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Understanding the Curriculum Gap in Systems Analysis and Design: An Exploratory Study

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Abstract

This research in progress describes an exploratory study that investigates the Systems Analysis and Design (SA&D) skills, knowledge, and practices that are considered most important by industry practitioners and compares with the course content, skills, and coverage in a typical undergraduate SA&D course. We present preliminary results and analysis of semi-structured interviews conducted with industry practitioners and outline the next steps. We believe that the final findings of this study should lead to a better understanding of the gap between what is currently taught in a typical SA&D course and what is considered as important by practitioners. It should assist educators in structuring their SA&D course to be more aligned with the contemporary needs of the industry.

Keywords Teaching Systems Analysis & Design, Systems Analyst, Business Analyst, IS Curriculum

1 Introduction

Systems Analysis & Design is an indispensable component of any program of study in information systems (Harris et al. 2006). It is a core course in the IS2010 undergraduate curriculum (Topi et al. 2010). The course content typically includes a method for analysing a business problem or opportunity, determining the role computer-based technologies play in addressing the business need, articulating business requirements for the technology solution, specifying alternative approaches to acquiring the technology capabilities, and specifying the requirements for the information systems solution (Topi et al. 2010). A business expectation of a SA&D course is for educators to ensure that students are adequately prepared to join the workforce with a semester's worth of understanding of the 'processes, methods, techniques and tools' of systems analysis' (Stevens et al. 2013).

In the industry, systems analysts take on various responsible roles such as business analyst, systems architect, and project manager, and are expected to have a range of skills – technical, business, and interpersonal. The projected growth of systems and business analysts' employment is always increasing. For example, according to the Bureau of Labour Statistics, US Department of Labor (2015), employment of systems analysts is projected to grow 25 percent between the years 2012 and 2022, much faster than the average for all other IT occupations. Similar growth is projected in other parts of the world (NZ Ministry of Business and Innovation and Employment 2015): Table 1 shows the comparison of growth in business and systems analysts' employments in the Australasian region of New Zealand between the years (i) 2013 and 2024, and (ii) the previous growth between 2007 and 2014.

Employment and skill shortages

ICT Business and Systems Analysts' employment

Current		**Projected growth***	
2013	2014	2014–19	2019–24
12,070	12,860	4.6% per year	4.2% per year

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

Table 1. Ministry of Business, Innovation & Employment Estimates for ICT Business & Systems Analysts

Over the past few years, there has been an ongoing debate on whether or not the education provided by the tertiary sector matches what is expected as essential by the industry (Asgarkhani and Clear 2014). While the differences between the IS educator and practitioner perceptions pertaining to the required skills and knowledge of IS graduates in general has been documented in the literature (Anandarajan and Lippert 2006; Stevens et al. 2011), there appears to less research that focuses on the skills and knowledge requirements needed by those graduates who enter the specific area of SA&D (Stevens et al. 2013).

Most extant literature on SA&D focus on addressing three main areas: (i) the significance of the SA&D course in the IS curriculum (Harris et al. 2006), (ii) teaching approaches and techniques (Bataveljic et al. 2006; Batra and Satzinger 2006; Costain and McKenna 2011), (iii) separate and individual assessment of the educators' (Guidry et al. 2011) and practitioners' (Stevens et al. 2013) opinions of the importance and coverage of topics. However, there is relatively limited research that addresses the 'teaching-research' gap that compares the views of both the teaching and practitioner communities. This study seeks to explore the skills, knowledge, and development practices that are considered most important by industry practitioners and compares with the course content, skills, and coverage in a typical undergraduate Systems Analysis and Design (SA&D) course in New Zealand. Thus, this study aims to answer the following research questions:

(i) Which SA&D topic areas, skills, practices, and approaches are considered important by academicians?
(ii) Which SA&D topic areas, skills, practices, and approaches are considered important by practitioners?
(iii) What are the significant differences between the SA&D topic areas, skills, practices, and approaches identified in (i) and (ii) above

The findings of this study should lead to a better understanding of the gap between what is currently taught in a typical SA&D course and what is considered as important by practitioners. The results should enable academics in redesigning or restructuring their courses to be more aligned with the expectations

of the industry. The following sections include a review of the relevant literature, research methodology, preliminary results, and next steps.

2 Literature Review

Powell and Yager (2013 identify three primary areas of research in systems analysis and design pedagogy: (i) core topics that should be included in a one-semester SA&D course (ii) popular approaches of methodologies included in an SA&D course, i.e. object-oriented methodology, merger of structured waterfall and object-oriented methodologies, and agile methodology, and (iii) course activities in teaching individual topics in the SA&D curriculum such as user participation in requirements definition, software inspection exercises, and role-plays for the elicitation of requirements and recording of Use Case Diagrams. Other research indicates that the SA&D course content and coverage varies widely depending on the instructor's beliefs and opinions of the relative importance of the topics (Guidry et al. 2011). Given the disparate set of opinions and the broad list of topics to be covered, it is therefore important to understand practitioners' opinions on the important topics to be covered in a SA& D course (Stevens et al. 2013).

