Flexible pacing: Aiding students to adapt to the complexities of multidisciplinary Higher Education

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Introduction

Given increasing multi-disciplinarity, rapid technological change, as well as the shift in higher education towards greater responsiveness “to contemporary societal and economic needs” (Kraak, 2000, p. 13), the challenge at tertiary engineering education institutions is complex. This is exacerbated by the twenty first century demands of our graduates to possess a solid foundation in the requisite knowledge and practices, problem-solving skills, and a broad range of portable competences. The challenge to traditional views of knowledge in the emerging disciplines and the increasingly diverse student base in response to equity and access policies make a one-size-fits-all approach to tertiary engineering pedagogy impracticable. Indeed, what is required is “pedagogies ... that provide the capacities for coping with supercomplexity” (Barnett, 2000, p. 419).

This paper presents the pedagogical approach of one particular HE engineering programme in response to the complexity of both a multidisciplinary knowledge region as well as an increasingly diverse undergraduate base. The focus is on the innovative use of time in enabling those students who need it to adjust to the practices of tertiary education, whilst simultaneously not constraining the performance of students better equipped to deal with the requirements of HE study. The research site is the Mechatronics Diploma Program (sic) at the Cape Peninsula University of Technology. This new multidisciplinary region is characterised by a synthesis of vertical and horizontal knowledge structures (Bernstein, 2000). Furthermore, being a technology-based programme, it is orientated to its ‘use-value’ to society, and this has resulted in a shift to a curriculum characterised by ‘doing’ rather than ‘knowing’ (Barnett, Parry, & Coate, 2001). This has implications not only for pedagogic approach, but also for the allocation of resources and time. In an attempt to cater for a broad range of subject types, as well as the diverse literacies and abilities with which students enter particularly the Technical Universities, the Mechatronics Program employs a Day-per-Subject (DPS) timetabling system. Each subject is allocated a single full day per week, comprising four lecturer-contact hours and four built-in practical/self-study hours, all of which take place in a dedicated venue. Initially a pragmatic decision based on having to staff the programme with part-time lecturers, the philosophy behind the DPS is one of flexibility with regard to programme content, human/material resources, and student needs. It is the prerogative of the lecturer to determine how he/she arranges and manages the four contact hours within the eight-hour day, and that of the students to identify their individual/collective needs so as to be able to manage the self-study portion(s) of the day.

The initial research impetus was an internal evaluation conducted in July 2010 to establish student and faculty perceptions of how the DPS system was working, with the purpose of programme improvement. Based on results of a quantitative Mechatronics student survey, the research methodology shifted to a multimodal approach as a qualitative series of semi-structured lecturer interviews and written student accounts ensued. Coded and triangulated data revealed that the key factors determining effective management of the system were the lecturer’s perception of the subject knowledge structure, the student’s perception of an explicit pedagogy, and the provision of enabling supports/resources. Student requests for ‘more structure’ in some subjects suggested the need for an analysis of precisely how time is managed on the DPS system, and the extent to which this is dictated by the perception of the subject knowledge structures. As such, the Bernsteinian concepts of *classification* and *framing* offer useful analytical tools. This paper presents an analysis of the pedagogical approach in three subject types, and focuses specifically on the *framing* of *control* and *pace*. Results suggest that weaker framing on pace benefits the diverse student base differently in the more contextual/applied subjects and opens a space for collaborative peer teaching and learning. This, in turn, indicates weaker framing on control by the lecturer, which enables the development of independent learning. However, research also suggests that *framing* of *control* and *pace* in the more conceptual subjects needs to be stronger in order to facilitate the grasp of fundamental principles of the various disciplinary strands that form a multidisciplinary region.

