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The Impact of the First Year on the Learning Behaviour of Engineering Students*

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This paper presents the results of an investigation into the stability of self-reported learning behaviour among first-year engineering students at the University of Cape Town. A statistical analysis of self-reported inventory responses indicates that, during the first year, a marked and disturbing change in learning behaviour occurs that is conceptually interpretable within a contextualized model of student learning. A conclusion is that a spiral of deteriorating learning behaviour is associated with an inability to cope with the perceived heavy workload demands of the first year. At the same time, there is also evidence of a development in terms of 'strategic' type actions aimed at passing examinations. The implications, and the possible causes, of these findings are discussed in the light of some suggested counter-measures.

INTRODUCTION

THE LEARNING behaviour of first-year engineering students has been the focus of a number of reported studies undertaken at the University of Cape Town. These studies essentially originated out of a concern about the quality of self-reported learning behaviour associated with students admitted to the University from educationally disadvantaged school backgrounds. Within this context, a number of important conclusions were reached concerning the considerable range of *inter-individual variation* in learning behaviour that can typically occur in a supposedly homogeneous group of students and, in particular, the extent to which recognizable forms of self-reported learning behaviour could be considered as a basis for risk categorization.

Ethically, students themselves were never compromised by this process. On the contrary, they were encouraged to discuss aspects of their learning behaviour as a normal part of their first exposure to undergraduate study. Students who described their approaches to studying, and their perceptions of the context within which these occurred, in a manner that conveyed an underdeveloped and fragmented conception of learning, generally did very poorly academically in their first year or failed outright. Based on what they themselves said and, to a degree, on how they themselves subsequently reflected on what they had said, a number of interventions were designed to enable students potentially 'at risk' to develop more sophisticated conceptions of learning, and to become more aware of, and assume greater control over, their own learning behaviour. As a result of these endeavours it has been concluded that a knowledge of self-reported learning behaviour at an individual level can inform subsequent teaching practice in a fundamental sense: a knowledge of students' learning behaviour can be used to alter the future learning experiences of the same students *in situ* and it can also supportively be used to develop the quality of learning in some individuals who might otherwise be 'at risk' [1, 2].

It is now clear that many of the learning problems manifested and experienced by first-year students from educationally disadvantaged school backgrounds are shared by other first-year students as well. Evidence has been gathered which suggests that regular first-year students (i.e. students who do not come from an educationally disadvantaged school background) *also* manifest a comparable qualitative range of inter-individual learning behaviour, the nature and consequences of which require further investigation. It needs to be ascertained, for example, to what extent a risk categorization of self-reported learning behaviour generally informs an expectation of academic performance.

The present study, which forms part of a broader investigation into the longitudinal learning behaviour of engineering students at the University of Cape Town, thus sets out to explore some aspects of both inter- and intra-individual variation in learning behaviour that are of strategic concern. It seeks, more specifically, to gauge the stability of learning behaviour across the transition from school into the first year, and also within the first

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year, as well as the association between distinguishable patterns of learning behaviour and learning outcome.

CONCEPTUAL FRAMEWORK

Student learning is basically a multivariate phenomenon that is characterized by qualitative *individual differences* in the manner in which both the context, and the content, of learning are engaged [3]. A number of models of student learning have been proposed that attempt to formulate a conceptual basis for understanding the manifestation of qualitative differences, for example, in 'deep', 'surface' and 'achievement' terms. At the simplest level, it has been argued that the basic determinants of such differential forms of learning behaviour are attributable to contrastingly congruent forms of motives and strategies [4]. A 'surface' form of learning behaviour (which is synonymous with a minimalist, reproductive and sterile engagement of course content) is thus explainable in terms of an *externally* motivated intention to *reproduce* (rather than understand) what is being 'learned'. At a more complex level, the influence of the (perceived) context of learning, as well as the presence of other postulated learning processes, are explicitly recognized as important sources of variation. More complex models do fuller justice to the multivariate nature of the phenomenon and also allow a broader range of individual-difference effects to be explored.

