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**Promoting tertiary learning strategically to meet today's multicultural student's needs**

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## Promoting tertiary learning strategically to meet today's multicultural student's needs

### Abstract

Many of today's metropolitan cities thrive on educating international students of diverse cultural backgrounds. However, most of these students struggle at two levels in their new environment, namely cultural and financial, and so require specific help in pursuing their educational goals. Tools are available to strategically develop people's learning skills using modern information and communication technologies (ICT). This chapter focuses on the effects of an online tool used along with well structured roles to induce collaborative as well as individual learning.

From an Activity Theory perspective our research indicates two main results of interest. First, increased attention to the dynamic of shared social interaction enabled by ICT results in deeper approaches to learning and greater satisfaction among the students who engage in the process. Second, to achieve an expanded learning role and greater independence among learners, particularly those from different cultural backgrounds, it is necessary to more explicitly define the rules and roles in the learning context than is usual in traditional teaching practice.

### Keywords

Promoting, Tertiary, Learning, Strategically, Meet, Today, Multicultural, Student, Needs

### Disciplines

Business | Social and Behavioral Sciences

### Publication Details

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# 11 Promoting tertiary learning strategically to meet today's multicultural students' needs.

Chris D'Souza, Kate Crawford

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## Abstract

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## Introduction

Many of the students taught in tertiary institutions find it difficult to cope with the stress involved with the academic demands and their personal lives. They have to tackle multiple objects such as adapting to live in a new society, managing finance, overcoming language barriers and most importantly

pursuing their educational goals. While academics cannot ease all student work pressures, they do have a significant role to play to ease those associated with time management, cultural differences and the academic demands. There is also a responsibility to facilitate their learning and ensure they become adept in their chosen field. This article is about how to achieve at least some of these outcomes using modern ICT tools along with strategically structured assignments that demand and also facilitate deep approaches to learning (Marton 1988; Atherton 2004).

### **The Need for a Change In Learning Strategy**

As academics, we have found it necessary to redesign the learning context to unshackle the strong grip of low academic performances by students and their habits of surface approaches to learning based on memorizing and reproducing selected information. We have used cultural historical activity theory (CHAT) as a framework to understand the dynamics of the complex activity system that underpins student learning at Universities.

Students form an important group of subjects in such a system. Many of them are from diverse cultural backgrounds and from various countries of the world. Most of them were educated in non-English speaking environments. Most have also been uprooted from their social circle to learn in an alien environment. Such students face multiple hardships. Too often, learning becomes a casualty. Even students, who have been born in Australia, face similar problems because many are professional workers as well as full time students. How can we innovate to facilitate new ways of deep learning that enable students to engage with society, become acculturated to a successful learning community and achieve success?

University academics, whom we view as another group of 'subjects' in the learning Activity system, have evolved a means of teaching with its roots in the cultural history of the past and that is often not consciously reviewed as a process to enable learning in an era when knowledge is created and used in new ways. For academics, innovation is often conceived too narrowly as associated with using new technologies or organizing computer based student presentations. The central 'object' of

university activity - to enable deep learning and capabilities for research, knowledge making and creative, flexible applications of knowledge - is often not considered by them with all its implications. In particular, scant attention is paid to the complex patterns of relationships, negotiated exchanges, tool use that could result in a shared understanding of rapidly evolving knowledge domains. According to activity theory new tools necessitate new activities and changes in the rules, community expectations and divisions of labour.

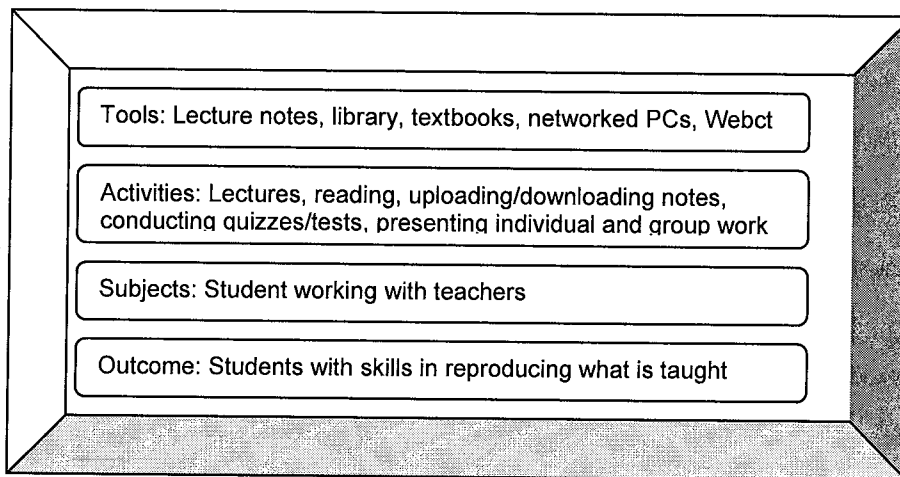
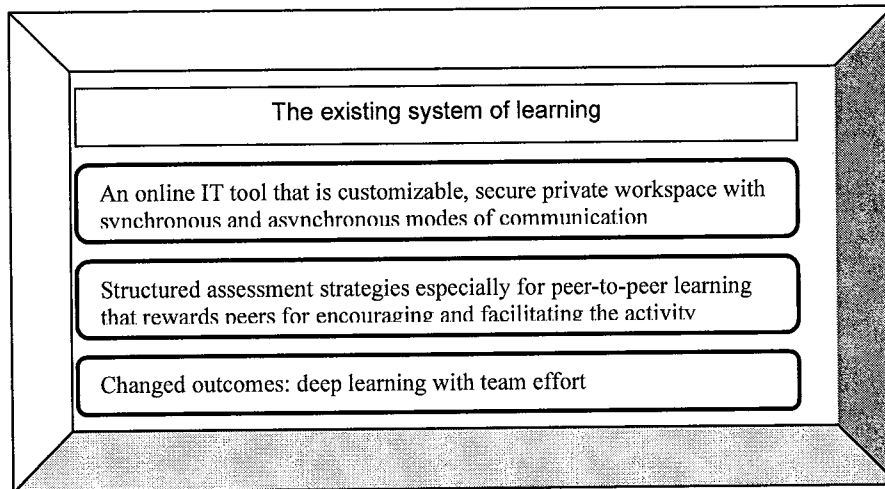


