A CURRICULUM AND PEDAGOGY FOR TEACHING PROBLEM ANALYSIS TO FIRST YEAR STUDENTS

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ABSTRACT

This paper describes the rationale, curriculum, and pedagogy for a course focusing on problem analysis during Information Systems Development (ISD). Problem Analysis is concerned with eliciting, identifying, understanding, and reconciling the disparate perceptions and needs of different stakeholders for new or modified systems. To accommodate the needs of first year students, the course replaces the emphasis on theory that is common in more advanced courses with an emphasis on simple conceptual frameworks, extensive use of familiar (to first year students) examples, simple and straightforward processes, building up knowledge and skills through repetition, and collaborative group work.

Keywords: IS Curriculum, Pedagogy, Systems Analysis, Business Analysis, Problem Analysis, Problem Solving, Cognitive Maps

I. INTRODUCTION AND RATIONALE

The School of Information Systems at Curtin University of Technology offers undergraduate degrees in business, with majors in Information Systems, Information Technology, and Electronic Commerce. Systems development is a key part of these majors. Within this area, the author has developed and introduced a first year course in Problem Analysis, which concerns eliciting, identifying, understanding, and reconciling the disparate perceptions and needs of different stakeholders for new or modified systems. The course is taught to first year students and is required in the IS and EC majors. The course has run for five years (since 2002), with substantial refinement of the content and approach.

The development and introduction of this course was driven by two key concerns. First, there is widespread recognition that systems development project failures are a large problem for the field. Developed systems are often late, over budget, do not meet requirements, are difficult to use (or completely unusable, are not used as intended, or not used at all. Key operational causes of this problem include technical difficulties, poor estimation, promising too much, poor project management, and changing needs. However, system development is also prone to failure due to poor understanding of the problem(s) to be solved, solving the wrong problems, failure to understand and resolve conflicting stakeholder interests, and the consequent poor acceptance and adoption of developed systems. Flynn [1998] identified quality problems as a major cause of system failure, including addressing the wrong problem, neglecting wider (contextual) influences, and undertaking a project for the wrong reason. McBride [1997] pointed out that organisations do not think carefully enough about business aims, re-organisation, or desired Internet presence when considering systems development.

Unfortunately, existing IS model curricula (e.g., the most recent ACM/AIS/AITP IS curriculum [Gorgone et al 2002]) and most ISD textbooks only touch peripherally on this issue and its solutions. While the ACM/AIS/AITP model curriculum does require "an embedded problem solving and critical thinking framework in all courses" [p. vi] and mentions "Organizational Problem Solving", including "Problem solving models, techniques, and approaches" among the areas of "Representative Capabilities and Knowledge Expected for IS Program Graduates" [Table 2, p. 14], the actual courses have little explicit content on how to "analyze problems" [e.g. p. 16], particularly organisational problems in a complex organisational context.

The Problem Analysis course described in this paper was designed to address this latter group of problems by teaching students how to analyse problems in organisational settings so that they could be solved effectively (whether using Information Systems or other approaches).

The second key concern was that the course should be designed to be taught to first year students. There were several reasons for doing this. First, it is useful for the students to develop a problem solving perspective on systems development early in their degree program, so that they can frame the rest of their study of systems development in that context. Second, by learning problem analysis and critical thinking skills early on, the students could apply those skills throughout the rest of their courses. Third, problem analysis naturally occurs early in the system development process, so it is useful to study it in a sequence corresponding to its use. Fourth and foremost, the author had experience teaching similar topics, but to final year students. Unfortunately, but the time students reach their final year, they would resist learning the material because "We didn't have to do this before when we were studying Systems Analysis and Design, we didn't use these techniques on our earlier projects and they worked just fine, and we don't have to use them on our final year projects; why do we have to study this now?" Many students simply never engaged with the material because they could not see the need and thought they knew better than the curriculum designers and teachers. It was decided that first year students would be more impressionable and easier to convince to engage with the material.

Having decided to teach this material to first year students, curriculum and pedagogy design would be challenging. The material is difficult to organise and convey even to more advanced students. Another key difficulty is that first year students have even less experience to draw on than final year students, so making the material relevant and understandable presented a key challenge.

This paper describes the curriculum and pedagogical design choices made to overcome the above challenges. Five key design choices were made.

1. Use a minimum of theory, but give simple frameworks to tie it all together
2. Teach a practical and straightforward problem analysis approach

3. Use examples that are practical, relevant, and familiar (to first year students) and that reinforce the unit content
4. Provide plenty of opportunities to practice and build up learning through repeated application
5. Work in groups to reinforce learning

The next section of this paper describes the Problem Analysis course Objectives. Following that, each of the five design choices above are described. Section VIII summarises experience and evaluation of the course. The paper concludes with a summary and recommendations for further research and action.

II. PROBLEM ANALYSIS COURSE OBJECTIVES

In the context of an overall major in either IS or EC, we designed the Problem Analysis course to meet the following objectives.

- Develop skills in critically thinking about problems and solutions
- Develop skills in working with groups to collaboratively analyse and solve problems
- Develop an attitude and perspective in students of the need to think clearly and take responsibility for solving problems
- Develop understanding of why all this is essential
- Prepare students for subsequent units

The course designer (the author) reformulated these objectives in to a series of student learning outcomes, which are communicated to the student in the first class:

On successful completion of the course the student should be able to:

1. Employ techniques for exploring a problem situation
2. Identify different perceptions of problems and different potential solutions
3. Produce a problem definition from an organisational situation
4. Identify clear goals and measurable and verifiable objectives
5. Conduct an interview

6. Facilitate a group requirements meeting
7. Produce a scope definition for a system solution to a problem
8. Produce a business case for a system solution to a problem

The next five sections describe each of the five key aspects of the course design to enable meeting the above objectives described in Section I.

III. FRAMEWORKS THAT TIE IT ALL TOGETHER

There are many theoretical perspectives that could be employed in a Problem Analysis course. However, at such an early stage in a student's study, such a strongly theoretical perspective would be too complex and hinder learning of a practical approach. Nonetheless, the course does develop several simple and clear perspectives early in the course. These conceptual frameworks are used to facilitate student learning by relating new topics in each lesson back to the frameworks. Some of the frameworks used in the Problem Analysis course are listed below.

