Using problem cases to develop generic and intellectual skills in Information Systems Analysis

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Section A: Overview

This section gives an overview of the design of the curriculum with reference to the theory of constructive alignment

Context

What was the driving force behind this intervention?

The main driving force behind this intervention comes from (1) the awareness of the increasing demand of generic and intellectual skills (e.g. problem solving, creative thinking, communication skills etc) in today's IT professionals and (2) the belief that quality education should go beyond imparting existing knowledge to developing students' capability for lifelong learning. I believe that these two goals can be achieved through appropriate teaching and assessment methods. Constructive Alignment happens to be a handy guiding principle in designing a curriculum with this quality.

Subject(s): Information Systems Analysis

Level: 3

Class size: 69

Duration: 14 weeks

The Curriculum: An Overview

→ Teaching & Learning Activities	Intended Learning Outcomes	← Assessment method
Hybrid problem based learning ▪ Problem case ▪ Lecture ▪ Tutorial discussions	a) **Identify** problems to be solved within a problem situation b) **Acquire** knowledge through information **search** for problem solving c) **Formulate** a plan to **solve** a problem d) Work **independently** and in **teamwork** e) Acquire **leadership** skills f) **Communicate** effectively through report writing and presentation g) **Describe** and **explain** the knowledge of the subject, and in addition, be able to **relate**, **apply** and **theorise** the knowledge of the subject **In formulating these outcomes, I try to:** ▪ Indicate the level of understanding expected in terms of professional competence. ▪ Emphasise the development of generic and intellectual skills that a professional systems analyst would need to possess	Problem case reports and presentations Peer evaluation on generic skills Structured tests

Mapping Learning Tasks to Outcomes

Intended Learning Outcomes	Teaching & Learning	Assessment
a) **Identify** problems to be solved within a problem situation	▪ Problem case 1 (feasibility study) ▪ All problem cases (problem analysis), facilitated with a web-based system	▪ Reports
b) **Acquire** knowledge through information **search** for problem solving	▪ Problem case 2 (system proposal) ▪ All problem cases (information search)	▪ Reports
c) **Formulate** a plan to **solve** a problem	▪ All problem cases (project planning), facilitated with a web-based system	▪ Reports ▪ 2 Structured tests
d) Work **independently** and in **teamwork**	▪ All problem cases (group work, schedules showing individual's responsibilities)	▪ Peer evaluation
e) Acquire **leadership** skills	▪ All problem cases (through leadership rotation)	▪ Peer evaluation
f) **Communicate** effectively through report writing and presentation	▪ Presentation for case 1 & 4	▪ Reports ▪ 2 Presentations
g) **Describe** and **explain** the knowledge of the subject, and in addition, be able to **relate**, **apply** and **theorise** the knowledge of the subject	▪ Problem case 3 & 4 (explore two approaches to system development)	▪ Reports ▪ 2 Structured tests

Section B: Aligning Teaching and Assessment with Outcomes

This section (1) explains how constructive alignment is achieved with the chosen teaching, learning and assessment methods, (2) highlights supportive features for promoting smooth implementation, and (3) reflects on the experience for improvement.

Teaching and Learning Methods

Hybrid Problem Based Learning

- **Methodology**

The aim of this subject is to provide students with the environment to acquire the technical knowledge as well as the generic and intellectual skills that a professional systems analyst would need to possess. Since the tasks that a systems analyst may encounter are often problem solving in nature, the need to develop problem solving skills should be adequately addressed in this subject. I find that problem-based learning (PBL) to be suitable for my subject because I could easily bring the development of problem solving skills into the context of the subject and at the same time engage students in active application and construction of knowledge. This adds to the authenticity of the learning tasks and supports students to work gradually towards higher levels of understanding as they work through the problems. PBL also allows the integration of other necessary skills for systems analysts such as interpersonal skills (through group work) and communication skills (through presentation and report writing) into the learning tasks.

A hybrid PBL approach was adopted with the hope that this would reduce the confusion commonly associated with PBL. Learning was centred around four **problem cases** supplemented with **lectures** and **tutorials**.

Problem case

- Learning was centred around four problem cases. Each problem case represented an authentic task of an IT professional in practice. Problem cases provide the opportunity for applying technical knowledge in the context of authentic tasks.
- To enable students to gradually build up their PBL skills, relatively simple problems were introduced first, followed by more challenging problems.
- Both well structured and poorly structured problems were used. The former provides an environment for acquisition of knowledge and training of specific skill, the latter demands the practice of critical thinking, creativity and problem solving skills.
- The problem case assignments were facilitated with a web-based system, which was structured to model a problem solving process. Each problem case exercise involves problem analysis, project planning and information search – such are the intended outcomes of the subject.
- Students were required to work in groups of five to six to work on the problems presented in the cases. Group work was used as the basis of the problem case exercises to provide the basic condition for the development of teamwork skills.
- Online scheduling was used in the web-based system to monitor individual work to encourage responsible independent work.
- Bonus points were awarded to innovative ideas to encourage creative thinking.