Theoretical Framework in Context

Renowned educational sociologist, Basil Bernstein, was concerned with developing a theoretical framework through which to analyse the production and reproduction of knowledge. He distinguished between vertical and horizontal discourses, with the former being ‘specialised symbolic structures of explicit knowledge’ (such as in education) and the latter context-specific and -dependent everyday knowledge (Bernstein B. , 2000, pp. 155-159). Within vertical discourse there are hierarchical (vertical) and horizontal knowledge structures. “Hierarchical knowledge structures develop through new knowledge integrating and subsuming previous knowledge, whereas horizontal knowledge structures develop through adding on another segmented approach or topic area" (Maton, 2009, p. 45). Bernstein further used the principle of *classification* to describe the degree to which knowledge categories are insulated from each other. The stronger the classification, the more unique a category's identity, voice, and 'specialised rules of internal relations' (Bernstein B. , 1996, p. 7). At the forefront of emerging engineering disciplines, Mechatronics Engineering is concerned with the principle of automation and is literally about making people's lives easier at the flick of a switch. Epistemologically, it draws its theoretical subjects from the traditional Mechanical and Electrical engineering disciplines, and simultaneously offers 'applied' programming-orientated, technology-based subjects such as Control Systems. Strongly classified knowledge areas, such as the *physics* inherent in the mechanical and electrical engineering subjects, are hierarchical in structure and require the specific selection and sequencing of content to allow for *conceptual* grasp. In contrast, subjects such as Programming or Computer Aided Manufacturing (CAM), which are taught *contextually*, straddle several disciplines and would be regarded as weakly classified. Each program has a vertical structure within itself, but learning one program does not guarantee that one can learn another, much like languages, and programming could thus be viewed as a horizontal/segmental knowledge structure. The Mechatronics knowledge structures are thus a synthesis of the vertical and horizontal, and represent a range of classification strengths. Furthermore, technology-based knowledge is increasingly orientated to its 'use-value' to society (Barnett, Parry, & Coate, 2001). Whereas the efficacy of a system might previously have been dictated by scientific principles, today this is dictated by human decisions as to economic viability, trends and desires. This suggests that the emerging discipline is situated even more closely to horizontal discourse itself. The 'use-value' of knowledge and resultant curriculum shift to 'doing' rather than 'knowing' (ibid.) implies an increasing shift towards a *contextual* pedagogy rather than a *conceptual* one. These factors have implications for curriculum design, pedagogic practice and allocation of resources.

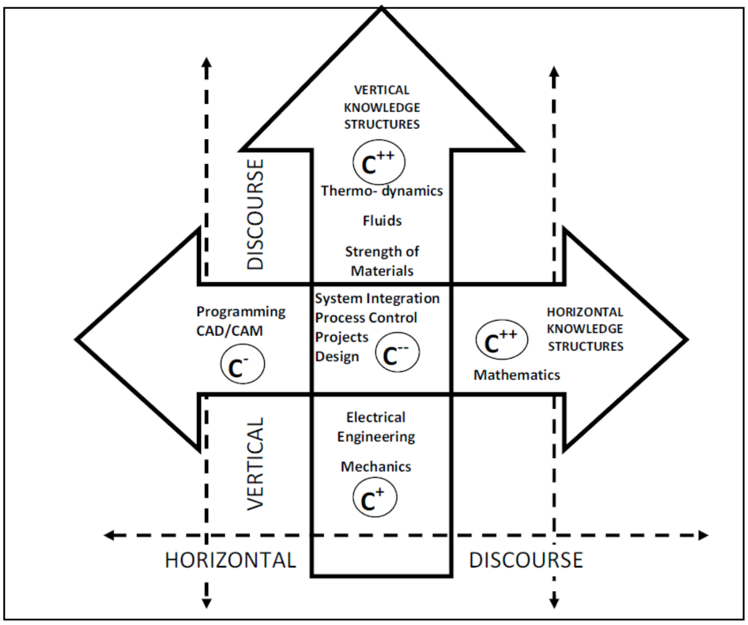

Figure 1. Mechatronics Knowledge Structures

"Disciplinary form … impose[s] constraints on appropriate curricular form" (Muller, 2008, p. 21). Bernstein described curriculum as the principle by which periods of time and their contents are brought into special relationship with each other (Bernstein B. , 1975). Given the complexity of the knowledge structures, the different subject classification strengths, and the differing *conceptual/contextual* curriculum and resource requirements, the solution on the Mechatronics Program has been to allocate a dedicated laboratory with the appropriate technology to a particular subject per day, and afford the lecturers the flexibility to design their curricula and determine a pedagogic approach based on the needs of the discipline and those of the students.

