AC 2007-2188: A HOLISTIC EVALUATION OF THE EFFECTS OF AN INFORMED PEDAGOGY ON INITIAL TEACHER EDUCATION

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A Holistic Evaluation of the Effects of an Informed Pedagogy on Initial Teacher Education

Abstract:

Science and Technology education plays an important role in Ireland's knowledge based economy. The University of Limerick is the main producer in the Republic of Ireland of Teachers of Technology subjects for the second level (High School) education system and therefore have a significant impact in this area. The undergraduate Engineering and Technology teacher education course has been recently reviewed and updated to bring it in line with the latest developments in the subject areas. The degree is a four-year full-time programme involving elements of Engineering Design, Manufacture, Automation, Information Technology as well as Educational theory and pedagogy. The new programme was launched in 2005 and replaces an existing one that had been running for over twenty years.

As a means of continuous evaluation of this redesign, student teachers from the new programme had their experiences, attitudes and preparedness monitored and correlated with students from the older version of the programme. Whilst carrying out these correlations, trends and common student characteristics began to emerge, forming the foundation of this study.

Engineering students have been found to follow a set of characteristics with regard to their preferred learning styles. Following well documented research studies (e.g. Felder 2005) it was found that the undergraduate students training at the University of Limerick adhered to these styles. These preferred styles were used to assist and inform pedagogies, and help student teachers create informed judgements about their own teaching styles.

The main findings of this work were that undergraduates studying in the redesigned course formulated an attitude of professionalism towards teaching, and performed better with problem-solving tasks. The active learning environment that the experimental group were exposed to led to the students becoming an active part in the creation of suitable pedagogies. The methodology that is described as a result of this work, acts as a strategic approach to inform engineering pedagogy in the University of Limerick.

Key Words: Engineering Education, CDIO.

Introduction:

The shift towards the Conceptual Age

Recent persuasive commentary on how the dominating information age must undergo change and become less logical, coherent and conservative, must be a consideration for all third level course providers. Even if the actions taken are only to consider commentators view points and ensure that we as third level educators are not missing the broader picture of the type of world our graduates will we partaking in, it still must be a consideration. Pink in 'A Whole New Mind' [1] comments on how the information age has been dominant in creating a strong economic and technological global society. However this is no longer going to remain the dominant age as according to Pink, this type of society can be easily maintained. In a recent newspaper article the author commented on how 25% of Irelands I.T. jobs are being filled by immigrants. This is a stark contrast to the 1990's when I.T. jobs were extremely sought after and college graduates competed to fill these jobs, certainly excluding immigrants from the equation. The required knowledge to succeed in a technological society has become global and Pink insists that the people who will dominate the future of our societies will be those who can waver from the norm, be creative, think conceptually, spot a niche and act upon their instincts. University graduates who will be the big achievers will be those who can adapt and expand their skills to suit the new Conceptual Age.

To consider this in the light of technology teacher education, and what third level teacher training courses must consider to ensure the relevance of their learning outcomes is the main aim of this paper. In a previous study, an initial teacher training cohort were analysed with regard to how they responded to their introductory subject specific module under a constructivist, active learning pedagogical framework. In the resulting paper it was noted that students of different demographics responded in particular ways. The idiosyncratic nature of students was at the forefront of the previous study [2] which examined the individual characteristics of students, categorised by their preferential learning styles, their educational background and their personal demographics. Taking these individual characteristics into account and correlating these with the students performance in design tasks assigned to them in their first and second semester of study, this paper discusses how students of a certain profile achieve or under achieve. This will lead to the discussion that if we can associate a certain type of student with creativity and strong problem solving skills, are these the people we should be training to become our future teachers to conform to the expected dominance of the Conceptual Age? Is creativity a skill that can be learned and is there a pedagogy that instils creative problem solving skills and develops a learning style in students that leads to them being more adaptable to the conceptual form of thinking?

Areas to be investigated

Determination of the learning styles of the students

Learning preference may be defined as an individual's propensity to choose or express a liking for a particular teaching or learning technique or combination of techniques [3]. Individuals have a tendency to favour one particular style and adopt it throughout their life. Riding and Rayner [4] claim that the awareness of style has the greatest implications for effective learning. If the learning style of the student and the instructional style of faculty are mismatched, the quality of the learning activity is proportionally affected. The implications that this theory holds for faculty is to ensure their pedagogical approach facilitates the

preferential learning styles of their student cohorts but also encourage development of less preferential styles.

Analysis and quantification of the students learning experiences when faced with an alternative educational paradigm.

