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# COMPUTING TEACHING AND LEARNING IN HEI'S USING CONSTRUCTIVISM

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**Abstract:** Constructivism is a major intellectual influence on the development of modern learning technology. This paper first reviews the main doctrine of the constructivist approach. The application of constructivism to teaching and learning computing subjects is then critically discussed. It is argued that constructivism provides a set of ideas that should have a deeper and more widespread impact on computing teaching and learning. There are many variants within constructivism - therefore the application of constructivism to computing requires careful evaluation of the validity and applicability of the pedagogical ideas and principles proposed.

## 1. Introduction

The recent pronouncement by the UK government for “pay as you go” university degrees will be another factor that will force many institutions to look outside their traditional market to expand their various subject offerings. Recent research has shown that increasing tuition fees could result in a large number of higher education students from European Union countries opting to study elsewhere. As a result of this, many new (and old) universities will endeavour to utilise modern means of overcoming the expected reduced numbers of students. More specifically, computing related subjects undergraduate figures have slumped have over the last few years in many UK universities.

A constructivist and collaborativist environment for future learning could significantly change traditional teaching and learning methods and help reverse this trend. In the first section this paper examines the constructivist guiding principles. This is followed by a discussion of constructivism in the computing classroom which explores the paradigm that learning is constructed,

active, reflective, collaborative, inquiry based and revolving.

## 2. Constructivism (a primer)

Constructivism is defined as an active learning process in which meaning is developed on the basis of experience and inquiry (McPherson and Nunes, 2004)[1]. Essentially it is a meaning-centred approach to both teaching and learning that emphasises the learner’s role in constructing meaning – as opposed to the simple and traditional transmission from the lecturer/teacher to student. There is a cluster of learning theories that falls within the ambit of constructivism; they all emphasise the idea that learners construct knowledge (and reality) for themselves by actively interacting with concepts and information in their environment. The theorists in this field of study include; Dewey (1859 - 1952) – with his theory of Social Activism, Vygotsky’s (1896 - 1934) Theory of Scaffolding, Piaget (1896-1980) – with his study of Stages of Development, Bruner (1915 - present) – Learning as Discovery, Papert’s (1928 - present) – Cognitive

Development and Gardner's (1943 - present) Theory of Multiple Intelligences.

Over the last few decades there has been a plethora of definitions as to exactly what the theory is about. (Mahoney, 2003)[2] at a conference in Italy presented a paper entitled "What is Constructivism and Why is it Growing?" Therein he argues that the use of the terms "construct", "construction" and "constructivism" have been growing in frequency in the titles and abstracts of books and articles in psychology.

At the same conference, Mahoney expounded five themes that express constructivism. These themes are: active agency, order, self, social-symbolic relatedness, and lifespan development.

The active agency theme proposes that human beings are not mere passive pawns in the play of larger forces – in fact, learners are active participants and they take an active role in assimilation. On the theme of order, it is envisaged that human learning is enshrined in order processing.

Learners always categorise and place objects, ideas, and concepts in an organised pattern and then make meaning out of it. The self theme is devoted to the idea that a learner's activity revolves around selfhood or personal identity.

Here the individual is like the fulcrum or center of activity, which then spreads out into forming relationships and new groups. In the fourth theme called social-symbolic relatedness, Mahoney explains that it refers to the idea that "individuals cannot be understood apart from their embeddedness [sic] in social and symbolic systems." The final theme – lifespan development is related to the idea that all the previous four themes together make the individual a cohesive whole. Therefore order and disorder can co-exist in an attempt to create a dynamic balance.

The aforementioned five themes undoubtedly show the spectrum of contributions that have shaped the theory of constructivism. The works of Bandura, Brunner and Gergen over that last century are tightly coupled within the themes. In spite of this, the theory of constructivism is still growing and there have been recent works by constructivists like Robert Kegan, Joseph Rychalk and Ken Wilber (Mahoney, 2003). As with any learning theory, there are some terms that have become associated with constructivism.

Two of these are the zone of proximal development and scaffolding. The zone of proximal development (Wu, 2002)[3] refers to the distance between the actual development level of a learner as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. Whereas, scaffolding - a term coined by Vygotsky is sometimes referred to as assisted learning.

It is described as the process of controlling the tasks that are initially beyond the learner's abilities so that the learner can concentrate on and complete those tasks within his or her immediate capability. Constructivism is more of a philosophy than a strategy - it is a way of seeing the world and engaging with the environment (the classroom). One does not have to be a philosopher to take a position because as instructors we should be driven by the desire to do the right thing and to be knowledgeable about the differing sources of bias.

From this perspective constructivism provides a set of ideas that should have a deeper and more widespread impact on the teaching and learning computing related subjects.

