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Abstract

This paper explores the idea of responsible systems design. To do so, it examines a case study - the accreditation of Information Systems (IS) courses by the professional body. A professionally accredited educational program, like any other non-trivial design product, represents the balancing of competing influences, ideas and stakeholders. The case is particularly relevant because there have been significant changes in the context of Australian IS education recently that have made more complex the task of designing educational systems in a responsible manner. A general approach to addressing this complexity is articulated here as a design pattern to guide IS educational design. The pattern identifies the influences on design, the processes and products of design and the feedback mechanism required to demonstrate that stakeholder requirements are satisfied. Design tensions and principles arising from the model are discussed and future work identified

Keywords

Design Pattern, Design principles, Education, Accreditation

INTRODUCTION

In terms of Gregor's (2006) concept of the uses of theory, the research presented here is to some extent descriptive, as it identifies categories of contextual influences on course design. It is neither explanatory nor predictive. But it is at its core clearly a normative theory with the explicit aim to inform course designers and other interested parties of the details of the context in which they operate and the means by which they might improve their designs and processes in terms of efficiency and completeness, but more importantly in terms of the ethics of responsible action.

Responsible systems are those that explicitly demonstrate their processes and products such that it is clear that stakeholder needs have been accommodated. However, those needs have to be identified and understood as part of the process of design, and the design artefacts that result need to be operationalised in teaching and learning practice to achieve the satisfaction of stakeholder needs. To assist designers to act more knowledgeably and responsibly is another aim of the work reported in this paper.

The case study is particularly relevant to the IS community as there have been significant changes in the context of Australian IS education recently that have made more complex the task of responsible educational design. The first of two major changes comes from the Australian Computer Society (ACS) which has adopted the Skills Framework for the Information Age (SFIA) as a specification of skills in the ICT industry, the Seoul Accord as a specification of generic skills and the Core Body of Knowledge (CBoK) to describe the minimum requirements for courses to be accredited by the society. The second major change is the restructuring of the Australian Qualifications Framework (AQF) and the attendant establishment of the Tertiary Education Quality and Standards Agency (TESQA). Taken in conjunction with a wide range of other ever-changing influences on course design, these major changes present a complex environment for IS course designers. A general approach to addressing this complexity is needed and developing such an approach is an aim of this paper.

A professionally accredited educational program, like any other non-trivial design product, represents the balancing of competing influences, ideas and stakeholders. The paper presents and details a model, or design pattern, for responsible course design. The model is informed by previous work in design patterns, particularly using the product-process design pattern (McDonald, Craig 2006). The model was developed slowly over a range of experiences both as course designer and as accreditation panel member and chair of seven ACS Accreditation evaluations that included discussions with many course designers and other stakeholders. The model that resulted was presented and discussed at the Australian Council of Deans of ICT education forum and as a result, the ACS sponsored a two-day workshop for thirteen universities that are facing re-accreditation.

This paper first articulates a general model or design pattern to guide IS educational design. It proceeds then to detail the influences on the design process, to identify products of design, to show how these products drive

educational activity and, lastly, identifies the feedback mechanism required to demonstrate that stakeholder requirements are satisfied. It concludes with reflection of design tensions and design principles arising from the model and identifies future work.

GENERAL MODEL OR DESIGN PATTERN

Figure 1 shows the general model or design pattern for responsible educational design. In the figure the ellipses represent the two main processes: (a) educational design, which identifies influences, and, using creativity, collaboration and testing, integrates them to produce design specifications and (b) teaching and learning, which uses pedagogy and resources to educate and assess students in a subject. The boxes represent artefacts including a design rationale, specifications of program objectives and structure, subject learning outcomes and content, and finally, the student assessment item. The unbroken arrows show input and output information flows. The broken arrow shows the feed-back loop.

