First year engineering students' approaches to study

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Abstract Student approaches to learning (SAL) and the levels of understanding they achieve are critically linked and closely related to motivation. This paper reports the results of a study involving first year higher education engineering students using the ASI-32 questionnaire to investigate approaches to study and end of year achievement.

Keywords approaches to study; ASI-32; assessment; SAL framework

The ideas of deep and surface approaches to learning have had significant impact on UK higher education (HE) where the concepts are often referred to as the student approaches to learning (SAL) framework. Currently, the importance of recognising the link between the levels of processing students adopt in the SAL framework and the level of understanding they achieve is considered critical and clearly linked to motivation. The SAL framework also suggests that approaches to learning are a function of the context, content and demands of the learning tasks and points to the uniqueness of each student's attempts at learning under uncontrolled conditions.

Originally, the SAL framework was developed by qualitative experimental investigations with campus-based students. However, following replication of the research with both campus-based and distance-learning students, the results do not appear to depend critically on the actual mode of course presentation. Additionally, the SAL framework is robust and can confidently be assumed applicable to students in Western countries.

Recent research[1,2] acknowledges the complexity and temporal nature of student motivation. To explore student motivation an approach which has been used extensively in Europe, Australia and New Zealand is the study process questionnaire[3] (SPQ). The SPQ contains seven items on each of six scales and was designed to measure motives and strategies of respondents. Although the SPQ in its original and revised form has been used extensively, Richardson[4] has questioned the reproducibility of the constituent structure. Nonetheless, the scales of the SPQ seem to define two factors: a generalised deep approach measured by deep and achieving motives and strategies and the other, a generalised surface approach measured by surface and achieving motives and strategies.

In the UK Entwistle and Entwistle[5] published a formal student attitudes questionnaire (SAQ) that was further developed to produce an approaches to study inventory (ASI). Since its inception, the ASI has been through a number of revisions[6] and has subsequently become one of the most widely used questionnaires in student learning in higher education. The ASI appeared in its final 64-item form in 1981[7] and the questions that form the final version of the ASI were published[8] in 1983. Richardson[9] developed a reduced form of the ASI (32-item ASI) and the factor structure of this form of the ASI has proven to be robust in a number of contexts.[6] This paper reports the results of a study using the short form version of the ASI (32-item form) to investigate the approaches to study exhibited by engineering students at the end of their first year of higher education. The results are also compared with the students' end of year grade.

Sources of variation in approaches to study

A general consensus has emerged in the research literature that suggests that, at least in Western universities, HE students exhibit a limited number of different approaches to learning. An approach to learning relates to the way in which a student organises a learning activity.[10] Importantly, it is not an inherent characteristic, but is a way of describing the response of the student to a learning task – a response that may change and one that is dynamic.[10–12]

In policy terms in a university setting, there are at least four main sources of variation in students' approaches to learning which are accessible to modification. These sources are:

- individual student characteristics;
- the operational characteristics of the institution, or university culture;
- the understanding of both the individual and the peer group of the context of learning, reflected by departmental culture;
- the requirements of the discipline(s) being studied.

Of these four potential areas for change the two most easily accessible are the individual student characteristics and the departmental understanding of the context of learning. One of the dominant features of undergraduate education in universities is that it is usually confined within one subject area, and often, particularly in English universities, to one discipline. From at least the time of Aristotle,[13] it has been recognised that differing subjects place differing demands upon the learner. In addition to the subject matter, a number of related norms and rituals are also associated with specific subjects. Additionally, the learning environment is shaped by different departments – through their teaching and assessment strategy and practice. Although this relationship between these teaching and assessment practices and the quality of student learning is not well understood[14] that there is a connection between the two has been recognised since at least the middle of the 19th century.[15]

Students' study context

Research into the process of studying undertaken by students in higher education emerged in the 1970s resulting from the work of a group led by Marton at the University of Göteberg in Sweden. The group's early studies used experimental work in which students' approaches to reading academic articles were studied. The research used qualitative methods in which open questions were asked of the students to elicit their approach to the process of reading. In addition, the students were asked a series of specific questions to assess what they had understood from the text. The resulting responses, in both cases, were recorded. Marton surmised that on one level, the students' initial intention in studying the article was aimed at understanding. In this case students critically reviewed the arguments put forward, related them to their own prior learning and experience, and evaluated the evidence basis of the article's conclusions. On another level, students focused on memorising what they considered important parts of the article with the knowledge that they would be asked questions about the article afterwards. As a result, the theoretical structure developed requires the acceptance of the 'essential uniqueness of each student's attempt at learning under **uncontrolled** conditions'.[16]

Marton was careful to acknowledge the limitations of the results, specifically as to generalisability; nevertheless, the approach showed important features relating to the nature of students' learning in real-world conditions. The first of these was that the outcomes of learning could be studied by careful analysis of recall performance. Secondly, that the process of learning could be illuminated by post-hoc interviews, and finally that the process outcome relationship could be judged between individuals. Subsequently many studies have relied on this heuristic procedure to evaluate teaching and learning approaches.