But who are the students and what, precisely, are their needs? In the CPUT Mechatronics Program context, it is not uncommon to have an age range of up to twenty years in one class, with a mixture of school-leavers and students with decades of work experience. Furthermore, the programme draws a large number of international students, with Africa well represented, as well as Asia, Europe and South America. These students display vast disparities in academic practices and a diverse range of literacies. In describing similarly diverse student demographic composition at Australian universities, Walkington proposes a philosophical shift in thinking about engineering curriculum design which makes "provision for variations in student experience" (2001, p. 131). She suggests a conscious catering to the needs of students in considering curriculum, including alternative pathways, distance learning and part-time study. In the CPUT Mechatronics context, however, with no current provision for a formal extended programme or part-time study options, the solution has been to afford the student the necessary time by building 'self-study' time into the curriculum.

The Bernsteinian concept of *framing* is about *how who* controls *what* across five sites: Selection, Sequence, Pace, Criteria, and Control over the social base which facilitates transmission of knowledge (Bernstein B. , 2000). Strong framing means the transmitter (agent/lecturer) has explicit control over the five sites, whereas weak framing suggests the acquirer (student) has more apparent control. Built-in self-study time would suggest a generally weaker framing of *pace* and *control.* However, the pedagogies associated with perceptions of what the teaching of different knowledge structures requires imply potentially different approaches to the overall framing of both pace and control. This paper presents a comparative analysis of the framing approaches by three different lecturers in three different subject types, with particular attention paid to *pace* and *control*. What has emerged is that the more weakly classified and contextually-based the knowledge structure, the stronger the procedural framing needs to be across all sites except *pace* and *control* in order for the student to experience the subject as successful, particularly in the first year of study. Conversely, it is suggested that the more strongly classified and conceptual the knowledge structure, the stronger the framing needs to be across all sites.

Research Methodology

A multimodal research methodology approach has been employed in the collection of data. Based on a need to evaluate student perception of the benefits and shortcomings of the DPS system, as well as their opinion on the management thereof, a quantitatively orientated ten-question survey was completed by one hundred Mechatronics students in the final week of Term 2, 2010. Despite the overwhelming (91%) approval of the flexibility and independence afforded by the DPS, 52% of the respondents expressed the wish for 'more structure' and particularly in the traditionally 'theoretical' subjects. This suggested the need to investigate more closely the concept of 'structure'. The second research phase entailed nine semi-structured recorded interviews with faculty members on how exactly the system was working for them. In addition to their perception of benefits and limitations of the DPS system, they were asked to describe how they managed a typical day and their opinion on the prerequisites for success. Furthermore, detailed written descriptions contrasting two subjects per semester (one 'theoretical' and one 'practical') were solicited from ten selected students, of whom seven responded. These accounts followed a suggested structure based on the themes that had emerged in the interviews, including descriptions of stages, activities, deliverables, resource availability and support.

The coded and triangulated data revealed that the key factors determining effective management of the system were the lecturer's perception of the subject knowledge structure, the student's perception of an explicit pedagogy, and the provision of enabling supports/resources. In order to determine the underlying knowledge structure and how it manifests in pedagogic practice, a fourth research phase has been initiated and entails the examination of subject guides and subject documentation. For the purpose of this analysis, however, the interpretation of knowledge structure will be limited to whether or not it lends itself to a more *conceptual* or *contextual* approach.