### 3. Application of Constructivism in the Teaching and Learning of Computing

Traditionally teaching and learning in Higher Education Institutions is behaviourist in nature, but historically many aspects of constructivism have been applied to computing related subjects. The Logo programming environments that have been developed by Papert (1980), [5] over the past 30 years are rooted in constructivist educational philosophy, and are designed to support constructive learning. Boyle (2000)[5] makes reference to the CORE approach which was first developed to support the learning of formal computer languages. CORE is essentially an approach which has been developed to teach a formal computer language on the same principles of a natural language. Therein, it is argued that constructivist principles can be applied. It is from this precept that today teaching and learning computing related subjects can be taught and learnt using the constructivist paradigm. From the instructor's perspective, the teacher or lecturer has to instruct students on how to construct meaning and how to monitor, evaluate and update their constructions. The lecturer also has to create a climate or environment of group learning where experiences can be aligned, designed and encouraged so that authentic and relevant contexts can be experienced. More generally, the classroom has to be conducive to allow for and experience modelling, coaching and scaffolding. Emphasis should be on collaborative learning, authentic learning and anchored instruction. Collaborative learning is the active reconstruction of a learner's knowledge and ideas through peer-to-peer dialogues which leads to commenting, discussing, sharing,

and re-conceptualising of ideas and knowledge. The goal of this is to develop and enhance critical-thinking skills. With authentic learning on the other hand, students know the facts about the subject and they are also able to interpret, process, and apply them. In other words, learning is with and for a purpose. Anchored instruction has become an important paradigm for technology-based learning that was developed by the *Cognition & Technology Group at Vanderbilt (CTGV)* under the leadership of John Bransford. While many people have contributed to the theory and research of anchored instruction, Bransford is the principal spokesperson and hence the theory is attributed to him. Anchored instruction uses context as a learning device. The anchored refers to the bonding of the content within a realistic and authentic context. One important aspect of anchored instruction is its goal of making the learner solve problems and at the same time think about the thought processes involved. (Brooks and Brooks, 1993)[6] in their book entitled "In Search of Understanding: The Case for Constructivist Classrooms", highlighted the principle that assessment in a constructivist classroom should strive to achieve. Their argument is that assessment should be used as a tool to enhance both the learner and the lecturer's understanding of the learner's current understanding. Below is an abridged version of the important elements that should guide the work of the constructivist lecturer/teacher.

1. A constructivist teacher should encourage and accept learners' autonomy and initiative. As has been stated earlier, learning is an active process where the learner uses sensory input and constructs meaning thereof. Dewey refers to this as the "active learner" – stressing that the learner

- needs to do something; that learning is not passive; and that the learner should engage with the environment. Students can be encouraged to build portfolios and serve as assessors who judge originality and uniqueness rather than relying on the lecturer's right answer.
2. A constructivist teacher should use raw data and primary sources along with manipulative, interactive, and physical materials. This principle is based on the notion called "reflective activity" as described by Dewey. The learning process includes what is in the learners mind as well as his or her interaction with practical, hands-on experiments, especially with activities such as Computer Networking.
  3. A constructivist teacher should use cognitive terminology such as "classify," "analyze," "predict," and "create" when framing tasks. This will allow students to construct meaning from the "things around them" and at the same time construct systems of meaning. Each meaning that is constructed enables one to give meaning to similar situations. This can be ideally fostered in the area of Systems Analysis and Design.
  4. A constructivist teacher should allow learners responses to drive lessons, shift instructional strategies, and alter content. This is important because learning is done in context – not as an isolated, disassociated activity that has nothing to do with the environment. The assimilation of facts, concepts, ideas and theories are not separated from the rest of the world. An area of study here is Computer Languages – how these are written and interpreted by the computer in order to achieve a specific goal.
  5. The constructivist teacher should inquire about learners' understandings of concepts before sharing their own understandings of those concepts. Here topics related to Databases come to mind, as many students would have some idea or understanding of sources of data and how these could be used for information.
  6. The constructivist teacher should encourage learners to engage in dialogue both with the lecturer/teacher and with one another. This principle was advocated by Vigotsky. Language plays an important role in learning. Learners talk to themselves, each other and their teachers as they learn. Therefore the appropriate language and level of language should be used in the learning process. Nearly all aspects of computing can be employed here, as what is posited here is social interaction. Team-working is the driving element.
  7. Learners should be encouraged to use inquiry by asking thoughtful, open-ended questions and encouraged to ask questions of each other. The main activity here should be problem solving – investigation of the problem, use of resources to find solutions and drawing conclusions.
  8. A constructivist teacher should seek elaboration of learners' initial responses.
  9. A constructivist teacher should engage students in experiences that might engender contradictions to their initial hypotheses and then encourage discussion.
  10. A constructivist teacher should allow a waiting time after posing questions. Learning is a time consuming activity. Content needs to be revisited, ideas need to be tried out, there needs to be time for interaction with the new content. Learning is therefore not instantaneous. What comes to mind here is a Software Development Life Cycle and its numerous derivatives.

11. Learners should be encouraged to construct relationships and create metaphors. Assimilation is not possible without prerequisite knowledge. Every learner comes with his or her own initial cognitive structure which is then used as a basis for further learning. Object – oriented concepts seems to fall within this area.
12. A constructivist teacher should nurture learners' natural curiosity through frequent use of the learning cycle model.

### Conclusion and summary

This paper has reviewed the main principles of the constructivist theory and examined practical ways in which constructivism can be applied in the classroom, especially in the computing related subjects. It is still a young and dynamic field of study and there is still much to be debated and alternative versions of the essential scope of the area are apparent. The realism that faces lecturers today, especially in Higher Education is how to cope with the ever increasing demands of the current behaviourist system. Constructivism appears to posit an alternative viewpoint. A viewpoint of change, which needs ownership by all the relevant stakeholders.

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