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Contents

Introduction

The papers selected for the December 2007 edition of Paradigms come from key academic developmental research areas in the institution; namely, mathematical teaching, multilingualism, indigenous knowledge and work-integrated learning.

All the papers have been presented at local, national or international forums and were drawn from the Teaching and Learning Week at CPUT, the Foundation Event and the International Conference on Work and Learning. The authors regard this publication as a first step in developing their work for more formal publication.

Criteria for Paradigm papers
Paradigms focuses on learning and teaching issues relevant to higher education and the vision and mission of CPUT, therefore articles should at least do one of the following:

- Probe new ways of understanding and thinking about changes in Higher Education and the implications of the changes for practice in the departments

- Show new ways of interpreting and reading practice in order that it may inform new and improved ways of reconstructing practice.

- Deal with appreciation and disclosure of good practice through critical reflection on research project(s) in which new strategies were being implemented.

- Highlight critical debates around policy in higher Education in a manner that will create an opportunity to find a way forward and design it differently.

- For empirical papers it would be nice to have a clear conceptual framework to give focus to the paper [enable readers to appreciate the paradigm through which data is being read and interpreted].

- We are particularly interested in higher education research. The areas of research may include any facet of teaching and learning in the institution which are of interest to the educational community.

- May be this should be the case even for the design section, decisions taken for ways and means of collecting data should be substantiated by referring to authors that deal with those particular issues.

- It would be nice if the authors would also try to provide detail around issues they are dealing with for clarity and nice flow of discussion.

- Contributions should be less than 5000 words and include no layout except for paragraphing and headings. There must be sub-headings and an abstract. Contributions should be clearly and concisely written.

Hands on enquiry in the teaching of the tetrahedron in mathematics with special reference to teacher education at the university.

Sibawu Witness Siyepu

(Paper based on a presentation at the teaching and learning week, August 2007)

Introduction

The National Curriculum Statement in Mathematics advocates for a move towards allowing learners to explore mathematics in the classroom in order to discover procedures, conjectures and formulae on their own (Department of Education, 2002). This means there needs to be a shift from teaching in old traditional methods of mathematics. Interestingly this stance assumes that teachers are familiar with these changes. It ignores the well known fact pointed out in Deyi (2007) that in South Africa some of the teachers teaching mathematics are qualified in other areas other than mathematics. This situation gives rise to a question whether there is much training taking place to assist them to cope with the transition expected. At this juncture, there is concern that teachers have not received adequate preparation to change from the traditional teaching approach (teacher tells) to the induction approach (self-discovery approach) to meet the high cognitive demands of the new curriculum (Kgosana, 2007). The workshop discussed in this paper attempts to familiarize senior phase teachers with an inductive approach in the teaching of geometry.

The workshop discussed in this paper engaged senior phase teachers, subject advisors and other stakeholders with respect to building a net, deriving the formula for the total surface area and furthering a method of developing a solid model tetrahedron. This involves the construction of equilateral triangles as well as counting the number of edges, faces and vertices in a solid (tetrahedron). In this workshop participants explored their understanding of the concepts and/or terms, like faces, vertices, edges, bisect, perpendicular, perpendicular bisector, congruent, total surface area of a tetrahedron and Eulers' formula for solids. The paper concludes by showing that while the approach is a toll that can be used to contribute positively to teaching and learning mathematics, more time needs to be given to capacity building and training of teachers.

Background

The experience of interacting with Eastern Cape Grade 9 mathematics teachers indicated that teachers have difficulties with developing geometric solids, nets and deriving conjectures and formula for the total surface area of solids. This emanates from the common task of assessment (CTA) where question 3.2.1 requires learners to write the formula for the volume of a cylinder (see appendix A). The nature of the problem needs an understanding of the total surface area of a circle (Department of Education, 2006). It should be noted that the problem was not to write the formula for the volume of a cylinder but was the derivation of it. In a mathematics workshop conducted to solve problem areas in a CTA, question 3.2 was a major problem for the teachers present in the workshop. This arguably encourages the presenter to develop an interest in designing activities for deriving formulae for the total surface areas of solids. This workshop focused on the tetrahedron. The understanding of the area of a triangle paves the way to the understanding of almost all areas of plane surfaces and volumes of regular solids as the volume of many regular solids is calculated as volume is equal to the area of the base times perpendicular height, for example volume of a cylinder is equal to the area of the base circle times the perpendicular height ($V = \pi r^2 H$).

The workshop attempted to address the problem of teachers who were not familiar with hands on enquiry, which is a practical learning process where participants construct knowledge on their own, to how to develop nets, solids and derive formulae of finding total surface areas. The aim was to equip teachers with skills to make meaning and construct understanding of the mathematical processes they engage with in applying the approach in teaching

Participants were given 5minutes to form groups of 5 members in each table. Each group had to select a group leader, material handler, scribe, process observer and reporter. The group leader was responsible for the progress of the group, that is, to see to it that all participants focus on the task. The leader also had to pay attention to the availability of working material. A material handler was responsible for the use of material to perform all the activities in the workshop. Material handlers may change after each activity. A scribe was responsible for recording, that is, to note contributions of the group towards the solution of the problem. A process observer had the responsibility to monitor the group members to stick to time scheduled for the activities and to stick to the task. And the reporter gave feedback on the contribution of the group.

This was followed by the first activity (allocated 15 minutes) which comprised of three steps. Step one was outlining the description of concepts listed. These concepts and terms were taken as central and a must to understand before embarking on a hands-on-enquiry-approach as they prepared participants to make meaning and understand concepts better. Step two allowed the facilitator an opportunity to give participants advanced prepared glossary of concept. The aim was to compare the existing concepts with ones prepared by participants. This helped participants to conceptualise terminology involved in that they got to think critically about the similarity or difference they see. In the third step groups gave reports of the processes undertaken and discussion is allowed. Many researchers, such as Buthelezi (1999), claim that there is a problem of conceptualization among mathematics teachers and other stakeholders. The aim of this activity was to ascertain the understanding of the participants of concepts and to give feedback (see Appendix B). They had to briefly outline the description of the terms or concepts on their own. They were then provided with the glossary of terms or concepts (see appendix B) and had to compare their descriptions with the glossary. This was followed by reports where agreed upon concepts that are compared to the glossary of concepts are presented by the group.

Drawing on the reports given, it would seem almost all the participants were not familiar with concept annulus and Euler's formula for solids. Some were not acquainted with terms such as bisect, bisector of an angle, perpendicular bisector, tetrahedron, two dimensional and three dimensional shapes. All the key concepts are explained and/or defined in appendix B. I refer the participants to appendix B and we worked together to unpack the meaning the concepts.

The second activity was allocated 30 minutes and was designed to allow the participants to use protractors and pair of compasses to construct triangles and use them to derive formulae for the total surface area of a tetrahedron. The following is the process they followed:
Step 1. Use the A4 cartridge papers, compass, ruler and lead pencils supplied to construct an equilateral triangle of 4 cm long, this means each side of an equilateral triangle measures 4 cm.
Step 2. Use each of the 3 sides of the equilateral you have constructed to construct 3 more congruent equilateral triangles using these 3 sides as the bases of the new triangles. We speak about an equilateral triangle of sides 4cm long.
Step 3. Find the area of each triangle and then make a conjecture for the total surface area of a tetrahedron using the net constructed in step 2.
Step 4. Groups report.

