TEACHING & LEARNING STYLES IN ENGINEERING AT UCC

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ABSTRACT

This paper investigates the learning styles of Process & Chemical Engineering students at University College Cork as well as the teaching styles of Engineering Faculty staff at the university and compares the two to see how well they map onto each other. This is done primarily by means of a widely used learning styles model proposed by Felder [1]. The results show that the two do not seem to map onto each other as well as they could, a finding which is largely in agreement Felder's hypothesis.

INTRODUCTION

The aim of this study was to ascertain what if any pedagogy or learning style applies to a group of Engineering students in the context of ongoing work being carried out by Shulman and others on pedagogies of the professions at the Carnegie Foundation for the Advancement of Teaching on signature pedagogies in the professions [2]. This led to Felder's seminal paper from 1988 which strove to define both teaching and learning styles that pervade to engineering disciplines [1].

Felder described a model for student learning comprising five learning style dimensions. Each dimension consists of two polar opposites. These are defined in turn as sensory versus intuitive, visual versus verbal, active versus reflective, sequential versus global and inductive versus deductive. Students' learning styles fall between each polar opposite. Felder subsequently dropped the last dimension on the basis that the 'best' learning (and hence teaching) style was inductive since it is the natural way that we learn from birth. The five dimensions and accompanying various learning styles in Felder's model are described in Table 1.

Felder suggested that most engineering students are visual, sensory, inductive and active learners (while some of the most creative students are global learners) while most engineering education is verbal, intuitive (abstract), deductive, passive and sequential.

This paper sets out to test this hypothesis among UCC engineering students and staff. Felder provides some metrics to ascertain the learning styles of students through the associated 'Index of Learning Styles' (ILS), an online survey initially developed in 1991 [4]. In order to ascertain teaching styles among UCC engineering faculty the author developed and administered a teaching styles survey. Results from the two tests were compared to help determine if teaching and learning styles are 'matched' at UCC.

RESOURCES AND METHODS

All Engineering Faculty were emailed (32 members) and asked to fill in the teaching styles survey (Table 2). All students of the BE in Process & Chemical Engineering (just over 100) were also emailed and asked to complete the ILS online and to email back their results. 15 replies were received from Faculty and 38 responses from students.

Learning style	Type of learner	Learning style	Type of learner
Active	Processes information through engagement in physical activity or discussion	**Reflective**	Processes information through introspection
Sensory	Sights, sounds, physical sensations: tend to be concrete, practical, methodical, oriented towards facts and hands on procedures	**Intuitive**	Memories, thoughts, insights: tend to be comfortable with abstractions (theories, mathematical models). Innovative and rapid problem solvers
Visual	Info most effectively perceived through pictures, diagrams, flow charts, demonstrations	**Verbal**	Info most effectively perceived through written and spoken explanations
Sequential	Understanding gained through a logical progression of incremental steps	**Global**	Understanding gained in large 'big picture' jumps
Inductive	Learns best through being given facts and observations, from which underlying principles are inferred	**Deductive**	Learns best through given principles from which consequences and applications are deduced

Table 1: Felder's model of learning styles [1, 3]

The Faculty questionnaires were specially designed to see if lecturers taught to aid any given learning style(s). Although each corresponding learning style is indicated beside the teaching activity in table 2, they were not included on the blank questionnaires sent to Faculty.

Faculty were asked two questions:
A. Which of the following teaching styles or pedagogies do you apply in your teaching?
B. In your opinion, how **effective** is this style in terms of **motivating students & enhancing learning**?

Tables 3 & 4 summarise the results in Table 2 by comparing what Faculty deem to be the most effective teaching activity or aid (rank) against what they actually apply in their own teaching (personal pedagogy). The figures in parentheses in the right hand column represent the deviation (difference) between the two; for example, a negative figure here implies that Faculty consider this pedagogy to be one whose effectiveness is not matched by its application. A positive figure on the other hand, may indicate that the pedagogy is applied more than it ought to be relative to its effectiveness in motivating students and enhancing learning.