- Role of problems and problem formulation in IS development
- Duality of elicitation and analysis
- Difficulties with problem solving
- Problems with problem formulation [Dumdum, 1993]
- Classification of types of systems and the problems they address

In the course, IS development is taught as an approach to problem solving, with a problem being defined as "a perceived difference between what is and what ought to be." [Kroenke, 2006, p. 31] IS Development is in turn defined as "Problem solving, when at least one potential solution is to create a new or modify an existing information system." This perspective is consistently repeated throughout the unit and frames all other topics.

A second framework used is a model of different forms of analysis (systems analysis, problem analysis, etc.) as having a duality of activities: elicitation and analysis. This framework is described both generally (see Figures 1 and 2) and then more specifically showing the techniques (those ones taught) for Problem Analysis (see Figure 3). This framework is then repeated for each new topic, as each of the techniques in figure 3 is taught in the course.

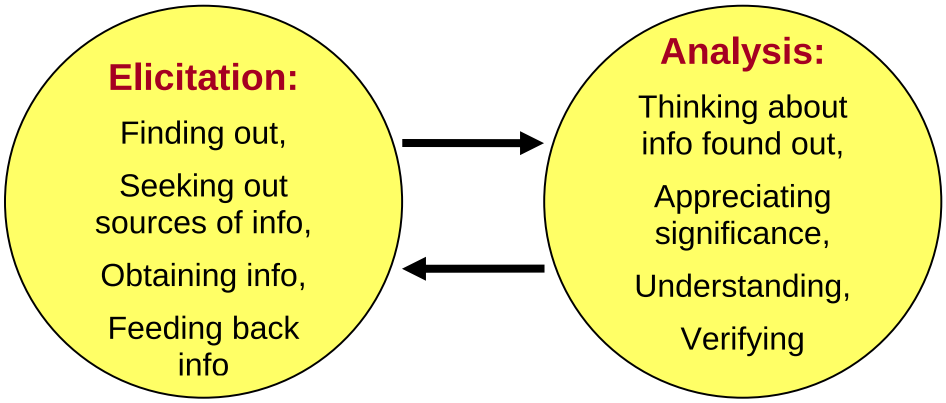

Figure 1: Dual Activities of Analysis

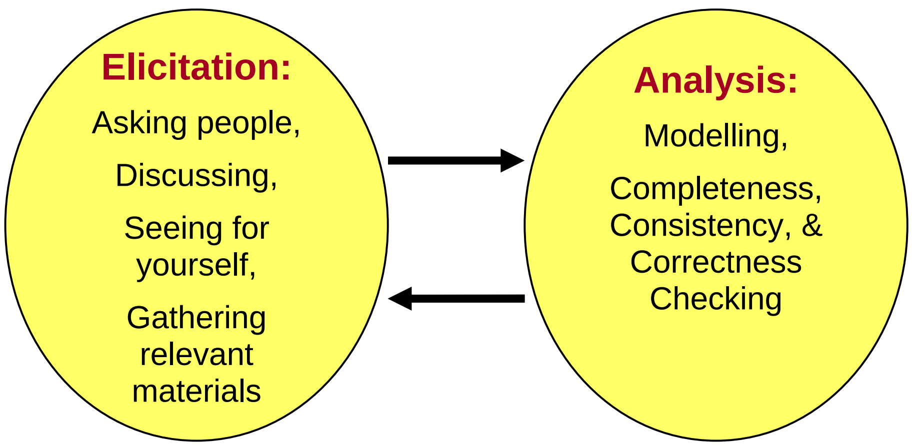

Figure 2: Generic Means of Analysis

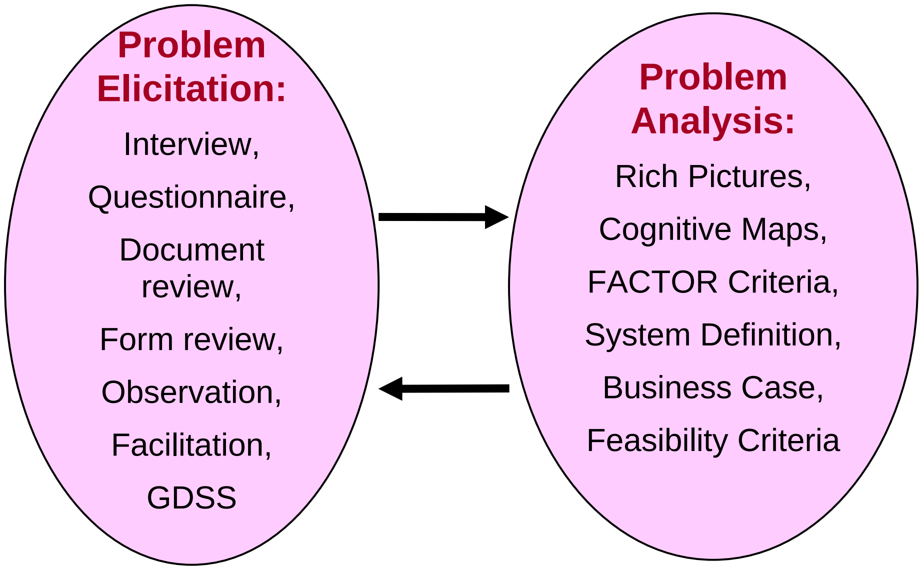

Figure 3: Problem Analysis Techniques (those taught in the course)

A third framework concerns difficulties in problem solving, including

- complexity of problems,
- lack of information about problems,
- scarcity of problem solving resources,
- different perceptions of problems,
- disagreement about solutions for problems,
- group process difficulties, and
- organisational politics.

The fourth framework taught and used throughout the course is one identifying and describing six problems with problem formulation [Dumdum 1993].

1. Insufficient attention to problem formulation
2. Bounded (limited) rationality
3. The self-sealing tendency
4. Unchallenged assertions
5. Lack of issue management
6. Lack of common (shared) understanding

As each of the techniques shown in figure 3 is taught, it is related back to this framework to describe the way(s) in which the technique addresses (or does not address) each of the problems with problem formulation.

