A study of project group formation and learning style preferences

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Abstract

An ongoing survey of the learning style preferences of the student intake in the School of Mechanical and Aerospace Engineering at the Queen's University of Belfast has shown profiles which are different and characteristic of the three undergraduate degree programs offered; namely Mechanical Engineering, Aerospace Engineering and the recently started (2004) Product Design and Development degrees. A significantly large number of newly enrolled students are dominated by a preference for practical, hands-on learning while many also have avoidance tendencies for learning that requires precise data collection, manipulation and presentation. There are students who are most comfortable when given a clear set of step by step instructions and others who feel out of their comfort zone when asked to generate original ideas or concepts.

In accordance with the CDIO methodology, syllabus and standards the School aspires to produce graduates who are professionally competent in all phases of the development of a product or system. This requires that students develop learning strategies which enable them to effectively and comfortably use a combination of learning styles most appropriate to the task at hand. Introductory courses in the first year of all three degree programs include a number of design build test (DBT) group projects of several weeks duration. These projects are structured to provide learning opportunities in the four CDIO phases and encourage development of the skills valued by employers. There is a challenge however in ensuring that all students in a group avail of the opportunity for personal development across the full spectrum of learning styles that will best prepare them for professional practice.

It is suggested that a number of factors influence student learning in this context which include the intended learning outcomes, assessment methods and the combination of learning style preferences found within the members of the group. With an objective of improving the effectiveness of the learning experience for all group members an investigation was undertaken to monitor the operation of such projects. Project groups among the three cohorts were formed with equal numbers by random and deliberate selection. Where group selection was controlled a variety of balanced and unbalanced learning styles combinations were

constructed. Data on the student experience was gathered through tutor observation records, peer assessment spreadsheets, individual reflective critiques and student questionnaires.

Results suggest that the makeup of the group in terms of learning style preferences is suggestive of how the team will operate and that knowledge of this by students and tutors can be useful in improving the learning experience both during the project and as a reflective process.

Keywords

Learning styles, learning strategies, project group formation, personal development planning, independent learning

Introduction

The four stages of the experiential learning cycle defined by Kolb [1] led him to propose that students have a dominant phase in which they prefer to learn. He subsequently developed a Learning Style Inventory (LSI) to identify how these preferences might vary across a group of students. Knowing how students prefer to learn, Kolb's objective was to individualize instruction to produce students competent in all four of these learning styles, who would be balanced and integrated learners. Kolb's and other methods of measuring learning style preferences have become popular and are widely used but are not accepted by all as being either accurate or robust. Reynolds [2] for instance highlighted that Kolb's model had received much criticism in the psychology literature and that there was a danger of students being stereotyped and locked into thinking that their learning styles were both innate and fixed. In a study of thirteen different models Coffield *et al* [3] found fault with many, little evidence of benefit and exaggerated claims from many practitioners selling services in this field. Others such as Sadler-Smith [4] identified a distinct difference between learning styles and learning strategies which defines how a different approach to learning can be applied according to context. Another school of thought describes the concepts of surface and deep approaches to learning [5] which are driven by students' intentions and motivations and the strategic learner [6] who seeks merely to maximize grades. Significantly this model allows for a flexible approach to learning strategy which Gibbs [7] suggested could be developed and improved by changing the context for learning and the methods of assessment.

The approach of the work described here seeks to use the measurement of learning style preferences to first identify and understand the position of individual students on entry to higher education. Student effectiveness in the use of appropriate learning strategies is then developed through awareness of their own preferences and those of their cohort combined with reflection on the operation of design, build and test (DBT) projects. In his attempt to find commonality between learning styles and approaches to learning Cuthbert [8] concluded that reflection upon their own process of learning was required for the student to develop their learning capabilities. Similarly Coffield *et al* [3] concluded that student self-awareness and metacognition facilitated an improvement in how they learnt.

None of the available tools for measuring learning styles is without its critics but the work undertaken seeks not to identify with absolute precision a fixed set of preferences. The tool is used merely to identify individual learning style preferences, not competences or personality traits, and characteristic trends within cohorts. These results are then used to direct course content and assessment and to facilitate a dialogue with the students which enables them to reflect on how they learn and as part of their personal development encourage them to undertake tasks which they might more naturally chose to avoid.