The present study embraces a set of explanatory learning behaviour variables that emanate substantively in motive, strategy and process terms from such a more complex model proposed by Entwistle [5], further extended, especially in contextual perception terms, by Meyer [6]. The source variables thus collectively represent a *contextualized* model of student learning; the basic and qualitatively contrasting motives, strategies, processes and other learning approach variables are contextualized in discipline-specific terms (the subject being studied), as well as in terms of perceptions formed about the associated learning environment. This means that students are not asked to externalize a *generally* held pattern of learning behaviour. They are asked to externalize how they are engaging learning in a *specific* subject, as well as their perceptions concerning the *context* of that engagement. The model is thus sensitive to the content, and the context, of learning as important sources of intra-individual variation (or stability) in learning behaviour [7, 8], as well as inter-individual variation (or individual differences) in learning behaviour [6].

INITIAL STABILITY OF LEARNING BEHAVIOUR

All students entering first-year engineering were asked (upon registration in February) to report retrospectively on how they had approached the studying of science in their final high school year. They were subsequently asked to report on how they were approaching the learning of applied mechanics in April and September. Complete longitudinal learning behaviour data was obtained for 228 out of the 370 students who entered the course. It should be noted that applied mechanics is not a school subject but it is studied as part of the science syllabus by most students. There is thus a pragmatic assumption that preferential, or habitual, modes of self-reported learning behaviour in science, or in a science subject (representing the closest school analogue to applied mechanics) can serve as an initial baseline for comparative purposes [1].

Table 1 summarizes the results of a paired comparison analysis of mean scores on the variables for entry-level (school), and April (university) learning behaviour. Only those variables across which this comparison reaches statistical significance (16 out of 25 source variables) at a minimum 5% level are shown. Table 1 communicates an unambiguous message of altered learning behaviour (in applied mechanics relative to science) that initially needs to be interpreted at face-value in

Table 1. Normalized paired comparisons (April versus entry)

Variable		Mean	SE	T	$P>\|T\|$
Workload	wl	1.11	0.06	17.27	0.0001
Disorganized studying	ds	0.96	0.06	16.76	0.0001
Fear of failure	ff	0.85	0.06	14.67	0.0001
Intrinsic motivation	im	−0.54	0.05	−10.52	0.0001
Fragmentation	fa	0.75	0.07	10.29	0.0001
Improvidence	ip	0.40	0.05	8.15	0.0001
Surface relationships	rs	0.46	0.06	7.97	0.0001
Syllabus boundness	sb	0.29	0.05	5.93	0.0001
Extrinsic motivation	em	0.34	0.06	5.34	0.0001
Relating ideas	ri	0.18	0.04	4.21	0.0001
Learning space (surface)	ls	0.20	0.06	3.64	0.0003
Assessment (deep)	ad	−0.11	0.04	−3.16	0.0018
Achievement motivation	am	−0.11	0.05	−2.45	0.0151
Deep approach	da	−0.10	0.04	−2.34	0.0199
Reflection	re	0.09	0.04	2.29	0.0231
Content (surface)	cs	0.28	0.14	1.97	0.0504

terms of the discrete variables represented. The meaning of these variables will be briefly explained in the order in which they appear in Table 1 (in decreasing order of difference magnitude and statistical significance). The *direction* of the shift on each variable is also indicated and enables a cumulative interpretation to be built up as the variables are introduced.