The fifth framework used in the unit is to view all kinds of systems and technologies as solutions to particular kinds or classes of problems. Information Systems (IS) and Electronic Commerce (EC) systems solve organisational problems related to unavailable, inappropriate, poor quality, or overly costly information, inefficient/costly information (data) processing and their consequences, such as inability to perform tasks or tasks performed poorly or inefficiently due to problems with information. Various different kinds of IS and EC systems, such as Transaction Processing Systems, Decision Support Systems, Enterprise Integration Systems, Business-to-Consumer Systems, and Business-to-Business Systems, are described in terms of the information or organisational problems that they are able to help to solve. On the other hand, Information Technology (IT) itself addresses more technical problems related to incompatibilities of systems, inability to exchange data, performance, risk, and/or ability to perform maintenance.

The use and repetition of these frameworks gives the students on overall conceptualisation of the course and its topics. This facilitates learning an overall perspective of the purpose of the course and the different techniques taught, as well as how the techniques compare to and complement each other.

IV. A STRAIGHTFORWARD & PRACTICAL APPROACH

Students in the unit are taught a simple, straightforward, and practical approach to problem analysis and problem solving. The aim is give them something memorable, which they can reasonably be expected to remember and apply. The approach also provides a clear context for the introduction of the specific techniques that are taught in the unit (see Figure 3).

One part of this approach is to teach a simple, three-step process for problem analysis and solving. An overview is given in Figure 4.

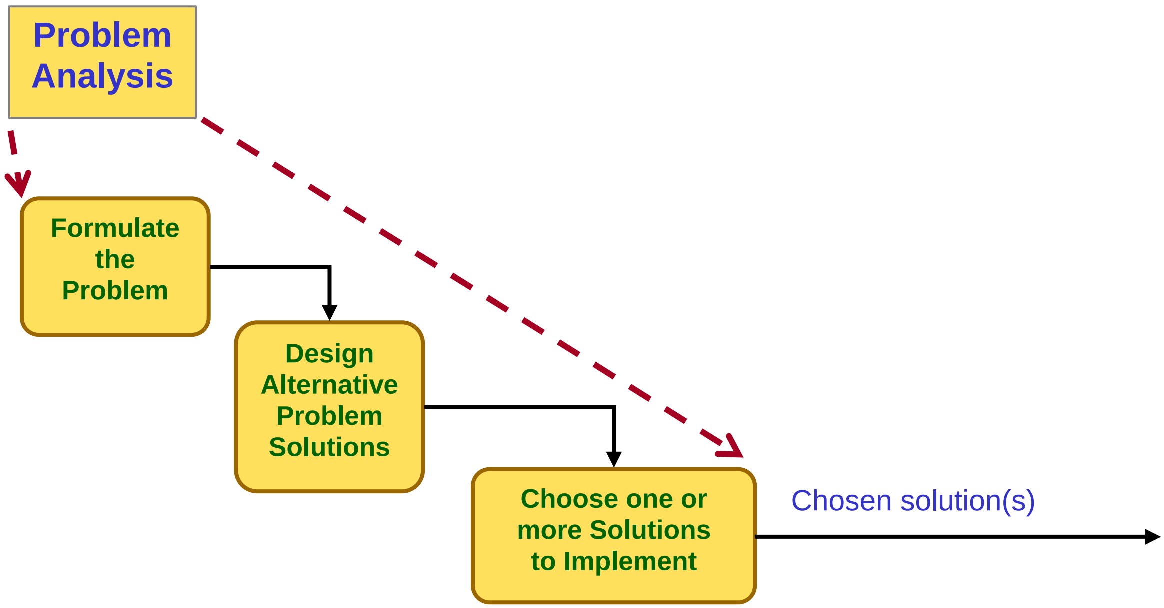

Figure 4: Simple, Straightforward Process for Problem Analysis and Solving

Each of the steps in Figure 4 is then expanded on and a step-by-step, cookbook approach is taught as shown in Figure 5. Similar to the frameworks described in Section III, this process is re-examined regularly and each technique taught is related to the activities within the steps in Figure 5 to which that technique is relevant. For example, the Rich Picture technique can be used primarily in Step 1 to Formulate the Problem, in particular for nearly every activity shown therein in Figure 5, but generally NOT for Steps 2 or 3 or for their activities. Group Decision Support Systems (GDSS) on the other hand could be used for nearly any step or activity.

A key technique used is cognitive mapping. The course initially used the cognitive mapping approach developed by Eden and Ackermann [Eden, 1988, Eden & Ackermann, 2001, Ackermann and Eden, 2001]. However, the students experienced difficulties (particularly confusing nodes for problems and nodes for solutions). A less theoretical, more step-by-step method and process was needed. An insight into the students' difficulties lead the author to develop a refined cognitive mapping approach [Venable, 2005]. The new approach uses a refined notation and a step-by-step process for Cognitive Mapping which clearly separates analysis of the problem itself (step 1 below) from its solution (step 2).

1. Formulate the Problem

- Make an initial statement of the problem
- Identify stakeholders, including the problem owner(s)
- For each stakeholder group, elicit their perception of the problem
    - Why is the current situation undesirable?
    - What is the extent of the problem and how important is it?
    - What are the causes of the problem situation?
    - What other stakeholders are there and what are their perceived interests?
- Model perceptions of the problem to gain understanding
- Share different perspectives among the stakeholders
- Facilitate stakeholder agreement about the problem

2. Design Potential Problem Solutions

- Determine what resources are available to solve the problem
- Create ideas (e.g. brainstorm) for potential solutions
- For each idea, develop the idea further
    - Flesh out with details
    - Consider potential effectiveness as a solution
    - Consider potential problems with the solution
    - Adapt solutions to account for problems (if possible)
- Write a concise definition of each potential solution

3. Choose One or More Solutions to Implement

- Estimate or predict the outcomes for fully developed solution ideas
- Facilitate agreement among stakeholders about a solution or set of solutions to implement
- Reconsider the chosen solution(s) in their full context
    - Business Case
    - Feasibility
- Facilitate agreement from the problem owner

Figure 5: Detailed Process Taught for Problem Analysis

Figure 6 summarises the step-by-step process. Figure 7 gives an example of the Cognitive Map Conversion process (second step) and the notation. While the notation and procedure meet the objectives of the course, appropriate computer-based tool support would likely be very useful [Novak and Canas, 2006], but remains to be developed or explored for use in the course.