Difficulties can be expected when undergraduate students transfer from a product model of education, such as the Leaving Certificate Programme. They are confronted with an educational paradigm where expectations are founded on a constructivist educational theory. It is difficult to measure the learning in a quantifiable manner. Therefore qualitative research methods must be used to augment the analysis of the students' motivation, attitudes, self-esteem, and ability to comprehend information. To observe how students act and the attitude they take towards completing predefined tasks can inform this process.

Examination of variations of student attitude and preferences.

Gender, age, learning styles and educational background are all understood to have considerable effects on how students react to teaching methodologies. The correlation between the differing groups and the result from the assessment mechanism can be used to check for significant implications.

Methodology

Participants

One hundred and thirty six first year undergraduate students initially participated in this study. Due to the longitudinal nature of the methodology an expected attrition rate of 44% was recorded. Students who failed to complete any aspect of the methodology had to be excluded from the remaining cohort. It should be noted that only 8% of the cohort left the course. The remaining cohort consisted of 76 students. The demographics of the participating cohort are outlined below.

Table 1 illustrates the gender and age profile of the cohort. The mature student group represented 12% of the cohort. Ages ranged from 17-34, with a mean age of 19.1 and a standard deviation of 2.9. The cohort was male biased with only 4% of the group being female. This is representative of the innate gender imbalance in Engineering Undergraduate Programmes on a national level.

Table 1 - Cohort Composition

Student Type			Gender		
	Number	**Percentage**		**Number**	**Percentage**
Mature	9	12	**Male**	73	96
Undergrad.	67	88	**Female**	3	4

Design

The initial stage of this study took place as a stand alone study of how students responded to a new educational paradigm as they entered third level education. This original study and its

results lead to further investigation and inquiry which led to this current study. In the initial study the students' preferential learning styles and the students' performances in their introductory subject specific module were recorded. The students' performances were measured under specific tasks. These included in-lab skills development assessment, on-going practical project work, a theoretical exam (traditional academic assessment) and an aesthetic design challenge. By using these specific tasks the assessment of the students' performance was carried out in accordance with Bloom's hierarchy of Learning Taxonomies, beginning with knowledge based skills such as demonstrating their workshop skills in the lab sessions, then advancing towards tasks that required students to create and operate demonstrating a higher level of learning, whereby they were expected to analyse and synthesise, forming a deep understanding of the relevance of their project work in light of what they had theoretically learned during their first semester.

This paper uses these statistics gained during the students' first semester, however it also focuses on the students' creativity and design skills through design tasks that were assigned to the same cohort in their second semester of study. Through this method of correlating learning styles and students' previous performances with their scores in these design tasks, the study aims to provide information about the type of student that is coherent to creativity and design lending themselves to participating in a more conceptual framework. In trying to persuasively carry out this research the students' second semester subject specific module was specifically designed to incorporate a conceptual design project teamed with an applied design challenge.

Conceptual Design Project

The students were confronted with a conceptual design task during their second semester subject specific module. As part of this task they had to design and realise a prototype of a suitable project that they as a teacher would use to teach workshop skills at second level (High School). The students were asked to deal with a phantom second level class and consider all design criteria associated with such a project. The task therefore led to students considering workshop logistics, student motivation, mixed ability teaching, required materials and resources and also applying their design skills to produce conceptual sketches, a set of working drawings a prototype of their final design.

Applied Design Challenge

As part of the module the students also had on-going lab sessions over the twelve week semester. In this lab time the students were presented with a challenge of designing and producing a popular caricature using basic bench tool skills and decorative metalwork processes to create and apply their pre-designed aesthetic design.

Questionnaire

As part of the previous study already mentioned the students partook in the 'Index of Learning Styles' Questionnaire. The Index of Learning Styles (ILS) is a forty-four item forced-choice instrument developed in 1991 by Felder and Solomon [5] to assess preferences on the four scales of the Felder-Silverman model. Eleven questions are designed to evaluate each of the learning preferences. A specific sequence within the questionnaire surveys the dichotomous learning styles. Seery [6] prescribed some terminology changes to this questionnaire to eliminate ambiguity arising from the questionnaire being originally designed for use in an American context. This modified version was used to conduct this study.

Qualitative Research

Observation techniques were used to analyse attitudes, motivation, and self-esteem of the students within the workshop setting [7]. This method was used as the nature of human attitude and motivations are too complex to analyse quantitatively. As Figure 3 illustrates, three observers were used to record observations of the student progress. This triangulation research method was used to ensure that the validity of the observations was increased.