- *Workload* (wl): A perception that there is an overcrowded syllabus, a heavy workload to get through, giving rise to stress and an inability to cope (*increased*).
- *Disorganized studying* (ds): An acknowledgement that difficulty is being experienced in getting down to work, managing time and concentrating on the task at hand (*increased*).
- *Fear of failure* (ff): A negative motivational influence attributed to a general concern about failing, but linked to exam tension, a lack of confidence and work pressure (*increased*).
- *Intrinsic motivation* (im): A positive motivational influence reflected in expressed interest, and even excitement, concerning the subject being studied, and coupled with a desire to learn more about it (*decreased*).
- *Fragmentation* (fa): Conceptually this may be regarded as one component of what is often described as a 'surface approach' to studying (the other component being memorising). On its own, it strictly represents the lack of an organizing principle in processing new information to be learned; such information is perceived to consist, in the absence of any apparent structure, of unconnected 'bits and pieces' (*increased*).
- *Improvidence* (ip): A pathological over-reliance on detail and procedure in problem solving, associated with an inability to integrate detail into an overall picture (*increased*).
- *Surface relationships* (rs): An uncritical acceptance of the words of the lecturer, or of the textbook, and a predisposition to anticipate exam questions by guesswork (*increased*).
- *Syllabus boundness* (sb): A preference for what needs to be done to be made clearly explicit, with little attempt being made to explore beyond given requirements by way of additional reading (*increased*).
- *Extrinsic motivation* (em): A basically extrinsic interest in the subject; the need for studying it is seen in vocational terms, such as a means towards obtaining a qualification and good employment (*increased*).
- *Relating ideas* (ri): An active (deep-level) process of attempting to relate new ideas to other contexts and experiences; also 'mapping' them out to see how they fit together (*increased*).
- *Surface learning space* (ls): An awareness of some aspects of the learning environment that facilitate or impede the efficient transfer of information such as noise, legibility and the use of media (*increased*).
- *Deep assessment* (ad): A general awareness of testing procedures reflected in an awareness of the purpose of tests, what they measure, different types of testing, and the educational benefit of receiving feedback from testing (*decreased*).
- *Achievement motivation* (am): A positive form of motivation characterized by a desire to excel in personal terms, as well as in competition with others (*decreased*).
- *Deep approach* (da): An intention to understand what is being learned that involves critical engagement and expenditure of effort (*decreased*).
- *Reflection* (re): A deep-level process of reflecting on past learning experiences and reassessing their personal meaning (*increased*).
- *Surface content* (cs): An awareness of some attributes of subject content in terms of structure and quantity (*increased*).

The difference analysis thus conveys a first impression of deteriorated learning behaviour in the group as a whole. There is, however, no indication of whether, or how, the observed shifts are interrelated at an individual, and at a group, level. It therefore needs to be established if the observed phenomenon can be interpreted within clearer and more coherent conceptual structures.

RISK CATEGORIZATION

Previous studies concerned with individual-level manifestations of student learning have reported on the employment of various forms of categorizations of self-reported learning behaviour that can be invoked to inform an expectation of how well an individual might perform academically [9, 10].

If, for example, a student is negatively motivated, uninterested in the subject, and is self-reportedly intentionally 'learning' in terms of fragmented content reproduction, then it seems reasonable to expect such a student to perform poorly academically. On the other hand, a student who is intrinsically motivated to apply, transform and extract meaning from what is being learned should perform considerably better, but might not do so due to other factors; the *intention* to understand is a necessary, but not sufficient, condition for understanding to occur. The validity of the above argument also obviously depends on the extent to which formal academic assessment procedures actually test the acquisition of conceptual understanding rather than simply a quantitative increase in knowledge. (In the present study this assumption is implicitly made in terms of the two major first-year examinations in applied mechanics.)

Based on earlier reported work, an experimental approach to the categorization of self-reported descriptions of learning behaviour via programmable logic has been employed in the present study [11, 12]. In essence, this approach treats a student response to a collective set of (learning behaviour) source variables as a *preference structure* based on a ranking of the normalized scores on the variables concerned [6]. This structure is then examined for any embedded characteristics that can conceptually be used as a basis for risk categorization. The resultant risk categorization is represented on a five-point scale with (conceptually) ordinal properties: category 1 represents responses characterized by high-risk features (typically those that emphasize directionless, pathological and disorganized patterns of learning behaviour), while category 5 represents those with low-risk features (typically those that approximate a holistic and deep approach to learning).

The frequency table of April versus entry risk categorization (Table 2) presents a clearer view of the previously discussed shift in learning behaviour based on the significant differences in Table 1. Various measures of ordinal association are presented in the statistical summary and they all indicate a moderate positive association between school and April categorization. This is consistent with the observation that the entry-level risk-category distribution indicated by the totals at the bottom of Table 2 differs from the April risk-category distribution indicated by the totals on the right-hand side of the Table. The diagonal entries in Table 2 indicate *stable* risk categorizations, while the upper and lower triangles of cell entries indicate deterioration and improvement respectively. It is clear that most of the shifts are located in the upper triangle and that they collectively suggest a deterioration (relative to the school science context) across all risk-categories greater than 1. The only counter-shift of any note is from category 3 to 4 ($n = 13$) indicating improvement within a small subgroup of previously 'average' entry-level learning behaviours. In addition, the upper and lower triangles are markedly asymmetric (as indicated by the McNemar statistic, $p < 0.0005$), confirming the significance of the observed deterioration relative to any improvement.