Lecture

- The lecture sessions were basically PBL sessions with a short lecture to begin with to provide students with the background information and guidelines for the problem case that they were to work on. Lecture serves the purpose of providing students with the basic

knowledge and guidelines that they need for the problem case assignments. Students are more comfortable with lectures than without. This reduces the stress that students might experience with PBL so that it set the ground for constructive learning to occur.

Tutorial

- It is impossible to cover everything in the four problem cases assignments without making them unrealistically complicated. So some topics were covered in tutorials. Even so, PBL was used in these sessions so that the learning environment was coherent throughout.
- Unlike the problem case assignments, in tutorials they can get immediate help when they encounter any difficulties with the problem solving process. This should in some way contribute back to their working on the main problem cases when they are on their own.

Other supportive features:

1. With the concern that students might not be familiar with the problem based learning approach, a few supportive measures were taken:
   - The problem case exercises were supported by a **web-based system** which was structured in such a way that it guides students through the problem solving process. [See snapshots of the web-based system]
   - In the first week, a briefing was given on the PBL approach. Students were given the opportunity to work on a trial case so that they could familiarise themselves with the approach as well as the web-based system.
   - Guidelines on PBL were made available on web for students' reference.
   - Suggested report format to reduce the stress cause by the novelty of the task on one hand and to ensure uniform assessment on the other.
2. The learning objectives were emphasised throughout. Related topics were stated in the problem case handouts to help students integrate different parts of the subject. The needed professional generic skills were highlighted to draw attention to their development. [See sample handout]

■ **Reflection for improvement**

Students seem to need time and experience with the learning tasks before they can fully appreciate or grasp the relevancy or meaning of the intended learning outcomes. This suggests that the learning tasks were quite in line with the intended outcomes on the one hand, otherwise students would not have grasped the relevancy of the outcomes at all. On the other hand, this indicates that the present approach to explicating the intended outcomes by stating them in the subject description and assignment handouts is not adequate in promoting an understanding or appreciation of the outcomes. It may be necessary to provide more opportunities for active engagement with the outcomes at the briefing stage.

Assessment Methods

Overview

The intended learning outcomes of this subject encompass a good range of generic skills and intellectual abilities. Multiple assessment methods were employed to assess the extent to which they had been achieved. Since the skills are expected to be applied in the context Information Systems Analysis, authentic assessment tasks were used wherever possible. This subject adopts a 100% continuous assessment scheme, with assessment methods including problem case reports and presentations, peer evaluation of generic skills, and structured tests with a problem solving component part. The formative function of assessment was borne in mind when planning the assessment tasks.

Problem Case Reports and Presentations

■ **Design of the assessment task**

Reports and presentations are authentic tasks that a systems analyst will need to perform. They would be suitable assessment for intended outcomes such as problem solving and communication skills as well as students' understanding of the subject content.

Reports

- For each problem case, students were required to submit a written report in a format appropriate to the task (e.g. one of the problem cases requires students to produce a system proposal). Reports were limited to 6 pages in length so that students would need to filter and summarise information.

Presentations

- Presentations were required for Case 1 and 4. This arrangement took students' workload into consideration yet retaining the opportunity for making improvement over time.

Other supportive features:

Online sharing of good works was used as a way to provide constructive feedback and incentive for continuous improvement.

■ **Reflection for improvement**

Students asked for prompt feedback, ideally before the 'next' problem case so that they could improve.

Peer Evaluation on Generic Skills

■ **Design of the assessment task**

At the end of each problem case assignment, students were required to fill in an electronic evaluation form in which they rated their team-mates on their generic skills and contributions to the project assignment. Peer evaluation was included in the assessment scheme because evaluation from peers tends to catch students' attention. Therefore it was used as a means to align their attention with the development of the intended learning outcomes and to provide a basis for them to reflect on their skills development. The generic skills listed in the evaluation form match those described in the intended learning outcomes. A description of each skill is available online for reference [see the descriptions]. The evaluation also consists of a part on individual's contribution to the project. Such rating would contribute to the individual's grade so to make the assessment fairer. Individual students could then view the ratings that they received online so that they can have some ideas about their relative strengths and weaknesses. [See the evaluation form]

Other supportive features:

Justifications were required when equal ratings to everyone were given to prevent students from 'playing safe' but to actually give ratings that were reflective of performance. This would make the ratings a more reliable basis for self-reflection on their skill development. Also, the web-based system keeps an individual log of each student which is accessible by the teacher only, so that the teacher can cross check the peer evaluation results with these records.

