A Critical Inquiry: Teaching Systems Analysis and Design Beyond 2015

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ABSTRACT

A systems analysis and design course teaches a methodical approach to solving complex problems. A similarly meticulous and critical approach is necessary for a computing department to analyse and redesign its own systems analysis and design course. At the same time, pedagogical best practices and developments in e-learning are influencing learners, teachers, and institutions to take charge of their own resources and systems. The purpose of this paper is to find and recommend practical ideas to guide the delivery and content of a systems analysis and design course. This includes looking at the problem from three distinct and essential perspectives: effective student learning, improving the use of learning technology, and making informed decisions regarding the content of a systems analysis and design course. The paper concludes with a discussion of the findings, reflections on the course, and recommendations for future research.

Keywords: Systems Development, Blended Learning, Educational Practices

1. INTRODUCTION

The Systems Analysis and Design (SAD) course plays an important role in many Bachelor's degree programmes in computing and related fields as well as other diplomas and certificates in information technology (IT). SAD is a broad perspective course that also impacts other courses. By itself, SAD helps prepare students for job roles such as IT project manager, business analyst, and systems analyst / developer. The study of systems analysis and design in industry and universities goes back several decades; however, its offering at other New Zealand tertiary institutions is relatively recent.

The class size in Semester 1 for SAD at our institution is typically between 30 and 40 students, including blended delivery for five to ten students at another (remote) campus. SAD is also a compulsory course for our degree, and carries double the number of credits; the SAD class meets twice as many hours each week for lecture and practical hours, and requires more self-directed hours from students for studying and working on the assignments. Lectures are delivered via video conference to the remote campus in a separate session. Otherwise, the content and assessments are the same for both campuses. The online course site plays a great role for both campuses as the central location for resources and activities.

The objectives of the SAD course are to enable students to analyse simple and complex information systems, identify requirements, and document design solutions using appropriate methods, tools, and standards. SAD also covers major concepts of modelling, and enables students to develop and document their solutions using modelling / diagramming. There is a group assignment that provides a valuable interpersonal learning experience and an intensive opportunity for students to apply their newly learnt methodology, tools, and variety of skills, such as communication and fact-finding.

Industry stakeholders expect to receive future graduates who can adapt quickly to the workplace by virtue of practical and interpersonal skills gained during their study. Problem-solving and analytical skills are useful to any IT professional.

Advanced IT courses, which focus on specific topics, expect students to have gained the prerequisite big picture, systematic, and methodological view from the SAD course. Theory plays an important role in systems analysis and design, including frameworks and guidelines describing various processes, methodologies, and activities. A good understanding of the theory, frameworks, and guidelines is important for applying these to a project, and preparing professional quality documentation. In doing so, the students investigate many aspects of a given information system. In industry, business / systems analysts work in and manage systems / software development projects. They collaborate and communicate with a variety of stakeholders including non-technical end-users and sponsors as well as programmers. They also bridge the gaps between these diverse stakeholders.

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2. LITERATURE REVIEW

A review of literature is necessary in order to better understand the context and desirable standards of teaching systems analysis and design. Furthermore, this review needs to include three distinct but equally essential perspectives: concerns related to effective learning, improvements to our use of technology in blended learning, and choices regarding the subject matter of a systems analysis and design course. Each aspect is covered below under a separate subheading.

2.1 21st Century Student-centred Learning

Course learning activities are not only for transferring knowledge but also for developing students' overall learning skills and attitudes. It is also important for teachers to help refine and reinforce the knowledge that the students gain from the lectures and their own reading. In addition to the theory, the learning activities also need to help build and activate the students' personal skills and attitudes related to systems analysis and design. According to Boud and Prosser (2002), an effective learning setting involves four general elements:

- Teachers need to ensure learner engagement by appealing to their prior knowledge and their desires.
- Teachers need to acknowledge and communicate the purpose of the learning within a broader context.
- Teachers need to encourage learner reflection, active participation, and self-monitoring.
- Teachers need to provide learners with opportunities to practice and demonstrate what is learned.