Note that the word 'program' is used here to mean a program of study leading to a qualification of, for example, a bachelors degree or a masters degree (in some educational systems 'program' this is called a 'course'). A 'subject' refers to a component of a program, for example, a bachelors program may have 24 subjects most of one semester's duration but perhaps a double subject for capstone project (in different educational systems called a 'unit' or 'course').
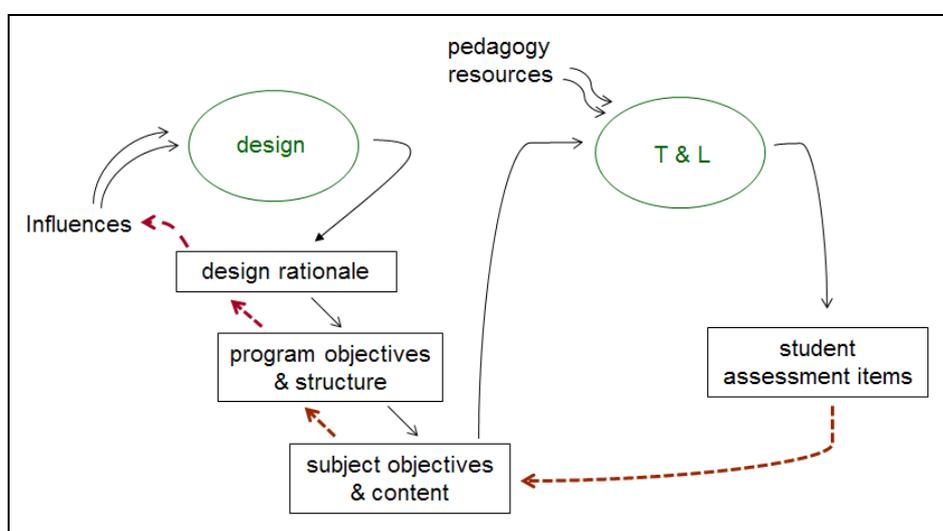

Figure 1: A General Model or Design Pattern for Responsible Educational Design

This pattern draws on general model of deliberative human action (eg. Morsella et al 2009) and specialises for the purpose of responsible educational design. It embodies the steps - analyse, design, act, reflect. It is just what you would expect of any quality assurance pattern in that it:

- explicitly meets a range of internal and external influences

- clearly specifies objectives

- specifies structural and functional designs to achieve those objectives

- mobilises quality educational and university resources

- operationalises the designs and resources in teaching & learning

- authentically assesses students (that is, demonstrates objectives have been achieved)

- provides access to operational evidence of all the above.

The paper now considers the details of each of the model's components.

DESIGN INFLUENCES

Below is a catalogue of the sources of influence over our program design. Before going into the detail of a situation a responsible designer would adopt an stance to help in the organising and evaluating the plethora of influences the to be addressed. One candidate stance in the case of program design in a university is that the purpose of the university is to build knowledge - to build knowledge in students through education, in and across disciplines through research and in society by engagement. Different influences come from sources that

rightly concentrate on just one particular aspect of knowledge building. So having an overarching stance is useful in seeing how each influence might contribute to, and be a resource for, the program design activity.

ACS Accreditation Requirements

Professional accreditation has always been optional, although most universities value it. The requirements for accreditation are specified in the Submission Guidelines and Accreditation Manual (see ACS Accreditation Workshop, 2012). Special accreditation policies exist for Advanced Subjects, Capstone Subject, Twinning and Distance Education. While these documents contain structural influences on program design (the requirement for a capstone subject, the minimum number of ICT related subjects and so on) the two key sections are:

- Core body of Knowledge (CBoK): is predicated on the idea of "a common vision shared by all ICT stakeholders, including industry, government, educationalists, academic disciplinary bodies, the community, students and professional standards bodies" (Gregor et al 2008). It specifies four types of program content (a) graduate skills, both technical and professional; (b) six areas of knowledge considered core; (c) specialist knowledge and (d) complementary knowledge

- Seoul Accord: is "establishing desired attributes for graduates of computing programs that prepare graduates for professional practice" (Seoul Accord 2012) and is an adjunct specification of generic skills for the ACS.

The need to embrace ACS accreditation will become stronger as TEQSA recognises professional accreditation as a quality attribute, if not a surrogate for a TESQA audit.

SFIA - Skills Framework for the Information Age

This framework is being adopted internationally and in large Australian organisations as a basis for specifying roles in the ICT industry (see SFIA). The Australian Public Service and the Queensland Government were early adopters as it gives a coherent picture of ICT roles and skills.

SFIA is presented as a matrix of major and minor role / task categories where the skills required to accomplish the role is specified in seven levels. Each cell in the matrix describes the skills details for that role at that level.

The ICT Disciplines

There are a number of disciplinary source that influence our program design. The ACM international curriculum for Information Systems Discipline (2010) is a key specification of knowledge in a globalised industry.

Neighbouring disciplines also have international curricular including the ACM IT curriculum (2012), the Computer Science Curriculum (2013) and the Software Engineering Body of Knowledge (SWEBoK 2004). In Australia there are a number of disciplinary bodies that are interested in program design including ACPHIS, CORE, and ACDICT. Other organisations that have an interest in accreditation that is associated with IS include Engineers Australia, ALIA, RIMPA, DAMA, PMI and so on. These disciplinary and professional bodies may be significant stakeholders in program design in particular circumstances.