Figure 1: The existing system of learning

Figure 1 summarizes the structure of the existing system of learning. It makes use of ICT tools, library resources etc for the transmission of existing knowledge in order to cope with the new object of learning in a multicultural environment. However it needs adjustment to meet the emerging conditions of academic work and new expectations about learning outcomes. At present, plagiarism is common because the requirements of student assignments still focus on the presentation of other people's 'information about' a domain, such information is now readily available on the web, it is easily copied and competitive individuals can easily paste information into routine

assignments. However, if the object of the assignment becomes one of demonstrating a deep and critical understanding of the domain and the capability to use the knowledge effectively and creatively, then students need to grapple with the information and become engaged in deep learning approaches in order to be successful. Plagiarism ceases to be a strategic activity. If one of the objects also becomes to share an evolving understanding with others then the scene is set for quality interactions between students (and between students and staff) such as critical questioning, probing, negotiating and the evolution of a shared consciousness (Paul (1995)).

A new socio-technical system of the form shown below (figure 2) is an offshoot of an emergent need. We observe that the new system of learning still runs within the existing system but also incorporates the online tool and new strategies for assessment. The model of the online tool is shown separately in figure 4.



**Figure 2:** New Socio – Technical System of Learning

The online tool has is modeled to enable a community of users to work either individually or collaboratively in teams. Further the community may work on many different projects and one or

more groups of users may be assigned to work as teams. Each user can be assigned different levels of privileges as shown by figure 3 in which user alextripp is assigned a “member” privilege at the “Info106 Programming Techniques 1 Sem2/2004” community level but is a guest at the TeamB level.

Username: alextripp

Super User:  (Grants access all areas)

Account Disabled:  (Disables the account, and stops any login. Can be reactivated at a later stage)

Area	Type	Guest	Member	Expert	Admin
Info106 Programming Techniques 1 Sem2/2004	Community	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
* Team B *	Team	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 3: A snap shot illustrating user access rights

Each user has access to various IT resources like online forums, quick polls, file systems, news etc. These resources are secure to users in their respective levels and privileges. The picture in Figure 5 is of a quick poll created by one of the student teams after a presentation of their group task.

The tool also allows users to customize their private team spaces so that a sense of personal attachment to the tool can be established. An illustration of such a customization done by the students is shown in figure 6. In addition each user can attach customized icons for personal identification.