As with any other challenging course, the learner's journey in SAD requires good independent study skills as well as a high degree of working in groups and building knowledge together. According to student-centred learning, teachers should shift away from direct lecture, and then facilitate more experential and student-centred learning activities instead.

2.2 Blended Learning in the 21st Century

Blended learning involves a mixture of both online (distance) delivery and traditional face-to-face classroom instruction. SAD is a blended or sometimes a purely online course at many universities and institutions around the world. Principles of online pedagogy are also important for blended learning. According to Pelz (2004), certain practices help make online courses more effective. The teacher needs to let the students do most of the work. Simultaneously, the teacher still needs to display a cohesive and affective presence. These are easier to achieve if the course begins with clear content structures and guidelines. The teacher is responsible for providing constructive feedback, which involves monitoring and negotiating with learners. Interactivity between everyone is pivotal to online delivery. When this requires any support, the teacher should be ready to use engagement strategies to increase student attention, curiosity, and involvement. The assessment tasks should be real world related and authentic.

Knowing your learner is one of the basic principles of teaching and is equally relevant for those teaching a blended or online course (Schwartz-Bechet, 2010). E-learning provides interesting opportunities for sharing information by the teacher as well as between the learners themselves. This shared information can continuously change and expand with the contributions of teachers who understand their learners as well as with the contributions of active learners themselves.

More specifically, it is important to know the preferences of learners within the course's online learning environment, i.e. the learning management system / the e-learning platform (such as Moodle, Blackboard, Desire2Learn, Schoology, etc.). Students (as a critical group of end users) have numerous expectations from the user interface; one of the most important of these is the ease of integration with other applications (Chawdhry, Paullet, & Benjamin, 2011).

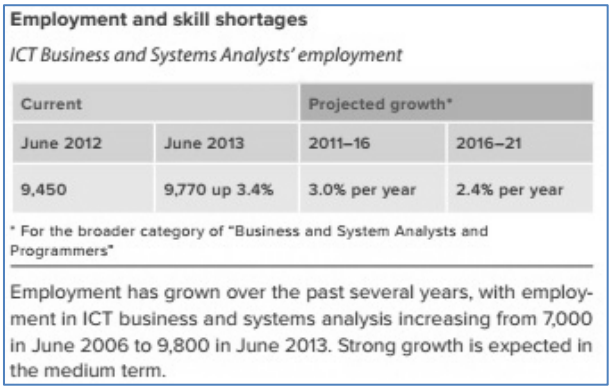
With the increasing abundance of web and cloud based applications and open educational resources, it is no longer desirable or realistic to expect a learning management system to provide all desired or interesting features within itself. In their paper "Open Source: A Metaphor for E-Learning", Koohang and Harman (2005) argue that free and open source software is truer to the spirit of e-learning and the philosophy of constructivist learning, as opposed to proprietary software. E-learning, with its most common learning activities, involves collaboration and contributing to other learners' knowledge. Open source learning software provides greater freedom and flexibility to schools, institutions, and users in regards to ownership and customization. Inherent in constructivist learning is the learner's freedom to experiment, to gradually improve oneself, and to construct new knowledge while adapting to potentially changing circumstances. According to Koohang and Harman, (2005), this is analogous to the process that the administrators and users of learning software and resources go through – they need to be actively involved in the ongoing construction and adaptation of their own system. According to Erturk (2009), whether or not one holds a philosophical view on this topic, open source also promises practical benefits such as reduced vendor reliance and costs.

There are many examples of open access, open source, or free software that can be utilized effectively within a course's broader e-learning environment on top of the main platform (e.g. Moodle). For example, YouTube is a user content driven and cloud based video repository with an open Application Programming Interface (API) interface for other applications (Al-Zoube, El-Seoud, & Wyne, 2010). YouTube videos are easily embedded inside Moodle; our institution has not only used videos from other sources but also created a few of our own instructional videos, and made them publicly available via YouTube. When greater volumes of data are involved, such a cloud based application can reduce local storage and storage within the learning management software database, and can make navigation easier for both lecturers designing their courses and for students finding these multimedia files.