Due to the lack of adequate mathematics knowledge some of the participants did not know how to use a protractor or a pair of compasses and were hence unable to construct or measure angles. The participants also explained on their own that they are not familiar with hands-on approach using compasses and protractors to construct nets and solids. The notion of forming conjectures was unfamiliar to most participants as many participants ask the meaning of the concept conjecture. This, as stated above is the result of the fact that teachers teaching mathematics may not necessarily be mathematics teachers. It is a well known fact that South Africa has a small number of qualified mathematics educators. Findings by Deyi (2007), show that even those who are qualified leave the profession for other better paying jobs.

Activity 3 was also allocated 15 minutes and it focused on introducing participants on the practical aspects of learning the hands on enquiry approach. Whereby, participants were given an opportunity to apply mathematics' knowledge, such as tessellation from other units of the subject. The process involved encouraged participants to use the material constructed in activity two to build solid of a tetrahedron. They were given the following instructions:

- Use the net constructed in activity 2 and construct dotted lines 5mm away from the solid lines of the net. These dotted lines are drawn to make tabs for gluing the solid together.
- Use the scissors provided to cut the net along the dotted lines.
- Fold the net along the outer solid lines to form a solid.
- Use the glue stick (pritt) provided to seal up the solid.
- Groups report.

The fourth activity (allocated 20 minutes) was focused on conceptualization of physical dimensional aspects of a solid.
The participants had to follow these steps:

- Use the solid formed in activity 3 to count the number of faces, edges and vertices of the solid.
- Use the cube and octahedron supplied to count their number of faces, edges and vertices. There is a special relationship among the number of faces (F), edges (E) and vertices, (V). Work with subtraction, addition and equal sign to find the relationship among the number of faces (F), edges (E) and vertices, (V) of the three solids, that is tetrahedron, cube and octahedron. Make a conjecture and generalize, that is, find the general formula for finding vertices or edges or faces of a solid if others are given and one is unknown.

- Groups report.

It was easy for almost all participants to count number of vertices, edges and faces but it was a big problem to almost all groups to make a conjecture and to give a general formula, which is Euler's formula as $F+V=E+2$. This is because some of the teachers themselves could not conceptualise abstract figures of mathematics. Even if they know that they had problems in conveying these, they seemed not to knew what to do about it and rather choose to explain simple sums as explained by the textbooks (Buthelelzi 1999)

The fifth activity (allocated 25 minutes) was aimed at consolidating activity 2 and 3 to enable the participants to apply the knowledge acquired in the two activities. They were given the following instructions:

- Use your compass to construct a perpendicular bisector of one of the triangles in a net constructed in activity 2
- Measure the height of the perpendicular bisector constructed in step 1of activity 4.
- Calculate the area of a triangle with a measured perpendicular bisector. This perpendicular bisector assists the participants to determine the magnitude of the height of this triangle as the area of a triangle is ½ bh, b is a base and h is a height.
- Calculate the magnitude of the total surface area of the whole tetrahedron.
- Groups report.

As we used collaborative approach many participants understood the application of the derived formula to calculate the total surface area of a tetrahedron.

The last session of the workshop was aimed at getting feedback from the participants for improvement purposes. Group members were to collaborate and discuss what they found good and less useful in this workshop in relation to their teaching of Maths at school. It was also to identify what could be done to improve and further ensure that the workshop contributed to their professional development in the subject.

Participants felt that the activities should be handled simultaneously with the explanation of concepts. According to them, this would strike a balance between theorizing concepts and application of these concepts in formulae during class. The fact that some of the concepts were new, participants felt that there was a need to focus on maintaining this balance until they are confident in terms of teaching these.

Conclusion

The author conducted this workshop to support Grade 9 teachers, subject advisors, and other stakeholders with respect to conceptualizing sections like solid geometry. It intended to assist participants in acquiring an understanding of accurate measurement, the construction of triangles, the use of mathematical instruments, and constructing perpendicular bisectors. The attempt was to change teachers' traditional teaching approach (teacher tells) to an inductive approach (learner discovers) as recommended by the National Curriculum Statement in Mathematics. However, interventions of this nature would need enough time to ensure that effective transition takes place. In a case like ours, where teachers may not necessarily be trained mathematics teachers, more time is needed. Linked to this is the need to support teachers conceptualise mathematics more. This would ensure that their skills in mathematics teaching are enhanced for effective delivery. Supporting teachers in mathematics would also reduce problems that students bring to institutions of Higher Education. In that, should teachers get enough and adequate training to teach mathematics, students entering HEIs would be adequately prepared. The current situation is they (students) are not well prepared and this is concerned with, amongst other things, the way in which teachers are supported in teaching mathematics.

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Appendix A

Question 3.2

Discuss in pairs how you will answer the following questions and then answer them individually.

3.2.1 Write a formula for the volume of a cylinder.

3.2.2 Use the formula for the volume of a cylinder to show that volume (V) of an annulus cylinder can be given by the formula: $V = \pi H [(R-r)(R+r)]$.

APPENDIX B

Glossary of terms and/or concepts

1. Triangle is the figure formed by three segments joining three non-collinear points.
2. Congruent polygons are polygons that are equal in all respects.
3. Equilateral triangle is a triangle with all sides equal.
4. Area is the amount of space covered by a flat surface. It is measured in square units.
5. Two dimensional shapes are flat surfaces with only length and breadth. For example a soccer playing ground.
6. Three dimensional shapes are flat surfaces with length, breadth and height combined together to form a solid. For example match box.
7. Vertices is a plural of a vertex, vertex is a common point where two or more lines meet.
8. Edge is the line of a three dimensional shape where two plane surfaces meet.
9. Face is one of the plane surfaces of a polyhedron bounded by edges
10. Bisector of an angle is the ray that divides the angle into two congruent adjacent angles
11. Perpendicular lines are lines that intersect to make equal adjacent angles.
12. Perpendicular bisector of a segment is a line that is perpendicular to the segment at its midpoint.
13. Circle is the set of all points equidistant from a fixed point. The fixed point is the centre, and the distance is the radius.
14. An annulus is the region between two concentric circles.
15. Cylinder is a solid shape whose bases are formed by congruent circles in parallel planes and whose lateral surface is curved.
16. Volume is the amount of space that an object or a container has or amount of space that can be filled in an object or a container.
17. Tetrahedron is a regular polyhedron bounded by four congruent equilateral triangles. Its area 2(bh) meaning 2 times base times height.
18. Cube is a rectangular polyhedron composed of six congruent squares.
19. Octahedron is a regular polyhedron composed of eight congruent equilateral triangles.
20. Euler's formula for solids is $F + V = E+2$; F represents faces, V represents vertices and E represents edges.

Promoting the multilingual classroom: Why the significance of multilingualism in HE?

Somikazi Deyi, Edwine Simon, Sandiso Ngcobo, Andile Thole

(Paper presented at the national Foundation Conference, Conversations about Foundation, Granger bay, 2-3 October 2007)

Introduction

The role of language as a medium of instruction in promoting effective teaching and learning is an issue that has occupied many scholars all over the world for many years (Orr 1987a, 1997b). This issue has been a concern mostly in countries where immigrant children are in the minority such as United States and Canada (Krashen 1981). It is in these countries where research has been widely conducted, a number of legislations passed and amended throughout the years. Despite such developments debates on use of lanaguges still rage on.

In South Africa where democracy is still at its infancy it is no wonder that today we have not yet resolved the language of instruction issue. As debates continue the problems associated with the use of English as the sole medium of instruction still engulf our education system. his happens despite the political will of the democratic government that has since its inception promulgated multilingual policies that give learners the right to be educated through their home languages.