UNDERLYING COMMON FACTORS

Given, then, that significant shifts in learning behaviour are being manifested, in terms of a set of explanatory variables, and in all permissible risk categories, it needs to be determined whether the observed differences associated with these variables are in any way interpretable in terms of the broader underlying theory of student learning. More specifically, it needs to be established whether there are explanatory common factors that can account for the observed differences in an interpretation that is conceptually coherent.

Table 3 contains the results of an exploratory maximum-likelihood factor analysis of the differences corresponding to the variables represented in Table 1. Under oblique rotation, it provides a simple and conceptually elegant interpretation of the observed differences in terms of two (negatively correlated) common factors. The five highest loadings on factor 1 represent a fragmented (fa), disorganized (ds), and pathological (ip) form of learning behaviour fuelled by perceptions of a heavy workload (wl) and fear of failure (ff). This factor is further qualified by syllabus boundness (sb), extrinsic motivation (em) and surface human relationships (rs).

In contrast, factor 2 can only be tentatively interpreted as indicating an incompletely manifested form of, possibly, strategic/deep learning behaviour by virtue of deep perceptions of methods of assessment (ad), relating ideas (ri), achievement motivation (am) and surface perceptions of course content (cs), and of learning space (ls). What this particular association of variables conveys is a competitive motivation to relate ideas, a perceptual focus on some aspects of the learning context that emphasize an awareness of the nature and purpose of examinations, as well as the structural attributes of course content. In turn, the

Table 2. Frequency table of April by entry categories

	Entry					
Freq	1	2	3	4	5	Total
April 1	13	7	16	11	2	49
2	7	12	25	7	4	55
3	3	4	22	18	6	53
4	1	1	13	26	14	55
5	0	0	3	2	11	16
Total	24	24	79	64	37	228

Summary statistics of ordinal assn:	Value	ASE
Gamma	0.540	0.057
Kendall's tau-b	0.422	0.047
Stuart's tau-c	0.404	0.046
Somers' $D\ C\|R$	0.415	0.047
Somers' $D\ R\|C$	0.429	0.047
Spearman's correlation	0.496	0.053

McNemar's chi square 53.74 ($P < 0.0005$)

Table 3. Factor analysis of April versus entry differences

		Factor 1		Factor 2	
Fear of failure	ff	63	(62)	–	
Workload	wl	63	(62)	–	
Disorganized studying	ds	62	(64)	–	(−26)
Fragmentation	fa	61	(64)	–	(−27)
Improvidence	ip	56	(53)	–	
Syllabus boundness	sb	43	(38)	21	
Extrinsic motivation	em	37	(37)	–	
Surface relationships	rs	37	(34)	–	
Assessment (deep)	ad	–	(−20)	62	(63)
Relating ideas	ri	–		43	(41)
Content (surface)	cs	–		43	(41)
Achievement motivation	am	–		35	(37)
Learn. space (surface)	ls	–		35	(32)
Reflection	re	–		33	(31)
Intrinsic motivation	im	−31	(−38)	33	(40)
Deep approach	da	−20	(−26)	27	(32)

Note: Inter-factor correlation = −0.23, all loadings are rounded to two decimal places and multiplied by 100, loadings < 20 not shown, factor structure loadings are followed in brackets by factor pattern loadings.

weaker loadings on reflection (re), intrinsic motivation (im) and deep approach (da), collectively nuance Factor 2 in terms of deep forms of learning behaviour. Thus, while the overall emphasis appears to be strategic, there is also some evidence of a deep influence.

Of additional interest is the fact that all of the variables with positive loadings on factor 1 reached statistical significance in Table 1 in terms of increases in effect, while the variables with positive loadings on factor 2 represent significant increases and decreases. There is thus a uniform and negative 'directional' interpretation in terms of factor 1, while factor 2 suggests that mixed shifts are occurring but are also doing so within a conceptually coherent structure.

WITHIN-COURSE SHIFTS AND LEARNING OUTCOME

Significant effects in learning behaviour differences between April and September are summarized in Table 4. Although the magnitude of the effects is generally not as great as those presented in Table 1, they once again convey a coherent shift in learning behaviour in terms of the variables already discussed as well as three additional ones that need to be briefly introduced.

