp. 969-977, 1958.
[13] C. Guey, Y. Chengand S. Shibata, "A Triarchal instruction model: integration of principles from Behaviorism, Cognitivism and Humanism." *Procedia - Social and Behavioral Sciences*, vol. 9, pp. 105-118, 2010.
[14] H. L. Petri and M. Mishkin, "Behaviorism, Cognitivsm and the Neuropsychology of Memory." *American Scientist*, vol. 82, no. 1, pp. 30-37, January-February 1994.
[15] J. C. Smith, *Historical Foundations of Cognitive Sciences.* Dordrecht: Springer, 1990.
[16] D. C. Leonard, *Learning Theories A to Z.* Westport: Greenwood Press, 2002.
[17] E. Von Glaserfeld, Ernst, "Constructivism in Education" in T. Husne and T. N. Postlethwaite, eds. *The International Encyclopedia of Education*, Oxford/New York: Pergamon Press, pp. 162-263, 1989.
[18] L. B. Resnick, *Knowing, Learning and Instruction.* Hillsdale: Lawrence Erlbaum, 1989.
[19] D. N. Perkins, "Technology Meets Constructivism: Do They make a Marriage?" Education Technology, pp. 18-23, May 1991.
[20] V. Richardson, "Constructivist Pedagogy." *Teachers College Record*, vol. 105, no 9, pp.1623-1640, December 2003.
[21] S. Barab and K. Squire, "Design-Based Research: Putting a stake in the ground." *The Journal of the learning sciences*, vol. 13, no. 1, pp. 1-14, 2004.
[22] P. Cobb, J. Confrey, A. Disessa, R. Lehrer, and L. Schauble, "Design Experiments in Educational Research." *Educational Researcher*, vol. 32, no. 1, pp. 9-13, Jan/Feb 2003.
[23] A. Collins, D. Joseph and K. Bielaczyc, "Design Research: Theoretical and Methodological Issues." *The Journal of the learning sciences*, vol. 13, no. 1, pp. 15-42, 2004.
[24] A. Collins, "Towards a design science of education." in E. Scanlon, and T. O'Shea, eds. *New directions in educational technology*, Berlin: Springer. pp. 15-22, 1992.
[25] W. Huitt, *Humanism and open education.* Date of access: 8 August 2012. http://www.edpsycinteractive.org/topics/affect/humed.html, 2009.
[26] N. Gage, and D. Berliner, *Educational Psychology.* Boston: Houghton, Mifflin, 1991.
[27] G. R. Taylor, *Practical application of Social Learning theories in educating young African-American Males.* Lanham: University Press of America, 2003.
[28] A. Bandura, "Social Cognitive theory." in R. Vasta, ed. *Annals of child development*, Greenwich: JAI Press, vol. 6, pp. 1-60, 1989.
[29] A. Bandura, *Social foundations of thought and action: A social cognitive theory.* Prentice-Hall, 1986.
[30] R. Wood and A. Bandura, "Social Cognitive Theory of organizational Management." *The Academy of Management review*, vol. 14, no. 3, pp. 361-384, July 1989.
[31] A. Bandura, "Social cognitive theory of moral thought and action." in W. M. Kurtines and J. L. Gerwitz, eds. *Handbook of moral behaviour and development*, Hillsdale: Erlbaum, vol. 1, pp. 45-103 1991.
[32] C. M. Reigeluth, *Instructional-Design Theories and models.* Mahwah: Lawrence Erlbaum, 1999.
[33] G. Morrison, S. Ross, E. Kemp and H. Kalman, *Designing Effective Instruction.* Chennai: Wiley and Sons, 2004.
[34] R. Mayer, *The Cambridge Handbook of Multimedia Learning.* Cambridge: Cambridge University Press, 2004.
[35] D. A. Norman, *Things that makes us smart: Defending Human attributes in the age of the machine.* New York: Addison-Wesley, 1993
[36] C. C. Schroeder, "New Students - New Learning Styles." *Change, pp.* 21-26, September/October 1993.