Learning and thinking styles: A Tool for engaging engineering students with their studies.

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ABSTRACT

This paper presents the results of a pilot study conducted with second and third year undergraduate students. The study was established to see if a learning styles assessment could be used to assist lecturing staff in engaging students in their own learning as well as a tool to enhance group work. Group work is widely used within engineering programmes to develop team building and leadership skills. Selection of groups is often by random or self-selection rather than by a specific beneficial method chosen to enhance the student's development and learning experience. Student feedback suggests some students are concerned about the benefit and assessment of group work.
An initial evaluation of the student learning style was carried out using a standard questionnaire. On the basis of the results the students were given an option of selecting their own working group or being selected on the basis of balancing and appreciating the individual learning style of their peers.
Equal numbers chose to self-select as were willing to participate in the selection process and the whole pilot is analysed in terms of the performance of the students on the module. The similarity in learning style response from all the engineering students that participated in this pilot scheme led the authors to reflect over the dependence demonstrated by the undergraduate engineering students. Students choosing to participate in the allocated groups performed at a higher level that the students who self selected which is consistent with the findings of other researchers. The awareness of staff and student's was raised by participating in this pilot study and the conclusion that a more selective learning style questionnaire was needed to develop a model for group selection is discussed.

1. BACKGROUND

Education literature suggests that students who are actively engaged in the learning process will be more likely to achieve success (1). Engaging students in their own learning process leads to an increased awareness of their individual differences, allows them to take greater responsibility for the process and enables lecturing staff to become facilitators (2). The gap between this theory, which all teaching staff would support as the way forward, and the practice is large in current Engineering Education in the UK. Some of the reasons for this lay in the very diverse backgrounds of students who enrol on engineering degree courses. Many have studied the necessary pre-requisite programmes but some have not and traditional methods of delivery in which abstract concepts are introduced with problems set at the end of the lecture course are not adequate. Group work is widely used on such programmes as a means of supporting skill development but groups are often selected by random methods or self-selection rather than by specific beneficial method chosen to enhance the student's development and learning experience.

Alternative pedagogical techniques have repeatedly been shown to be more effective and likely to lead to a deeper more permanent learning . One such method is problem-based learning (PBL) in which the problem is posed before the students have acquired the knowledge to solve it (3). The student begins with the problem, figures out what they need to know, create the hypotheses, reviews the literature, talks to experts, models, and experiments and finally solves the problem. After the problem is set there are various methods used to facilitate the students learning from lecturing, seminars and group work in which the students skills to monitor and self assess their work are also developed. Evaluation of such programmes shows that participants exhibit a greater tendency to adopt a deep approach to learning, a greater mastery of interpersonal skills and greater satisfaction with the learning experience however a good level of confidence and background skill is required. There is also a large amount of group work on such programmes in order to develop individual and team working skills and provide opportunities for the students to fully engage with the abstract concepts in concrete ways. A key to getting and keeping students actively involved in learning lies in understanding learning style preferences, which can positively or negatively influence a student's performance (4). It has also been shown that adjusting teaching materials to meet the variety of learning styles benefits all students and can increasingly affect retention rates (5). Dropout rates are a considerable problem within the technological disciplines as students fail to engage fully with the abstract and numerical nature of the material. In engineering departments there is a diverse range of backgrounds and entry qualifications and in some sections teaching delivery is very traditional. As a result of this variance, educational academics point to the need for staff to be aware of the learning styles of the students and themselves in order to be able to develop suitable teaching
materials (6).

A considerable number of people have tried to catalogue learning styles of which Kolb is one of the best known. It is a relative simple model based on four main styles:

- Concrete experience; the student wants to be actively involved in a new experience.
- Reflective observation; the student watches others or collects and analysis data.
- Abstract conceptualisation; the student creates theories to explain observations.
- Active experimentation; the student uses theories to solve problem and make decisions in practice.