	A. Pedagogy?			B. Effectiveness?
In your lecture do you…?	**Often (most/all lectures)**	**Some times**	**Seldom or Never**	**1 for most; 5 for least Avge (st.dev.)**
Emphasise principles, theories, mathematical models [Intuitive]	13	2		1.92 (0.90)
Emphasise heuristics, hard data, typical values [Sensory]	7	7	1	2.33 (0.98)
Emphasise practical problem solving methods [Sensory/Active]	10	4	1	1.58 (1.38)
Emphasise fundamental understanding of material [Intuitive/Reflective]	14	1		1.67 (0.78)
Emphasise the applied nature of the material by providing concrete examples of the phenomena the theory describes or predicts [Sensory/Inductive]	8	6	1	1.83 (1.19)
Provide the big picture/context/goal/relevance of a lesson or topic before presenting the steps [Global]	8	7		2.00 (1.28)
Assign some exercises to provide practice in the basic methods being taught [Sensory/Active/Sequential]	3	12		1.75 (0.75)
Pose questions and have students organise themselves into small groups and come up with collective solutions/suggestions [Active]		4	11	2.55 (0.96)
Recap on material just covered to allow students to think about/reflect on what they've been told [Reflective]	4	9	2	2.00 (1.13)
Encourage class participation, comment & feedback [Active]	8	6	1	2.00 (0.85)
Use…				
Verbal description of material [Verbal]	9	2	2	2.36 (1.63)
Typed Handouts with text [Visual]	7	2	6	3.00 (1.50)
Typed Handouts with diagrams, pictures, plots, etc [Visual]	7	5	3	2.50 (1.35)
Prepared overhead acetates with text [Verbal]	1	1	12	3.89 (1.27)
Prepared overhead acetates with diagrams, pictures, plots, etc [Visual]	1	5	8	2.90 (1.52)
Prepared Powerpoint slides with text [Verbal]	4	2	9	3.11 (1.36)
Prepared Powerpoint slides with diagrams, pictures, animations, etc [Visual]	6	3	6	2.40 (0.97)
Overhead acetate (write text) [Verbal]	4	1	10	2.75 (1.67)
Overhead acetate (draw plots, diagrams, etc) [Visual]	5	2	8	2.19 (1.36)
Blackboard/whiteboard/greenboard (write text) [Verbal]	4	3	6	2.05 (1.07)
Blackboard/whiteboard/greenboard (draw plots, diagrams, etc) [Visual]	6	3	5	1.91 (0.94)
Videos [Visual]		5	10	3.32 (1.15)
Animations [Visual]	1	5	8	2.75 (1.14)
Classroom physical props [Visual]		10	3	2.50 (1.08)
Live demonstrations [Visual]		3	10	2.22 (1.48)

Table 2: UCC Faculty of Engineering Teaching Styles

Rank	Pedagogy	Use
1	Emphasise practical problem solving methods [Sensory/Active]	**3 (-2)**
2	Emphasise fundamental understanding of material [Intuitive/Reflective]	**1 (+1)**
3	Assign some exercises to provide practice in the basic methods being taught [Sensory/Active/Sequential]	**8 (-5)**
4	Emphasise the applied nature of the material by providing concrete examples of the phenomena the theory describes or predicts [Sensory/Inductive]	**5 (-1)**
5	Emphasise principles, theories, mathematical models [Intuitive]	**2 (+3)**
6	Recap on material just covered to allow students to think about/reflect on what they've been told [Reflective]	**9 (-3)**
6	Provide the big picture/context/goal/relevance of a lesson or topic before presenting the steps [Global]	**4 (+2)**
6	Encourage class participation, comment & feedback [Active]	**5 (+1)**
9	Emphasise heuristics, hard data, typical values [Sensory]	**7 (+2)**
10	Pose questions and have students organise themselves into small groups and come up with collective solutions/suggestions[Active]	**10 (-)**