It is the above concerns that prompted the discussion in this paper. The paper draws on a workshop that was collaboration between academics from Cape Peninsula University of Technology (CPUT) and Mangosuthu University of Technology (MUT) involved in Extended Curriculum Programmes in their institutions. Of importance here is to discuss the significance of promoting multilingual classrooms in Higher Education and further share work-in-progress on the use of multilingualism as an approach to teaching and learning. Most importantly, the overall aim of the paper is to engage higher education practitioners in a constructive and collaborative discussion on the issue of bi-/multilingualism in higher education.

Multilingualism in South African Higher Education (HE) Institutions

There are varied reasons for promotion of multilingualism as significant in South African classrooms which includes using the home language of the learner to create an enabling environment to make sense of concepts. Such an approach at the initial stage of the workshop was considered necessary due to the fact that students when entering Higher Education are not adequately prepared to cope with academic demands and the language of teaching and learning seems to be a barrier.

Political arguments

The democratic government of South Africa that dates back from 1994 has throughout the years promulgated a number of multilingual policies that give recognition to and require the development of indigenous African languages for use in high status domains. Multilingual policies that give learners and students the entitlement to be educated in their home language are: the *South African Constitution* of 1996, *Language in Education Policy* (LiEP) of 1997 and *Language Policy for Higher Education Institutions* (LPHE) of 2002. Both policies advocate for use of African languages in teaching. However, more than thirteen years since democracy very little progress has been made towards the implementation of multilingual policies, especially in higher education institutions (HEI). The LPHE commits to the long-term development of indigenous African languages for use as languages of learning and teaching (LOLT) in HEI thus giving the impression that the use of mother tongue (MT) can be implemented in the long-term. This trivializes the pressing academic issues that have for a long time and continue to face the students that are not coping with being taught in a second language. Having said that, the policy could also be understood to mean that HEI need to take their time and investigate this matter thoroughly before embarking on full implementation.

In acknowledgement of the fact that the language of instruction for the majority of the citizens of this country constitutes a barrier to access and success in higher education the LPHE then requires of all higher education institutions to participate in facilitating and promoting the goal of the National Language Policy. The multilingual approach in facilitating teaching and learning has the backing of the policies discussed but there is also an academic argument to it.

Academic issues

Of the few learners who manage to sit for the Grade 12 examinations the results are not pleasing. According to a report in the *Rapport* newspaper on research undertaken by the South African Institute of Race Relations only 8% (84 741) of the 1 057 935 learners who started Grade 10 in 2004 passed the final Grade 12 examination in 2006 well enough to obtain entrance to university study. Unfortunately, only 4, 8% passed mathematics and 5,6% passed science on the higher grade. In response the Department of Education (DoE) argued that learners' limited proficiency in English, the general language of teaching and learning (LOTL) in South Africa's government schools, may be an important contributing factor in these performance levels, and that learners may achieve higher levels of success if they had access to the examinations and in the teaching and a learning process in a language they knew well (Webb, 2007). It was however not for the first time that the DoE had identified LOTL as the major cause of the appalling state of education in the country.

The above-mentioned conditions prevalent in the schooling system impact negatively also on HEI. As a result of Grade 12 learners' poor performance in their examinations the majority of black school-leavers in South Africa who venture into HEI do not qualify for direct entry except through Extended Curriculum or bridging programmes. This is particularly so in fields such as medicine, engineering and technology where very good higher grade results in mathematics, science and English are the major entrance requirement. However, not many learners even attempt mathematical subjects at higher grade level in school, as pointed out above. At the same time the ECP help boost the enrolment figures in HEI which would otherwise be half empty or closed down due to poor Grade 12 results. Not surprisingly, the programmes mainly attract black African students who are mainly from disadvantaged educational backgrounds wanting to pursue scarce skills. It is however noted that the ECP have throughout the years failed to achieve what they were meant to redress partly due to that English remains the sole medium of instruction in South African HEI. When black African students with poor matriculation results begin higher education through ECP they further face hurdles in acquiring the basic understanding required in their fields of study. Students have to grapple with scientific concepts, general academic vocabulary and its corresponding expressions that are often foreign to them.

It appears that English poses a problem for use at an abstract, symbolic level of thought, particularly in working class communities and in rural areas (Webb 2002a & 2002b). It is this problem associated with the abstract nature of scientific and general academic terminology that it is necessary to consider the use of multilingualism as an approach to teaching and learning in HE.

The importance of a good foundation in acquiring meaningful knowledge in a scientific subject is confirmed by a study conducted at the University of Durban-Westville on using isiZulu to teach chemistry to isiZulu-speaking students. In the study Shembe (2002: 06) points out that "the hierarchical nature of chemistry is such that the understanding of certain key concepts is fundamental to the proper acquisition of subsequent knowledge". Shembe further argues that if this understanding does not occur effectively, students "memorise certain points from the text-book long enough to regurgitate them during tests and exam time." Shembe concludes by saying that such "learning" is not effective and inevitably "leads to a high percentage of African students who either drop out in the first year or fail". The same could be said to be true to what has been happening in most foundation programmes, as pointed out above. It is for these reasons that it is necessary for English lecturers to consider teaching academic, content and English vocabulary through bi/-multilingualism. This is suggested in consideration of research that asserts that language is best developed within a content-based curriculum (Short, 1993; Snow, Met and Genesee, 1989).

Research evidence

In pursuing this argument, the thinking is encouraged by Cummins' (2000) assertion that one of the most strongly established findings of educational research, conducted in many countries around the world, is that well-implemented bi-multilingual programmes can promote literacy and subject matter knowledge in a primary language without any negative effects on development in the second language. In the country's situation this translates into using mother tongue to facilitate the understanding of academic concepts with the hope that it would not interfere with the acquisition of the other tongue (English). The idea seems plausible since it is backed by a body of research, conducted mostly in countries such as United States of America, Canada and a few in South Africa, testifying to the positive effects of bilingual education on foreign language achievement and educational development (Baker, 2000; Cummins, 1979, 2000; Hoffman, 2001; Ramirez, 1992; Sanz, 2000; Sherwood Smith, 1992; and Skutnabb-Kangas, 2000; Shembe 2002). Research suggests that bilingual learners may develop flexibility in their thinking as a result of processing information through two different languages. For example, Sherwood Smith (1992: 21) refers to metalinguistic skills and to superior abilities of bilinguals with a notion that in the process of acquiring and using different languages they may have the opportunity to reflect consciously upon the ways in which languages differ. In this regard, I am particularly intrigued by one of the fundamental assumptions underlying the efficiency of dual language instruction that *skills and knowledge* *learned in L1 transfer to L2* (Goldman, Reyes and Varnhagen, 1984; Malakoff, 1988 – cited in Keshavarz and Astaneh 2002). This suggests that if students understand and know how to do something in their primary language they should be able to transfer this knowledge to English using the relevant taught terminology. This could mean producing bi-literate citizens who could be better placed to share knowledge gained to the benefit of their communities.

Creating a multilingual classroom: some examples from classroom based research

As discussed above that in view of the Language Policy for Higher Education (LPHE) of 2002, and the linguistic context within which we operate there is a need to rethink language practices/language use. Multilingualism is recommended in the policy for Higher Education as a means to ensure equity of access and success in higher education. Even though many institutions have developed language policies that display how multilingualism will be promoted in communication and outlook, the implementation of multilingualism in teaching and learning programmes seems to pose a serious challenge. This section of the paper attempts to closely look at the following:

- Understanding of multilingualism in the context of our (lecturers) work.
- Challenges that are facing us in relation to implementation.
- Ways of resolving such challenges
- Benefits multilingual practices can yield.