Learning Combination Inventory (LCI)

The Learning Combination Inventory (LCI) tool used throughout this study was devised by Johnston & Dainton [9] at the Rowan University, New Jersey. The LCI has 28 Likert scale (5 point), forced answer, tick box questions which are well matched to the learning objectives of the group based DBT projects and takes 10 to 15 minutes to complete. The questions focus on identifying preference in specific circumstances; for example “I would rather draw or build a model than read or write about the same subject”. Valid responses range from Never (score = 1) to Always (score = 5). The questions relating to the different learning styles are not obvious to the student as they are irregularly mixed throughout the questionnaire and the students are not given prior information about the definitions of the different styles. Totals are calculated using a separate guide sheet which the students do not see beforehand. Preference between four learning styles; Precise, Sequential, Technical & Confluent processor, can be identified by four integer totals between 7 and 35.

Table 1: Interpretation of Learning Combination Inventory Totals (Johnston & Dainton)

LCI Total	**Interpretation**
7 - 17	'I avoid this action tendency wherever possible. This is not really me'
18 - 25	'I use this as needed'
26 - 35	'I strongly favor this action tendency. This is typically me'

A **precise** processor prefers to gather, process and use data and to demonstrate their understanding through the writing of answers and factual reports.

A **sequential** processor prefers clear and explicit instructions. They need to be organised and to have the time necessary to complete tasks to their satisfaction.

A **technical** processor is much less comfortable with writing, preferring hands on practical experiences and problem solving tasks.

A **confluent** processor is creative and imaginative and enjoys finding and making the widest connections between ideas.

It should be noted also that, unlike some other metrics, the LCI focuses on the combination of preferences rather than characterizing or "pigeon holing" the student as a particular type of learner or individual.

Characteristic Cohort Profiles

An ongoing process of measuring the learning style preferences of students in all three degree programs offered by the School of Mechanical and Aerospace Engineering when they first enroll in Stage 1 has been undertaken and data for 3 years has now been collected.

The results from this study have proved consistent over the 3 years and shows that there are significantly large numbers of students dominated by a preference for practical, hands-on learning. Many have avoidance tendencies for learning that requires precise data collection, manipulation and presentation. There is a significant minority of students most comfortable when working to a detailed plan and others who feel out of their comfort zone when required to generate original ideas or concepts. Among the three degree programs characteristic cohort profiles can be identified (Figures 1 thru 3). This is consistent with the notion proposed by Kolb [10] that individuals choose careers congruent with their learning style preferences. The Aerospace and Mechanical Engineering programs for instance have the same entry requirement prerequisites but produce a consistently different LCI profile for the two cohorts.

Each vertical line of each graph in Figures 1 thru 3 has four colored points which represent an individual student's LCI totals. The cohort profiles as plotted here in rank order for each preference enable a better understanding of the cohorts than simple statistical indicators such as average and standard deviation since trends across the body of students are more easily identified. Lines appearing either above or below the body of the data highlight areas of particular concern as they indicate large percentages of the cohorts with either dominance or avoidance tendencies. Such tendencies are undesirable and counter to the objective of producing students with well balanced LCI profiles who are capable of adopting a learning strategy most appropriate to the task at hand. Such "limbs" or "tails" appear consistently for the same preference in the different cohorts and will be discussed below with these areas of particular interest circled by a dotted red line in the corresponding figures.