While much research on understanding industry/practitioner expectations exists on the critical skills and/or knowledge requirements of IS graduates in general (Downey et al. 2008; Stevens et al. 2011), research on the knowledge and skills needed in the specific area of SA&D is relatively low (Stevens et al. 2013). Few exceptions are the studies conducted by Lee (2005 and Stevens et al. (2013. Based on data from job advertisements posted on corporate websites of 230 Fortune 500 firms, Lee (2005 identified most essential skills for systems analysts: development skills (i.e. analysis, design, development), software skills (i.e. database, operating systems/platforms), business skills (general business and function-specific), and social skills (communication and interpersonal). By using entropy as a measure to determine the extent to which practitioners agree about the importance of specific topics (e.g. traditional topics, structured analysis topics, and OO topics), Stevens et al. (2013 found that IS graduates may not have the knowledge, skills, and abilities desired by their potential employers. Their analysis provides a basis for future comparisons, both to future practitioner perceptions and to the perceptions of educators.

New IS and software engineering graduates are not always well prepared to meet industry expectations (Begel and Simon 2008). This lack of preparation includes both technical (familiarity and proficiency with contemporary software development processes, tools, techniques, and practices) and soft skills such as communication and team work (Radermacher et al. 2014). The differences that exist between what is being taught in academic programmes and what is actually required of industry practitioners is referred as the 'curriculum gap' (Trauth et al. 1993). Given that the role of the systems and business analysts have gone through significant changes in the past two decades, it is important for SA&D educators to continuously align their course content with the requirements and expectations of the contemporary industry, i.e. close the curriculum gap in this important area of IS (Guidry and Stevens 2014). However, as discussed in the above two paragraphs, most previous studies have examined academic and practitioner views of SA&D knowledge areas individually. Research that has specifically addressed the differences in SA&D educator and practitioner perceptions pertaining to the required skills and knowledge areas include a recent study conducted by Guidry & Stevens (2014). The authors compare the findings from their previous two studies, one examined instructors' perceptions and the other evaluated SA&D knowledge and skills from a practitioner perspective.

In a more recent study Karanja et al. (2016), present a review of studies that investigate various issues related to the SA&D course and the related role of systems analysts. Out of the 13 studies presented, 11 are surveys and the remaining two are analyses of online job advertisements for systems/business analysts. 11 of these studies were conducted in the USA, one included data from more than one region (i.e. USA, Australia, Europe, and India), and the other one was in Taiwan. While 11 studies targeted potential employers or practitioners, only two involved academics from IS faculty. The above studies have no doubt provided valuable insights to our understanding of issues related to SA&D skills and coverage. However, while the dominance of questionnaire-based survey method is common in IS research tradition, the over-reliance of survey method has some potential problems (Wu 2011): (i) all the data gathered from questionnaires are self-reported, and therefore prone to some well-known biases associated with acquiescence and non-response, (ii) closed survey instruments are inflexible to ad-hoc changes during the research process, which might lead the researcher to overlook unexpected but potentially important new findings, and (iii) very limited comparison of academic and practitioner perceptions.

This research aims to address the gap identified above and attempts to shed some insights on the differing perceptions that may exist today in an attempt to bridge the 'curriculum gap' in SA&D. It uses an exploratory qualitative approach (using semi-structured interviews) and compares the views of both the teaching and practitioner communities.

3 Methodology

Semi-structured interviews enable carrying out research in which few previous studies exist. Their focus on stakeholder perspectives and perceptions (Dubé and Paré 2003) matched the requirements of the current study. A series of exploratory qualitative interviews was conducted in order to explore the views on the topic areas, skills, practices, and approaches that were considered important by both SA&D educators and practitioners. The inquiry focused in depth on relatively small sample, industry participants (n=10) and academic participants (n=4). Industry participants were recruited using the logic of *maximum variation* purposive sampling strategy (Patton 1990). Participants' had at least 5 years' experience in either a systems analyst, business analyst or in a role closely associated with the systems development. Out of the 8 universities in New Zealand, 7 were invited to participate (the researcher's university was not included). Academic staff from 4 universities participated in this research. Participants had at least 2 years' experience in the design, teaching, and delivery of an undergraduate IS SA&D course. Tables 2 and 3 show the profile of the interviewees from both sectors.