In order understand multilingualism in the context of work, there is a need to be aware of the diverse context we work in. This awareness can be displayed by creating opportunities or language exercises to take place. These exercises could be in the form of unpacking the particularized vocabulary of the discipline. In the process concepts that present challenges for the learner can be teased out, and explained. One explained learners can then provide the equivalents in their own languages. In cases where learners' mother tongue is not strong, allowing research (asking other people either in class or at home wit the hope to give feedback) is necessary. In planning such activities, doing the language profile students is important.
The language profile can be done through a questionnaire which could be completed by students.

Because challenges to give multilingualism a status are institutional rather, this refers to the prolonged language policy development at CPUT, than confined to classrooms. This means we have an opportunity to easily use our classrooms to overcome such implementation. The benefits could be seen in students' perceptions

Vignette 1 in Graphic Design

The research investigates the possibility of using multilingualism in an extended Curriculum Programme in Graphic Design to enhance learning. Multilingualism in the classroom poses many questions and many problems. Being faced with a richness of diversity amongst our students, calls for an approach that would create an enabling environment for use of other languages, without negating English. It is this richness that we are taping into so that students see their languages as resources to draw on. Using home languages creates an opportunity to develop an additional language alongside the home language (Winberg; 2006). Using this diversity "as training on the one hand, and education on the other hand, is imperative to ensure that multilingualism creates a language development space for learners.

Looking at the various cultures inherent in our classroom and we are trying to make sense of issues that matter; to understand social justice, racism (class and race) and question results and encourage the student's to make choices through critical thinking, problem solving and reflection.

This is done using multilingualism by means of story-telling; poetry; creative writing, the appreciation of beauty- the arts and design. Students everyday use of language when carefully guided bring about change in the classroom. This is how it began in this particular,:

Foundation mounting workshop
The workshop introduces the student to the practical understanding on how to present their two dimensional design work for each portfolio evaluation.

Here are the technical skills that the student's are required to master. These examples need facilitation that is sensitive to language applications

- To measure accurately
- To cut the measured area sharply
- To understand how to calculate and prepare the designed image for mounting
- To mount the finished design
- To be able to present designs mounted onto a flat black sheet of paper or a cut window mount on white card
- To understand the concept of presentation

A peer workshop initiative: An Overview
The third, second and first year ex Foundation students conduct the mounting workshop for two hours from 2-4 P.M. in Term 1. The students demonstrate and help the new Foundation students how to mount their practical design work for their first evaluation.
The workshop is the "Foundation" for the new students to build on for subsequent evaluations throughout the academic year. Follow up workshops are held throughout the year when required. It is accepted in the graphic design department that ex-Foundation students, when they pass into the next level of study, they will put back into the Foundation Programme some of their expertise. In this way they help to empower the new students, with important skills required for graphic design.

An important aspect of these workshops is that they are given in the student's mother tongue. There are sufficient ex foundation students in the department from year 1, 2 & 3, who are able to conduct the two most important workshops ' mounting" and "painting" in Xhosa, English and Afrikaans.

The "painting" workshop is held in Term 2.

The rationale behind the concept is that empowered ex Foundation students, who have graphic design technical skills will in turn share and empower their peers.This very successful initiative was put in place when the programme began in 2003. B.Tech students were asked to help in order to overcome a very real practical skills problem. In that year the more advanced Foundation students helped one another to master the technical skills required for graphic design.

This tradition has continued ever since that first year.

Reflection on the use of Multilingualism

Multilingualism used as a teaching method in the classroom is becoming the norm at Foundation level as it is now integrated into all practical and language oral presentations. Using multilingualism in the oral presentations is well structured and integrated and in this way brings the real world into the classroom; and is most appropriate for oral presentation discussions, group work and the interactive student audience target market. Like teaching a concept of tone as one colour is used to re-create an advert and a poem in not more than 5 lines is written to explain the concept and understanding of the transformed advert. The students were not restricted to English and could use any language of choice and write as some of them did in their "mother tongue" placing visual and verbal communication in context. They wrote in Chinese, Xhosa, Afrikaans and English. Languages again used in the presentations are: Afrikaans; English and Xhosa

The communication and language component in design practice is teaching the students about understanding academic development as an interactive class activity, which in turn prepares these young designers for the "real world" graphic design industry and that "language has aesthetic cultural and social dimensions"

The diversity of language and imagery are the keys to unlocking the hidden talent of the young minds. More and more we are finding that communication skills are important in an academic environment, in order to develop "self awareness," knowledge product and an ability to think innovatively in alternative disciplines. Multilingualism is a great and enriching experience in the classroom. The diversity of language is a personal development for each student, and it is encouraged in many creative writing projects and is integrated in visual and verbal communication projects in graphic design.

Vignette 2 in chemical engineering

Linked to examples above is an example which displays the process involved in unpacking concepts in chemical-maths, Chemical Engineering. The process involved encourages students to work in groups. The process is in the form of steps to ensure a clear process:

- The first step is to identify concepts, in a unit or chapter that is about to be taught, that pose a difficulty to understanding
- The second one is to unpack the meaning of these concepts in English
- Students then find equivalents or phrases that explain the concept in mother tongue. In cases where some of the students use mother tongue only, the lecturer or students themselves take the role of an interpreter. This ensures that all participants are on the same level in terms of understanding the discussion.
- After that they do the back translation and agree on one more appropriate for the context of Chem-Maths.

The table below is an example of the discussion above:

Concepts identified

English	isiXhosa	isiZulu	Afrikaans	TshiVenda
Reaction	udibaniso			
Molecular Formula	Ubume bemoletyhul	Ingxenye yezinto ezinamandla ahlanganisayo futhi abumbene ngamandla amakhulu	molekulvormela	Ifha nomboro ya vhuiluma yazwithu zwo fhambanaho zwire kha tshithu
Ionic Compound	Iintlenge edityanisiweyo	Izinto ezakhiwe ngendlela yokuthi iyahlangana futhi iyaphusha		
Substance	Into ephathekayo			
Forces		Amandla esiwathola phakathi kwezinto ezimbili mhlawumbe uyayidonsa noma uyayidudula		
Natural	ezendalo			
Synthetic	Ezenziwe ngabantu			
Formula Unit	Ifomula yento enye			
Ionic substances	Izinto eziyintlenge			
Computer generated	Eyenziwe ngekhompyutha			
unit	Ubonisa le nto uthetha ngayo			

The process does not only enable students to think critically about their learning but it also creates an opportunity to increase their study skills. Concepts are internalized through such a process, so there is an amount of deeper learning taking place. Since the process involves interpreting of concepts it allows understanding of concepts students are dealing with. Even though some of the students, like the Afrikaans speaker, were not so open to the process but they were able to transfer the "scaffolding" process involved in making sense of concepts learnt. This is affirmed by students perceptions on the process.

Students' perceptions on the use of Multilingualism

- Using mother tongue alongside English helps one think deeper about the concepts
- One starts looking at concepts and words in a sentence rather loose items.
- It is now easy to apply the process into other courses of study.
- It helps me to interrogate text, I go beyond the surface meaning of concepts involved

- One becomes an independent learner because once you have managed to understand that you can use your language to fall back on, you can also do your translation. This translation helps you to understand.
-

Drawing on the above points, it could be argued that students bring to the teaching and learning environment a wealth of understanding all that needs to be done is to embrace their languages, by using them to mediate understanding. This would enhance their understanding of concepts in any context. Some of them felt that the gap between language use at primary school level and high school is huge. At primary school mother tongue is the main language of facilitation, across all subjects. This practice yields to code switching and code mixing in high school, and a monolingual approach in HE, where English is the only language of teaching and learning. This becomes a complete change for the students and may lead to misunderstanding of concepts taught. So, the benefits of multilingualism are that an opportunity is created for students to use mother tongue while their second language skills are developing.