■ **Reflection for improvement**

Students appreciated comments from peer and found it a potentially useful source of prompt feedback. They agreed that it could reflect their performance given that the ratings were genuine. This was true for some. Some others, however, expressed that they were reluctant to give low ratings to their peers, for sentimental reason and also because they were afraid that their peers could guess who gave the ratings. Some went for doing this 'collaboratively' so that by agreement, no one would receive really low rating.

To address this concern about anonymity, it is my intention to randomise the order of the peer raters appearing on the result page in addition to removing the name of each rater. (Students should be acknowledged of this mechanism to avoid any unnecessary misunderstanding.)

Structured tests

- **Design of the assessment task**

It is an intended outcome of the subject that students would be able to describe and explain the knowledge of the subject, and in addition, be able to relate, apply and theorise the knowledge of the subject (Outcome g). Structured tests were used to assess this. Two tests were given during the semester. Each test consists of three parts: Part 1 requires recalling of information; Part 2 requires explanation of relevant theories; Part 3 requires solving of problems in the context of systems analysis. Elements of explanation and problem solving were incorporated into tests with the intention of encouraging deeper learning and the pursuit of higher level of understanding.

- **Reflection for improvement**

It is noticed that while Part 1 and 2 of the structured tests are common, they do not correspond well with the stated intended learning outcomes. It is intended that the proportion of these two sections to be reduced to make this assessment task more aligned with the learning outcomes (from a 30:35:35 ratio to 20:40:40).

Students found Part 3 difficult. Interviewer pointed out that this might be an indication that students were weak in solving problems individually. Another source of difficulties was that, according to the interviews, the criteria were unclear to students. Some students were also doubtful about the appropriateness of using tests to assess problem solving abilities.

Section C: Evaluation

This section contains a summary of the evaluation methods and the results obtained. As a closing remark to this experience sharing, the author talks about the insights he gets in this experience of introducing constructive alignment into his curriculum.

Evaluations

Comparing students' preparation strategies in problem case with test

- **Methodology**

It is hypothesised that problem-based learning (PBL) engages students in more active and deeper engagement with the subject material than test. This pertains to the development of problem solving skills in the context of Information Systems Analysis, which is a major intended learning outcome of this subject. This evaluation attempts to find out whether the students' preparation strategies for these two assessment methods were indeed different.

The Assessment Preparation Strategy Questionnaire (APSQ) was used as the base instrument for this investigation. The APSQ is a 29-item questionnaire consists of the following scales: (1) processing of information, (2) focus of learning, (3) professional perspective, (4) academic perspective, (5) achieving strategy, and (6) affective and perception of effects. The original questionnaire was adapted for the particular assessment methods under investigation, namely, problem case and test.

The data obtained at the end of the semester with these two versions of APSQ were compared along the six scales. Students' scores on the APSQ problem case were compared with their own corresponding scores on the APSQ test for difference (i.e. paired-sample t-test).

- **Findings and discussion**

Test was shown to provoke more cue seeking behaviour and narrow focusing in students than problem case ($p<0.05$). Students were more likely to relate what they were studying to actual practice in workplace when preparing for a problem case assessment ($p<0.01$), while associating tests to the learning of other academic subjects ($p<0.05$). Students were more positive about and enjoyed problem case assessments than tests ($p<0.05$). No significant difference was found in students' processing of information and achieving strategy.

The results provide some evidence for the hypothesised merit of PBL in engaging students in deep learning as indicated by the lower scores in the focus of learning scale, which measures the degree of cue seeking behaviour which is associated with a surface approach to studying rather than a deep approach. The significantly higher scores on the professional perspective scale for the problem case is evident of its advantage of providing an environment for contextualised development of problem solving skills. This finding is consistent with the student feedback obtained in a focus group interview at a later stage:

'Because I felt that the working environment was quite similar to the problem case given, I had greater confidence. If I could cope with the problem cases, I should be able to adjust to the environment outside.'