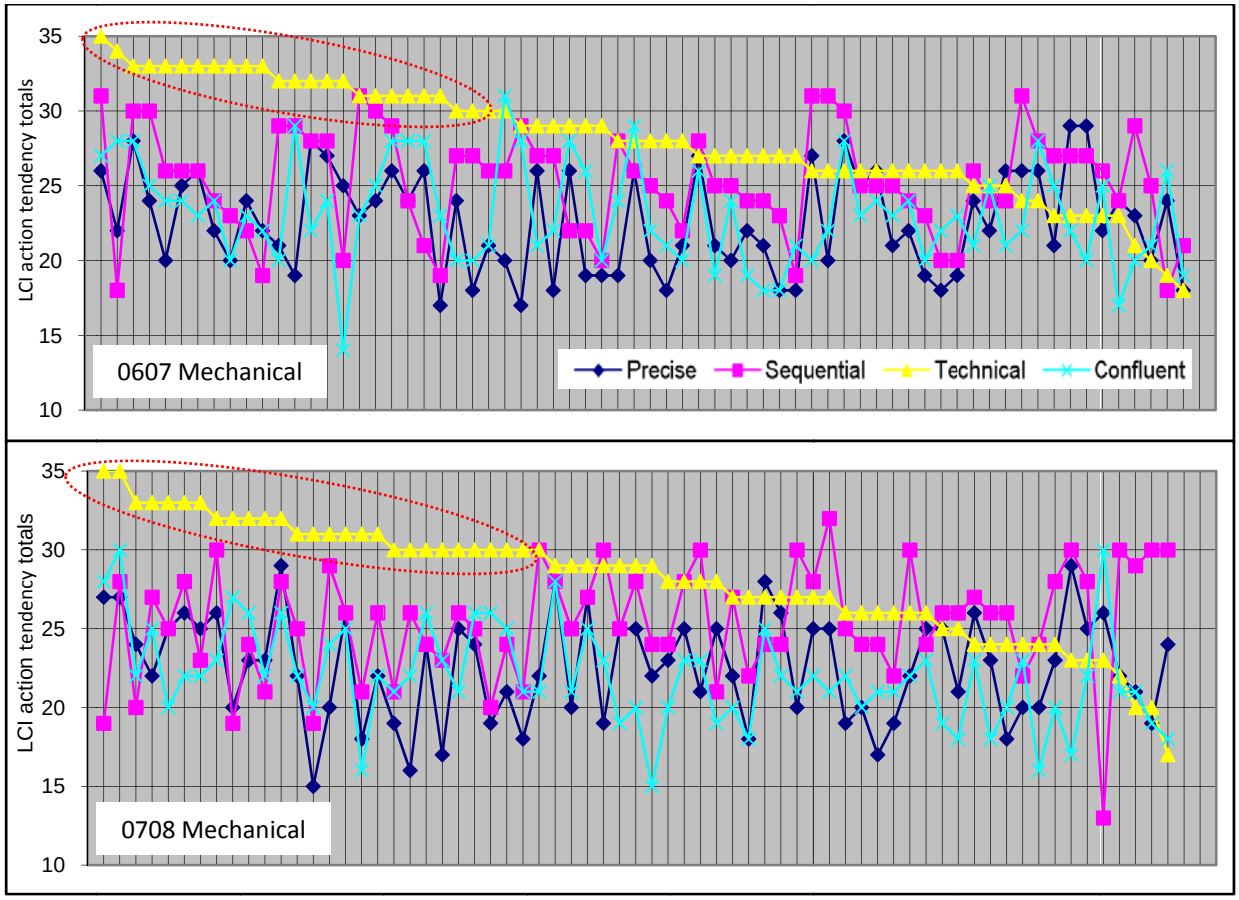

Figure 1 – QUB 0607 & 0708 Mechanical Engineering Stage 1 LCI totals ranked by Technical processing preference

The Mechanical Engineering student group has a large percentage each year who are dominated by a Technical learning style preference. In a DBT project these students may often be identified as the ones who are most eager to get on with building a model or prototype rather than plan or schedule tasks within the project. Without considering LCI totals when forming groups it is quite possible for all members to have this same dominant tendency and for other key roles to be neglected, avoided or carried out with less enthusiasm. The "clear air" between the students with high Technical scores (indicated by the position of the yellow line to the top left of the graphs in Figure 1) and the other scores in their individual combinations suggests that this tendency will have a strong influence on how these students will approach any task.

Many of the Product Design and Development students favor the Precise processing style least and almost none has this as their most favored learning style (Figure 2). For this group of students this is the area which requires most improvement to move the "tail" up to lie more in the zone of "use as required" (LCI total of 18 to 25). Like the Mechanical Engineering students there is a significant percentage with a Technical dominance.