Participant Current Role	Experience in Systems Development
Product Owner/Business Analyst (IP1)	10
Systems/Business Analyst (IP2)	8
Systems/Business Analyst (IP3)	9
Product Owner (IP4)	7
Project Manager (IP5)	13
Business Analyst (IP6)	12
Lead Developer (IP7)	11
BA Consultant (IP8)	14
Developer (IP9)	15
Solution Architect (IP10)	17

Table 2. Profile of Industry Participants

Participant Current Role	Experience in Teaching SA&D
Lecturer/Course co-ordinator (AP1)	11
Senior Tutor (AP2)	16
Tutor (AP3)	3
Lecturer/Course co-ordinator (AP4)	20

Table 3. Profile of Academic Participants

IP – Industry Participant

AP – Academic Participant

Interviews ranged from 60 to 90 minutes, with an average of 45 minutes. Though the interview protocol was used to support data collection, it was mainly used a guideline to facilitate conversation rather than as a rigid questioning protocol. The protocol consisted of the following main sections: SA&D development methodologies (e.g. waterfall, agile, RUP), development phases/practices (e.g. analysis, design), skills (e.g. working in teams, requirement gathering techniques), tools (e.g. Visio, Enterprise Architect), and notation (e.g. UML, BPMN). Other key interview questions included: *what are the important skills (e.g. requirements gathering, identifying problems, working in teams) that new hires for your organisation should have an understanding/knowledge of? What are the important development practices (e.g. Scrum practices) that new hires for your organisation should have an understanding/knowledge of? What are the important diagrams (e.g. Class diagrams) that new hires for your organisation should have an understanding/knowledge of?* All the interview transcripts were

imported into NVivo 11 program for coding and analysis. At the time of writing this paper, the coding of all industry transcripts is complete, but the academic transcripts are yet to be coded. Segments of the industry transcripts were labelled with keyword (nodes) based on the interview protocol, and new codes were created as new themes or ideas emerged from the data.

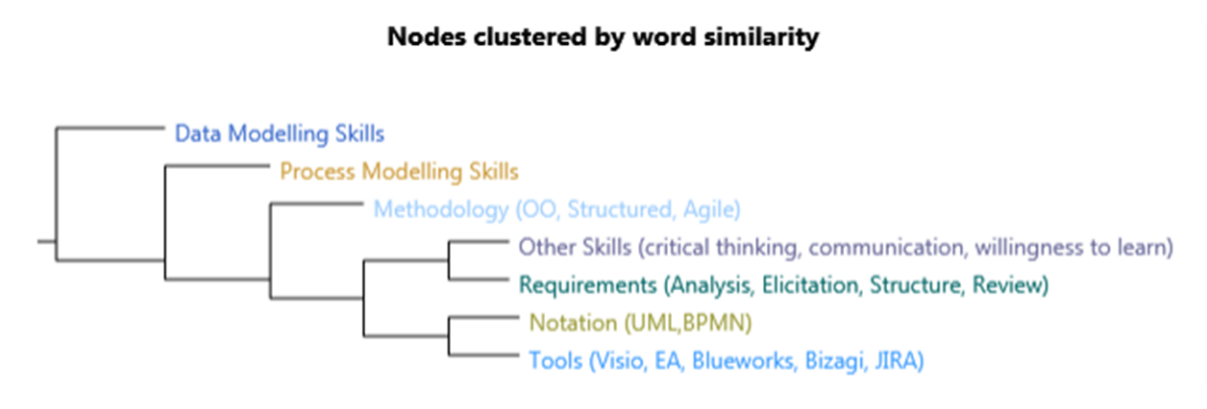

Figure 1: Initial Cluster Analysis

Cluster analysis was used as an exploratory technique to visualise initial patterns in the data by grouping the nodes that shared high degree of similarity. Figure 1 shows the nodes that have a higher degree of similarity based on the occurrence and frequency of words clustered together, i.e. while requirements, tools, notation, and other skills are clustered closer together at one level, and then with methodology, data and process modelling skills are farther away from the other two groups. The next section explains the preliminary findings in more detail.

3.1 Preliminary Findings

In terms of methodology requirements, industry participants emphasised that students should have an understanding of both structured and iterative and incremental approaches (including contemporary methods such as agile). Significance of understanding the difference between predictive and adaptive approaches to systems development, when to use which methodology, and combining aspects of different methodologies was deemed important.

Requirements analysis and elicitation was considered the most important skill expected of graduates entering into systems and business analyst roles. The importance of Use Cases, Use Case diagrams, supporting techniques for requirements such as requirements elicitation, requirements writing, structuring requirements, reviewing requirements, and systems requirements specification templates were also highlighted. New graduates should have an understanding of the significance of investigating and gaining a deep understanding of the problem domain, be able to communicate effectively to relevant stakeholders., "*..what we are looking for them is to be able to do documentation, use templates, describe a process, know BPMN…they need to know how to maintain issues and changes, constraints, assumption, understanding of models,..*" (IP1) – understanding the concepts of quality assurance, version control and change management were also highlighted.