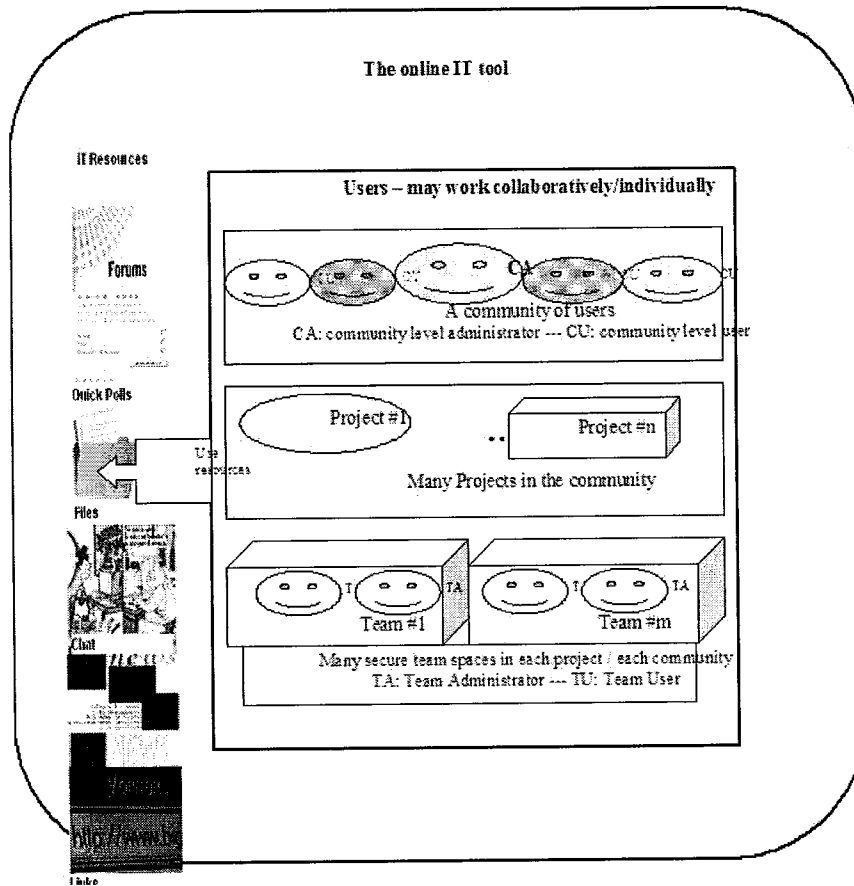


Figure 4: The model of the online tool

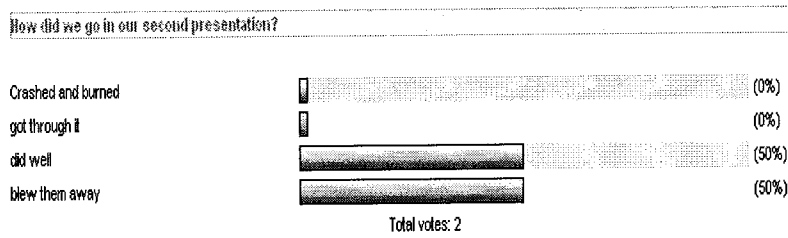


Figure 5: A snap shot of a quick poll



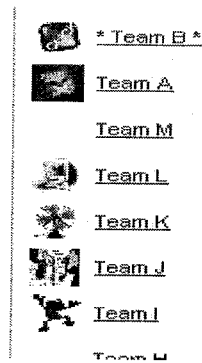


Figure 6: Customized icons for each team

### Activity Theory And Deep Approaches To Learning

Deep learning factors like critical thinking, reviewing, negotiating, reasoned analysis, and logical thinking do not materialize without appropriate social fabric around them. Hence we decided to use Cultural Historical Activity Theory approach to design a more integrated activity system that facilitated deep approaches to learning and engaged students through human interactions, relationships and new technologies.

Activities in which humans participate are the basic units of development and human life and thus form the basis of all conceptuality. Bannon (1997) states Activity Theory as “a very general framework for conceptualizing human activities that provides an alternative formulation to that of human information-processing as to how people learn and society evolves ... based on the concept of human activity as the fundamental unit of analysis.”

Engeström (2000, p. 961) describes CHAT, or Activity Theory as a “global multidisciplinary research approach ..., which is increasingly oriented toward the study of work and technologies.” It (Vygotsky (1979), Engeström (1999)) stresses on sharing knowledge among peers as the key to any learning activity.

In our work we have become increasingly interested in the use of a framework of ‘socio-technical systems’ to describe the complex dynamics of people working together with technologies in ways that change their consciousness. Academic work that facilitates deep approaches to learning is one such systematic

'Activity'. In Engeström's terms, academic work can be considered as an activity system in which multiple subjects act in a community according to agreed rules, roles and division of labour towards multiple 'objects' and observable outcomes.

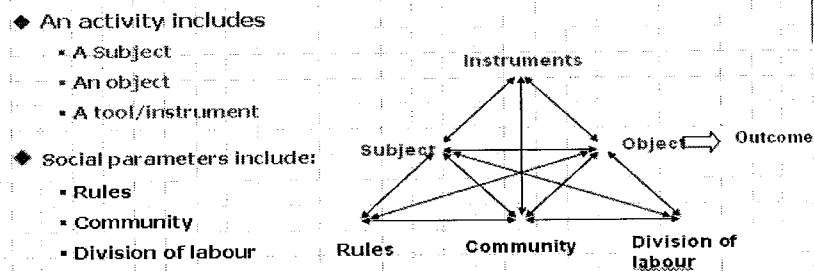


Figure 7: An activity system according to Engeström

Figure 7 explains activity theory with respect to learning systems. It shows that students form a group of subjects; their 'objects' are shaped by a range of factors including their approaches to learning, the tools available, and other resources such as libraries. Academic staff are also 'subjects' in the system with their own diverse objects, favorite tools and conceptions of learning and their role to facilitate it.