- *Strategic approach* (st): A conscious attempt to marry effort expended to the 'reward system' of the course by being sensitive to cues concerning what is, or might be expected to be, required in terms of assessment procedures (*increased*).
- *Deep relationships* (rd): An appreciation of the value of human interaction in learning, and how this can be affected by one's own attitudes (*increased*).
- *Deep books* (bd): An awareness of the attributes of books (such as their 'search apparatus', layout, and composition) that facilitates their skilled utilisation (*increased*).

Compared to April, and in terms of the variables discussed earlier, there is now a significant and a further increase in deep perceptions of methods of assessment (ad) as well as relating ideas (ri). With the further significant addition of increases in strategic approach (st), deep perceptions of relationships (rd), and books (bd) introduced above, the collective impression now is one of increased strategic/deep learning behaviour. In contrast, there is also a decrease in the motivational influence of fear and failure (ff), a further increase in syllabus boundness (sb) and fragmentation (fa) that is readily attributable to, and interpretable within, a posited separate common factor.

The frequency table for the September by April categories (Table 5) indicates a higher degree of stability in the categorizations than for the April by entry categories, as also evidenced in the increased measures of ordinal association. Such shifts as do occur are not statistically significant ($P > 0.05$) in terms of asymmetry, and are largely confined to units of one category as indicated by the cell entries adjacent to those on the diagonal.

Of particular interest is the academic performance of the 2 × 5 subgroups corresponding to each of the April and September risk categories. Performance is summarized here as the average of the two major (mid-year and final) examinations written, and the resultant percentages are indicated in Table 5 next to the corresponding risk category. (For example, the average performance of the students associated with category 1 in April and September is 48.8% and 46.7% respectively.) There is a clear indication that performance of the subgroups is consistent with the presumed ordinal properties of the risk categories, especially so in the case of the September categories; the two high-risk subgroups (corresponding to categories 1 and 2) perform very poorly given that the pass mark is 50%.

The probability of producing such monotonic subgroup gradations of performance by chance categorization is < 1% in either case. Furthermore, under the minimalist assumption of no association between risk category and outcome, the chance probability of producing two such sets of correctly ordered monotonic relationships is very small indeed ($P < 0.0001$). It is inferred that there is some salient relationship between categorization and outcome. The indicated possibility of *modelling* learning outcome in terms of risk categorization is, however, a separate issue and is not further explored here. There is, nonetheless, considerable empirical support for both the categorization procedure employed and the assumption that academic performance is reflecting a measure of the acquisition of conceptual understanding.

Table 4. Normalized paired comparisons (September versus April)

Variable		Mean	SE	*T*	$P > \|T\|$
Strategic approach	st	0.13	0.04	3.51	0.0005
Fear of failure	ff	−0.13	0.05	−2.82	0.0052
Relationships (deep)	rd	0.10	0.03	3.08	0.0023
Assessment (deep)	ad	0.08	0.03	2.40	0.0174
Syllabus boundness	sb	0.10	0.04	2.22	0.0273
Books (deep)	bd	0.07	0.04	2.10	0.0368
Relating ideas	ri	0.07	0.04	2.03	0.0438
Fragmentation	fa	0.10	0.05	2.02	0.0447

Table 5. Frequency table of September by April categories

Freq	April 1	2	3	4	5	Total	% Mark	*n*	SD
Sept 1	25	11	3	3	0	42	46.7	40	13.9
2	16	24	11	8	1	60	50.3	56	12.8
3	7	14	25	13	0	59	57.1	59	15.2
4	1	4	13	26	9	53	64.1	52	16.8
5	0	2	1	5	6	14	66.9	13	18.5
Total	49	55	53	55	16	228			
% Mark	48.8	52.0	55.6	60.8	71.6				
n	48	51	51	54	16				
SD	16.6	14.1	14.7	15.9	14.6				

Note: Due to missing data, there are fluctuations in the sample sizes used in calculating the overall percentage mark for each of the April and September risk-categories.