Lecturers' views on the use of multilingualism

Lecturers involved in multilingualism have first invited such a programme to their classes because there was a need. Students could not comprehend with concepts or written text. This led to working together. They perceive the process to have done the following:

- Enhanced the cognitive development of the students. Students seem to transfer the process followed in implementing multilingualism in the class across. This process involved, identifying concepts, unpacking concepts first in English and then find the equivalent in the home language. This pattern of learning, according to the students, became a study method across subjects. This assisted them in understanding their work fully or accounting for their misunderstanding. This process creates an opportunity for students to think carefully and critically about their learning decoding meaning in the language they are familiar with before translating into an additional language (Deyi; 2007). They could pin-point their (mis)understanding (mis)conceptualization through the process. Their language skills displayed a particular level of development. A discovery made by scholars such Winberg (2006) in their language research. This shows the significance of creating a multilingual environment in learning to enhance conceptual development.
- The confidence of the students is boosted because multilingualism prepares a space for mistakes and correction in a healthy learning milieu. Mid-intervention students seemed more comfortable to learn and ask questions. This is shown by results of their classroom tasks. In this process students' fears in making mistakes, through using the language become reduced. Their confidence becomes evident in oral presentations where they either resort to systematic code-switching in case some of the words have slipped or are unknown. Instead of seeing language as a barrier, they tended to straddle between the languages used in class or in their groups. Also, in cases where one goes into a blank they invite their peers to bring the word out. This becomes a great process where all students become involved in learning. The level of communicating ideas also improved.
- The time is short, there is need to increase the intervention to a year that will empower enough to conduct multilingualism independent of team teaching.

> According to lecturers involved, time was an impediment to adequately prepare students to go deeper the actual subject matter per concept in each unit. According to these lectures, multilingualism could have been implemented much more earlier to ensure that students who enter HE have their concepts taught in their home language as a resource to build on. While this is the case, the least time available to implement multilingualism made a huge difference. It became imperative to integrate language across our subjects to ensure that all students have the opportunity to achieve success in learning.

Conclusion

This classroom based research, even though it is quite on a small scale displays cognitive advantages in using multilingualism. However, it is early to use to draw any concrete conclusion even though there are traces of success. One of these is the manner in which students' confidence has increased, in participating. Even though there is significant increase in marks attained by students, we feel that we cannot say multilingualism is the sole attribute but rather one amongst many. We hope that this years' group will inform us how to introduce more activities involving multilingualism in the future. We can then make comparison and conclude that the intervention is working well. It is also significant to highlight the fact that it is not only understanding of concepts that is achieved, but also development of English as a language that they have to use in accessing textbooks, assessment tasks, and communicating with broader world. An observation that was made by scholars such as Winberg (2006) that when concepts are taught in learners' home language their additional language skills also develop. The process proves, once again, that there cognitive advantages in learning concepts in the students' home language (Krashen, 1981).

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Indigenous Knowledge: Systems or Resources?

Terry Volbrecht

(Paper based on a presentation at a seminar entitled "Unpacking the IKS Puzzle", as part of Teaching and Learning Week, at the Fundani Centre for Higher Education Development, 23 August, 2007.)

This paper is based on my understanding of Indigenous Knowledge, an understanding that has grown through intermittent engagements with this field of study and practice. These engagements have included reading some of the published literature in the field, attending seminars, workshops and discussions, surfing the internet for insights and information on the topic, and writing on the subject in the context of Recognition of Prior Learning (RPL) (Volbrecht and Hendricks, 2007).

It is my impression that there are two main ways of approaching Indigenous Knowledge (IK): one which others and I call the "systems" approach (as in the familiar term Indigenous Knowledge Systems [IKS]), and one which I would like to argue for in preference to this – the "resources" (IKR) approach.

Before I proceed to characterise these two approaches, I would like to look briefly at the etymology of the word "indigenous", based on my reading of several dictionary definitions It is derived from the late Latin word *indegenus*, from the Latin *indigena*, meaning "native", from the Old Latin, *indu* and *endo*, meaning "in, within", and the Latin *gignere*, meaning "to beget". It refers to something having originated in and being produced in a particular region or environment as in the expressions, "indigenous plants" and "indigenous culture". A second meaning revolves around something being considered innate, inborn or native.

If I relate these meanings to indigenous knowledge as it is represented in the relevant literature, it appears to have the following characteristics. It is generally

- generated within communities;
- location and context specific;
- not systematically documented (here we usually encounter the binary of orality and literacy);
- concerned with critical issues of human/animal/plant life, food security, primary production, human and animal health, natural resource management, and related practices concerned with policy, planning and design;
- dynamic – based on innovation, adaptation and experimentation;
- holistic – a "way of life", linking knowledge to wisdom (UNESCO 2003).

It is the holistic view of IK that in my view informs the "systems" approach. I don't have any objection to anthropological or cosmological attempts to define indigenous knowledge in a holistic way. I do have a problem when these approaches get stuck with a binary opposition between indigenous knowledge and other forms of knowledge, and with sweeping generalisations and abstractions that are not linked to specific contexts. I would like to see a shift away from decontextualised epistemological binaries that counterpose Western/colonial forms of knowledge with "indigenous/pre-colonial" forms of knowledge. Instead I would like to see a discourse situated within contemporary debates (Rist 2003) about the nature of development and how it conceptualised and practised in specific contexts. The UNESCO (2003) project I have already referred to gives an indication of what such an approach would entail.

In the rest of this paper I want to indicate briefly how some theoretical constructs put forward by Basil Bernstein (1999) could be helpful to us in thinking through how IKS could be practiced in a transformative way. Before doing so I want to repeat that I am not opposed to holistic or systemic conceptualisations of IK. My point is that these approaches tend to be sterile unless they are brought in to play within specific contemporary developmental contexts. Within such contexts, IK cannot, in my view, retain a holistic or pristine character, simply because it has to enter into a dynamic relationship with current realities. In such a relationship aspects of elements of holistic systems have to be brought into synergistic interaction with aspects or elements of our globalising world. This means that the relationship between IK and other forms of knowledge may have to involve design and improvisation as the dynamics among the aspects or elements unfold.

Drawing on Bernstein (1999), who, incidentally, was not developing his theory within the context of IK debates, I want to suggest that we can conceptualise resources as gathered or used for collective or individual purposes, with the a resource-base for former characterised as a *reservoir*, and for the latter as a *repertoire*. In a developmental context we then have to ask: What reservoir/s are available to us, and how can we draw on these to create a newly designed reservoir that is empowering in our collective context, so that each individual within this context has an empowering repertoire? In such a context, bringing indigenous and other forms of knowledge into dynamic and synergistic relation will require what Bernstein (1999) calls *recontextualisation.* To my mind, such recontextualisation makes the retention of an unchanged epistemological system impossible. This is not to deny the importance of an in-depth understanding of the value systems or cosmologies that are being recontextualised. This way of seeing IK in the context of specific development projects clearly resonates with contemporary debates about the relationship between Mode and 1 and Mode 2 Knowledge Production (e.g. Kraak: 2000).

The UNESCO (2003) project referred to earlier provides many examples of how IK can function within specific developmental contexts. These include a Kenyan indigenous food plants programme in which locally available edible species are used to enhance community health, provide income and preserve biodiversity; a Canadian bi-cultural, community-based approach to Early Childhood Development (ECD) in indigenous communities; an Indian project involving the manufacture of organic carpets; and a Cameroonian project involving the use of traditional ethno-veterinary medicine.