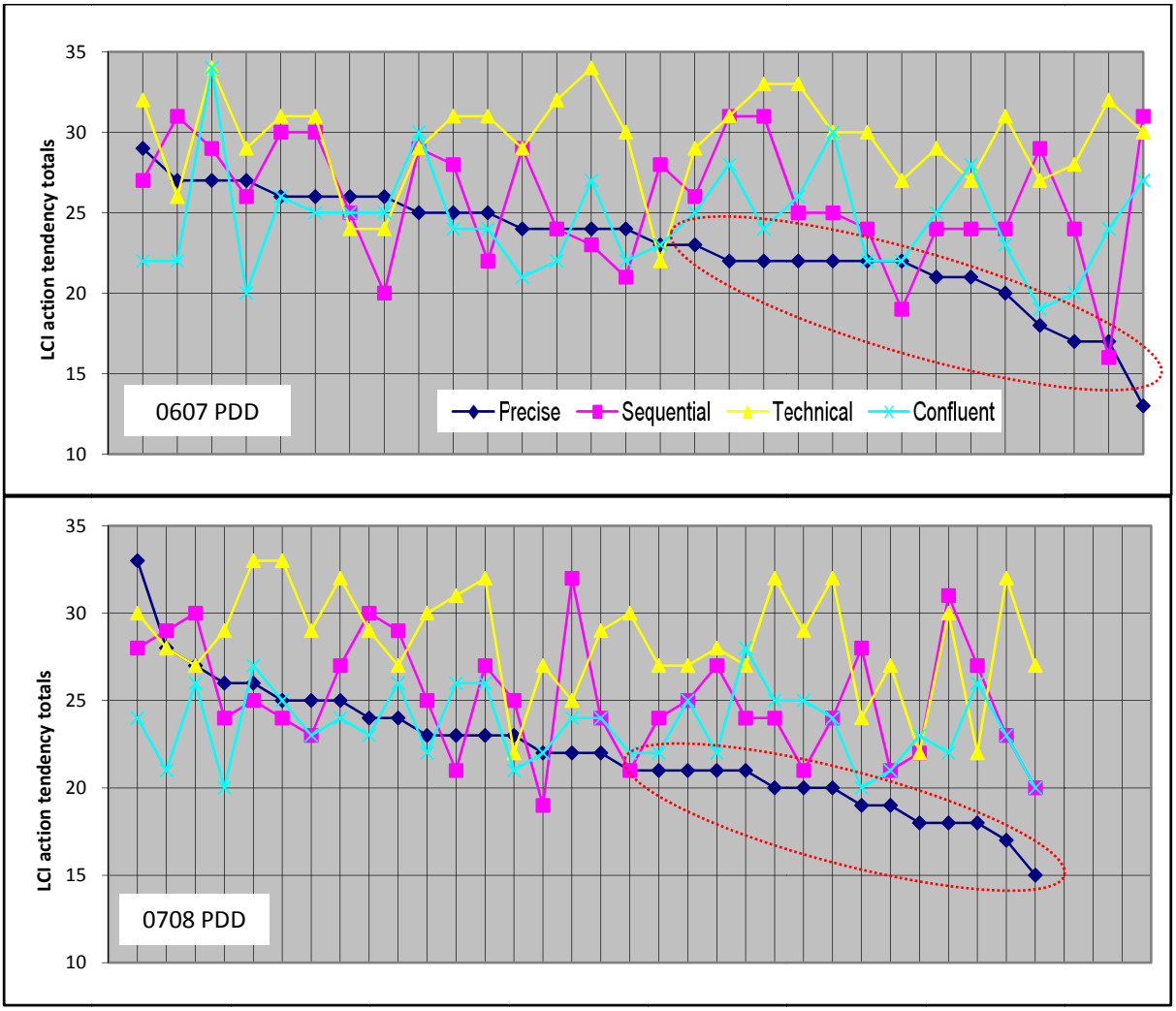

Figure 2 – 0607 & 0708 PDD Stage 1 LCI totals ranked by Precise processing preference

For the Aerospace Engineering cohorts it can be seen (Figure 3) that a Confluent processing style is the least popular with a significant percentage lying in the "avoidance" zone (LCI total of 17 or less). This suggests that these students will be uncomfortable if asked to conceive new ideas or make broad connections between concepts.

To date these characteristic cohort profiles have been both consistent and significantly different between disciplines. This was not the outcome that had been anticipated when the study was undertaken with an objective of measuring how different the PDD students, with a more diverse academic background, might be compared to the students on the more established degree pathways in the School. In fact the PDD students have proved to be more like the Mechanical students than the Aerospace students are. This is despite the 2 engineering programs having the same prerequisite academic subject requirements and entry grades.