Google Hangouts enable live conversations at no cost between lecturers and their online students. In the case of Adobe Captivate, participation in meetings is free of charge for attendees, i.e. the students. There is also a growing number of video recording software available for creating new course resources, such as Movenote (for presentations with video alongside), Camstudio (which includes screen recording), and Wink (which produces videos in Macromedia Flash format). Furthermore, mobile learning (m-learning), which focuses particularly on learning with the assistance of mobile devices, has its own demands in terms of being able to access information quickly and anywhere despite relatively limited hardware specifications. M-learning can also be facilitated by using cloud based applications and resources (Erturk, 2013).

2.3 Analysis and Design in the 21st Century

Employment of business and systems analysts is growing. In order to briefly illustrate the positive long-term job outlook, two countries can serve as examples, the United States and New Zealand. According to the US Department of Labor (2014), the employment of computer systems analyst is projected to grow 25% between the years 2012 and 2022, much faster than the average of all occupations (11%), and also faster than the average of all computer occupations (18%). In New Zealand, the projected growth in job opportunities for business and systems analysts is even better (NZ Ministry of Business, Innovation and Employment, 2014). Figure 1 shows the expected employment trend in New Zealand between the years 2012 and 2021, along with a note on the previous growth between 2006 and 2013.



Employment and skill shortages

ICT Business and Systems Analysts' employment

Current		Projected growth*	
June 2012	June 2013	2011–16	2016–21
9,450	9,770 up 3.4%	3.0% per year	2.4% per year

* For the broader category of "Business and System Analysts and Programmers"

Employment has grown over the past several years, with employment in ICT business and systems analysis increasing from 7,000 in June 2006 to 9,800 in June 2013. Strong growth is expected in the medium term.

Figure 1: Ministry of Business, Innovation & Employment Job Estimates for Business and Systems Analysts Reproduced under the terms of the Crown copyright

It is apparent in the literature and explicitly stated by Burns (2011) that, among teachers of systems analysis and design, there are numerous areas of difference and contention. One issue is how much material or theory to cover. Because there is a large body of knowledge available in the systems analysis and design discipline, courses may follow either a broad approach to try to bring out many different concepts and methods or a more minimalistic and selective approach (in

terms of what each institution and its teachers find to be current, industry relevant, or pedagogically desirable).

Another issue is whether to teach a more traditional (waterfall/structured) methodology or an iterative (rapid) and object-oriented methodology for systems analysis and design, or maybe even teach more than one methodology – if feasible depending on course length, and lecture and practical hours. Another common issue revolves around the duration of SAD courses (i.e. one semester vs. two semesters). This issue is typically raised in combination with the making the choice as to whether to keep it as one big course, or to divide it into two separate courses. This could be along the lines of teaching different practices (i.e. an analysis course vs. a design course) or along the lines of greater aptitude and application (i.e. a first or second year course vs. an advanced final year course).

In a survey of 172 SAD instructors and professors, Burns (2011) found that the one course delivery option and limiting the duration to one semester are the by far more common than options involving splitting to two. One reason behind this simplification has to do with fitting SAD into the rest of the programme. The SAD course may also be available to students from other departments such as business. For some institutions, the computing department is also part of a larger business faculty or department. Although the data collected Burns (2011) encompasses many other variables and also lists many less popular responses, this paper aims to bring out the results related to the major issues in this discipline as well as the most popular choices. Table 1 shows the main results regarding the methodology issue:

Table 1: System Development Methodologies Taught

SAD General Approaches Covered:	
Both Traditional and Object-Oriented	53%
Traditional only	25%
Object-Oriented only	15%
Development Methodologies (multiple answers allowed):	
Waterfall	80%
Prototyping	81%
Object-Oriented	66%
Rapid Application Development	75%