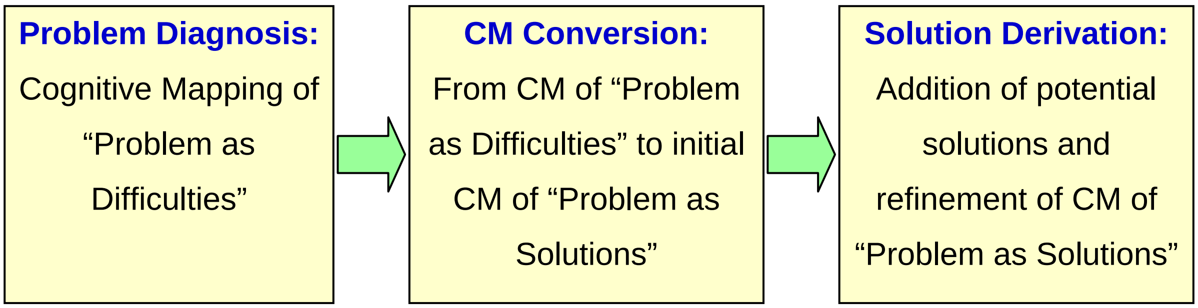

Figure 6: Procedure for Problem Analysis with Cognitive Maps [Venable, 2005]

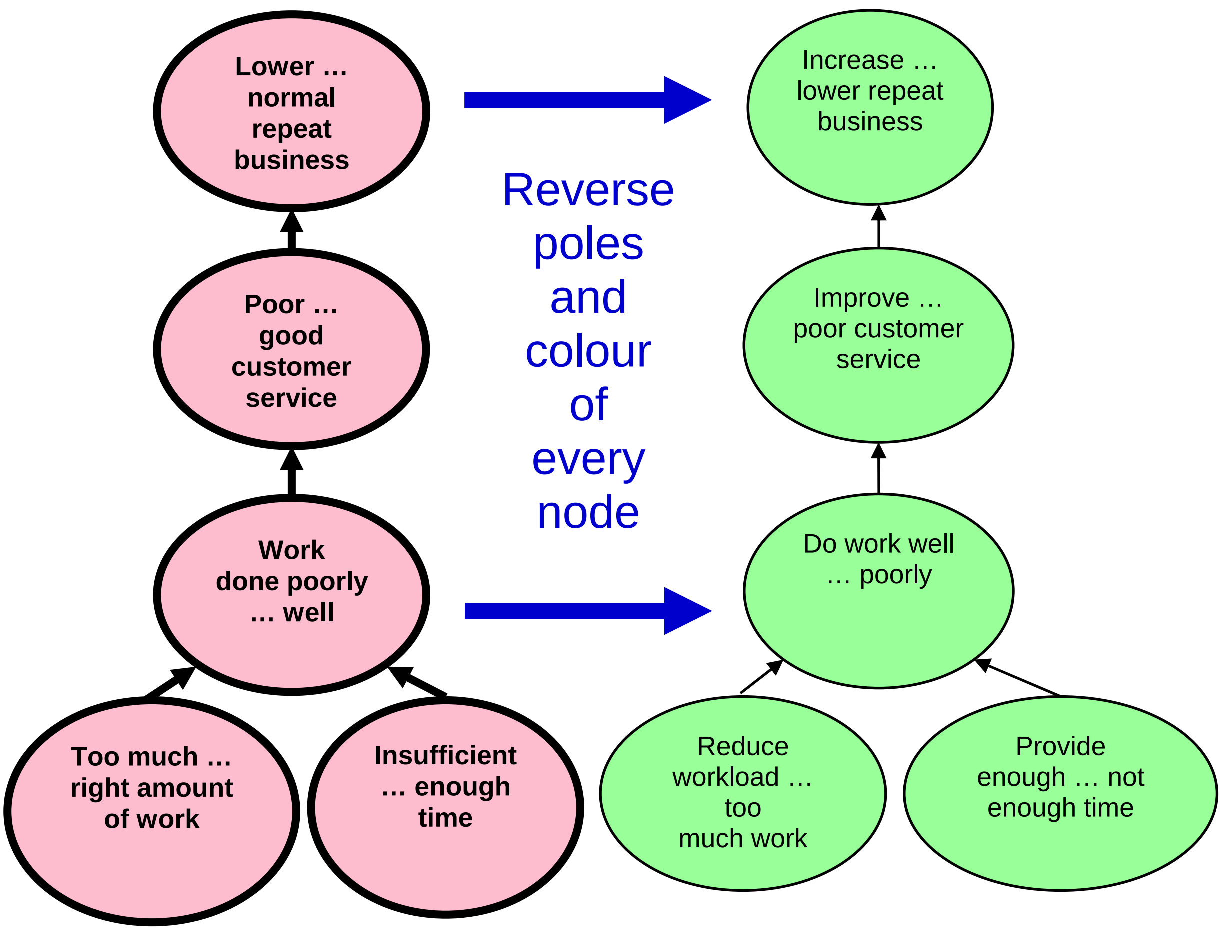

Figure 7: Example Conversion of Cognitive Map from Undesirable to Desirable

V. PRACTICAL, RELEVANT, AND FAMILIAR EXAMPLES

Because the students are first year students, a key aspect of the pedagogy for the course is to use examples that are practical, relevant, and familiar (to first year students). It does no good to use examples from unfamiliar problem domains or that require life experience or experience working in organisations. While some first year students may have this experience, most will not.

Instead, the course lecture, tutorials, and assignments use examples that are related to students' current lives and experiences. Example topics used include university parking, student enrolment systems, group collaboration, and assessment marking and feedback. Furthermore, one example (plagiarism and cheating) is developed in more and more detail each week in the lectures, while another example is worked on and developed (by the students) in the tutorials.

For example, Figures 8 and 9 show two sets of stakeholder concerns with plagiarism, while Figures 10 and 11 show two rich pictures of plagiarism from different perspectives. Figures 12 through 15 show examples of Cognitive Maps of undesirable aspects, causes, solution strategies, and detailed solutions to plagiarism and illustrate the complexity and the ability of the tool to deal with it.