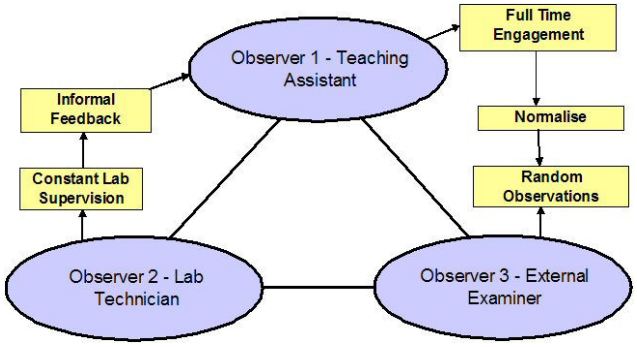

Figure 1 - Triangulation of Observational Research Method

Findings

Background

As a result of this longitudinal study numerous aspects identifying the innate characteristics of the partaking cohort were recorded. These included the Preferential Learning Styles of the students, the personal demographics of each student, and also through group and individual interviews a clear perception of the students' attitudes towards their course of study was portrayed and recorded.

Learning Styles Questionnaire

In table 2 below the tabulated raw data collected from the online *Index of Learning Styles* questionnaire shows how expected trends amongst engineering undergraduate students began to emerge. The data was recorded against a 5 point scale, 1 representing a mild preference and 5 representing a strong preference towards the particular style modes.

Table 2 – Preferential Learning Styles

Scale	Active/Reflective		Sensing/Intuitive		Visual/Verbal		Sequential/Global	
1	27	17	22	11	8	8	20	18
2	24	1	30	7	20	1	24	5
3	15	4	16	1	30	0	16	3
4	5	0	5	0	19	0	7	0
5	0	0	1	0	7	0	0	0

When grouped into specifics styles, figure 2 illustrates the overall preferential styles of the cohort. This shows a clear preference for the Active, Sensing, Visual and Sequential learning styles.

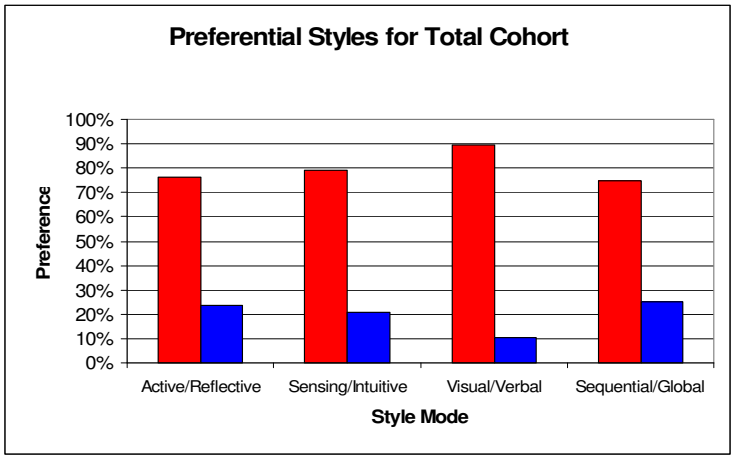

Figure 2 – Preferential Learning Styles

The average scores obtained by the relevant cohort groups, in the numerous aspects of the module are shown in Table 3 below. It is evident that the mature student group outscored the undergraduate group in all aspects of the modules assessment.

Table 3 – Average Assessment Scores

Group	Conceptual Design Task	Applied Design Task	Exam	Total
Overall	67	65	69	59
Undergrads	66	63	68	58
Mature	79	78	81	70

Figure 3 gives a clear graphical representation of how the mature student group, on average, outperformed the undergraduate group, in all aspects of the module. It must be noted that a number of undergraduate students did achieve excellent grades in the module and that figure 3 below is showing the average scores obtained by the cohort groups.

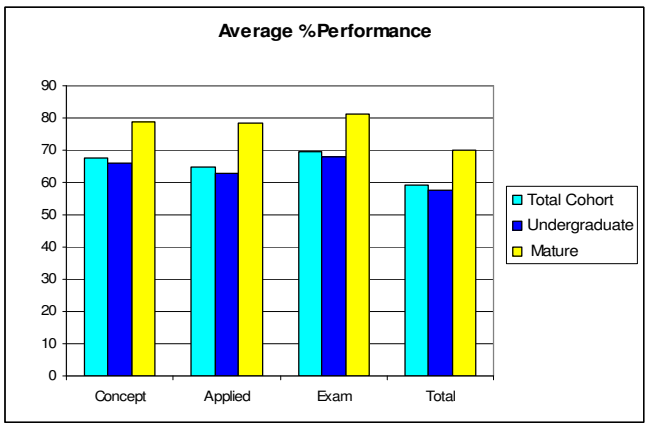

Figure 3 – Average Cohort Groups' Scores

Due to the number of existing variables within the student cohort it was essential to analyse the significance of these variables against the results of the assessment procedures. The main

variables within applying to this study were student type (Mature/Undergraduate), the students' educational background at second level (Academic/Vocational) and the dichotomous learning styles. T-tests were used to test for significance between the cohort variables and the students' assessment scores. The results are presented in Table 4 below.