Analysis framework

The focus of the analysis will be three particular subjects representing different classification strengths and the pedagogical approaches in their teaching which suggest different approaches to framing based on the perception of the teaching requirements for a specific discipline. An external language of description, following Bernstein, has been devised through which to 'read' the data, translate the evidence and draw conclusions. A strong classification value (C^{++}) is assigned to a subject clearly insulated from others, whereas weak classification (C^{--}) here refers to a subject encompassing multiple disciplinary roots. In determining the strength of framing value (F^{++} - F^{--}) over the various sites, the following principle has been applied:

F^{++} Clearly defined and controlled by lecturer
F^{+} Broadly defined and flexible control
F^{-} Open and encourages student control
F^{--} Entirely up to the student
F^{0} Not defined and no evident, consistent measures of control

The following is an overview of the framing values across the three selected subjects. The left-hand column in each represents the lecturer's perception of framing as evidenced through interviews and subject documentation, whereas the right-hand column represents the student's perception of framing as evidenced through written accounts. It is important to note that these reflect the pedagogic practice of the particular lecturer and the perception of the student, and are not necessarily a reflection of the knowledge structure itself.

Table 1. Framing values across subject types as perceived by Lecturers (L) & Students (S)

	Subject-type	**Theoretical**		**Mixed**		**Applied**	
	Subject name	Mathematics		Strength of Materials		Computer Aided Manufacturing	
	Knowledge Structure/ Classification	↑ $\mathbf{C^{++}}$		↑ $\mathbf{C^{+}}$		↔ $\mathbf{C^{--}}$	
	Curriculum approach	**Conceptual**		**Mixed**		**Contextual**	
		L	**S**	**L**	**S**	**L**	**S**
FRAMING	Selection	$\mathbf{F^{++}}$	$\mathbf{F^{++}}$	$\mathbf{F^{++}}$	$\mathbf{F^{++}}$	$\mathbf{F^{++}}$	$\mathbf{F^{++}}$
	Sequence	$\mathbf{F^{++}}$	$\mathbf{F^{0}}$	$\mathbf{F^{++}}$	$\mathbf{F^{++}}$	$\mathbf{F^{++}}$	$\mathbf{F^{++}}$
	Criteria	$\mathbf{F^{++}}$	$\mathbf{F^{++}}$	$\mathbf{F^{++}}$	$\mathbf{F^{++}}$	$\mathbf{F^{++}}$	$\mathbf{F^{++}}$
	Control	$\mathbf{F^{--}}$	$\mathbf{F^{--/0}}$	$\mathbf{F^{+}}$	$\mathbf{F^{+}}$	$\mathbf{F^{+}}$	$\mathbf{F^{+}}$
	Pace	$\mathbf{F^{+}}$	$\mathbf{F^{--/0}}$	$\mathbf{F^{-}}$	$\mathbf{F^{-}}$	$\mathbf{F^{-}}$	$\mathbf{F^{-}}$

Analysis

A conceptual pedagogy: Mathematics

Student written accounts describe the Mathematics lecturer as ‘a pure mathematician’, who does ‘the pure maths/concepts/theories first’ in two 1 ½ hour sessions consisting of ‘writing out formulae on the board and lecturing’. In contrast to student perception, the lecturer, himself a post-graduate student at an academic university, describes himself as ‘an engineer who uses mathematics as a tool.’ He is unequivocal about mathematics as initially about ‘fundamental’ principles which need to be conceptually grasped before they can be applied. He is quite clear on the structuring of the knowledge which leads to potential application.

> *‘You cannot solve differential equations if you cannot use integrals; you cannot do integrals if you cannot do trigonometry. You also need algebra, vectors... All of these have nothing to do with each other but you need them all to do differential equations.’ (Mathematics Lecturer)*

The subject guide indicates this progression (F^{++} Framing over Selection and Sequencing) and the lecturer spends the first class making this explicit. There is, however, in the student accounts no reference to an awareness of this progression. All Mathematics is merely labelled as ‘theory’. Mathematics is the subject with the highest failure rate (at the time of data collection), and is also the subject with the greatest traditional status. These factors need to be seen in the context of a Technical University where the majority of students do not evidence the mathematics proficiency required at an academic university and where the perception of the knowledge structure is framed by the context, in this case the notion of a ‘practical’ course of study:

> *“The majority of people, myself included prefer the practical examples first to see where we can use what we are learning, once we can see where we will use it, it becomes clear why we need to learn the theory and then becomes easier.” (Mechatronics S1 student)*