Summary statistics of ordinal assn:	Value	ASE
Gamma	0.679	0.047
Kendall's tau-b	0.546	0.042
Stuart's tau-c	0.529	0.042
Somers' $D\ C\|R$	0.549	0.042
Somers' $D\ R\|C$	0.544	0.042
Spearman's correlation	0.631	0.045
McNemar's chi square 7.70 ($P > 0.05$)		

CONSOLIDATED EFFECTS

Table 6 presents a summary of consolidated effects, attributable to within-course differences in learning behaviour between entry and September. As a net accumulation of the differences that have already been discussed, Table 6 brings into sharper focus the statistically significant increases in disorganized studying (ds), perceptions of heavy workload (wl), fragmentation (fa), syllabus boundness (sb) and improvidence (ip). Motivationally, there is a decrease in intrinsic motivation (im), and achievement motivation (am), and an increase in fear of failure (ff) as well as in extrinsic motivation (em). The decrease in deep perceptions of learning space (ld) and the increase in surface human relationships (rs), surface perceptions of course content (cs) and surface perceptions of learning space (ls), further nuance what appears to be a significant shift in disorganized, fragmented and externally motivated learning behaviour during the first year. At the same time, there is improvement in terms of strategic approach (st), relating ideas (ri), reflection (re), deep perceptions of books (bd) and of human relationships (rd).

The frequency table representing the consoli-

Table 6. Normalized paired comparisons (September versus entry)

Variable		Mean	SE	*T*	$P>\|T\|$
Disorganized studying	ds	1.00	0.06	17.44	0.0001
Workload	wl	1.18	0.07	17.00	0.0001
Fear of failure	ff	0.72	0.06	11.96	0.0001
Fragmentation	fa	0.85	0.07	11.46	0.0001
Intrinsic motivation	im	−0.59	0.05	−10.95	0.0001
Surface relationships	rs	0.48	0.06	7.76	0.0001
Syllabus boundness	sb	0.39	0.05	7.76	0.0001
Improvidence	ip	0.35	0.05	6.72	0.0001
Extrinsic motivation	em	0.35	0.06	5.39	0.0001
Surface content	cs	0.17	0.05	3.50	0.0006
Surface learning space	ls	0.14	0.06	2.57	0.0109
Deep learning space	ld	−0.10	0.05	−2.07	0.0397
Achievement motivation	am	−0.10	0.05	−2.03	0.0439
Relating ideas	ri	0.25	0.04	5.80	0.0001
Strategic approach	st	0.16	0.04	3.59	0.0004
Deep relationships	rd	0.10	0.04	2.61	0.0096
Reflection	re	0.12	0.04	2.74	0.0066
Deep books	bd	0.11	0.04	2.54	0.0119

Table 7. Frequency table of September by entry categories

Freq	Entry 1	2	3	4	5	Total
Sept 1	13	5	12	9	3	42
2	9	8	26	13	4	60
3	2	8	24	18	7	59
4	0	2	14	22	15	53
5	0	1	3	2	8	14
Total	24	24	79	64	37	228

Summary statistics of ordinal assn:	Value	ASE
Gamma	0.464	0.062
Kendall's tau-b	0.360	0.051
Stuart's tau-c	0.343	0.049
Somers' $D\ C\|R$	0.355	0.051
Somers' $D\ R\|C$	0.364	0.051
Spearman's correlation	0.423	0.058
McNemar's chi square 51.72 ($P<0.0005$)		

dated shifts in risk categorization from entry to September are presented in Table 7. As expected, the ordinal measures of association indicate a weaker relationship between entry and September categories compared to that between entry and April categories. There is also, once more, a corresponding and statistically significant asymmetry ($P<0.0005$) evident in the upper and lower triangles. In summary, there is thus concluding evidence of an overall relative deterioration in learning behaviour attributable to the first-year experience.

The results of a maximum-likelihood factor analysis on the significant September by entry differences are summarized in Table 8. Two negatively correlated common factors emerge once more and these are presented under oblique rotation. Factor 1 preserves the essence of the earlier discussed factor 1 based on the April by entry differences. The interpretation of factor 2, however, is now in terms of a well-contextualized, and essentially *strategic*, form of learning behaviour.