These styles can be assessed in a straightforward manner by a questionnaire (7), in which the Activist, Reflector, Theorist and Pragmatic styles of learning typify these four basic types. An assessment of the learning styles of the engineering students should enable appropriate teaching methods to be selected. Recent work (2) took Kolb's learning style and gave examples of how one might teach to each of them in order to optimise the student experience. Suggestions for them included:

- Activist – offer laboratories, filed work observations or video's
- Reflector – offer logs, journals and brainstorming
- Theorist – offer lectures, papers and analogies
- Pragmatist – offer case studies, simulations and planning tasks.

Most students enter University as dependent learners relying on the lecturers to present and interpret the information. A model was developed to explain the transition to independence (8). In terms of engineering students enter as reflective learners wishing to watch and be told how to increase and apply knowledge. In contrast professional engineers and lecturers tend to

demonstrate much more pragmatic and theoretical styles of learning. During the time at University a student should gradually make the transition between these different approaches. The lecturer's job is to assist in this development of the individual. Working with others is crucial and helps students to recognise their own learning styles, strengths and weaknesses and to take advantage of the synergy that comes from working with people from a diverse range of backgrounds. As lecturers are aim them in becoming independent learners and developing a reliance on their own ability rather then acquiring information from others.
This pilot study was to explore the possibility of using a learning styles questionnaire as a means of encouraging students to engage with their own learning and take responsibility for it. The benefits of such a study were seen to be to.

- Develop better methods of selecting teams and groups of students to work together
- Demonstrate to students the advantages of appreciating their own learning styles and the individual differences of peers
- Demonstrate to staff the advantages of appreciating the learning styles of students to assist them in facilitating and identifying the most appropriate teaching methods to help student learning.

2. THE PILOT STUDY

2.1 Learning styles questionnaire analysis

Learning style questionnaires (7) were given to two separate groups of undergraduate engineering students (twenty-four second year and nine third year students). The results of this first stage of the study are shown in Figures 1 and 2.

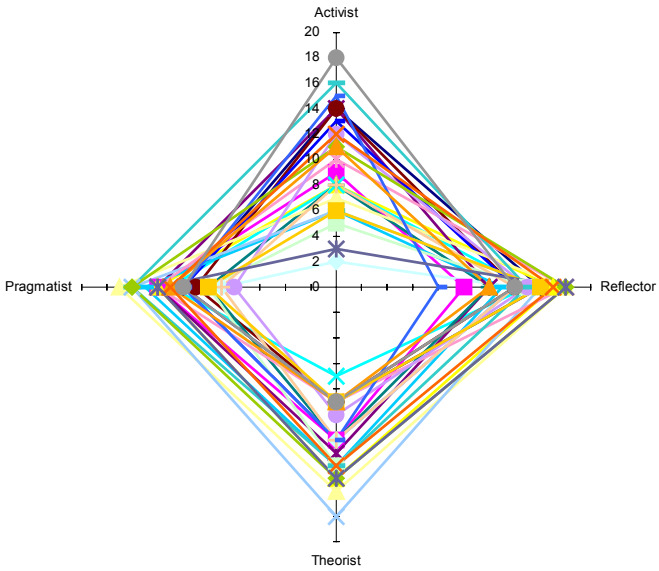

FIGURE 1 Learning style results for the second year engineering students

The majority of students participating in the pilot scheme showed a broadly similar learning style response; their highest scores being reflective in nature and lowest scores that of activists. The pragmatic and theorist responses were identical within the standard deviation of the study. This method appeared to make no distinction between students by level.