The lecturer makes it quite clear that this subject is not about application. It has to be applied in all other subjects. As such, there are no indications of pedagogic extension into application. Homework sometimes consisted of ‘writing up 4-5 examples on the board, getting progressively harder. Then he would do the hardest one with us and tell us to do the others for homework’, but which were not required to be handed in. Other homework consisted of tutorial assignments, but these were mostly undertaken without a tutor. ‘Even if the homework had to be handed in the next day, most students stayed in class and worked together.’ ‘The tutor was the one that marked all the assignments and handed them back to us about a week before the final exam’. The student perception of no consistent framing (F^{0}) over pace (regular evaluation of work) or control is countered by the lecturer’s awareness of specific problems which he picks up in class and for which he then ‘adjusts’ his teaching in order to accommodate the problems. Twenty five percent of all students polled requested Mathematics ‘more than once a week’ in the initial survey, and feedback indicates that they perceived the subject as ‘unstructured’. That the ‘students organized themselves into groups to combine their efforts in solving problems’ is an indication of their assuming control over the learning process (F^{--}). Furthermore, that they remained in class on the same day indicates implementing their own framing of the pace of work (F^{--}).

A contextual pedagogy: Computer-Aided-Manufacturing

The CAM subject involves three clear stages:

'The first stage is the introduction to the program and section of work, ... The second stage of the course is practice on the program (which in itself is the largest learning process) and a practical design that needs to be machined. The third stage is the practical itself involving the physical machining of the work piece.' (Mechatronics S3 student)

Student description reveals that each stage of work is 'checked throughout the day', mostly by the lecturer himself or a lab-assistant. The students are 'shown the bare minimum and expected to work the rest out for themselves. This creates a large learning curve, however it emulates the real world requiring use of common sense and lots of practice.' The use of the entire day enables the lecturer to work interdepartmentally, and also to 'get so much more done in CAM that I do four practicals as opposed to one practical due to the extra time that you effectively manage to get out of having a subject per day' (CAM Lecturer). The marking system is unique in that the work is marked continuously and if more effort is put into one particular piece or stage, the mark can improve. Alternatively, students can accept the mark and move onto a next practical. According to student feedback, 'slower class members are encouraged to get help from the faster ones'.

The consistent use of the word 'practical' in all the interviews clearly situates this subject as a contextual one. However, the lecturer starts the semester by issuing the 'theory' after which a test is written. Once they pass the test, the focus of the semester is 'using various computer programs to create various software jobs and then the software jobs get cut in the machine shop'. The reporting student ends his submission by saying that the teaching style 'links the theory to the real world and completes the learning process'. The framing over pace is extremely flexible (F^-) , allowing for those who need more time, as well as challenging those who can cope with more work. This flexibility is further supported by the fact that students are permitted to do the work at home if they have the correct software. The only criterion is that they present their work for evaluation on the same day. Although the lecturer does constant rounds, the framing over control (F^+) is not inflexible in that students are encouraged to help one another and the lab assistant is also often present. Only three students requested CAM more than once a week.

A mixed pedagogy: Strength of Materials

One glance at the subject guide for this subject is a clear indication of both a contextual and conceptual approach to teaching. The weekly topics cover fundamental *physics* and *mathematics* pertinent to the conceptual study of materials, with afternoon tutorials to support this. However, there are also regular laboratory practicals and assignments to support the physics element contextually. Student accounts confirm all support material being available on the network, and that they are required to read ahead. Classes always begin with the lecturer probing what the students know about the topic, and 'he would then start the lecture by providing the proper definitions and move on into the lecture'.

Tutorials and practicals are conducted in the afternoons, and supported by tutors who 'will allow students to tackle examples individually on the board. This approach gives students confidence and builds a certain amount of teamwork and working spirit in the class'. The lecturer 'enjoys giving assignments which provide good practice and understanding' and these are usually required to be handed in a week later. Feedback is given on all practicals and tutorials. The students are encouraged to help one another and in this particular subject students have the help of 'friends in other classes'.