Stakeholder - Student: Why is the current situation undesirable?

- Students who plagiarise assignments don't learn well or at all.
- Students who aren't caught may get higher marks without learning than students who don't plagiarise.
- Students who plagiarise may fail exam and have to retake the unit.
- Students who plagiarise may be caught and have reduced marks or fail.
- Students who plagiarise may graduate without knowledge and skills needed by employers.
- Students who are caught lose time and marks (and units!) to disciplinary action.
- Students who plagiarise are behaving immorally.

Figure 8: Example of Student Stakeholder Issues with Plagiarism

Stakeholders - University: Why is the current situation undesirable?

- Teaching staff have to spend time teaching about plagiarism.
- Teaching staff have to spend time examining assignments to detect plagiarism.
- Students who are caught take up time and administration to discipline.
- Less time for teaching or other university work.
- Poor university reputation when lots of its graduates haven't learned.
- Lower value of degrees from the university.

Figure 9: Example of University Stakeholder Issues with Plagiarism

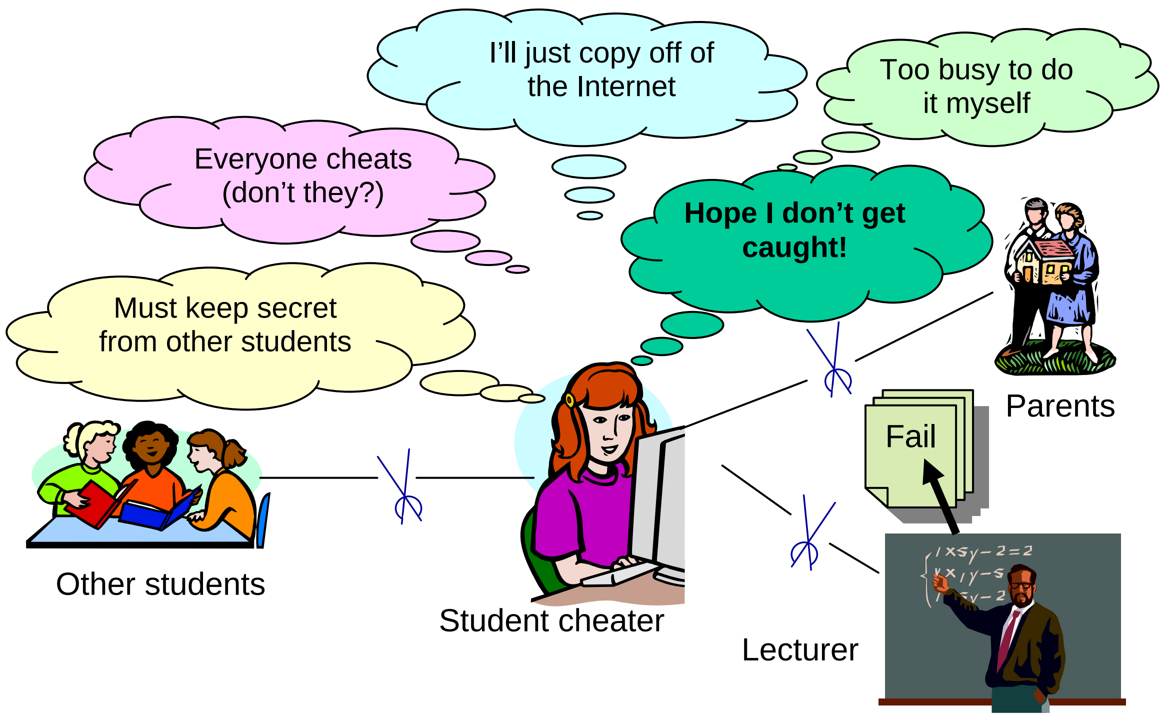

Figure 10: Example Rich Picture Example of Plagiarism from Student (Cheater) Perspective

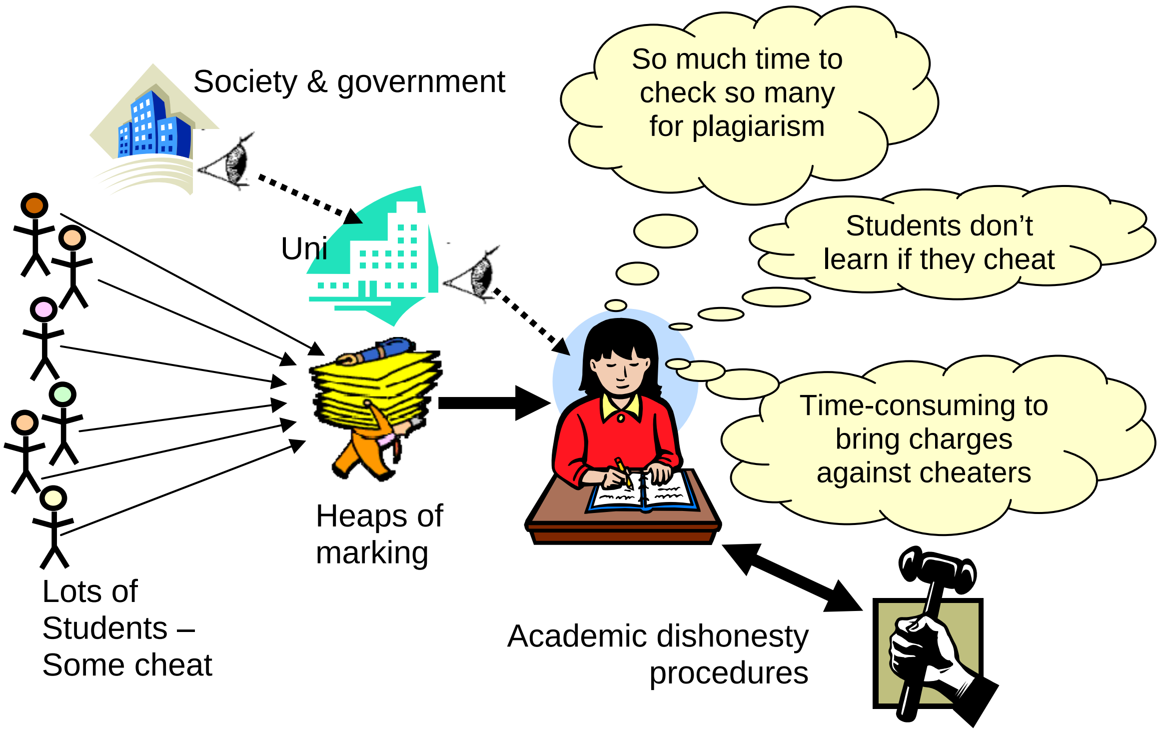

Figure 11: Example Rich Picture of Plagiarism from University Lecturer Perspective

