

## TRANSFERABLE SKILLS TEACHING IN CHEMICAL ENGINEERING EDUCATION - THE INVESTIGATION OF A CONSTRUCTIVIST THEORY

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**Abstract** - This paper investigates the education of undergraduate chemical engineers with respect to their development of interpersonal skills, such as teamworking and leadership for which there is an increased employer demand. The main objective of this work is to compare the impact of different learning frameworks, which are in place at four academic institutions actively involved with teaching skills, and relate the results to a constructivist theory. Constructivism relates to a learning theory whereby the teacher or educator starts from the students' initial conceptions and understanding of a particular subject area and then 'builds' or constructs further knowledge on that initial foundation. Data has been collated through the observation of specific courses, obtaining feedback from both students and course providers. The results are of particular interest in establishing a link between how skills are taught and what impact that teaching has on student learning. Findings so far indicate that, for those institutions with established skills programmes, this learning process has been reflected in their students. They become articulate about their learning, and can identify the transition from being taught to actually learning, understanding and subsequently applying their transferable skills to their academic and work-related activities.

**Index Terms** - Constructivism, engineering education, teaching frameworks, transferable skills

### THE BACKGROUND TO THIS WORK

Nobody would doubt that providing academic excellence is an essential part of any degree course. Increasingly though, employers are looking for more than in-depth knowledge and understanding of relevant subject material from their recruits. These days it is important for graduates to also have acquired some degree of transferable skills. Transferable skills, for example effective teamwork, creative problem solving and communication are skills that are developed within one situation, education, and are successfully transferred into another, namely that of employment. Multi-national companies employing engineering graduates have continued to support the development of these skills in higher education. Many institutions of further and higher education in the U.K. teach transferable skills to their undergraduate engineering students and have been doing so

for the past 10 years or so. It is important that the teaching frameworks in place to accommodate this training are adequate for students to develop these skills to such a degree that they can 'hit the ground running' when entering the employer market.

The objective of the work is to compare four very different frameworks for teaching transferable skills in place at four academic institutions; then to compare them to a constructivist learning theory.

### WHAT IS CONSTRUCTIVISM?

Constructivism is a learning theory whereby the teacher or educator uses the student's personal understanding and perceptions as the initial foundation on which to teach. Constructivism is both psychological, (Piagetian) and sociological (Vygotskian). These two traditions in themselves, can further influence the teaching and subsequent learning of a particular subject. Many studies have been carried out on constructivism and its relation to the teaching of natural sciences. Those that have carried out research in this field have concluded that a strong case exists for the effective teaching of such subjects using this particular theory. It is however important to appreciate that constructivism is primarily a learning theory and not a teaching one.

### The Two Traditions of Constructivism

Piagetian or psychological constructivism maintains that learning is primarily a individualistic enterprise and that education consists of educating the student in a manner that supports their own particular interests and needs. The theory is based on the assumption that learning is an ingrained, natural and biological process - similar for all individuals regardless of gender, class, race or the social or cultural environments in which learning take place.

Vygotskian or sociological constructivism maintains that individual learning is derived from social interactions within which cultural meanings are shared by a group and subsequently internalised by the individual. This theory is based on the assumption that theory and practice do not develop in a vacuum and are shaped by both social and cultural changes.

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### Why is it the 'Best-fit' for this Work?

Constructivism was chosen as the most suitable learning theory for this work owing to the nature of skills development. It is suggested that transferable skills are developed in stages or levels, in order to recognise the development of these skills it is essential for the educator to establish what level the student is at with respect to their education. It is necessary to measure the level of improvement and as there are usually no formal assessment procedures for transferable skills, it is fundamental that there is a structure to the teaching - based on the student's current level of understanding.

Another reason why constructivism is the best fit for this work is that learning, within a constructivist framework, is not passive but active. Human beings do not find or discover knowledge so much as construct or make it. For example we have all started off with the perception that the earth is flat, gradually came to realise that it is round and further on from that knowledge base, that there is a gravitational force acting upon it. Similarly students are responsible for their own self-realisation, self-assessment and most importantly self-learning when learning skills. This is not ingrained in the students but becomes part of the learning process.

Constructivism is also a viable theoretical framework for teaching and learning and is one way of effectively exploring how knowledge and understanding are formed and constructed. These are key for the comprehension and development of transferable skills as transferable skills are about personal development which is best demonstrated through personal understanding and application.

### The Associated Challenges

Before considering constructivism for this work there are a number of associated challenges which need to be taken into account. When constructivism is considered from the viewpoint of the educator, it needs to be translated from a learning theory into a theory of teaching. This invariably raises questions about what teachers need to know and are able to do. There is also the possibility of student knowledge becoming idiosyncratic - if the educator starts teaching from a number of different foundations, there is every danger that students will arrive at different understandings or interpretations of a particular concept.