Table 3: Lecturing styles of UCC Engineering Faculty

Rank	Teaching Aid	Use
1	Blackboard/whiteboard/greenboard (draw plots, diagrams, etc) [Visual]	**4 (-3)**
2	Blackboard/whiteboard/greenboard (write text) [Verbal]	**7 (-5)**
3	Overhead acetate (draw plots, diagrams, etc) [Visual]	**6 (-3)**
4	Live demonstrations [Visual]	**15 (-11)**
5	Verbal description of material [Verbal]	**1 (+4)**
6	Prepared Powerpoint slides with diagrams, pictures, animations, etc [Visual]	**4 (+2)**
7	Classroom physical props [Visual]	**10 (-3)**
7	Typed Handouts with diagrams, pictures, plots, etc [Visual]	**2 (+5)**
9	Overhead acetate (write text) [Verbal]	**9 (-)**
9	Animations [Visual]	**11 (-2)**
11	Prepared overhead acetates with diagrams, pictures, plots, etc [Visual]	**11 (-)**
12	Typed Handouts with text [Visual]	**3 (+9)**
13	Prepared Powerpoint slides with text [Verbal]	**8 (+5)**
14	Videos [Visual]	**13 (+1)**
15	Prepared overhead acetates with text [Verbal]	**14 (+1)**

Table 4: Verbal and visual teaching aids employed by UCC Engineering Faculty

Table 5 sums the figures in parentheses in Tables 3 & 4 under each of the associated learning style characteristics. For any given dimension (e.g. active vs. reflective) the style that has the lower (i.e. more negative) sum value can be construed as the style which UCC Engineering Faculty feel they could adapt more for better student motivation and learning. The other style is the one which they perhaps they feel they use a little too often. It can be seen therefore that Faculty feel that if they were to modify their teaching styles that 'in an ideal world' it would behove them to adopt a style which would be more active, sensory, visual and sequential than they do at present. This would therefore tend to confirm Felder's hypothesis among UCC Engineering Faculty, at least in terms of self perception if not in reality.

		Sum	**Sum**		
Active	-2-5+1+0	-6	-2	+1-3	**Reflective**
Sensory	-2-5-1+2	-6	+4	+1+3	**Intuitive**
Visual	-3-3-11+2-3+5-2+0+9+1	-5	+5	-5+4+0+5+1	**Verbal**
Sequential	-5	-5	+2	+2	**Global**

Table 5: Summation of teaching styles (from tables 3 & 4)

LEARNING STYLES OF ENGINEERS

If UCC Engineering Faculty feel that their teaching style is a little more reflective, intuitive and verbal than it might be, does it follow that most of their students are active, sensory and visual learners as Felder and many other published studies would have us believe [3]?

The cumulative results from the ILS for 38 Process & Chemical Engineering students are presented in Figures 1-4. Having completed the survey, each learner is assigned a point on the scale from –11 to +11 for a given dimension. For example a learner who is an extremely visual learner might come in at –11 on the visual-verbal line (Figure 3), whereas a learner who is only marginally visual would score –1. In each case the hatched bar represents the point on the scale that the author scored (not included in among the 38 student learners). The point on the scale which represents the overall average of all 38 learners (with standard deviation) is presented on each plot as is the percentage of learners which are predominantly one type or another.

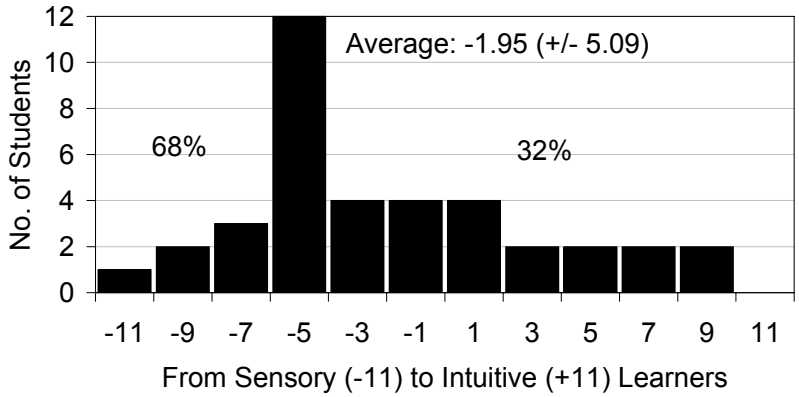

Figure 1: Active versus reflective learners at UCC (Process & Chemical Engineering)