The results obtained by Burns (2011) show that a minimalistic approach to content choice is not common, and the responding teachers attempt to cover a broader range of topics. Table 2 shows the main results from Burns (2011) regarding the content issue:

Table 2: SAD Concepts and Techniques Taught

Economic Feasibility	84%
Interviews	94%
Entity Relationship Diagrams (ERD)	77%
Data Flow Diagrams (DFD)	81%
UML Class Diagrams	52%
UML Use Case Diagrams	54%
Interface Design	68%
Buy vs. Build	63%
Scope Creep	58%
People and Resistance Issues	54%

Another interesting issue in the practice and learning of systems analysis and design is moving forward by gaining sufficient momentum to transition from analysis to design, and then from design to the construction of the product (Jafar & Babb, 2012). However, this may require using professional systems analysis and design software such as IBM Rational, Visual Paradigm, or Altova UModel.

3. METHODS

The next step is to evaluate how the current systems analysis and design course at our school stacks up against the demands, practices, and circumstances that are discussed in the literature review. This entails simplifying and filtering some of those ideas in order to make the measurement or judgement easier. Despite these simplifications, the analysis in this paper attempts to cover all of the three different angles: facilitation of effective learning, use of up-to-date technology in blended learning, and our coverage of the modern and essential aspects of the field of systems analysis and design. Simple ways for any institution to evaluate each of these three aspects is covered under a separate subheading as follows.

3.1 The Learners' Thoughts

Feedback is an important part of designing a course, according to Boud and Molloy (2013). When redesigning an assessment, for example, teachers should think about the constructive feedback that can be provided in conjunction with that assessment. Boud and Molloy (2013) suggest the use and improvement of feedback in a broader sense, not just from the teachers to the students. For example, feedback can be encouraged and exchanged between students themselves.

Another common form of useful feedback comes from students, when evaluating or reflecting on the course. The student feedback that will be used anonymously in this paper comes from an unofficial survey that our course conducts at the end as a reflection by the students on their teamwork and team mates as well as general comments about the course.

3.2 Good Use of Technology

The categories of features offered by learning management systems and how effectively or frequently those features are used by an institution are discussed in many papers. A convenient model with five levels (Levels 0 through 4) was proposed by Janossy (2008); a similar model was also adapted by Abazi-Bexheti, Kadriu, & Ahmedi (2010) with some modifications, which, for the most part, involved changing the highest level. Whereas Janossy's (2008) Level 4 looks at the extent to which synchronous class instruction is provided via real-time or recorded audio and video, Abazi-Bexheti's (2010) Level 4 looks at the extent to which students are sharing knowledge and co-developing course resources. As these two ideas are both plausible and interesting, this paper will consider them both. The levels for evaluation (as simplified and informally operationalized by this paper) are as follows:

Level 0: There is no online course site.

Level 1: The course site involves document distribution by teachers as well as submission of work by students.

Level 2: The course site uses a variety of communication tools such as email, discussion forum, and chat.

The communication feature was especially important for pioneering learning systems, e.g. WebTycho ("History of WebTycho", 2003), which first went into operation in days when web based email and social media were not widespread.

Level 3: The course conducts quizzes and tests directly online.

Level 4A: Class sessions are available either in real-time or through multimedia files. Some learning management systems

make it possible, as in the case of Desire2Learn (http://www.brightspace.com/solutions/higher-education/), to accomplish these types of tasks using internal tools. Otherwise, it typically involves using external third-party software to create the files, and then integrating those outputs into the learning management system.

Level 4B: Students are involved in updating course content, and, therefore, are able to engage in a peer teaching role.