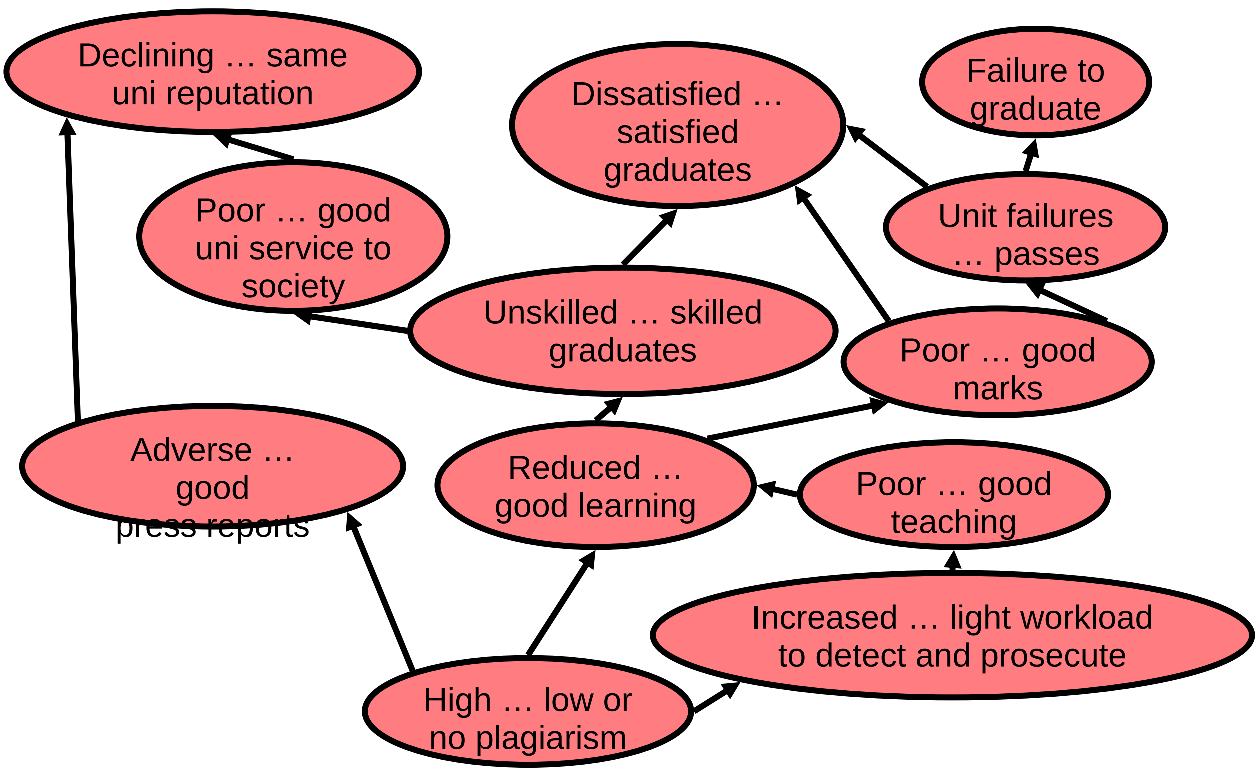

Figure 12: Example Cognitive Map of Consequences of Plagiarism

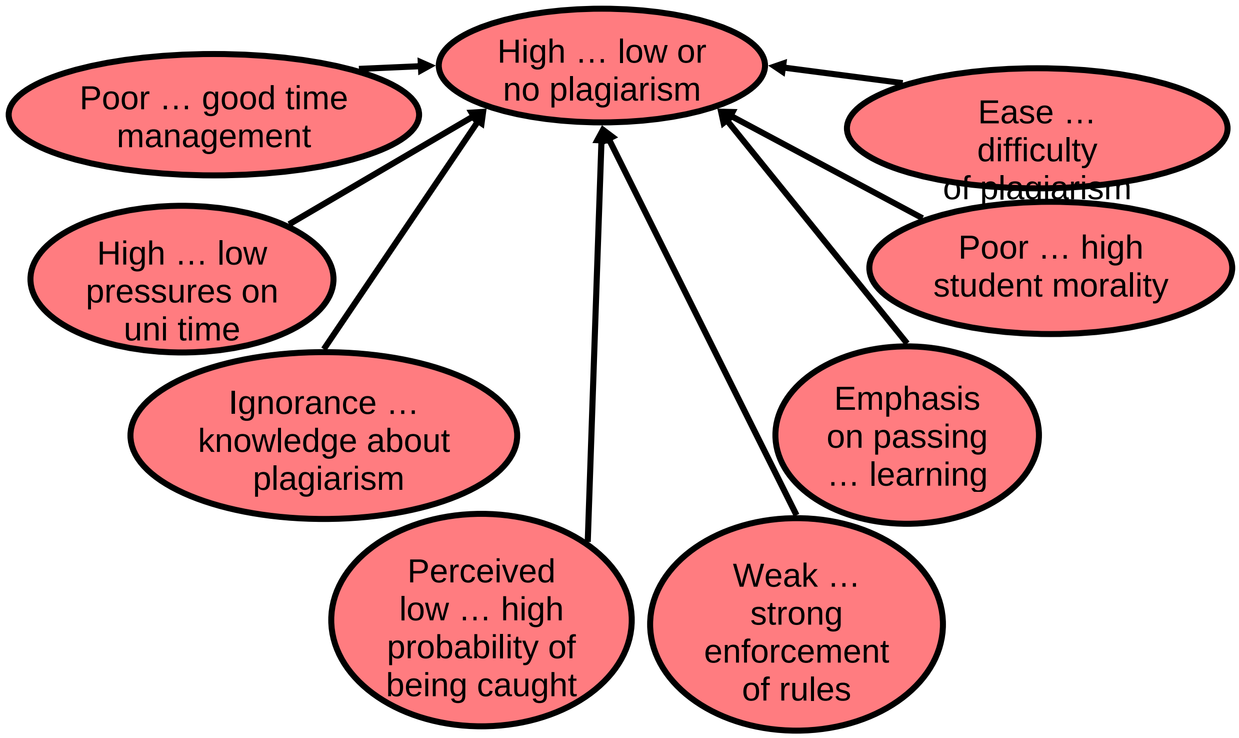

Figure 13: Example Cognitive Map of Causes of Plagiarism