Impact on problem solving abilities

- **Methodology**

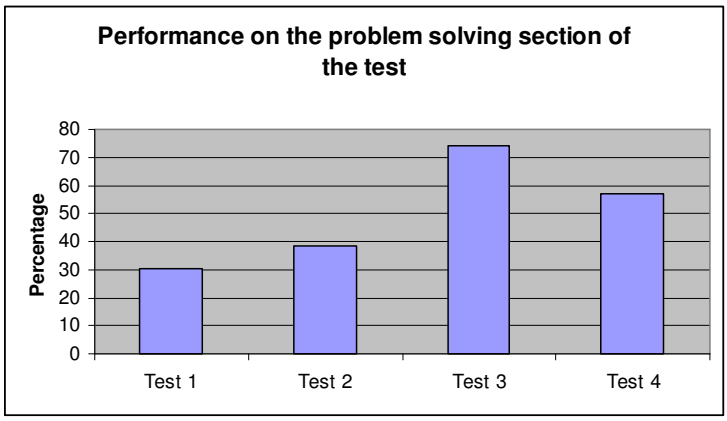
In the present implementation, problem solving was made part of the 'structured tests' (see 'Structured tests' in Section B for details). Score obtained in that part of the test should be a direct reflection of the student's problem solving abilities in the context of information systems analysis. On this premise, if the curriculum were effective in helping students achieve the intended outcome of development in problem solving skills,

there should be a trend of improvement in the test score over time.

The structured test was featured in two consecutive semesters. Students were given two tests in each semester so a total of four sets of scores were available for analysis. The individual's scores in the problem solving part were compared for difference (i.e. paired-sample t-test).

- **Findings and discussion**

A steady trend of improvement was observed for students' problem solving abilities as reflected by their performance in part 3 of their tests (except a drop between test 3 and 4). The score of this part of the last test was significantly higher than that of the first test ($p<0.000$).



Despite the fact that one student commented in the focus group interview that 'everybody did not know how to answer' the problem solving part of the test, a trend of improving scores was recorded. This coincides with the finding that students perceived their problem solving skills to have improved (see 'impact on generic skills' below). It may be said that there is evidence supporting that the teaching and assessment methods adopted have indeed achieved the expected goal of developing students' problem solving skills. One should be aware that however, as it is always the case with test scores, this conclusion is made on the assumption that the test difficulty was comparable to each other.

Impact on generic skills

- **Methodology**

Development in a number of generic skills was expected to be one of the outcomes of this subject and the learning tasks were designed to provide the opportunities for such development. A measure of students' perception on their generic skills should shed light on the extent to which this alignment has been achieved.

A questionnaire survey was administered at the start and the end of the implementation period. The questionnaire is comprised of statements related to a range of generic skills and students were to rate how applicable the statements were in their case. The individual's scores for each skill were compared for difference (i.e. paired-sample t-test).

- **Findings and discussion**

Students perceived improvement in their problem solving skills ($p<0.05$), communication skills ($p<0.01$) and interpersonal skills ($p<0.01$). The findings is compatible with the nature of the learning activities adopted (e.g. PBL for problem solving skills, presentation for communication skills, and group work for interpersonal skills).

Impact on approaches to studying

- **Methodology**

A curriculum in constructive alignment encourages deep approach to studying and discourages surface approach. The impact on students' approach to studying is therefore indicative of the extent that constructive alignment has been achieved.

The Study Process Questionnaire (SPQ) was used as the instrument for measuring student approaches to studying. The SPQ contains 20 items measuring two factors – deep approach and surface approach. The questionnaire was administered at three points (beginning, middle, and the end) over the period of implementation (two semesters) so that changes in student approaches to studying over time may be examined. The differences between scores were computed to represent the changes over time. Such changes were compared with those obtained from two other classes who have not experienced the constructive alignment intervention (i.e. a control group) using a statistical procedure (t-test). One of these classes consisted of students from the same university ('General'), the other consisted of students from the same faculty ('Faculty'). It should be noted that the other class (the control group) only completed the questionnaire at two points, that is, at the beginning and the end of one semester only.

- **Findings and discussion**

	Experimental group			**Control**	
Interval	**Change over Semester 1**	**Change over Semester 2**	**Overall change**	**General**	**Faculty**
Sample size	(68)	(67)	(66)	(164)	(81)
Deep Approach	-0.51	0.57	0.05	-0.18	-0.58
Surface Approach	1.85[a]	1.82[b]	3.70	3.34	4.27

[a] Increase in surface approach significantly smaller than the general control ($p<0.05$) and the faculty control ($p<0.01$)
[b] Increase in surface approach significantly smaller than the general control ($p<0.05$) and the faculty control ($p<0.01$)

The deep approach scores of the class went down over the first semester then up again over the second semester, returning to the original level. Neither the drop nor the rise in one semester was big enough to be statistically different with that of the control group. Because changes in approach to studying were only measured over one semester for the control group, it cannot be sure whether similar rebound in deep approach score would be observed in that group.