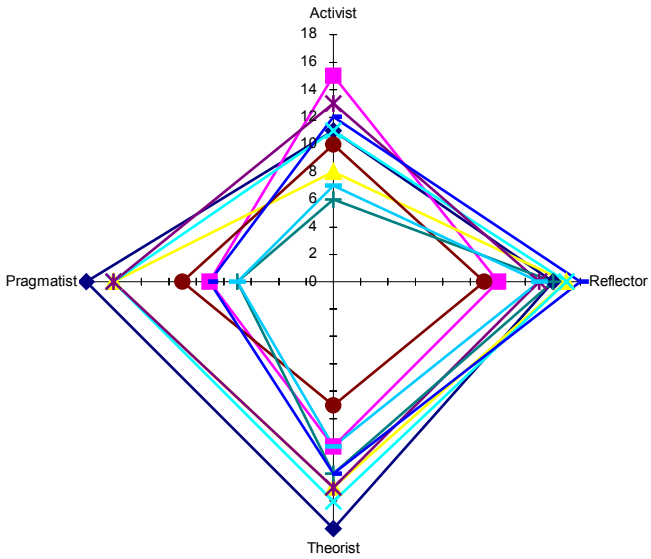

FIGURE 2 Learning style results for the third year engineering students

Student group	Reflector Average	- Deviation	Pragmatist Average	- Deviation	Theorist Average	- Deviation	Activist Average	- Deviation
Year 2	14.6	2	12.8	2.1	12.3	2.2	9.8	3.5
Year 3	15.1	1.9	11.4	3.5	13.4	1.8	10.3	3.1

TABLE 1 Average and standard deviations for the undergraduate engineers learning style scores

2.2 Group selection by learning style

The second year UK students were given an option on being allocated into groups on the basis of balancing the learning styles within the group or self-selecting. Equal numbers of students elected for each method. The pilot was then conducted with a set of selected groups and a control group. The aim of the selection process was to produce groups with a balanced group learning style. There were no major differences in the learning styles of the group and subtle variations were used to combine the students.

Figure 4 gives a typical illustration of the way in which students was combined by an appraisal of their different learning style scores.

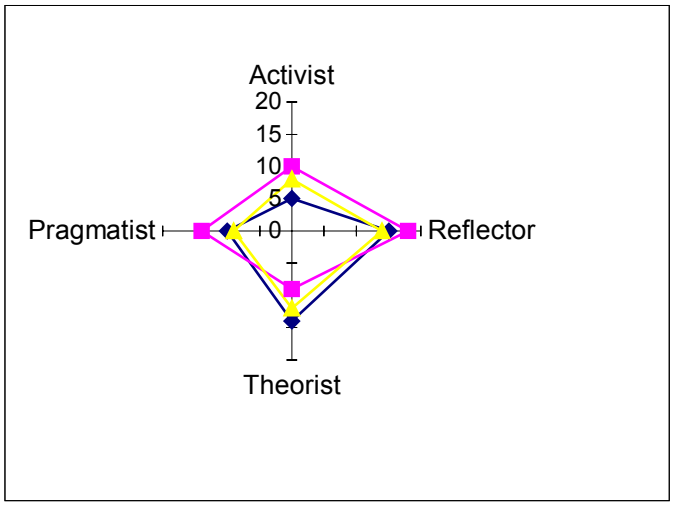

FIGURE 3 Typical example of the combining of students with different learning styles

The selected and self-selecting groups were re-examined in terms of their average learning style scores and these results are given in Table 2. All students show a dominant reflector style followed closely by pragmatic and theorist tendencies with the lowest scores again being that of activists. It is interesting to note the balance of styles within the groups have not changed significantly, as a comparison with the original averages in Table 1 indicates.

Group	Selected Reflector	Selected Pragmatic	Selected Theorist	Selected Activist	Self Selected Reflector	Self Selected Pragmatic	Self Selected Theorist	Self Selected Activist
Average	14.3	13.0	13.2	9.6	14.3	12.3	12	10.1
Deviation	2.3	2.6	2.0	2.9	1.8	1.6	2	3.4

TABLE 2 Learning style scores of the selected and self selected groups of second year students

2.3 Performance of the groups

One of the aims of this pilot was to use the learning style questionnaire to engage the students with their personal development, their team working skills and hence to see if this assisted them with learning demonstrated by achieving good marks. The students' performance on both formative and summative group assignments has been listed in Table 3.