Table 8. Factor analysis of September versus entry differences

		Factor 1		Factor 2	
Workload	wl	76	(74)	–	
Fear of failure	ff	69	(70)	–	
Fragmentation	fa	58	(60)	–	(−21)
Disorganized studying	ds	58	(60)	–	(−24)
Improvidence	ip	43	(43)	–	
Surface relationships	rs	39	(36)	–	
Syllabus boundness	sb	38	(35)	–	
Extrinsic motivation	em	35	(33)	–	
Deep relationships	rd	–		57	(54)
Learning space (deep)	ld	–		51	(48)
Content (surface)	cs	–		51	(51)
Relating ideas	ri	–		50	(47)
Books (deep)	bd	–	(−23)	49	(52)
Reflection	re	–		38	(37)
Strategic approach	st	–		38	(40)
Achievement motivation	am	–		36	(36)
Intrinsic motivation	im	−34	(−41)	36	(42)
Learn. space (surface)	ls	–		22	(20)

Note: Inter-factor correlation = −0.19, all loadings are rounded to two decimal places and multiplied by 100, loadings <20 not shown, factor structure loadings are followed in brackets by factor pattern loadings.

DISCUSSION

The results and interpretation of the analyses presented convey a graphic impression of ebb and flow in the first year of university study. There is an unmistakable impression in the data of initial relative instability as evidenced in the marked deterioration across all risk-categories. This is followed by a relatively stable pattern of equilibrium in which further shifts are largely confined to units of one category. The net impression, however, is one of considerable change within conceptually coherent dimensions.

Deterioration is interpretable within a common underlying factor that starkly emphasizes the destructive spiral associated with perceptions of a heavy workload, fear of failure, fragmentation, syllabus boundness and disorganized studying. There is nothing in the analyses presented that can identify the *cause* of this depressing phenomenon. In terms of the underlying theory, however, it can be argued that the problem arises in the *context* of learning, notably perceptions of a heavy workload and an inability to cope with it because of inappropriate engagement mechanisms. This interpretation is consistent with that of other studies that have concluded that many students entering their first year have an unrealistic anticipation of how much work lies ahead and are ill-prepared to cope with it. There may also be considerable inconsistency (in terms of teaching) between what students expect and what they experience, requiring a major adaptation on their part that they may not have the versatility or confidence to manage. The school-learning history, or entry-level behaviour, of a student must be seen as a starting point from which any required adaptation must proceed, and it can clearly influence both the rate and the quality of any such process.

'Improvement', by contrast, appears to be essentially in terms of a strategic form of learning behaviour, conceptually geared to passing examinations. This is not surprising, and probably indicates the perceived survival adaptation required to cope with the first year. Again, this interpretation is consistent with conclusions of other studies. Whether this is a *desirable* form of 'improvement' is open to argument against the well-established fact that students can often pass examinations without understanding what they have been examined on. They may well pass their first year of study using theoretically inappropriate strategies, only to fail in their second year as the conceptual demands on them increase.

Several important issues flow from the present study. Student failure, attrition and demotivation constitute a syndrome of common concern to all engineering educators. In this case the adoption of a student learning research perspective has facilitated a plausible interpretation that can aid early diagnosis. It seems reasonable to argue on the evidence presented that an early warning system should be triggered at various stages in the course when students begin to feel overwhelmed by the workload and their inability to cope with it. The disarming simplicity of this statement should not be allowed to mask the gravity and complexity of the underlying condition it can represent at an individual level.

At the very worst it has already been established that some such students enter their first year of study with fragmented conceptions of knowledge, and of learning. In cases where these prevail, the prognosis is not encouraging: in the present study nine students were consistently considered to be severely 'at risk' (category 1), on entry, and throughout their first year. Of the nine, only one student came from a disadvantaged school background. The rest were regular students who, at face value, had satisfied the stringent entry requirements of the Engineering Faculty. Seven of them failed outright while two of them (including the disadvantaged student) managed a borderline pass. Again, this observation is consistent with previous studies involving only students from disadvantaged school backgrounds [10].

At the University of Cape Town the present study coincides with a review of the first-year engineering curriculum and provides a benchmark for assessing the impact of future changes on students' experiences. The findings presented here also create an opportunity for exploring suitable intervention mechanisms, one of which (intended specifically for 'at risk' students) has already been attempted in pilot form [13]. Another, presently in a planning stage, centres on the concept of a 'learning hot seat' in engineering where students can go to discuss their learning, in context, as a normal part of their undergraduate experience.

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