In examining the approaches students undertook, two levels of outcome were defined by Marton and Säljö[17] as deep and surface levels of processing. In the case of surface level processing, the students directed their attention towards learning the text itself or at least the recall of it (Marton and Säljö term this the sign), indicating that the student had adopted a reproductive conception of learning and was strongly constrained towards adopting a rote-learning strategy. In deep-level processing in contrast, the student is directed towards the intentional content of the learning material, in other words what the discourse is about (termed the signified) and towards comprehension. It is important to note that the terms deep and surface were used by the early Göteberg studies to indicate the ways of learning and not an individual differences characteristic of a student.

The Göteberg group's experimental work was based upon a desire to characterise qualitative differences in the process of learning under constant conditions of learning. This feature differed from previous work cited by Marton[18] in which different levels of processing were experimentally induced by manipulating the conditions of learning. Conditions were modified for example by suggesting that particular outcome requirements, approaches, or aspects of the material required specific focus. As expected there was a clear relationship between the students' adopted levels of processing when reading the set text and the levels of outcome evidenced by their recall of the text. Since qualitative differences were being examined, the outcomes were measured by reference to the text and determined by utilising four classifications which relate to different levels of understanding. The levels subsume one another and the most accurate level, called level A, includes understanding at levels B, C and D, and understanding at level B includes understanding at level C and D etc. An attempt to produce a context-free expression of the four levels was subsequently produced:

A The principle and the example as well as the relationship between them is understood.
B The principle and the example are understood (separately) but not sufficiently to understand the relationship between them.
C The principle is not understood but constructed on the basis of the fragments retained.
D The example in itself is seen as the main point of the text.

(Marton and Wenestam[19])

In a second paper Marton and Säljö[20] concluded,

> The fundamental importance of recognising the necessary link between the level of processing adopted and the level of understanding achieved cannot be overstated.

In other words, there is a functional relationship between process and outcome. Subsequently, broadly similar distinctions were obtained by the members of Marton's research group.[21,22] One of these, Svennson,[21] also differentiates between the outcomes of the learning and the process and went further in claiming a causal link between the two.

The initial work of the Göteberg group identified what were termed levels of processing. Subsequently, work carried out by at the University of Lancaster by a group led by Noel Entwistle, suggested that the term 'levels of processing' was too narrow, and that the term 'approach to learning' better represented the crucial intentional element in the process of studying. Consequently, the Göteberg group accepted the change resulting in general acceptance of the new terminology as used in this paper.

Laurillard[23] later supported these concepts amongst technology students and importantly for practical application, Marton and Säljö[24] identified that,

> a significant component of a deep approach is that the reader/learner engages in a more active dialogue with the text . . . a fairly obvious idea would be an attempt to induce a deep approach through giving people some hints on how to go about learning.

Following the work at Göteberg a categorisation of learning approaches has been developed which also admits a strategic approach to learning. Of the three types of approaches to learning now recognised in HE, the deep approach is viewed as most desirable with perhaps both the surface and strategic approaches viewed as being equally undesirable. The three approaches are characterised as shown below in Table 1.

Qualitative conceptions of learning

Approaches to learning are intimately related to students' conceptions of learning. Säljö[25] identified five qualitatively different conceptions of learning resulting from interviews with adults in which learning is seen as:

1 a quantitative increase in knowledge;
2 memorising;
3 the acquisition of facts, methods, etc., which can be retained and used when necessary;
4 the abstraction of meaning;
5 an interpretative process aimed at understanding reality.

Van Rossum and Schenk[26] showed that for first year psychology students (who compulsorily took part in the research) that surface approaches to learning were associated with learning conceptions 1–3 and deep approaches associated with conceptions 4 and 5.

Subsequent work by Marton, Dall'Alba and Beaty[27] as part of an initiative called the Study Methods Group characterised the conceptions of learning by a group of 10 students taking a 6-year course with the Open University (UK). The group concluded that these conceptions were:

1 increasing one's knowledge;
2 memorising and reproducing;
3 applying;
4 understanding;
5 seeing something in a different way;
6 changing as a person.

As with the conceptions Säljö[25] found, conceptions of learning at levels 1 to 3 are, in general, not meaningful in higher education. The additional sixth conception appeared only during the later years of a student's academic career with the Open University and only in the case of students who had already exhibited the fifth conception. Whilst the Study Methods Group worked with distance learners, subsequent work reported by Richardson[6] identified the sixth conception amongst campus-based students, although arguments exist that this form can be induced by local cultural conditions in the absence of any real intellectual development.