Among the social parameters, rules also represent the rules of engagement between students and between teacher and students. In the case discussed in this chapter, the community is the tertiary institution, with a long cultural history, and the society in which the student does the learning. Traditionally, students engage in learning as competitive individuals who are assessed separately by their tutors. Thus the relationships between students are shaped by competition, and the relationship between students and their tutors are shaped by the role of teachers to assess and compare individual capabilities. In such a system student collaboration to complete assignments is generally viewed negatively as cheating. One change we made to these rules and relationships was to insist on teamwork among students and learning through independent and creative projects. Many papers (Engeström (2001a); Engeström (2001b); Engeström (2004), Coupland (2002)) have been published on

activity theory and learning. Engestrom (2004) has specified four types of learning: **Transferable exploitation** is the transmission of existing knowledge in order to cope with a new object or activity. **Adjustable exploitation** is the gradual acquisition and internalization of the existing knowledge and skills embedded in the given activity. **Incremental exploration** is the construction of new knowledge by experimentation within the given activity and **radical exploration or expansive learning** begins when experimentation is not anymore aimed only at making a well-bounded new technology work in the framework of a given pre-existing activity. Radical exploration is learning what is not yet there. It is creation of new knowledge and new practices for a newly emerging activity, that is, learning embedded in and constitutive of qualitative transformation of the entire activity system. Such a transformation may be triggered by the introduction of new technology, but is not reducible to it. Radical exploration is the most poorly understood and historically most interesting type of learning.

This is shown in a matrix form:

	EXPLORATION		
O L D  O B J E C T / A C T I V I T Y	INCREMENTAL	RADICAL	N E W  O B J E C T / A C T I V I T Y
	EXPLORATION	EXPLORATION	
	Context of experimentation	Context of transformation	
	ADJUSTABLE	TRANSFERABLE	
	EXPLOITATION	EXPLOITATION	
	Context of participation	Context of transmission	
	EXPLOITATION		

Figure 8: Four types of learning

In this chapter we demonstrate the results of a working model of an IT system that applies activity theory for expansive learning. It is an expansive learning methodology because the students are facilitated with the online tool and a set of structured assessment guidelines but are then left to their own devices to apply the principles learnt to a group task.

### **Qualitative Analysis of the Initial Attempts at Fostering Collaborative Learning**

Teamwork requires teams to regularly meet to discuss the plan of action. This is often very difficult for busy students who also work many hours each week. To overcome this difficulty, an online ICT tool was introduced to facilitate teamwork. As a result, each team had a secure virtual workspace and resources like forums, chat, news, document management etc to facilitate resource sharing. The students worked in teams to create a joint project and each member of the team received the same mark for the project.

Having organized the environment it was initially expected that collaboration would automatically occur. The results were however not encouraging. It was found that some groups worked well as a team. However, most groups failed in developing the critical thinking, negotiation and collaborative skills to coordinate their teamwork effectively. One or two members in a team would be actively engaged in the group activity but hardly any creative thinking was achieved. Consistency of workloads between the members of teams was also lacking. Many groups had members who contributed very little to the task - these 'free riders' caused considerable anger and frustration among their team mates who felt it was unfair that they should share a group mark for a shared project. Also, many students had no experience of actually paying attention to their peers as sources of useful knowledge. People were throwing new messages into forum discussions without reading or analyzing the messages from other members in the team. Hence duplication and redundancy was rampant. There were hardly any messages that critiqued fellow teammates' messages, even though many of the messages weren't accurate in terms of either the shared events or subject matter. Members who posed questions to other members in the group were rarely answered.

The active members were simply posting messages without bothering to explain the messages in simple terms. Requests for help from teammates were generally ignored and conceived as being an extra load on the more knowledgeable team member. A message by one of the student is reproduced here -- *"I'll explain what methods I've come up with for this program to run efficiently, but I'm not a teacher, and i can't explain everything to you. you need to sit in front of a computer, open your book, open the .cpp and read. theres no better way to learn."*

In summary, the dynamics and underlying values for effective teamwork were not understood by the students and through lack of experience and sufficiently explicit understanding of the new context many floundered.

Why did collaboration not occur in spite of all the technical resources being made available to the students? Despite the new technical context, students continued to behave in the usual ways as they understood the community roles and rules in a University setting. There was no shared discourse. There was no discussion or shared planning. There was no trust between members of the teams. Obviously, each team member was being treated as, and behaving as, an individual in the role of student – an entity. There were no explicit opportunities for the social bonding to occur. The groups were just not behaving as a community. Celina (2001) enumerates empowerment, trust, forgiveness, cultural cohesiveness, commitment, openness and a culture of information sharing as the overarching values that facilitate effective social learning. Discussion of the role of these overarching organizational values in nurturing the identified motivators and enablers can be found elsewhere (Ali (2001)).