While knowledge of UML (Use Case Modelling, Class Diagrams) and BPMN (Process Modelling, Process Mapping) notation was considered important, the ability for new graduates to understand things at the conceptual level was deemed more significant. New graduates were expected to do research and analysis in order to gain understanding of the current business, able to find links, communicate complex ideas in a simple form, and be familiar with the language that business and technical team (e.g. developers) speak (p7).

Examples of tools commonly used to support SA&D in the industry such as Enterprise Architect, Blueworks Live, Bizagi Process Modeller, Microsoft VISIO, and JIRA were identified. However, there was a general consensus among participants that while familiarity with tools was useful, it was more important for students to have an understanding of the underlying concepts related to using these tools and to have some exposure to small real world problems/projects. This expectation is well expressed by the following two interview excerpts, " *….knowing theory behind a technique is more important. If I know how to use IBM Blue works and I go to another company using iServer, because I have knowledge of methods of checking processes, version control, etc., ….then I just need to do how to do those things in that new place. That is different to not knowing what those things mean" (IP9)*

"..they need to know the tools but tools can be learnt, but more importantly, can they understand the real problems that needs to be solved? … The universities can't teach but they need to work with industry as part of their curriculum otherwise there is no way they can understand the business problems which is a key skill" (IP10).

As a solution to the above issue, another interviewee suggested, "*….if the examples are not real it is very hard for them to be very imaginative. So* ***educators*** (emphasis added) *should mimic real life examples not the examples from books that came out 20 years ago..*" (IP11)

In terms of non-technical skills, though a number of important skills such as communication, critical thinking, keenness, curiosity, lateral thinking, listening, and stakeholder management were identified, **aptitude and willingness to learn** emerged as the most significant expectation. As one participant expressed, "*…but we want to see aptitude for learning because studying and working is not same thing. As long as people have that in their mind it is very easy to teach them because at that age it is easy to pick up stuff. Sometimes it is a problem with good students because they know they have done well at university. I will look at people who are not high achievers necessarily but they show the aptitude that they can pick up new things quite easily..*" (IP1)

A typical systems analyst role would require experience on different type of projects including different organisations and industries. So, in order to achieve rich and broader experience, analysts would typically need to work in 3-4 industries and 8-10 different organisations' covering about 40 – 50 projects. So, new graduates should be focused on achieving broad experience, "*….say get a full time role in big call centre because most of the companies they like to promote people internally. Say there comes a role in lending services and you move to lending services and learn to know the industry and get involved in a project because typically if you involve in projects then you get experience and using knowledge you gained at your school. It can be a lengthy process…* (IP9)

A leading consultant (IP8) argued that it is not only important for academic institutions to be delivering knowledge and skills that meets the industry expectations, it is also important to sell/promote and justify why their graduates would be good candidates to hire,

"*…why should I consider graduates from your course?. So, at the moment I get the graduates applying but they really don't know what they don't know. Would that not be great from universities point of you if they talked to me and I say that hay, I didn't realise that you taught that stuff and didn't realise they already had 6 months' work placement during their course and I didn't realise that kind of people graduating now are getting jobs in IBM and doing really well. I did not know that and now I know and perhaps you can offer to be a point of reference and if I get a reference from you and that works very well then it becomes a point of trust and perhaps one university will be above in terms of what they deliver to industry…. "*

In summary, practitioners believed a balanced approach to understanding both structured and object-oriented/iterative and incremental approaches (including contemporary methods such as agile) was important. This is contrary to the findings of a recent study, where traditional topics especially structured analysis topics (such as data modelling, normalisation, database design, and program design) were found more important that object-oriented topics (Guidry and Stevens 2014).

The significance of understanding the problem domain, underlying concepts related to modelling and tools were deemed more important than being able to just use a particular notation or develop diagrams. And, in the other skills category, *aptitude and willingness to learn* emerged as the more important skill. The findings also emphasise that academic institutions should establish closer links with the industry and also inform the industry about the specific skills, knowledge, and content covered in their SA&D course.

It is acknowledged that this study is still a work in-progress, and therefore specific conclusions cannot be drawn at this stage. After completing analysis of educators' data and additional analyses of practitioner data, the differences that exist between what is taught in a SA&D course and what is actually expected of industry practitioners will be presented along with recommendations on how this 'curriculum gap' can be addressed.

4 Next Steps

The next steps includes analysis of academic transcripts, and comparison of the findings from both industry and academic participants' data. We expect that critical reflection upon the final results and analyses should assist educators in structuring their course to be more aligned with the needs of the industry.

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