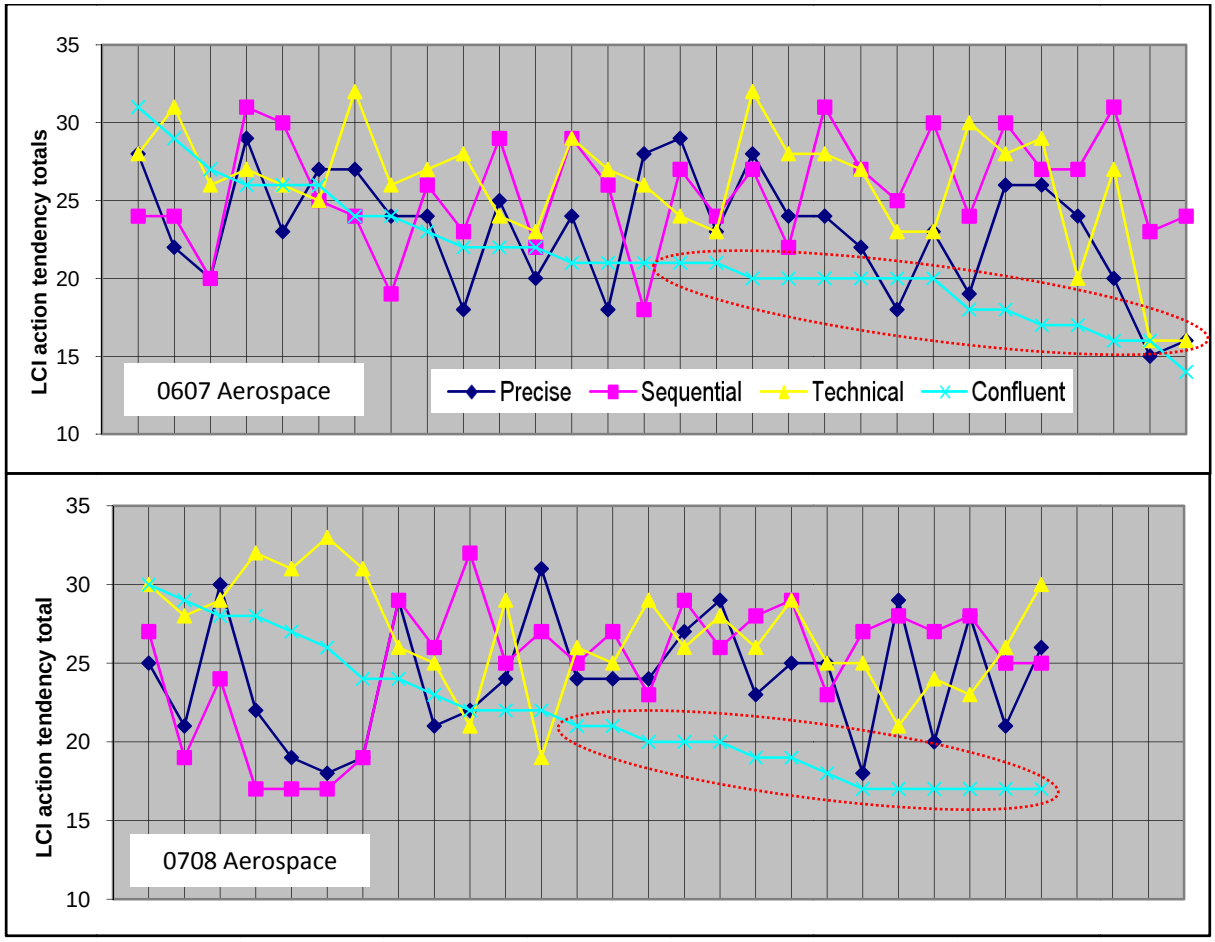

Figure 3 – 0607 & 0708 Aerospace Engineering Stage 1 LCI totals ranked by Precise processing preference

Group Formation

Stage 1 grades on the degree programs in the School of Mechanical and Aerospace Engineering do not contribute to the overall degree classification of students. Introductory modules added to the syllabus as part of the School's policy of making all degrees fully CDIO compliant have a number of important roles to fill in this respect including motivation, raising awareness of the discipline as a professional practice and facilitating the transition to independent learning required of higher education [11]. Associated with this transition is the requirement to develop effective learning strategies. A first step in this is self awareness of learning style preferences. This comes through the LCI questionnaire and subsequent feedback of LCI totals to individuals along with the profiles for their respective cohorts, ranked by each of the learning style preferences as above. The development of individually balanced LCI totals requires opportunities for this to happen which can be designed by careful consideration of tasks and assessment regimes appropriate to the needs of each of the cohorts. For instance in a typical DBT project the generation of a wide range of concepts and ideas which draw from a broad range of stimuli favors the Confluent processing style while the compilation of a project report requires the gathering, sorting and presentation of technical data and results which suits a Precise processing style preference. The building of

prototypes or the production of Computer Aided Design (CAD) models aligns well with a Technical style while the project planning and organisation requires a Sequential processing approach. The proportion of the assessed elements related to these tasks can be altered so that more activity is required in any area where development is desired.