So we set about asking questions about how to build this social bonding so that the 'object' of learning through deep engagement in quality interactions and teamwork could be achieved. We felt that there was a misalignment between the opportunities for new forms of learning provided by the technical system and the habits of learning behaviours that were largely unconscious outcomes from the students' cultural histories of formal learning. We had changed some technical elements of the activity system and we had asked students to work in teams but there had been no attempt to make the dynamics of project

based learning and shared teamwork explicit. The following questions made us pause for thought:

We talk of the need to engage in deep learning regularly. But do we actually facilitate it? Often we do not explicitly mention what is expected of a task leaving them to their own devices to make assumptions.

Do we facilitate the students to learn to bring out the best in others?

Do we respect their diverse capabilities, creativity and their efforts?

Do we facilitate and reward peer-to-peer requests for help and offers of help?

Do we facilitate initiation of new knowledge?

Do we facilitate the questioning spirit?

Do we facilitate the answering spirit?

Do we facilitate the critiquing spirit?

Do we foster trust among students and earn their trust?

Do we offer considered feedback to queries and expect them to do the same?

Do we let them know of their standing in the community and accept similar information from them?

It became clear that there was a need for clear rules of engagement for student-student interactions and also student-teacher interactions. ICT tools should be used to encourage trust, bonding, generation of social, domain, workspace knowledge and its persistence. The community of students and teachers must be able to interact at any place and time. The context for lively discussions they hold must not disappear after passage of time. This will not only make us more responsible about what we said but will also help new members of a learning community to understand what to do and to learn on his/her own..

We were motivated to develop a new model of quality interactions between people and shared experiences to facilitate deep learning. The basic premise was that whatever minimum time spent on an activity has to be useful. The model had to be generic enough to be used for any subject matter, be it programming, social studies or mathematics.

### The model

The model consists of a structured tool for negotiating multiple objects while learning. The following point were key specifications that took into account the needs of students and the dynamics of deep learning that we were seeking to facilitate. Tools need to be structured to avoid the complexities involved in collaboration. Students also need incentives to participate.

- Incentives for preventing messages of repetitive nature.
- Incentives for peer-to-peer critiquing.
- Incentives for requesting help from peers.
- Incentives for offering help to peers.
- Incentives for initiating new lines of thought.
- Incentives for raising questions to peers.
- Incentives for answering questions raised by peers.
- Incentives for being consistent
- Listing clear rules and rewards for educational and social engagements upfront.
- Encouraging responsible activity by students' offering contracts with time frames upfront.
- Strategically listing objects for the moderate student and for the high achiever.
- Facilitating collaboration by listing mandatory and optional collaborative activities in the object.

The strategic learning capabilities that we were hoping would be used in the learning process and encourage greater engagement by students in the learning activity included:

- Redefining the object in their own words
- Outlining the major activities in the object
- Prioritizing the activities
- Analyzing each activity with a high level perspective
- Drawing figures to visualize the activity
- Listing prior knowledge of issues essential for an activity
- Listing assumptions made while doing the activity
- Listing limitations of the solution
- Listing likely problems faced while dealing with the solution and ways and means to overcome it.
- Listing issues they have learnt by doing the activity
- Listing alternate ways of doing the activity and the reasons why they were not chosen.

We also developed an explicit template for communicating our expectations, assessing and rewarding students' participation in forum discussions. It became clear that for students to engage in quality interaction, learning must entail individual goals and also team goals. Students needed initially to learn through meeting requirements about forum usage as well as usage determined by their own habits, beliefs and needs.

### **Mandatory Individual Expectations**

We developed a set of undertakings that explicitly stated the duties and responsibilities each student commits to fulfill as a member of a team. These were elucidated with questions like:

- Did the student offer to do any sub-task?
- Did the student specify a time frame for the sub-task?
- Did the student do the sub-task as offered?
- Did the student complete the subtask in the planned timeframe?
- Did the student contribute at least three "comment" messages?
- Did the student contribute at least three "domain knowledge" messages?
- Did the student contribute the above messages over a period of at least 3 weeks?
- Did the student describe the process of doing the sub task clearly?

We were then able to negotiate a clear set of expectations for shared behaviours in teams.

When we analysed the resulting forum use we are able to make a clear distinction between messages of a general operational nature and messages about the domain knowledge. Students were required to demonstrate both kinds of activity.

For example, comment messages were of general nature about the task like "yes I will see your work later today", "the task is to find the sum of the first ten natural numbers" etc.

And domain knowledge messages were of solution like nature, e.g. "in order to find the sum of the first ten natural numbers we need a loop structure in the algorithm".



**Optional Individual Expectations for bonus marks**

Additional expectations were made explicit to guide and encourage high achievers. These were elucidated with assessment strategies based on explicit criteria like:

If the student offered to do more than one sub task, marks on a scale of 1 to 3 for the amount of work done e.g. 1 for one extra sub-task, etc.