This brief account of how we may "read" and "write" the phenomenon of IK in relation to other forms of knowledge implies a form of literacy that goes beyond the "three Rs" associated with what Brian Street (1995) has called the "ideological" model of literacy. What we need is reservoirs and repertoires for:

- recognising the value of IKR;
- re-imagining work, communities and futures with IKR;
- recontextualising diverse forms of knowledge (e.g. IKR in the university and in responsive curricula);
- researching creative IKR practices in development;
- renewing urban environments through using IKR(SGI 2007).

With this argument in mind I would like us at CPUT to find ways of building our understanding of IKR through combining the development of our theoretical understandings with careful analysis of particular case studies. I believe that it is through well contextualised and theorised case studies that we are most likely to make IK a familiar and actively engaging concept in our universities.

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Theorising experiential learning in terms of Bernstein's recontextualisation principles

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Introduction

The study focuses on current perceptions and understandings of students, academic staff and work mentors on the nature of the research project in the student's experiential training (EL) year, with a particular orientation to transfer and development of academic knowledge. The study also has a developmental perspective for staff involved. We wanted to plan and implement an improvement, based on our research, in work preparation for students which would better enable students to transfer knowledge from the academy to the workplace. Perceptions of transfer and an intervention in students' preparation were not separate projects but happened simultaneously, the one feeding into the other.

Students in South African universities of technology SET programmes are required to satisfactorily complete their EL year before they are awarded a diploma. In Science and engineering this period is typically 1/3 of the total study time of three years. What actually happens during this period varies according to academic department and employer but all programmes have in common that students are required to keep a logbook of activities done at work which is then signed off by the work supervisor. This is then checked by the academic departments and if deemed satisfactory students receive experiential accreditation and their diploma.

In 2006/7 the overall numbers of first time entering students to the field 'analytical chemistry' at the universities of technology was significantly lower than in previous years. Anecdotal evidence put forward by a senior lecturer in the department suggests that students viewed the diploma as involving only two years of learning as compared to a three year university degree; many students were thus opting for the 'higher standard' degree. The assumption being made by students is that the experiential year at work does not involve any advance in learning about chemistry but rather simple application of knowledge. In addition, the degree was viewed as being more advantageous than the diploma for entry into the job market. This poses serious questions for the identity of the newly emerging universities of technology which pride themselves in integrating work and academic learning and hence better preparing students for the workplace. A further pressure related to identity is that of offering higher degrees equivalent to traditional universities, but where students effectively have only two years of undergraduate academic development.

A second pressure on the universities of technology concerns government subsidy for the experiential year. The Department of Education does not recognise the experiential year as involving substantive higher education learning and thus will only provide partial subsidy, or no subsidy at all. The result is that the three year diplomas are under-funded compared to university degree programmes. The UOTs are seemingly trapped in a chicken-and-egg situation. There is insufficient subsidy to employ staff to design, monitor and assess the EL year so that it gains the same status as academic study, yet such an initiative would require increased staffing.

Thus, the problem faced by the universities of technology is to better understand what the nature of learning during this year at work is, so that it may be appropriately developed and put forward as university-level learning. Broadly the following questions may be asked about the experiential experience:

What is being learnt?: How is it being learnt ?: At what level is learning taking place?: If learning is occurring then how is it to be assessed? And more specifically: Are students developing their knowledge learnt earlier in the classroom and orientating it to the workplace or are they simply 'seeing and doing' what they have learnt in authentic settings?

A review of all papers presented at a recent South African co-operative education conference (SASCE, 2000) was revealing for two reasons. There was, firstly, an assumption that experiential learning would afford a beneficial learning environment for students and, secondly, that such learning would occur without any empirical or theoretical examination of what learning at work and its relationship to learning in the academy would entail. This pattern can be recognised in other EL documentation, for example the SASCE website text 'about co-operative education' (SASCE, 2003).

In this study we examine attempts made by the department of analytical chemistry at the Cape Peninsula University of Technology, to improve the academic status, design and monitoring of their experiential year. This department was originally a site of study in a now defunct national project to gain subsidy for the experiential year and also because the year incorporated a research project which, we believed, contained the seeds for a stronger academic experiential approach.

In order to give the reader a sense of the research conducted by the students, here are three random project titles.

- Preliminary investigation into the ratio of sodium to chloride in SA wine
- Optimal pH for the precipitation of metals in waste-water treatment
- A comparison of infrared and near infrared spectrometry of aspirin
- Preliminary investigation into the ratio of sodium to chloride in SA wine

Owing to the recent merger of the two previous technikons (polytechnics) into a single entity, there were two variations on the 'research' module offered. In one the research was part of a portfolio which included: A review of relevant literature; a review of the companies quality control procedures; and a letter of application for work to a company. These elements were treated separately and adjudged against outcomes for each entity; there was no attempt at integration. In the other variation only the research project was included. Both variations required that the research project component was to be judged against the following outcome.

> Perform a research project to benefit the industry and use communication and technical skills to fulfil these requirements against the following criteria: Recognise a problem which requires to be researched and demonstrate a sequence to follow this problem; compile and organise scientific data; gather and use information from various sources; documents are organised and written in the correct format and; oral presentations are organised and delivered using appropriate language and technical aids.

As can be seen from the criteria there was an emphasis on presentation skills, both in the form of a written report and its oral presentation to an audience. In order to complete their diploma students also had to present their project orally at an all-day event known as 'Science Idols'. Science idols is a derivative of the extremely popular 'Pop idols' in which young, aspirant singers compete publicly for recording contracts.

Theory

Given that the issue is that of the development of more academic subject knowledge in its application, we need some sort of model for the vocational curriculum which can be applied to the development of the student's research project as a curriculum element in EL.

Layton et al. (1993) give us some indications about the relationship between vocational and more academic knowledge. Using the example of moving between school science knowledge and technology in order to solve a technological problem, he suggests that, firstly, a student needs to understand the complex reality of the problem and, secondly, to pick and choose from available scientific knowledge sources:

> The problems which people construct from their experiences do not easily map on to existing scientific and pedagogicial organisations of knowledge. What is needed in solving a technological problem may have to be drawn from diverse areas of academic science at different levels of abstraction then synthesised into an effective instrumentality for the task at hand.
> …. Solving technological problems means building back into the situation all the complexities of real life, reversing the process of reductionism by recontextualising knowledge.
> (Layton et al., 1993: 58-59)

What this suggests is that in developing a vocational curriculum there is an additional step to that of pedagogic recontextualisation of the disciplinary field. It first has to be reorganised as a different sort of disciplinary field, one which is attuned to the profession rather than just the field. Disciplinary knowledge needs to be first 'reclassified' as occupationally focussed knowledge before it can be pedagogicised (Barnett, 2004: 147).

Barnett (Ibid.) operationalises Bernstein's (1996) theory of recontextualisation to explain the development of vocational disciplines and pedagogy. According to Barnett the recontextualisation route for vocational subjects - such as those in law, medicine, engineering, education, commerce, social work and so on - is the selection of elements of the field, not through a focus on teaching and learning, but through the lens of the sorts of application-orientated subject knowledge required by the professions. Once suitable professional subject matter has been identified, the second recontextualisation involves its re-packaging as teaching and learning units. The way in which the academic research field of physics is re-packaged into the engineering subject 'Applied Mechanics 1' could be said to follow this process. Then there is an additional level of pedagogic recontextualisation in which more situated practices, as opposed to academic knowledge, are pedagogicised. An obvious example in engineering education is the recontextualisation of collaborative workplace activities, often across hierarchies and job types, into group project work in the institution.

In being recontextualised, Work knowledge would be disaggregated, reordered and certain parts may be amplified or reduced so that they are more in line with subject teaching; the focus has changed from Work to pedagogy.