3.3 Keeping up with the Joneses

Another benchmark in the critical inquiry is how our school's offering compares with other institutions and universities that teach systems analysis and design as well as industry expectation and practices. Our school also needs to replace its textbook for the coming 2015 academic year. The Business Systems Analysis course offered by University of Canterbury (UC) closely resembles our course in a number of ways. First, the three assessments are very similar (although with slightly different weightings): group project, mid-semester test, and final exam (University of Canterbury, n.d.). Second, UC tries to cover both the traditional and the object-oriented approaches, which is also a realistic alternative for our school. Their course currently uses *Modern Systems Analysis and Design* by Hoffer, George, and Valacich. In addition, another popular text, *Systems Analysis and Design* by Kendall and Kendall, is a recommended reading for the UC course.

In order to evaluate our current standing in comparison to other institutions and universities, this paper uses not only some of the quantitative results of the Burns (2011) survey but also three important ideas that permeated the qualitative responses to Burns (2011) and a number of other papers in the literature, for example, one recently written by Kettles (2014). First, good teamwork and the development of team skills among learners are important in a SAD course. These attributes are also expected by the industry and useful in the future workplace. Second, there is the possible option of providing students with a real project to work on, rather than a simulated project or case designed by the lecturer. When this is not possible, it is still beneficial to bring a few occasional guest speakers from industry to speak with the students. The option of working with a real client becomes more feasible if the project is with a small or local business. Furthermore, this can be even more suitable for students if the desired product is a mobile or web based application with a limited scope and clear requirements (Kettles, 2014). In that case, the third idea held by some lecturers may be possible: the students could find an opportunity to practice some skills related to the later phases of development, such as creating mock-ups, coding (e.g. forward engineering or visual programming), and testing.

4. FINDINGS AND DISCUSSION

This section attempts to assess how our current systems analysis and design course stands compared among other institutions, in terms of the best practices discussed above, and in the eyes of our students. Again, this is viewed from the three different angles: facilitation of effective learning, appropriate use of technology in blended learning, and coverage of the modern and essential aspects of the field of systems analysis and design. Each of these three aspects is covered under their respective subheadings.

4.1 The Learners' Thoughts

The student responses analysed here are from the years 2013 and 2014. First, the amount of positive feedback has clearly increased, especially in regards to using Google Drive as a repository for group project deliverables and artefacts. This may be due to the lecturer promoting it regularly (rather than just expecting it), taking a proactive role in helping students in using it, and monitoring it more frequently in 2014.

Next, it is necessary to mention or quote some of the representative individual responses. To be more impartial and also for the benefit of potential improvement, equal numbers of critical suggestions vs positive thoughts need to be shared.

One student mentioned his gratitude for the flexibility in allowing him to switch to another group when circumstances mandated a reorganization of the original group. Although teachers should give students room for independent learning; there may be times when it would be to the students' benefit, if the teacher (similar to a manager in a real life systems development project) intervenes and mentors them. Many students have mentioned interpersonal issues of arranging meetings with their team members and using their time efficiently outside of the classroom. Although this may also be seen as a learning experience, it poses risks – against which the teacher might perhaps provide better guidance and control.

Another outcome that permeates the students' responses is their own appreciation for what they have accomplished during the assignment. One student commented "a very good assignment overall feel I learnt a lot". Another student referred to how each member brought unique qualities and "aided in the creation of a final finished assignment that I was proud to be involved in." However, another student also pointed out the missed opportunity for further continuation and application, and commented that physical systems design could have been covered more, along with delving into how the software construction can follow the SAD documentation. In summary, the cumulative learner response is positive but nevertheless offers suggestions for enhancing the course.

4.2 The Use of Technology

In order to assess how well we are delivering the online component of our course, the course site has been reviewed in terms of the quantity or quality of certain types of resources that correspond to the different levels of learning software use in Janossy's (2008) model, and current trends mentioned in the literature review. Table 3 summarizes these findings.