If the student offered to do more than one sub task, marks on a scale of 1 to 3 for the quality of work done e.g. 1 for analyzing the task, 2 for analyzing and proposing a solution, 3 for analyzing, proposing a solution and identifying limitations of the solution.

**Team Expectations on forum usage**

We developed both mandatory and optional sets of team criteria for each member.

**Mandatory Team Expectations**

These expectations set the bottom line for minimum acceptable contributions to a team. These could be highlighted with questions like:

Did the student contribute at least three "help requests"?

Did the student contribute at least three "help offers"?

Did the student contribute at least three "critique" messages?

**Optional Team Expectations for Bonus Marks**

The second list gave clear criteria for assessment rewards for supporting others in a team and showing leadership in project development. These included questions like:

Did the student offer help more than three times? (Marks on a scale of 1 to 3 for the quality of help offers)

Did the student critique team members work more than three times? (Marks on a scale of 1 to 3 for the quality of criticism?)

### A template for recording deep learning activities

Messages	Analysis	Design	Critique	Help Requests	Help Offer	Question	Answer
Count							
Quality							
Consistency							

### THE MODEL IN PRACTICE

The authors used the model with undergraduate students for teaching fundamentals of programming in C++ and at the postgraduate level to teach software design. However this chapter deals with the issues based on analysis of the results of the undergraduate performance.

The undergraduate class of about 60 students comprising of students from diverse countries were divided into random groups of three to four people each. In all about 14 groups were formed at the beginning of a 12 week semester. Each group had to complete two unrelated group tasks. Group task one was assigned for the first 6 weeks and group task 2 was assigned for the week 7 to week 12. While group task one problem definition was unique for each group, group task two was common to all groups. Also group task two required the knowledge gained from group task one activity.

The students were asked to collaborate using an online tool (**Unilinks: Now called Eviva System. See [www.eviva.com.au](http://www.eviva.com.au)**) that had support for organizing secure team space, customizing the team environment, it also had resources for discussions on forums, file handling, quick polls, creating links, news items and posting one to one private messages among members. Upfront rules of engagement as outlined earlier were made available to all the students.

Out of the 60 students, 12 students did not complete the course. Data was available for 48 students'. About 1000 forum messages were analyzed over the 12 week period. These messages were classified as "domain knowledge messages", "critique message", "social messages", "question messages",

“answer messages”, “initiation messages”, “help request messages” and “help offer messages”.

The main objective of the whole exercise was to determine whether the strategic usage of ICT environments along with structured assessment strategies do have an impact on deep learning given the stress faced by modern students in a multicultural society.

Here are some extracts of some team’s reflection on the use of our system.

1. *“The importance of working as a team on the task, rather than four separate teams, that the theory of 1+1>2 is correct and is important to remember in group work situations. It is important to work with the talents of other group members”*

2. *“As mentioned in the questions section above teamwork and co-ordination of the sub-tasks, communication and time schedule was important to the success of the task being completed. By using a sub-task assignment method of working through the project the members of the group did not feel overwhelmed with too much work to do. Another distinct advantage of working by dividing the tasks in this manner was that the one member of the team was doing the work while the others offered advice and opinions and then the next team member got involved with the project and the others again offered advice. Therefore all team members had an interaction with the project in practical work as well as from an opinionated stance”.*

3. *“The main ‘skill’ we learnt regarding the whole task was to work together as a team. By doing this, the results produced was much more fluid and of greater quality. We also learnt some time management skills as well. Instead of leaving the task to the last minute, we realised that we should’ve started the assignment within the first week of receiving it”.*

A snapshot of a power point presentation slide that was uploaded in file section of a team area is presented here (figure 9) to illustrate the quality of the work achieved by this set of first year students.

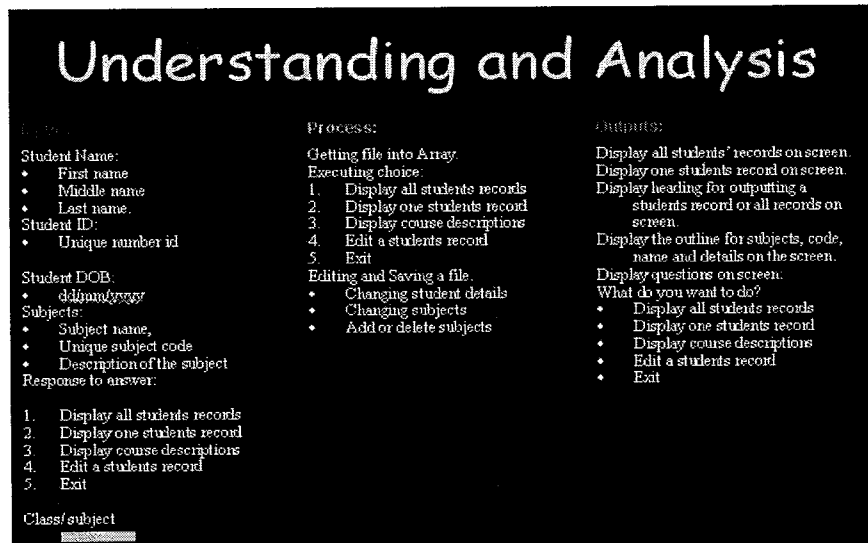
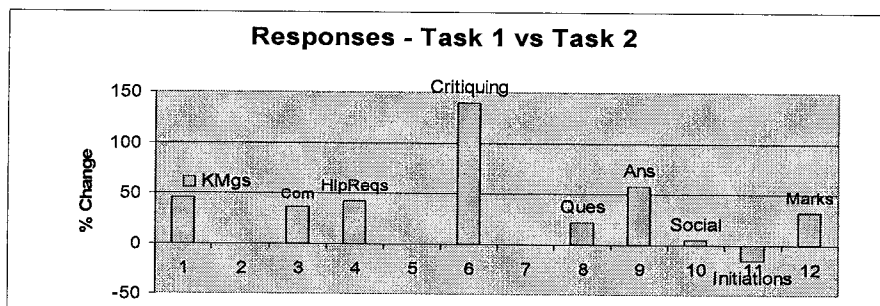