The Government

The specifications for programs mandated by the Australian Qualification framework (AQF) and the advent of the Tertiary Education Quality and Standards Agency (TESQA) to monitor their implementation represent a necessary baseline for the program designer. The AQF describes the knowledge, skills and application of knowledge and skills for each level of program in the framework. Some key features that influence program design are:

- The description of AQF qualifications includes generic skills

- Qualifications must explicitly prepare students for both work and for further learning

- Program design needs to document pathways into the course and onward to higher levels in accordance with AQF

- Program design needs to document the linkage between subject components and course learning outcomes.

The University

All universities have strategies, policies and educational orientations that influence their course designs and educational practice. Examples include university-specific:

- generic skills / graduate attributes

- program design criteria, for example a requirement for a certain number of electives or general education subjects

- educational strategies such as work-integrated learning, research-led education, internationalisation, interdisciplinarity, and life-long learning

- teaching and learning assessment practices.

The Market

Both the sources of our students and the industry we educate them for form the market facet of our program design. As with the specific influences above market influences are largely the preserve of each university. The ACM IS Curriculum and the ACS both indicate that the IS industry is a global one and that local workplace needs should be balanced with boarder perspectives.

The market influences also involve the collaboration and competition both with other programs in the same university and with other educational providers.

The Faculty

The skills and orientation of our faculty members are, like the market above, specific to each university and have a considerable influence on what designs are going to be practical and feasible. In particular, academic educational capability and interest profiles, the academic research agenda and requirements, industry engagement and disciplinary alliances & inter-disciplinary relationships.

Summary of Design Influences

This section of the paper has identified, described and referenced seven types of design influences that a responsible program design needs to respond to. Subsequent sections examine the processes and products of design then elaborate on design tensions and principles.

DESIGN PROCESS AND PRODUCTS

Reviewing the large body of literature on educational program design (eg Moore 2005) is not possible in this paper where the focus is just on responsible IS design. The process of program design is collaborative, iterative and emergent. It is not top-down or bottom-up although there are sometimes elements of both of these approaches. It is agile and minimal. Rarely is it 'green fields' as most design work is re-development and re-focussing rather than creating from scratch.

The greatest creative challenge in the program design process is to recognise all the influences identified above and to address them explicitly, to the requisite degree. This is a matter of judgement. However in at least one area, generic skills, a national project to develop a coherent ontology is overdue.

The model in Figure 1 proposes three key design artefacts; a design rationale, program level specification and subject level specification; and in one key operational artefact, the student assessment. Four key design principles are used to guide the design process; embodied design, explicit design, requisite design and responsible design. There are many other possible artefacts and design principles, but those selected are the minimum set, the core, needed for effective and responsible program design.

Design Rationale

The purpose of a design rationale is to explain how the influences have been translated into educational specifications and therefore, conversely, how a student satisfactorily achieving the specified education will satisfy the influences.

In *An Enhanced Product-Process Design Pattern* McDonald (2006) identified management and governance layers of human activity systems as stakeholders as well as actors in systems. A design rationale may include business case, alignment with university strategic directions, performance indicators, student and graduate surveys, faculty structure and processes, including course advisory committee, quality reviews and so on. These issues are important but are not the focus of this paper which is concerned with the educational design.

The design rationale artefact answers the question 'why are we doing X?' It gives an account of the reasons for the designs being the way they are. It is for use when a quality review is required (for example by TEQSA) and to help future designers to change programs in a knowledgeable manner.

The two educational design specifications are at the program level and the subject level. Samples of these artefacts are available at the ACS Accreditation Workshop website.

Program Level Design Specifications

The purpose of the program specification is to define the objective of the program, the structure of subjects and to demonstrate that the education a student receives in subjects develops them to a point where the objects can be seen to have been met.

Universities have their own specification templates and processes that address objectives learning outcomes, broad generic skills / graduate outcomes and AQF required pathway information (pathways into and onward from the program). In addition an IS program specification should indicate the SFIA categories and levels achieved by the program.

Two common and useful parts of the program specification are a diagram showing the subjects in a pre-requisite structure and a matrix showing the generic skills and how core subjects develop, use and assess those skills as education proceeds.

Subject Level Specifications

The purpose of the subject specification is to define the minimum knowledge and skills to be assessed. As with the program level specification, universities usually have their own template and process. These usually embody the concept of constructive alignment (Biggs & Tang 2011) where each assessment item explicitly assesses particular knowledge and skill objectives. Perhaps the greatest breaches of the principle of requisite design occur in this process as attempts are made to assess extensive sets of objectives (see example at ACS Accreditation Workshop website).