Barnett's theorisation provides us with a useful model for both understanding and exploiting the development of academic knowledge in work contexts. The various stages can be operationalised as a methodology which students can use, and be taught to use, in transferring their academic knowledge into the workplace as well as developing it further. Further development would involve some level of reflection from the student.

Reflection in higher education

Schon (1987: 40) understands practicum as being the centre point for curriculum design in higher education. The problem is, he believes, that subject knowledge derives from the empirical world but is then canonised and taught then re-applied to the real world in problem situations. But there is now a gap between what has been learnt at the university and what is required in practice. The key to bridging this gap is 'reflection-in-action', which is about the student coming to know the nature of the variation between what they already know and what has to be done, and developing ways to bridge between them. But this cannot be done alone and requires that the mentor creates activities and dialogue to facilitate the development of the learner in crossing the gap. The nature of the dialogue is to allow the learner to frame and re-frame the problem and also to sometimes be encouraged to think outside of the box.

Olga Dysthe (2003) coming from the perspective of teacher education underlines the importance of reflection as a student activity in supporting learning that is not about reproduction but about production of knowledge. She argues that a focus on production is surely what is required in higher education, a direction that is supported by the emphasis on high levels of reflection in university level descriptors here and world-wide (see New Academic Policy, 2001).

Methods

Different sources of data were drawn upon in order to seek replication of patterns and hence some measure of reliability (Cohen et al, 2004). In 2006 the Science Idols in which students presented their projects were observed. A selection of the written projects was also examined. In both instances we were interested in how students dealt with their subject matter and how academic their rendition was.

In 2007 two staff members at Cape Peninsula University of Technology responsible for the EL component and three work supervisors from two companies were interviewed. The companies were chosen as they were recognised as being supportive of student learning. The interviews were the same for work and academic representatives and followed a semi-structured protocol in that the questions were not strictly determined and adhered to before or during the interview (Cohen et al., 2004: 275).

Staff were asked to describe the research projects performed by students, and what they liked and did not like about these projects and what changes could be suggested. More direct questions concerned how the projects originated, what the role of academic and work supervisors was in the development of the projects. Then there were questions probing the academic nature of the project and whether or not students were developing their academic knowledge in any way.

Four students, two from each company, were also interviewed but there was now a greater focus on probing to what extent they used and developed their knowledge learnt in the university.

The research projects, the observation of their presentations and perceptions of their nature from staff and students constituted multiple case studies in which patterns and replication were sought (Yin, 1994). Case study research has been used extensively as a method in higher education and in social research generally (Nisbet and Watts 1984, Yin 1994, 2003; Hammersley and Gomm 2000; Cohen et al, 2004). The same authors have discussed the uses and limitations of case study research. Such research is typically associated with more qualitative, socially-constructive or interpretivist research paradigms (Cohen et al, 2000). Case studies in social research can be loosely defined as events whose location, organisational constraints and the characteristics of participating individuals and communities set them apart from other events. It is easier to say what case study research is not – it is not laboratory experimental or broad survey research – rather than what it is. The problem, as Tight (2003:9, 186) outlines, is that almost any higher education research can 'in some sense' be termed case study research and thus elaborating on case study research as a method or a methodology is not particularly helpful in providing guidance as to the researcher's research design.

Cohen at al (2000: 181ff) advocate the use of case study research as it is possible, through providing readers with richly contextualised descriptions, to bring the reader into the world of the researcher, and to enable them to transfer patterns observed to their own world (Nisbet and Watts, 1984).

There is an issue of generalisation in case study research. Lincoln and Guba (2000) maintain that there is no such thing as a valid generalisation in social sciences and that one can only, at best, have what they refer to as a working hypothesis. Anderson (2005) makes much the same point by referring to a 'moderatum generalisation' in qualitative social science research. Both of these labels refer to generalisations which can explain current actions in the future but which also need to be continuously tested, adjusted and developed within new sites.

Even the idea of a working hypothesis is problematic where the choice of cases was non-random and purposeful Yin (1994). We deliberately chose workplaces which the academic staff recognised as supportive of student learning as we wished to uncover how best we could later develop EL as a higher education learning experience. We are, however, still able to make some form of generalisations about learning organisations, even though this was not the initial purpose of the study.

Results

Work supervisors

The work supervisors at the two 'good' workplaces investigated expressed strong support for the research project. As one supervisor put it:

> Supervisor 1: These are small scale research projects we would really like to do but never get round to doing. So they fill a gap for us. So the students actually do something useful for us and they really enjoy it.ites. We also have the most up-to-date equipment which students can learn to use. We have top class scientists and everybody is willing to help the students with any questions or problems they may have. So much so that when the students are not around people say 'hey, where are our students?'. In other workplaces EL involves just being given anything just to keep them out of the way! The scientists here come up with the problems. Depending on the student different amounts of help are needed; sometimes they do not know where to start.

As can be seen there is also a lot of support for students. Students at these workplaces seemed to be involved with a constant source of feedback from their supervisors, as well as general support from the scientific staff. One supervisor described how he would meet regularly with the student and ask her to 'think bigger' about the problem, to make them come with ideas when they get stuck on a problem.

> Supervisor 2: She just was not getting the results she wanted and I asked her to try to think bigger about the problem, to think beyond it, and she came up with this idea of doubling the volume of the sample from 20 to 40 ml and this solved her problem.
> Supervisor 3: Yes, she seems to have a nose for seeking out problems and solving them. She sees things we do not always see.

In terms of knowledge transferred from the university the supervisors agreed that students needed to know the basics of chemistry theory and needed to know how and why machines worked the way they did if they were going to get authentic results. They were less certain about whether students reflected on their learning or whether or not they managed to extend what they had learnt at the university in their practice. They thought that this is not something you can tell or that it may be related to students having confidence in themselves. They agreed that students' 'recognising the gaps' between university and work was a step in the right direction.

Two supervisors commented that they thought the students would benefit from more substantive support from the university, as students were only visited once or twice a year. The last point concerned the situated practices of the company. Supervisors acknowledged that there were particular ways of doing things in the company, and that ideally, academic staff should introduce students to different approaches in different companies.

Student interviews
In talking to the students we were attempting to get a sense of mentoring and whether they were consciously bringing forward university knowledge, and more importantly, reflecting on the development of knowledge. Mentoring was strongly acknowledged:

> 'When I first saw the project, I thought wow, I don't know what to do … but you aren't frightened by this or that you just ask and they guide you …' and 'there is this guy here who did his masters on precipitation of metals. He does give me a lot of guidance, we do lots of brainstorming, it has made me think what to do if I haven't got that thing …'.

However, there was little evidence of students overtly recognising developmental learning, though, given the nature of the extensive mentoring, it was likely that substantial development was in fact occurring. Students seemed to understand what they were learning as now doing what they had been taught to do at the university in a work environment, a sort of horizontal transfer.

> Student 2: I was just saying to my moms how good the university lecturers are. Everything we did at the university now makes sense. It was perfect. We did not know why we learnt these things and wrote them down in tests and now we are doing them just like they told us.
> Student 3: I think I understand what you mean by horizontal learning? Yes that is probably what we are doing. We are not really growing up (she is referring to developmental learning here), not at the moment, though maybe this will happen later …'

Nor were they reflective of the content learnt at university and its selection, application and possible development at the workplace:

> Student 1: There is not lot of chemistry, it is quite basic stuff. I did not look back to my text but found this waste-water treatment group on the internet. Theory is not so useful. I did not bring much theory from the university. The practical side of university education was good. I think the difference here is that I work with more samples and I have learnt to organise myself better.

Despite this comment the students' lecturer suggested that the student was not really thinking things through carefully and is probably just focussing on the method. He could, she suggested, have read quite a lot more from the text.