Group	**Basis of selection**	**Formative**	**Summative**	**Outcome on the module**
1	Learning Style	**A+**	**75**	All individuals 1st or 2(1) on module

2	Learning Style	**A**	**72**	Mixed group 1st, 2(1), 2 (2)
3	Learning Style	**B+**	**65**	Mixed group 1st, 2(1), 2 (2)
4	Learning Style	**B**	**70**	All low 2 (1)
5	Self-selection	**C**	**65**	All individuals 1st or 2(1) on module
6	Self-selection	**None**	**55**	Mixed group 1st, 2 (2), 3
7	Self-selection	**E**	**45**	Mixed group 2 (2), 3
8	Self-selection	**F**	**50**	Mixed group 2 (2), 3

TABLE 3 Comparison of the learning style selection and performance of the students

The students who engaged most fully with the learning styles questionnaire performed most effectively on the module. Group 5 students, although self-selecting, performed well gaining an upper second for the task and a first or second-class mark on the module as a whole. The remaining self-selecting students did not perform well on the group task and overall achieved borderline performances on the module.

3. DISCUSSION

This pilot study was to explore the use of learning styles questionnaires as a means of encouraging the students to engage more fully with their own learning and to take responsibility for it. The results of this first stage, completion of the questionnaire and analysis, are shown in Figures 1, 2, and Table 1. These indicate that the level 2 and 3 engineering students on the pilot scheme have an almost identical balance of learning styles. On initially looking at the data it appears well spread. However these are just variants in the score and do not effect the overall learning styles, which are so similar. Most students demonstrated a strong reflective style and were least likely to have an activist style. Given the diverse backgrounds of the participants it had been expected, as many researchers have found (9), that there would have been greater differences in the individual learning styles both within the same year group and other years. The fact that all students showed such a significant reflective learning style is understandable for a strongly vocational subject such as engineering in which the students are initially very dependent on their lecturer (8). The fact that the scores of the final year students are still exhibiting such reflective learning styles is cause for concern. It had been expected that the final year students would have exhibited more pragmatic and theorist tendencies typical of more independent learner and professional engineers. Certainly there was no clear distinction that could have been made between these students in terms of level of study.

In the second stage, allocation of students into groups was achieved by matching students with lower scores in the same category with students with higher scores as illustrated in Figure 3. This produced four groups with optimised learning styles. As a result of the general similarity in style of all students the four non-selected groups had almost identical average scores as shown in Table 2. The only slight variant is the higher value and wider variance of the self selected groups' activist scores. This presence may have had a negative effect on

these groups if some of the students preferred non-interactive exercises (10). Clearly shown in Table 3 is how well the students who completed the learning styles questionnaire and opted for group selection on that basis actually did on both the group exercise and the module in comparison to the others. How far this is due to the use of the questionnaires to interest them and encourage them to participate and whether they would have achieved identical performances without this approach cannot be stated and more research needs to be conducted.

4. CONCLUSIONS

- A learning style questionnaire has been used to encourage and engage students with their learning.
- Students who fully participated in the pilot obtained the best academic results, although more research is needed to establish the reasons.
- Students enjoyed evaluating their learning styles but the differences between the engineering students were small and appeared not to be dependent on level of study.
- Staff were concerned that all engineering students showed such a dominant reflective style and new methods to explore greater independence needed to be explored.

5. FURTHER RESEARCH

More research is required into the relationship between learning and teaching styles. This initial information on learning styles and student performance is useful but alternatives such as thinking styles may be more useful to engineers as a method of selecting groups and building teams. In addition more information on the learning and thinking styles of staff who are teaching on the programmes and the development of teaching materials that engage and motivate students to become independent learners.

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