Despite the conceptual/contextual mix, the pedagogy leans decidedly towards the former. This particular subject received the second highest request for 'more than once a week' (17 students). An interview with this particular lecturer reveals that he feels he is 'not able to fully cover all that I would have loved to cover, because it is too [conceptually] stressful on the students because ... to fully absorb the theory they can apply' cannot be done in a day. An experienced lecturer who teaches in three departments, he nevertheless states that the Mechatronics pass-rate in his subjects is higher than in other departments.

Discussion

The notion of Structure

Close examination of the data, particularly the student written accounts, reveals that a distinction needs to be made between the knowledge structure and that of the pedagogy. Subjects described as successful and perceived as 'structured' were those in which the following stages were explicit:

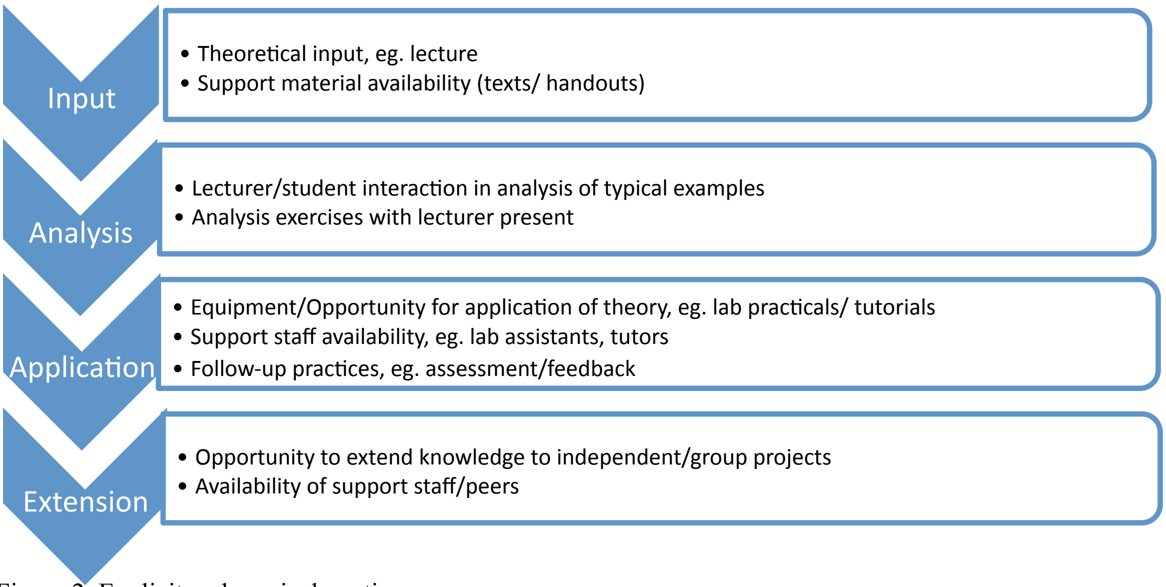

Figure 2. Explicit pedagogical continuum

These stages are controlled by *procedural framing*. A comparison of the three pedagogical styles reveals that the framing over control and pace are similar in the mixed and contextual subjects. In both cases there are deliverables which receive feedback, but in the case of CAM, the feedback is on the day itself. This may seem to suggest stronger framing over pace, but as the students are allowed to do more than the required work, it suggests they are granted the flexibility to frame their own pace. The presence of tutors or lab assistants and the encouragement of peer-support indicate the existence of control, but that it is flexible. In other words, the learning is not driven by the lecturer him/herself. Both subjects, too, evidence all the stages listed above. And yet, far more students struggle with Strength of Materials than CAM. The allusion to the densely conceptual nature of the former subject suggests that the question of structure applies to that of the knowledge structure itself and not the procedural pedagogic approach.