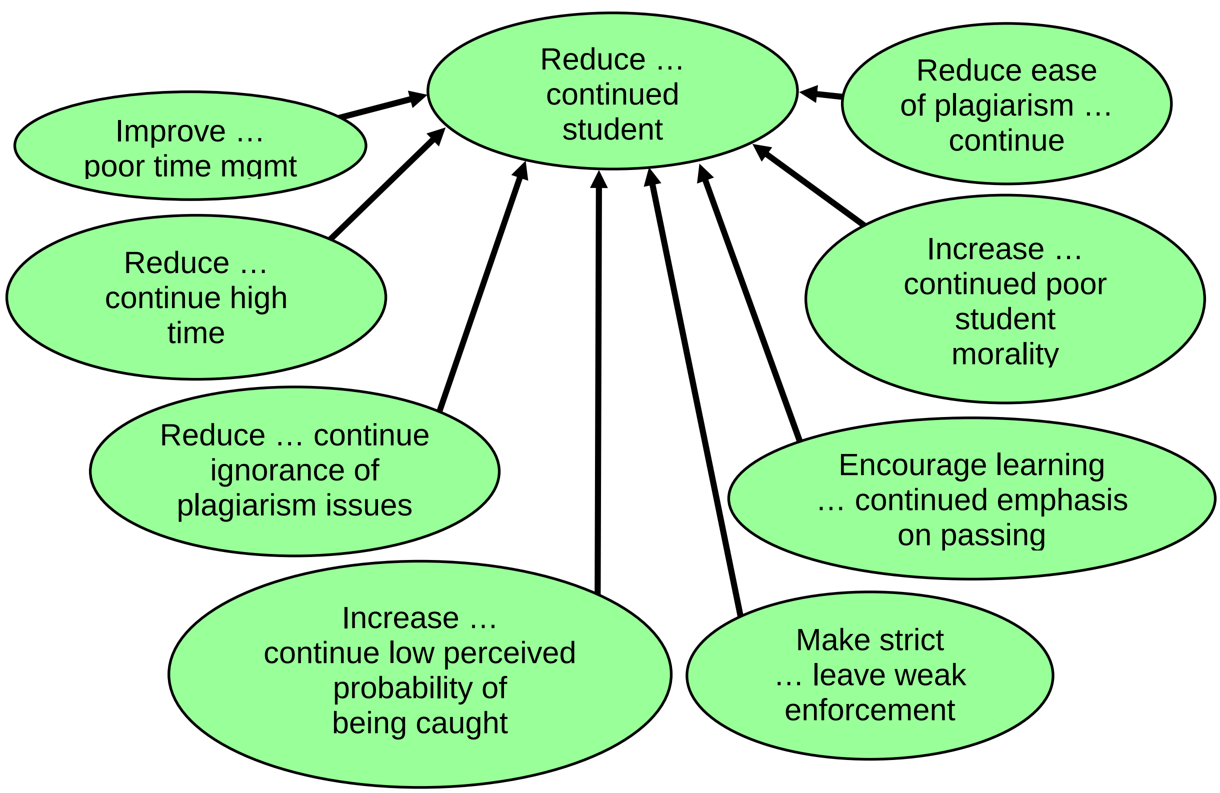

Figure 14: Example Cognitive Map of Plagiarism Solution Strategies

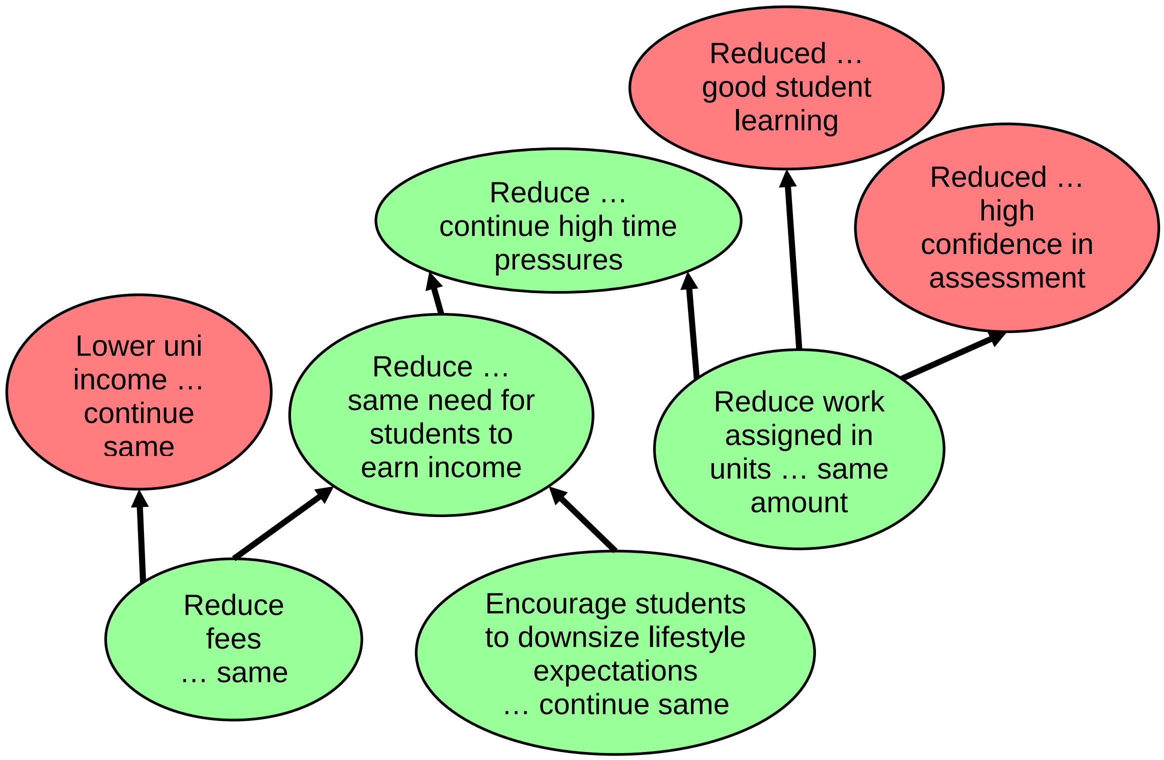

Figure 14: Example Cognitive Map of Detailed Plagiarism Solution (partial)