Although the overall result does not point to a significant difference between the experimental group and the controls, the rebound in the second half of the implementation observed for the experimental group is suggestive of the impact of the teaching approach on student learning approach. A possibility is that students need time and practice to adapt and therefore gain the benefits of the problem based approach. This speculation is supported by the student feedback obtained in the focus group interview, which basically says that students did not appreciate the intended learning outcomes at the beginning but gradually grasped their relevance as they worked through the learning tasks.

Both the experimental group and the controls had an undesirable increase in surface approach, but the degree of increase of the experimental group over similar period (i.e. a one semester interval) was significantly smaller that that of the controls.

As indicated by the change in scores in surface approach for the controls, it is a common tendency for students to adopt a more surface approach to studying as they go through their university study. The current teaching approach seems to have mitigated the process a bit.

Impact on student learning

Students' comments were solicited through a one-hour interview at the end of the first semester. A total of 11 students were interviewed. The interview focused on a wide range of issues from learning to implementation. Below is a selection of students' comments with particular reference to the impact on learning.

Skills development

- *'…when we went through the process, we found that without the skills, we got into troubles and might possibly not be able to complete the work. By going through the process, we were building up ourselves with more (skills).'*

Peer learning

- *'…having finished my work, I studied what team-mates did. Of course, I was more familiar with my part, but I learned others as well.'*

Higher level thinking and more practical

- *'In the old format, we read and wrote, and everything was okay. But we need to do analysis in the current one. The process is different. It is more practical.'*

Practical experience boosts confidence

- *'Plenty of work. This made my life more meaningfully occupied. I really learned more. Should I have not been involved to work out everything by myself but rote-learned like others and gave very valid answers, the return might be good. However, being able to work with my hands on, like writing reports and presentation, no matter whether it was to train up my English or to give me confidence, I like the experience.'*

Authenticity leads to increased perceived transferability of learning

- *'Because I felt that the working environment was quite similar to the problem case given, I had greater confidence. If I could cope with the problem cases, I should be able to adjust to the environment outside.'*

Closing Remarks

This pilot project displays some evidence of the effectiveness of problem case as a teaching and assessment method for improving generic skills and promoting high level learning. I think one of the merits of problem case is that it integrates learning and assessment, so that students' effort can be kept on track throughout the learning experience. This integration of teaching and assessment also brings the subject one step closer to achieving constructive alignment, which requires *both* teaching and assessment to be aligned with the intended learning outcomes.

An honest truth is that this approach demands more work from both teacher and students, but the outcomes worth the effort:

> *'… I was quite fond of this subject because I had no doubt that the more I did the more I learned. Although, in comparison with other subjects, this made me quite busy…' (student's comment)*

The introduction of the web-based system in some ways relieves part of the workload by providing guidelines to students and by simplifying the grading procedures. More importantly, the structure of the system is designed with developing students' problem solving skills in mind. It is therefore more than a channel for delivering teaching materials; it is a piece of teaching material itself. I think this is something for those who are interested in using IT in teaching to further explore.

In problem-based learning, students should attempt to solve problems by themselves. One problem that emerged in this case was that students were not very comfortable with PBL and kept asking for more guidelines. This is understandable because they happened to have little experience of a PBL approach in the earlier years of their university study. Problem solving is a key skill for IT professionals and it is a high level skill that can only be developed over time. PBL, in my view, is one of the most suitable methods for developing problem solving skills. Therefore, students should be exposed to PBL or at least elements of PBL even in Year 1 of their university study. This points to the need of a more holistic approach to curriculum development so that a right

mix of subject can be integrated for the benefit of the intended development. Constructive alignment works well at a subject level; it can work even better if there is constructive alignment at the programme level as well.

Promoting constructive alignment at a programme level would require orchestration among many aspects of the education system including the mechanism for evaluating teaching. For example, student feedback mechanism such as the Student Feedback Questionnaire (SFQ) can be reoriented to evaluate the extent to which constructive alignment has been achieved in a subject.

One of the more difficult parts of this intervention lies in the formulation of appropriate learning outcomes and criteria that are clear enough to guide student learning and at the same time not so prescriptive as to restricting the space for creativity and exploration. This is especially crucial when student learning is largely driven by assessment. Finding the balance between the two requires a lot of reflections and continuous evaluation. Teaching is a learning process too.