Table 4 – Significance Tests

	Conceptual Design Task	Applied Design Task	Exam	Total
Student Type	**0.012**	**0.003**	**0.005**	**0.0002**
Ed. Background	0.245	0.727	0.109	0.209
Active/Reflective	0.905	0.709	0.950	0.757
Sensing/Intuitive	0.593	0.937	0.360	0.569
Visual/Verbal	0.125	0.414	0.445	0.791
Sequential/Global	0.534	0.085	0.332	0.106

Note: For t-tests, a value <0.05 is deemed significant. Significant findings are in bold text format.

Discussion:

As with any multi-faceted study, difficulty arises when trying to create a generic model from results gained that can be looked upon as a reliable framework to achieve required outcomes. This difficulty is multiplied by numerous factors when dealing with a cohort of idiosyncratic students, as was the case with this study. However, by using globally recognised techniques to recognise and categorise the differing tendencies of students, one can start to form an understanding of how they react to different learning/teaching mediums. This was also reinforced in this study, by the fact that the author of this paper had a large amount of contact time with the student cohort for the duration of the study.

The quantitative research methods used, such as the Index of Learning Styles Questionnaire and the assessment procedures of the relevant module were reinforced by qualitative research methods such as one to one and group interviews, whether they were carried out on a formal or informal basis. These research methods led to the author creating a strong feeling of how students were reacting and performing to the pedagogies that were being introduced to the undergraduate teacher training program for the first time.

The aim of these research methods were to ensure that the pedagogies being implemented were having a positive effect on the students' awareness of how they should be approaching the teaching profession they have chosen to pursue. Also being considered was that the course being offered was achieving the learning outcomes that are outlined as being paramount in the field of work that they will enter as graduates

Many interesting and thought provoking results emerged from the methodology, including the dominance of mature students in a course designed for students who have recently achieved in the academic exam driven assessment procedures of the Irish second level system. One must ask, what is it that these mature students, who have been out of the education system for up to ten years, have experienced that leads to them surpassing their undergraduate classmates on all aspects of the module assessment procedures. Initially, one may think that their dedication and maturity must be the determining factor, however through observations at the lab sessions and through group interviews, it is clearly noticeable how they approach problems with a different mentality. They think much more conceptually due to their life experiences, and it is

these experiences that we must consider and recognise as valuable for our undergraduates to become more at par with their mature counterparts.

In a previous study of the same cohort, the mature group only outperformed the undergraduate group in the formal exam assessment. However, in the follow on module that this study is concerned with, the mature group have readjusted themselves to the education system and have, on average, performed significantly better in all aspects of the module. It must be noted that not all undergraduate students are being out performed by the mature percentage of the cohort. A small percentage of the undergraduate cohort has exceeded the mature group at design tasks and also academic exam assessments. This suggests that there are undergraduate students with the right mentality and awareness to succeed at these core module tasks. Have these students acquired the skills and mentality that their mature associates obtained through life experiences through their second level learning experiences? Can we recognise what these skills are and more importantly can we teach these skills to our students?

Conclusion:

The study that this paper was concerned with took place over a thirteen week process technology module during the second semester of the cohorts first year. The study acted as a follow on to a previous study which took place during their first semester. The findings from the study suggest that the framework being employed is increasing the students' awareness and appreciation for their subject area in comparison to a framework that was implemented for the twenty years previous to September 2005 when the new course was launched for the first time.

However the main significant findings were that the mature student group accomplished greater average grades than their undergraduate classmates. Through group discussions, interviews and lab observations it was noted how mature students demonstrated the greater ability to think creatively and effectively problem-solve at a higher level than undergraduates.

The considerations for the University of Limerick, as the sole provider of Technology Teachers in the Republic of Ireland is to ensure that relevant teaching strategies are continued to be used so that student teachers can become aware of the mind shift that is taking place and adapt their learning styles to succeed at a higher level in a conceptual age.

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