Analysis of the students' reports
The reports analysed were from the previous year's students and provided us with supportive data for the sentiments expressed in the interviews. The reports were generally short, 10 pages or less at 1 ½ spacing, much of the text being occupied with tables of data. All reports included some sort of introduction to the field, a problem statement, methods, results and conclusion/discussions. The discussions tended to be relatively short with a focus on descriptions of the methods used, for example:

> 'The software does six different types of predefined checks which can be customised by the user. Additional QC capabilities include at least three types of blank checks multiple sample calculations including duplicates and dilution

> calculations, multiple spike calculations as well as the ability to design custom QC protocols …. '

It was not always clear if these were actual reports of work done by the students or descriptions of larger research projects going on in the companies which the students could get access to.

Students had been asked to reflect on methods used in solving their problem. This was done well in a few cases, for example:

> 'Both methods are satisfactory as measure of cholesterol in food. The method of fat extraction before assay gives lower results which could be due to cholesterol loss or interference by reagents. A comparison of the methods is shown in tabular form for ease of reference' (this is followed by a substantive comparative table and a full page of discussion).

But generally reflection on method was restricted to a few short statements:

> 'The average % recovery is shown in the two tables. The relatively high SD is due to the different industries from which the effluent came. The lower % recovery is due to vigorous digestion processes'.

Both the researchers and the lecturers agreed that there was little evidence of reflection on what knowledge had been used and how this had been selected and extended in order to perform the research. This is not surprising given that there is no requirement for such reflection in the outcomes and assessment criteria.

Students were required to refer to texts and clearly there had been attempts to incorporate ideas from texts into the write-up, though it was unclear whether these were simply instructional manuals which were being followed rather than ideas which were being synthesised or modified into a whole.

Students at the one campus were asked to present a 'strategic plan' or 'development plan'. Though not part of this research project, some of what students have said indicates the decidedly non-academic and low-level of reflective ability shown by students which would need in future to be spelt out more clearly, for example:

> I learned to trust myself more and work under pressure. It was an honour to work in such a firm. I realise I must become more assertive …' and 'I am weak when giving presentations and often do not project my voice enough. I learnt I must rehearse first.'

Science idols

This is where the students presented their projects to an audience of fellow students, industry supervisors and academic staff against the outcomes and assessment criteria mentioned earlier. Given the nature of the event and the criteria it was no surprise that the focus of the presentations was on issues like voice projection, power point slides and other media issues, rather than on the chemistry of the project, though this was examined in the written project.

Discussion

Data drawn from interviews with staff and students shows little evidence of reflection within the projects, though there are attempts by academic staff to promote reflection, though sometimes in academically inappropriate forms. Observations of the Science Idols indicate, perhaps, a focus on 'performativity' rather than depth of learning. If reflection is an essential component of more depthful learning in higher education (see Wake et al., 2007;New Academic Policy, 2001) then there need to be more concerted and structured attempts to do this in the experiential component. Given that we are dealing with learning at work and its relationship to learning at the university, we can bring in Barnett's recontextualisation model as a framework in which reflection can occur.

The process of content selection within the projects can be outlined as follows. The first step is a description of the project followed by an identification of the sorts of knowledge required in order to deal with the problem. For example, in the use of atomic absorption spectrometry (AAS) to test the components of drugs, various reagents need to be used. Students are required to understand the theory of AAS, the practical aspects of operating the machine (which also depend on the theory), the chemical composition and hence characteristics of the different reagents and the chemistry of the substances being tested. There are also elements of mathematical knowledge which need to brought to bear in calculations. These selected elements constitute the reclassification and recontextualisation of academic knowledge learnt to the problem as it is 'synthesised into an effective instrumentality for the task at hand'.

The reflective portion here would be one of consciously selecting appropriate sources from the academic curriculum, the work library, work supervisors and the internet and appropriate knowledge within these sources. In the written report the student would be required to explain why they chose these sources and elements of knowledge and not others, as well as how they put the elements together to deal with the problem.

This type of reflection would also constitute a pedagogicisation (or in Barnett's, (2004) terms, pedagogic recontextualisation) of the selected knowledge as students justify their selection. A further pedagogicisation occurs when students evaluate what knowledge they bring from the academy and how this must be developed to deal with the problem, and record this as evidence of their learning and development.

The data indicates that students may need quite a lot of help in dealing with the project, both at the start and during its progress. This scaffolded approach to students doing the project, including providing activities which promote learning and continuous evaluation and support from mentors, can be said to be characteristic of good, 'learning organisation' workplaces. If we are to develop EL as an appropriate academic learning experience as is suggested in this paper, then workplaces need to be chosen which can develop learning. Not all work places are like this. Some may even retard learning and the development of student's self esteem (Hughes, 1998).

Students and supervisors clearly see value in the master-apprenticeship relationship in the project, and it can be suggested that significant new learning is occurring here, even if it is not always recognised by the student. This is another example of pedagogicisation of work knowledge. It could be exploited more through asking students to record their learning within this dialogic process, and to signal where significant developments beyond what is already known have occurred, and how they dealt with problems which arose in their research.

In Barnett's (2004) model for the development of the vocational curriculum the final stage is the pedagogicisation of situated practices. As part of student's reflective practices they could be asked to elucidate how things are typically done in the workplace and hence how this has influenced how they conducted and wrote up the project. As with the other reflective steps suggested for the research project, the student both contributes to the workplace and develops their own knowledge to a higher level.

Conclusions

Eraut (2004: 220) points out that mobilising and developing university knowledge to deal with a variety of work problems is far from straightforward. Furthermore, the separation of theory and practice, and the low level of understanding of and involvement in work learning by academics exacerbates this difficulty.

Our contention is that an intervention in students' preparation for work, following the Bernstein/Barnett recontextualisation model, and the inclusion of a strong reflective requirement in the research project would go some way to enabling students to mobilise and develop their university knowledge. It would also provide an argument for the recognition of EL as appropriate higher learning, in both the students' and department's minds. The intervention would involve students being guided and inducted into reflective practices, and their being required to answer these questions for successful completion of their research project:

- What is the workplace I am in? What does it do, how does it typically function, how are decisions made? How are problems solved and by whom etc? How is what I am doing at work different to what I did in the academy? How have I used/not used what I have learnt in the academy? What are the knowledge gaps and how have I attempted to bridge them? What are the elements of academic knowledge I have used and how have I used them? What can I take back to the institution?

One lecturer suggested that this sort of approach is important for two main reasons. Firstly, there is much that goes on in workplaces which is tacit – 'you develop a circle of friends and contacts at work it is one of those things you do without really thinking about it' – and students could benefit from reflecting on how these contacts were made and used to develop their own knowledge. Then there is the recognition of knowledge gaps between University and work and how work provides a place for *further* learning which could be fruitfully encouraged and developed through EL:

> Lecturer 1: Gaps? There will always be gaps. We cannot do everything, it is more the basics that we do.

Even Student 1 who had previously stated that he was not learning much beyond what he already knew agreed that he *could* develop his knowledge around, in his case, precipitation reactions to a substantially higher level of chemistry learning.
The research project does not, even now, have to be restricted to the experiential year. As one student suggested, we should be using the projects as teaching resources in the academy. Students would also be asked to critique the projects, both as a way of

enriching their academic knowledge with work knowledge and going some way to bridging the practicum/classroom gap.

The continuance of this project involves tracking student and staff responses and competencies in taking on a more reflective stance in their EL preparation in the fourth quarter of this year. In 2008 we will then track the students development of their research projects to include a significant reflective component and evidence of learning.

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