Figure 9:

### Results of the analysis

Given the appropriate facilitation do students really indulge in deep learning? Did our strategic model encourage deep learning? The following graph (figure 10) shows the percentage change in various kinds of forum messages between group tasks 1 and 2. Though the two tasks were not particularly related the graphic clearly shows given the right structuring, students do think critically as there is a significant percentage increase in the number of messages for group task 2 over group task 1 in all but the initiation case.



**Figure 10:** Percentage change in various forum message counts between group task 1 and group task 2

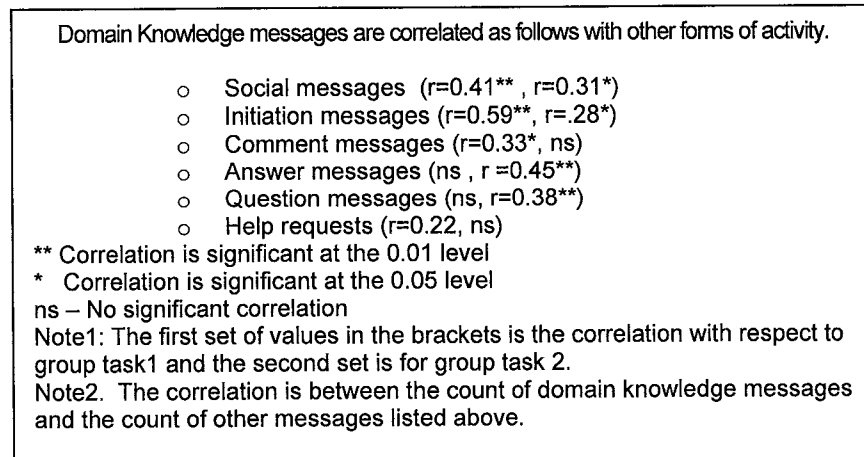
The legend for the graph:

KMgs	Domain Knowledge Messages
Com	Comment Messages
HlpReqs	Help Request Messages
Critiquing	Critiquing Messages
Ques	Question Messages
Ans	Answer Messages
Social	Social Messages
Initiations	Initiation Messages
Marks	Group Task Marks

We then wanted to learn if there is a relationship between the domain knowledge messages and the other kind of messages. If so what kind of relationship exists?

The box below shows the correlation between the count of domain knowledge messages with the count of other messages like comment, help requests, question messages, answer messages and initiation messages. E.g. it answers questions like "does comment messages contribute to domain knowledge messages?" From figure 11 we notice that there is a significant correlation between the count of social messages and the count of domain knowledge messages both for group task 1 ( $r=0.41$ ,  $P \geq 0.01$ ) and also for group task 2 ( $r=0.31$ ,  $P \geq 0.05$ ). The figure also contains similar correlations of domain knowledge messages with other kinds of messages. From the figure it is apparent that academics should strongly facilitate communications within teammates and incentives should be given for messages like

questioning, initiating new lines of discussions, social messages etc because they will in turn generate more domain knowledge messages. The co relational statistics validates our claim of the existence of a strong bond between non domain knowledge messages and domain knowledge messages. In other words, higher participation in social interaction of any kind was associated with increased engagement in communication about domain knowledge.