Despite the best intentions of the teacher it is however possible for students working in groups to avoid some tasks which they find difficult, or which do not match their learning preferences. This is compounded by the willingness of students to take on tasks which they feel they are good at or most comfortable undertaking. Surveys of Stage 4 students revealed a strategic approach. In order that the group attains the highest grade it was common practice for individuals to take on the tasks at which they were best so that the team optimized the use of its existing skills. While this may well be accepted as best practice in industry, where the objective is to best utilize the human resources available, it can serve to reinforce a dominant or avoidance tendency in an educational context rather than encourage personal development. A high level of attainment from the group does not necessarily mean that all members have developed in all areas, or even participated in all the tasks linked to the learning outcomes.

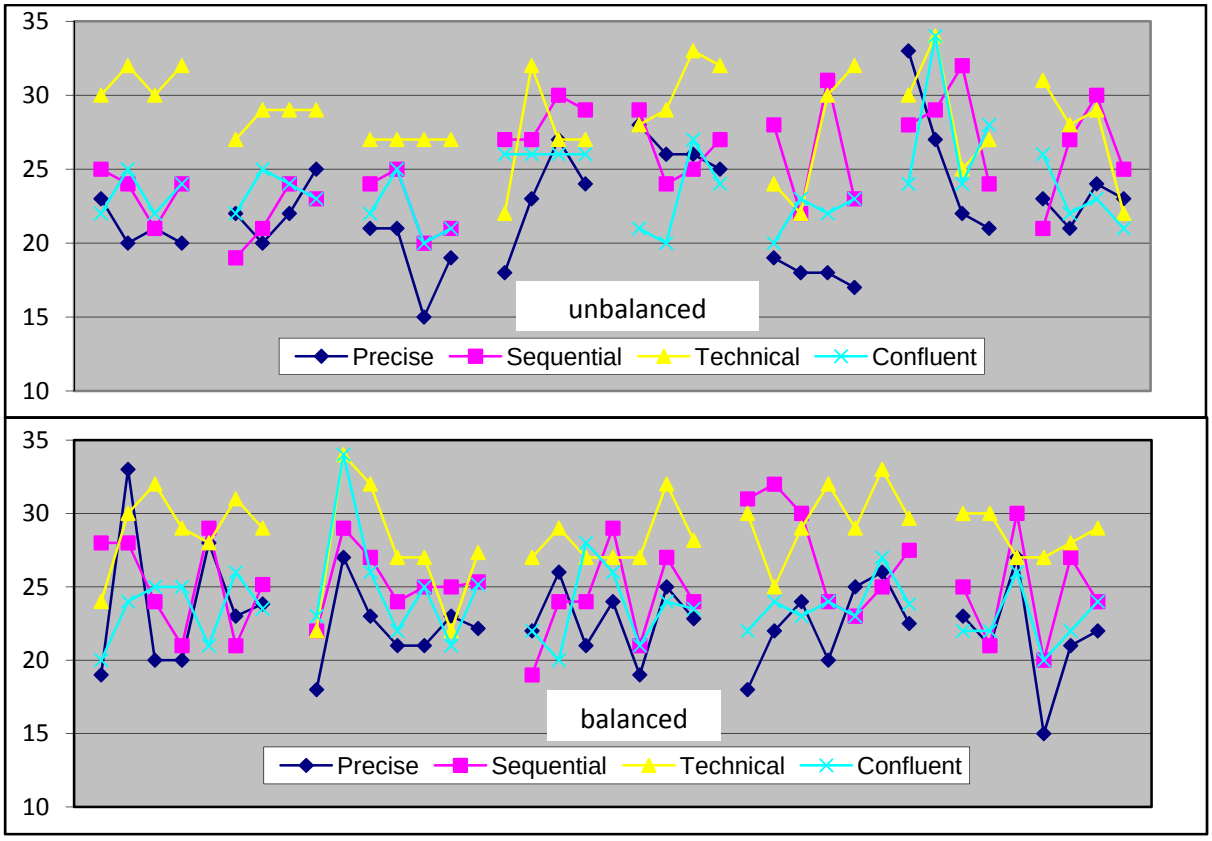

Figure 4 –0708 PDD Stage 1 project groups (unbalanced and balanced LCI totals)