Marshall, Summers and Woolnough[28] using a phenomenographic approach recast

TABLE 1 *Learning approaches in the SAL framework*

Deep approach	Goal to understand, enthusiastic interaction with content, relating new ideas to previous knowledge, relating evidence to conclusions, examining the logic of the argument
Surface approach	Goal to complete task requirements, treating task as an external burden, unreflectiveness about purposes or strategies, focus on discrete elements without integration, failure to distinguish principles from examples, memorising information for assessments
Strategic approach	Goal to obtain highest possible grades, target work to perceived preferences of teacher, awareness of marking schemes and criteria systematic use of previous papers in revision, organising time and effort to greatest effect, ensuring right conditions and materials for study

the conceptions of learning in terms of HE engineering students. Their results are as follows:

1 no learning conception was recognised at this level;
2 learning as memorising definitions, equations and procedures;
3 learning as applying equations and procedures;
4 learning as making sense of physical concepts and procedures;
5 learning as seeing phenomena in the world in a new way;
6 learning as a change as a person.

In the last decade there has been growing concern and evidence that engineering courses are over-filled with subject content.[29–31] The 1990 Engineering Professor's Conference[30] accepted that action was needed to ensure that course content was more manageable so that engineering students would be encouraged to adopt a deep approach to learning. In addition, Gibbs[32] in trying to analyse students' approaches to learning derived a number of indicators that *induced* the surface approach to learning, as follows:

- a heavy workload;
- relatively high class contact hours;
- an excessive amount of course material;
- a lack of opportunity to pursue subjects in depth;
- a lack of choice over subjects and a lack of choice over the method of study;
- a threatening and anxiety-provoking assessment system.

On first reading of this list, many of the points seem to represent traditional teaching strategies of courses in engineering. As a result, by 1998 departments were still being encouraged to focus on student learning and consider reducing student work volume and address learning styles.[33] Given this decade of support for change in engineering courses the author's departmental learning, teaching and assessment committee decided to seek information on first year students' approaches to studying in 2001. The relationships between the learning conceptions that students hold and their academic ability also requires further exploration for two reasons. Firstly, there is some suggestion that the relationship between an individual's learning conception and their academic ability might be used as a tool to judge suitability for entry into courses of study as has been suggested in medicine.[34] Secondly, and probably more usefully, McLean[34] also suggests that students with poor academic records might become better achievers if they are made aware of the benefit of evolving to higher conceptions of learning.

Learning approaches adopted by first year engineering students

The 32-item approaches to study inventory (ASI) was completed by 113 students while attending normal classes during a 2-week period prior to the Easter vacation 2001. The students were drawn from electrical and mechanical engineering courses and included mature foundation students. The questions used in the 32-item ASI were published by Richardson.[9] Following confirmatory factor analysis on a larger

TABLE 2 *Scales and subscales of the 32-item ASI*

Scale	Subscale	Meaning
Meaning orientation	Deep approach	Active questioning in learning
	Comprehension	Readiness to map out subject area and think divergently
	Learning	
	Relating ideas	Relating to other parts of the course
	Use of evidence	Relating evidence to conclusions
Reproducing orientation	Surface approach	Preoccupation with memorisation
	Improvidence	Overcautious reliance on details
	Fear of failure	Pessimism and anxiety about academic outcomes
	Syllabus-boundness	Relying on staff to define learning tasks

study using the 32-item ASI (Rowe, to appear), the subscales and scales of the 32-item ASI shown in Table 2 were confirmed.

From the completed questionnaires, 99 first year students provided sufficient information to determine their meaning and reproducing orientation and a cross correlation was undertaken between the scales, subscales and the students' end of year grade to search for associations. The surface approach subscale correlation was significant at the $p < 0.05$ ($p = 0.003$) level and was moderately negatively associated with the end of year grade (correlation = –0.313). The strength of the association is on the same moderate level as that of the positive association between 'A' level results and degree classifications in applied science courses.[7]

Conclusions

The negative correlation between end of year grade and surface approach was expected. However, it is noteworthy, and somewhat disappointing, that no positive association was found between the meaning orientation scale and final grade and no negative association between the reproducing orientation scale and final grade. It may be concluded that no evidence was found to support the hypothesis that first year students are rewarded for adopting a meaning orientation in terms of final marks.

If it remains accepted that a deep approach to learning is to be encouraged amongst engineering students, further changes are required to reward students who adopt a meaning orientation. In addition, support for students to help them adopt a higher conception of learning may improve performance. These changes might flow from modifying assessments to reward critical analysis and synthesis in contrast to assessment that rewards memorisation even at the first year level. This is of importance to first year students because it is likely that study approaches that are developed during the first year of study persist into the second and third year and, of course, beyond. In the short term academics developing assessment schemes may wish to consider how published assessment criteria can be used to encourage both higher conceptions of learning, reward deep approaches to learning and meet the qualitative demands of subject knowledge.

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