In the case of the mathematics pedagogy, which is purely conceptual and does not include the last two stages in the subject itself, conceptual grasp is intended to occur in the classroom, during the lecture, and the tutorial material is provided for reinforcement. I believe students requested more structure in this subject because they are not recognising the structure of the knowledge, despite the lecturer's attempt to make this explicit initially. They see 'structure' as different activities evidencing a practical learning continuum, and clearly 'marked' in time by stages of evaluation. I would argue, along with Bailey McEwan (2009), that both the conceptual and mixed subject topics are segmentally viewed by the students as a 'collection-type curriculum' within each subject, in other words, insulated from each other. This 'segmental' view of the curriculum is further supported by the fact that there is no reference to an awareness of having Mathematics 'more than once a week' in the 'Mechanics' subjects, such as Strength of Materials. The request for more 'structure' possibly has more to do with the knowledge itself being explicitly structured, scaffolded, and then linked. This would require a stronger approach to framing, and certainly warrants further specific investigation as to student perception of knowledge structures themselves.

Implications of shifts in framing strength over pace and control

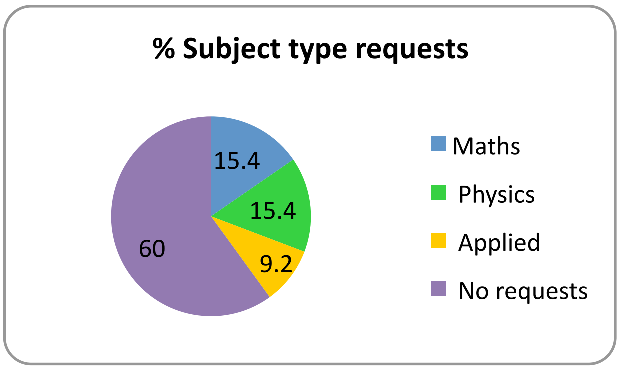

Figure 3. Percentage of subjects per type requested more than once a week

The initial quantitative survey polled one hundred students. In answer to the question 'Would you prefer some subjects more than once a week, and if so which', only nine students responded 'yes' and specifically requested

Mathematics, a physics-based subject *and* an applied subject. This corresponds to the 91% who endorsed the DPS system as granting flexibility and independence. While 35% of all the students requested Mathematics and/or a physics-based subject more than once a week, despite endorsing the DPS system, only 5% requested an 'applied' subject (one of four). The contextually-taught technology-based subjects, therefore, are experienced as more successful than the conceptual subjects. Student accounts and observation confirm that these are also the subjects in which students make use of the venues/resources until late in the afternoons, and in some cases on weekends. This suggests that the weaker framing on pace and control in the contextual subjects allows students enough time and opportunity to engage with the technology and to self-manage the required learning. One lecturer, who works inter-departmentally, compared the DPS system to that of his department in which there is the common practice of multiples of 45-minute periods and several subjects per day:

> *I like it, I prefer working like this. ...if you look at the basic program we do [different department], there's no time for students to sit down and actually do their work. If you take a full day subject schedule... they actually get time to do and follow up on the work for the next day. (Inter-departmental Lecturer)*

The provision from the first semester of self/group study periods in extending learning to application demonstrates the Mechatronics Program scaffolding of the process towards the predominantly Project-Based Learning (PJBL) which takes place in the third year in collaboration with industry. The benefits of PJBL are well documented and a staple element of vocational education. The key attributes are precisely the collaborative and problem-solving practices required of engineering graduates in the twenty first century. An unintended and welcome consequence of the organic development of cooperative learning practices has been the impact of diversity. The range of literacies and experience in the diverse Mechatronics student body has enabled many students to take on the role of peer mentors particularly for school-leavers without the benefit of experience. Whereas in other departments these students may have been placed in extended programmes, the DPS system enables these students to function in the mainstream programme as a result of the flexibility in pace and control. Several students have described the help they receive from and give to each other in the 'practical' subjects.