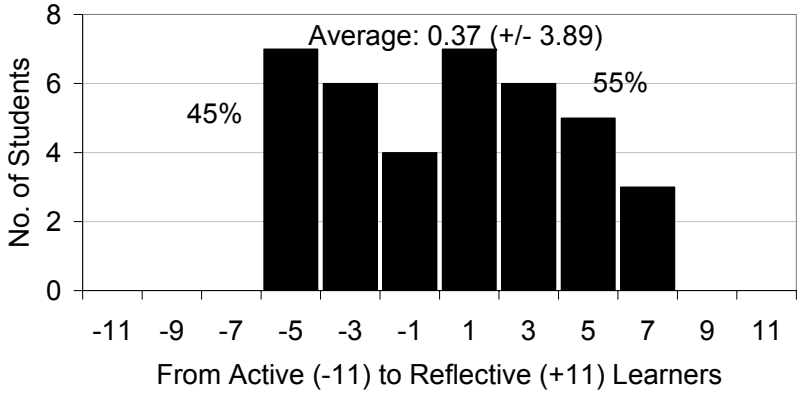

Figure 2: Sensory versus intuitive learners at UCC (Process & Chemical Engineering)

UCC Process & Chemical Engineering students are a broad bunch. They are certainly generally very visual learners as well as being mainly sequential and sensory. They also lean a little more towards reflective than active. Hence Faculty have good reason to believe that they might be well advised to develop visual and sensory teaching pedagogies. The sample of students who replied did not appear to require a great deal of active teaching however.

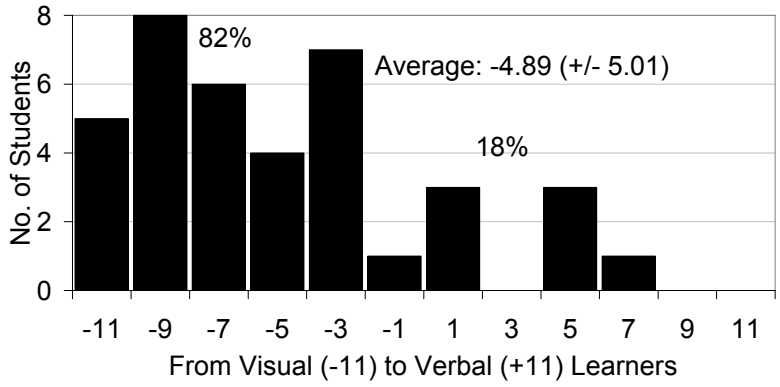

Figure 3: Visual versus verbal learners at UCC (Process & Chemical Engineering)

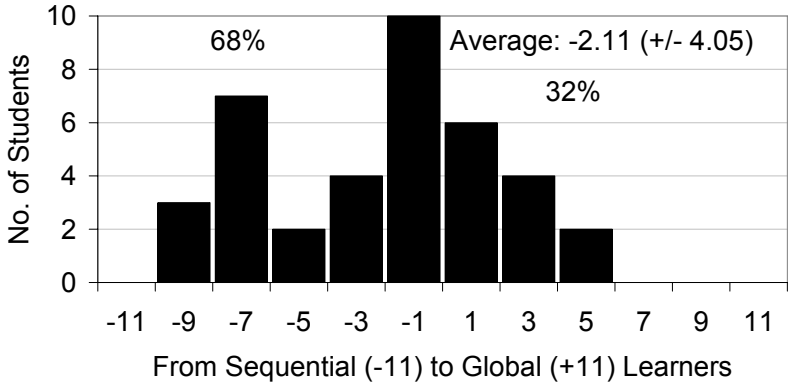

Figure 4: Sequential versus global learners at UCC (Process & Chemical Engineering)

CONCLUSIONS

Felder has suggested that more engineering students are visual, sensory, active (and in many cases global) learners while engineering teaching styles tend to emphasise the opposite styles. A survey or UCC engineering students and staff found students were indeed visual and broadly sensory and sequential learners. However, most were also found to be reflective learners. Moreover, UCC Engineering Faculty felt that their teaching styles could veer towards active, sensory, visual and sequential if they were to better motivate students and enhance learning. Perhaps the most striking feature of the results among learners is the non-homogeneity of the group; all learners are different. However, that is not to say that teachers should despair in attempting to adopt a style or styles to suit as many as possible; by applying a range of teaching techniques the lecturer can reach all types of lecturers, if not in every single lecture or session, then throughout the module.

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