Those that have carried out research in this area have found a number of other challenges which need to be overcome when using constructivism as a learning theory:

- There is a considerable time constraint involved in achieving similar understandings of particular concepts by the students learning those concepts.
- For programmes to be successfully implemented, incorporating constructivist methods, a

restructuring of views of knowledge and learning is required by the educators, researchers and students involved.

- Most current assessment techniques focus on 'encapsulated' knowledge, and changes need to be made to develop techniques that assess knowledge-in-action.

### THE FOUR INSTITUTIONS

The institutions referred to in this research all run comprehensive programmes that teach transferable skills. Each of the institutions have very active programmes and are continually making changes to incorporate new ideas and methods in their current teaching practices.

### The Differences and Similarities between Them

- **Institution 1** This institution has been teaching transferable skills incorporated into its curriculum for the past 10-15 years. About 80% of the student population undertake a professional placement year and courses are run where students are given opportunities to develop their transferable skills.
- **Institution 2:** This institution has a structured training programme for the development of transferable skills, which has been running for about 8-10 years and incorporates much in the way of integrated skills development. Several courses are run within the undergraduate syllabus during which transferable skills are taught and developed exclusively.
- **Institution 3:** Many changes have been made to the curriculum at this institution to incorporate further skills development. The programme initially did not incorporate much in the way of teaching transferable skills, but now includes a number of bolt-on skills development courses during which skills are integrated back into the curriculum in some form.
- **Institution 4:** Transferable skills are embedded into the curriculum at this institution, but are not exclusively taught through any courses. Changes are currently being made to the curriculum so more skills related activities can be included for the development of personal and professional transferable skills.

### THE RESEARCH CONDUCTED

A total of 13 modules and courses were analysed over an 18 month period; they included a wide range of academic, academic-related and non-academic activities all of which incorporated teaching ideas or methods used for developing transferable skills.

### How was the Data Collated?

Courses from each of the institutions were analysed to establish the link between these four teaching frameworks and a constructivist learning theory. The analysis was carried out in stages:

- The course provider was initially interviewed to establish the teaching ideas used in their courses that account for the development of personal and professional skills.
- The courses were observed to confirm that the methods stated were actually employed and students were developing their transferable skills to some degree.
- Student responses were obtained, through focus groups, questionnaires and one-to-one interviews to establish their views about the learning of transferable skills from these courses.
- The course provider was re-interviewed about any discrepancies between what was observed and what students said of the courses. They were asked to comment on these and any other changes made from the intended course material.

### What can be concluded?

From the findings, it was possible to denote that there were differences in the learning outcomes of the students at institutions 1 and 2 compared to those at institutions 3 and 4. The more structured and longer-running skills training programmes were in place at institutions 1 and 2. Students from all four institutions were involved in discussions on their skills development during the research period via questionnaires, focus groups and one-to-one interviews. It gradually became evident that students from institutions 1 and 2 demonstrated an increased awareness of the development of their transferable skills and were able to better articulate upon their learning in this area as compared to those from institutions 3 and 4.

From observation, it can also be suggested that when students are informed of developing their transferable skills to some degree, prior to the actual learning, they become more aware of their development and can reflect back on it.

### The Evidence Available

From the studies carried out at each of the four institutions, and from the information collated and analysed, student perception and understanding of skills development became much clearer.

Video footage has been obtained of students speaking about the skills training undertaken. The video footage from institution 1 in particular depicts students being readily able to give examples about their skills training and

identify the transition from incomprehension to understanding. They are also able to identify the application and further development of those skills. The students used for all these studies came from a cross-section of the year group, they were all able to contribute to the discussion on their skills development irrespective of their background and/or former training. Similar evidence was also available from institution 2.

When students from institutions 3 and 4 were posed similar questions, they were unable to identify their learning with respect to transferable skills or pinpoint where in the curriculum that learning occurred. The programmes at these institutions were still in the developmental phase; it was evident from the responses received that students were taught about skills without being actively engaged in the learning process and that the structure of development also remained unclear to them.

### ACKNOWLEDGMENT

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### REFERENCES

- [1] Abdal-Haqq, I, "Constructivism in Teacher Education: Considerations for Those Who Would Link Practice to Theory" *ERIC Clearinghouse on Teaching and Teacher Education, Washington, DC, December 1998*
- [2] Driver, R, and Oldham, V, "A Constructivist Approach to Curriculum Development in Science" *Studies in Science Education, Vol, No 13., 1986*
- [3] Bertelsen, R, and Chadha, D, "Existing Good Practice" *A Review of Good Practice Across the Consortium, TRANSEND Publication, January 1999*