> *A lot of the students I helped managed to do well, (Mechatronics S1 student)*

> *The students that required assistance were generally assisted by the students that have already completed that part as you can go at any pace you like (Mechatronics S3 student)*

> *A lot of people organized themselves into groups according to their natural friend network while they were working on their practical projects (Mechatronics S2 student)*

> *The Study group helped us considerably. This course requires a lot of practice... Some students mostly who are not part of a study group did not do well. (Mechatronics S4 student)*

Yet a further benefit of the flexibility in framing over pace and control is the catering to student needs as regards access. In line with the trend towards student-centred education, curriculum design must take into account the heterogeneity of the student body (Walkington, 2001). The DPS system enables those employed in industry to continue their education by enrolling for one subject at a time and thereby being able to negotiate a day off per week, as opposed to three different sessions at different times on different days. The system also enables students who do not have access to facilities after hours to complete their requirements on campus, as well as those who need to maintain their part-time employment so as to fund their studies.

An interesting approach to framing of pace is the Wits University Mechatronics project subject. Initially, this subject was offered over a semester with three morning theory sessions and two practical afternoon sessions per week. In 2009, however, it was decided to 'run' the project full time during the first quarter and then the theory full-time during the second quarter (Bailey McEwan, 2009). The motivation for the approach was to enable the development of situated problem-solving skills in a cross-disciplinary region. The difficulties highlighted in the Wits research speak to the complexity of synthesising knowledge structures across disciplines and the focus on an alternative approach to framing of pace so as to accomplish this synthesis.

Framing implications for multidisciplinarity

It seems apparent that the more contextual or applied the subject, the more flexible the framing over pace and control needs to be to enable effective learning. However, Mechatronics as a knowledge region is fundamentally about innovation which "relies on conceptual knowledge" stemming from vertical knowledge disciplinary roots. "The more vertical the discipline, the greater are the conceptual coherence adequacy requirements in the curriculum... [which] include necessary coverage and appropriate pacing, but foremost among them is sequence" (Muller, 2008, pp. 25-26). The required level of abstract thinking to enable creative, problem-solving skills in twenty-first century engineering education depends on an entirely different approach to pedagogical framing than that required for a contextual pedagogy. This is challenged, however, not only by society's increased valuing of 'knowledge-in-use' and thus 'doing' (Barnett, Parry, & Coate, 2001), but also by the predominantly apprenticeship-based vocational training orientation of the former technikons. The shift to Technical University status and increased research thrust brings with it the challenge "to simultaneously perform seemingly contradictory functions" (Castells, 2001, p. 212).

Conclusion

Given the flexibility to design their curricula and pedagogies based on the complex needs of a multidisciplinary knowledge region and those of a diverse student body, the question has been how lecturers interpret these needs and what measures are implemented to facilitate them? The Bernsteinian concept of *framing,* which governs control across five sites, has been used as a conceptual tool to analyse the pedagogical approaches of three different lecturers in three different subject types in a tertiary engineering programme. Results suggest that in weakly classified or contextual subjects (multidisciplinary), strong framing on *procedural* selection/sequence/criteria, but weak framing on pace and control seem to best enable students to progress along a learning continuum. The learning experience is perceived as structured and successful when this strong framing manifests as an explicit pedagogy in which the stages are clearly signposted and supported by way of materials, equipment, opportunity and mediation. The DPS system is effective in subjects which reinforce procedural systems (problem-solving stages). It allows for diversity in ability and learning styles. It harnesses the diverse capital brought into the higher education context by providing opportunities for self-initiated cooperative learning, leading to the acquisition of vital teamwork practices. The organic development of socially mediated learning through peer mentorship has been particularly effective for school-leavers facing the demands of tertiary education. These benefits cannot be underestimated in light of the range of student abilities and experience brought into the Higher Education context, as well as the ideological access imperative.

The challenge for the system, however, is to re-examine the conceptual/contextual divisions in the curriculum. Given that theoretical grasp at a highly abstract level enables greater competences in the longer term, the approach to framing of conceptual pedagogies needs to explicitly reflect disciplinary coherence. However, we also need to acknowledge that our traditional student base lends itself to a more contextual pedagogy highly valued by industry, an increasingly influential stakeholder in engineering education. The reality of multidisciplinary Higher Education - an inescapable feature of the twenty first century – demands the capacity to design curricula and pedagogies that accommodate the inherent knowledge and social complexity.

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