A study of Stage 2 PDD students [12] showed that particularly under time pressure students have "reverted to type" and concentrated their efforts on what they felt best and most comfortable doing, even if care has been taken to construct groups with evenly balanced LCI totals. Since at Stage 1 the students' marks do not have a direct impact on their overall degree the authors felt justified in constructing groups which had deliberately unbalanced LCI

profiles to assess if this had any impact on their learning strategies. Subsequently the same groups of students were rearranged so that there was a more even LCI balance for a later project. Data was gathered by means of reflective questionnaires which asked for specific information on which parts of the project had been enjoyed most and least as well as the amount of time spent on tasks. Comments on the general operation of the group and reflection on what had been learnt were also collected. The results showed that there was no direct correlation between what the students spent time on or enjoyed most and their highest learning style preferences in the unbalanced groups. The balanced groups had fewer comments which contradicted what their learning style preference scores predicted but still showed some anomalies, such as a student with a lowest total in the Confluent style enjoying the concept generation phase of the project most. While statistically insignificant these results might suggest that these Stage 1 students are at least experimenting with developing different learning strategies.

In comparison to the study of Stage 2 students [12] the general comments included many more references to organizational difficulties within the teams which were largely due to lack of commitment and motivation among other members. Encouragingly there were several comments which stated that an awareness of how others liked to approach tasks differently had been gained. For some this awareness however led to frustration as they struggled to adapt to a team working environment, which for most is a new educational experience, and complaints about the poor time keeping and lack of rigor of others were common.

Further Work

On the basis of the evidence gathered it is suggested that learning styles alone are not a sufficient means of creating project groups in which the learning environment for all is optimized. In an attempt to mitigate against undesirable avoidance or approaches dominated by a single learning style preference rewards for peer mentoring have recently been introduced and are listed as learning outcomes aimed at developing leadership and management skills. Additionally peer assessment is used on all group projects from Stage 1 up as a means of validating tutor observations of individual's behavior and conduct during the project. The peer assessment works on a zero mean basis with each student scoring themselves and all other members of the group in each of fifteen categories, which are aligned with the deliverables and learning outcomes of the project. Each category must have a zero mean score and any non zero marks for individuals must be collaborated by supporting comments. Student surveys have revealed that they consider just reward within the marking of group projects important and they have been overwhelmingly in favor of the confidential peer assessment method used. The amount of individual adjustment about the group mean has been the subject of review and currently sits at +/- 25%. This level has been found to both reward those who contribute most and to prevent "freeloaders" within the groups. Another recent introduction has been the use of project blogs. Each group has its own private area in which they can collaborate on ideas and post details of progress on specific tasks. In place of emails this area becomes a central repository for information. Agendas and minutes of

meetings are also posted allowing the tutor to keep track of and advise on the direction of the project outside of face to face design review meetings during timetabled classes. Students are graded on a weekly basis for their contribution to this blog and lack of engagement can be easily identified at an early stage in the project. Early feedback from students has been positive and it is hoped to extend the use and functionality available through these group portals and conduct a study on the resulting impact on group dynamics and communication. Perhaps most importantly reflective critiques are included more often as part of the assessment regime in order that the students are regularly encouraged to reflect on what has just been learnt and also the manner in which it was done.

It is intended to continue with the Stage 1 intake surveys and to start collecting exit data to measure if any change in LCI totals has resulted from completion of the degree programs.

Conclusions

- The LCI tool for measuring learning style preferences has identified cohort profiles which are consistent and characteristic for the 3 degree programs in the School of Mechanical and Aerospace Engineering at Queen's University Belfast.
- Knowledge of the LCI profile of a student cohort can assist in the setting and weighting of tasks and assessment methods to provide an environment which facilitates the personal development of learning strategies.
- In group DBT project students have been observed to both avoid tasks they find difficult or do not enjoy and to volunteer for tasks they find easier or are better aligned with their learning style preferences.
- Learning styles alone do not appear to offer a sufficient mechanism for group formation which guarantees students will avail of the opportunity to develop their learning strategies.

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