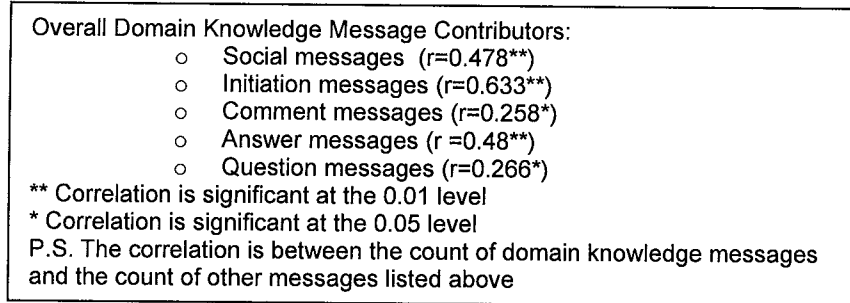


**Figure 11:** Correlation between domain knowledge messages and other messages for group task 1 and for group task 2.

Interestingly, there was anecdotal evidence of a possibly developmental shift in learner behaviours between the first and second team task.

In the data for the first task, only social messages, comments and messages initiating an interaction were significantly correlated with the number of messages about the knowledge domain. For the second task the pattern shifted to include a significant correlation between questioning and answering activity and comments about domain knowledge implying a more critical level of engagement. Comment messages were no longer correlated with domain knowledge messages. Interestingly there was no association between help requests and domain knowledge.

A similar picture emerges when group task 1 and group task 2 are considered together as shown in figure 12.



**Figure 12:** Correlation between domain knowledge messages and other messages when the message counts of group task 1 and group task 2 are considered together.

Having become convinced of the significance of the relationship between non domain messages and the domain knowledge messages, we then wanted to know about the significance of the domain knowledge messages (and the other messages) on the final examination results of the students. That is, we wanted to predict if the final exam score based on the count of these messages. Hence we conducted a multiple regression analysis with the final exam score as a criterion variable and the various messages as the predictor variables

Using the enter (i.e. simultaneous) method, a significant model emerged. ( $F_{8, 39}=2.971$ ,  $p=0.011$ . Adjusted R square = .251) where F is the ratio of the variance due to manipulation of the all types of messages to the error variance. Further it is seen that of all the various kinds of messages only the domain knowledge messages and the initiation messages have a significant impact on the final marks. The metrics of these significant variables are shown below:

Predictor Variable	Beta	p
Number of domain knowledge messages	.763	$p<0.0005$
Initiation messages	-3.166	$p= 0.003$

(None of the other kinds of messages were significant predictors in this model.)

Note that beta (the standard regression coefficient) measures how strongly each message variable (predictor) influences the criterion variable (final marks). It becomes clear that the final exam based assessment, with its cultural history in traditional modes of teaching and learning in universities, reflects the traditional learning contract with a focus on demonstrated domain knowledge. It is seen that the domain knowledge messages have a large impact. The initiation messages also have a large negative impact. The negative impact could be due to the large number of irrelevant lines of initiations.

An examination of the tolerance values (a measure of the correlation between the predictor variables) revealed domain knowledge messages, initiation messages, critique messages and help request messages respectively have tolerances of 4.031, -3.166, 1.241 and .522 indicating using a regression model in which only these kinds of messages could be used for prediction.

Hence we refined our regression analysis with the much more sophisticated stepwise model which is suitable when insignificant variables are not considered.

The results of the second multiple regression analysis are as follows:

Using the stepwise method, a significant model emerged ( $F_{2,45}=12.116$ ,  $p<0.0005$ . Adjusted R square = .321. Significant variables are shown below:

Predictor Variable	Beta	p
Number of domain knowledge messages	.756	$p<0.0005$
Initiation messages	-.575	$p=0.001$

(None of the other kinds of messages were significant predictors in this model). The stepwise regression test reinforced the prediction done by simultaneous test, namely domain knowledge messages and initiation messages are the two major sources of contributors of the final exam scores. However, here the effect of the initiation messages has been drastically reduced, obviously due to less error variance by non-significant messages.

### **OBSERVATIONS from the analysis of data**

From the analysis of the data three strong points emerge:

Students do indulge in critical thinking if they are properly facilitated.



Peer learning by critiquing, questioning, answering, commenting, requesting for help and offering help in turn generates domain knowledge.

Domain knowledge has a very significant impact on the final exam scores.

### **Concluding remarks**

From our model and its analysis the following conclusions can be made.

Students do indulge in critical thinking and analysis, when the social context reinforces such behaviours and there are easy opportunities (ICT tools) to enable them, even in cases where they had not been groomed in the elementary and secondary schools to develop such skills.

Effective peer to peer collaborative learning, using modern ICT tools, needs strategic structuring of the socio-cultural context for its use through assessment methodologies to facilitate critical thinking and analysis.

Enhanced levels of engagement in quality social interaction through shared virtual team work spaces is associated with individual successes in traditional exam based assessment.

Academics need to provide explicit incentives not only for developing the task at hand itself but also for engagement activities like critiquing, answering, requesting help, offering help, initiating new lines of thought etc in relation to the task.

In future work we would like to explore whether these explicitly defined rules for engagement in quality shared interactions lead to internalized habits of learning and interacting over time. Additionally, there are some signs of developmental shifts as students learn to interact in new ways. However in this study the unexpected effect is confounded with the different task demands between the first and second team task.

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