VI. BUILD UP LEARNING THROUGH REPEATED APPLICATION

In addition to the above aspects of the curriculum and pedagogy, the course provides the students with an opportunity to build up and improve their understanding through a number of activities, which repeat and enhance their exposure to the techniques. This gives the students excellent opportunities to develop and refine their skills in using the techniques taught in the course. This philosophy is explicitly conveyed to the students by describing the following activities as a planned “road map” for their learning.

1. Read the assigned **pre-reading** before the lecture
2. Listen and learn concepts and techniques in the **lecture**
3. Apply and practice the concepts and techniques in the **tutorial preparation exercises**

4. Discuss and refine your understanding and practice the techniques further in the **tutorial**
5. Discuss and refine your knowledge and skills in your **assignment groups** while preparing your group assignments
6. Get **feedback from your tutor** along with your assignment marks
7. Review and demonstrate your knowledge and skills on the **exam**

To accomplish the above, there are a series of tutorial exercises covering the different techniques taught in the unit (see Figure 3). The same example (e.g. university parking as mentioned in Section VI) is used in tutorials throughout the semester, so that understanding of the problem domain is built up over the whole semester. The topic of the tutorial changes from semester to semester so that previous students' work cannot be re-used (i.e. for cheating). A particular problem domain is used in the lectures, then the same concepts are explored by the students in their tutorials (with help and feedback by their tutor), and then a third problem domain is explored using the same techniques as a group in the group assignment. Finally, many of the exam questions are also practical in nature, asking the students to draw diagrams or make analyses based on a short case study. Students who engage in the prior learning activities usually have no problem with such questions, indicating that they have learned the material and skills well.

VII. GROUP WORK TO REINFORCE LEARNING

Finally, group work is used in both the tutorials and on the group assignments to enhance and reinforce student learning. In the tutorials, exercises are prepared individually, but then discussed both across the tutorial and in individual groups. Other group exercises are developed during the tutorials themselves. The students are encouraged to discuss the concepts and how to apply them during the tutorial sessions.

Furthermore, the assignment is done in groups. The assignment has two stages, a problem analysis report and a business case report. Both reports concern the same problem domain/topic. Both assignments emphasise the modelling and analysis skills in the unit rather than the elicitation skills. Groups are encouraged to work together on each section of the assignment. They are especially encouraged to review and discuss sections of each assignment. While the work is done as a group, marking/assessment is individual. To enable this, students are required to provide regular progress reports and plans, to indicate on the reports who wrote and worked on which sections of the report, and to provide an end-of-course peer review of their fellow group members. However, this concerns assessment rather than learning.

VIII. EXPERIENCE AND EVALUATION

The Problem Analysis course described in this paper has been taught every semester (and most summers) since 2002, both on the main campus and on external campuses. During that time it has undergone some change, such as the removal of group presentations (too time consuming in the context of the unit), development of the peer evaluation and individual marking of the group assignment, reduction in the number of marked tutorial preparation exercises (to reduce tutor workload), and simplification of the cognitive mapping process (as described in Section IV).

Student feedback is generally positive. Most students succeed, with a failure rate similar to other first year courses. Most students pass the exam (it is a requirement to pass the exam to pass the course) and do reasonably well on the practical exam questions. Some students complain about the workload, but evidence is that they're only spending, on average, 4-6 hours per week on the course (with the usual big push at the end of the semester). Student satisfaction runs at around 80% or more, which is reasonably good for a first year course.

More importantly, staff teaching subsequent units report that students are thinking more critically about the material that they learn and have developed better communication and group collaboration skills. They clearly are concerned with meeting organisational needs and are aware of the issues of identifying different stakeholders and resolving conflicting stakeholder interests.

One weakness of the existing course is that there is no suitable textbook. Currently various disparate readings are used, some written by the author. A suitable textbook, perhaps purpose-written, would be useful.

IX. SUMMARY AND RECOMMENDATIONS

This paper has described some aspects of a curriculum and pedagogy for a first year course in Problem Analysis. The development of the course was motivated by a perceived weakness in current IS Development practice, curricula, and textbooks and by weaknesses in teaching such material as an advanced, elective course. The course is very applied, teaching and developing skills in practical techniques. It is less theoretical in its approach than typical advanced courses, but provides the students with conceptual frameworks to organise their understanding and reinforce their learning. Our experience with the course has been that it is meeting its objectives.

Existing ISD approaches, curricula, and textbooks seem to have a weakness in the area of problem analysis. Given the research emphasising this area as a key source of ISD failure, one recommendation would be to develop this topic further and undertake research and action to bring it into ISD practice, curricula, and textbooks.

Another potentially useful line of research would be to refine the approach outlined in this paper. Potential refinements to the approach that could be researched include the use of computer-based tools for facilitating editing, analysis, and collaboration between student learners [Novak and Canas, 2006], development of techniques for improved marking of rich pictures and cognitive maps (e.g. as in Ruiz-Primo and Shavelson [1996]), as well as further refinements to the cognitive mapping technique itself (such as accommodating differences in importance or weighting of the nodes, or of the degree of causality of the links.

Finally, it would be very useful to develop better ways to measure the improved performance of students and graduates who take such a course. Assessment of learning and improved performance and attributing it to different curricula or pedagogy within a complex milieu remains a thorny issue in education.

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