Table 3: SAD Course Moodle Site

Level 1: Documents	More than 100
Level 2: Communication	6 forums, no internal chat or email function used
Level 3: Quizzes/Tests	3 quizzes, no official tests or exams conducted online
Level 4A: Audio-visual	1 video, 25 audio Podcasts, 1 walkthrough book, weekly video conference sessions
Level 4B: Co-development	None (although our school has used this technique in the postgraduate courses)
Open Education Resources	4 high-quality resources (including one interactive)
Integration with the Cloud	No direct link on this site (although our school uses Google Sites, Documents, and Drawings directly in other online courses sites)

The current collection of online resources and activities forms a solid foundation for the future; although this review also shows that the outlook for our SAD course can get even better if more open and cloud resources can be incorporated.

4.3 Teaching Systems Analysis & Design

As explained previously, this paper relies on past literature to help evaluate our course's approach to and coverage of systems analysis and design methods, topics, and skills. There

are two immediate shortcomings to this approach; the exemplary sources come from an American background, and Burns' (2011) work is currently several years old. Therefore if similar surveys are conducted today, the results may change slightly. One recommendation for the future is to conduct a survey only among practitioners in New Zealand, along with potential research collaboration across multiple institutions. However, there is also a lot to be learnt from other countries. Table 4 summarizes the findings on our SAD course's current approach alongside other institutions.

Table 4: Concepts, Techniques, and Skills

General Approach	Traditional only – this puts our course in the minority (although there is another course in the programme covering object-oriented)
Development Methodology	Waterfall and Prototyping are covered – however, object-oriented and rapid application development are not standard to our course
Feasibility & Requirements	Well covered and practiced
Diagrams: ERDs and DFDs	Well covered and practiced with many examples
UML Diagrams	Not in the compulsory course except brief coverage of use case diagrams
Team Skills	Conscientiously cultivated, including team building
Real Life Orientation	No real project in the compulsory course; but final year projects provide that opportunity. There are good and relevant guest speakers.
Software Building	Not part of this SAD course (as it is one semester long).

This review points out some of our strengths. On the other hand, there is a need to get up-to-date with more agile and less structured practices. This is challenging because these practices are easier to understand when contrasted with the older approaches, which the students may need to learn initially as part of preparation. Despite the need to cover more than approach, teaching and utilizing UML diagrams do not necessarily have to be affected by the various philosophies of the discipline. They are accepted and proven, in industry and at many institutions and universities.

5. CONCLUSION

Course design is a challenging and interesting task, which should not only involve the individual preferences of lecturers but should also critically examine the course, its delivery, and its subject matter from different angles, in light of current practices and trends. As course design can become arduous and may not be possible to do every year, it is recommended that institutions do their best to make the course future-proof when they undertake the effort. The changes highlighted in the findings and discussion section of this paper will be implemented in our course starting in 2015.

It is recommended that a part of the institution's repository of online resources and activities be updated, and some of the older and passive links be replaced by new resources, in accordance with the shift in concepts toward UML, software development, and connections to industry. Furthermore, the associations with other institutions and open educational resources can be increased, while taking advantage of cloud based storage and collaboration tools directly from Moodle via links to a variety of Google Documents (e.g. drawings, presentations, tables, and sheets).

Just like any other course, SAD is increasingly being delivered in a blended or even purely online environment. The same goes for industry based or professional certifications and training courses. Therefore, a recommendation for further research is to compare the current academic and professional offerings, and realize what each side can learn from the other in order to improve their online content and delivery. This type of research involving multiple organisations would be more feasible and can capture more qualitative information when carried out within one country, e.g. in New Zealand. Another recommendation for future research is to investigate the links between this course and prior courses and courses that follow SAD in the degree programme. Enhancing our SAD course may require adjustments to its prerequisites. Furthermore, while considering the impact of a given course on subsequent courses, Lopez, Lopez, McCarthy, & Oliver (2013) suggest looking the relationship in two ways: how well this course prepares students for future courses and how well future courses build on SAD knowledge and skills. Therefore, another future paper or institutional white paper may focus primarily on the progression of information systems and system analysis and design courses from the initial diplomas, the Bachelor's degree, final year capstone or project courses, and up to any related courses in the postgraduate program.

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