For IS subjects both the ACM IS Curriculum (2010) and SFIA contain useful text for expressing knowledge and demonstrating an explicit response to design influences. Subject specifications also embody delegated aspects of the program design: the pathways information (pre-requisite knowledge for example), SFIA code where relevant, and the generic skills education allocated to the subject in the matrix part of the program specification.

TEACHING AND LEARNING PROCESS AND PRODUCT

The Teaching and Learning process that operationalises educational design by mobilizing resources and pedagogical methods is not discussed in detail here as the profession of university education is well developed. It is worth noting that the process is enhanced by having clear and concise baseline requirements beyond which there is great latitude for creative engagement. In particular clear and concise requirements help in assessment design and marking.

Perhaps the key to determining whether educational outcomes are being achieved lies in the design and marking of a student assessment. This is a 'pivot point' for the pattern described in Figure 1. All of the analysis and design boils down to this one point - the demonstration that the student has achieved a specific intellectual capability. From this little point others accumulate, if the overall program design works, to fulfil the university mission.

The ACS Accreditation Workshop Website (2012) contains some sample assignment design and assessment marking artefacts that embody influences from SFIA, Seoul and so on.

CLOSING THE LOOP

Perhaps the key to determining whether educational outcomes are being achieved lies in the design and marking of student assessment. The feedback mechanism in Figure 1 shows the student's response to assessment being the key measure that outcomes are being achieved.

The whole point of IS education is build knowledge and intellectual and the capacity to use them effectively to improve the way the world works.

Responsible IS education is evidenced by the actual capacity of graduates. Specifying that capacity is the task of responsible design, creating it is the task of the educator. The AQF prescribes that the program design must enable graduates to demonstrate learning outcomes have been met.

The feedback loop highlights this issue. If a student assessment demonstrates that he/he has achieved the required level of performance in part of a subject, does that really mean that she/he has achieved the objectives of the program? And again, if the objectives of the program have been achieved, has she/he met the needs of stakeholders? There may well be design issues in the process which break the chain and these need to be detected and addressed.

DESIGN TENSIONS AND PRINCIPLES

This paper has put a design pattern over what is a complicated picture of competing and overlapping design influences. Complex, real, human situations like this one are 'grist to the mill' of the Information Systems discipline. The reality is that there are many hundreds of ICT programs in Australia, all the product of historical influences, economics and personalities inherent in the local situation. The idea behind this paper is to present a well-grounded design pattern that can help address parochial influences.

Perhaps the greatest design tension faced by the program designer is the plethora of generic skills that are differently conceived in the AQF, CBoK, SFIA, Seoul Accord and in individual university's policies. It may be that within each of these influences the generic skills seem coherently specified, but taken as a whole the variety is huge and mappings between them difficult. It is a telling point that conceptualisations of generic skills are not accompanied by means for their assessment in practice. Two projects need to be undertaken to address this issue, one an ontological analysis to integrate and settle the conceptual structure of these skills and the other to develop effective, adaptable means of their assessment.

Four design principles arose in the project that forms this case study and they are explored below. They are significant because they respect the nature of the academic users while meeting the requirements of responsible design. They are described here to contribute to a developing catalogue of design principles (see for example the *Universal Principles of Design* (Lidwell et al 2010)).

Embodied Design

The quality of an educational program is not in its description but in its action. In *Quality by Design: Towards the One-page Quality Portfolio* McDonald (2008) argues that quality portfolios, like that sought for accreditation by the ACS, "should consist only of a method for a quality auditor to access the operational, real quality work of the university: a one-page document". The justification for this view is that quality inheres or is embodied in an object or act, it is not something separate from it. Therefore there is no need to describe quality separately from the reality. For example, the ACS is interested in the library and other information sources available to students and asks universities seeking accreditation about them. A common response to this request is text and tables written for the ACS that describes print resources, lists of journal subscriptions, etc. This response is costly to produce and reading it is just 'going through the motions' for the assessor. A better response is to recognise that the reason resources are important is because of the role they play in education, so rather than write text, universities should simply indicate to the assessor the library's student guide to ICT resources (if there is no such guide then perhaps this useful artefact should be created to support student learning) and the way each subject indicates the relevant resources. In this way students and academics benefit, and the assessor is addressing the reality of education, not some shadow of it.

Design artefacts that live as part of practice, rather than descriptions of it, embody design. Material being specifically written for accreditation, for example, should be questioned to see if it ought to be part of normal practice.

Explicit Design

Design is for use. It needs to be in terms that users can act upon, that stakeholders can inspect and that those doing re-design can deploy.

In some contexts there is a close mapping between concept and reality but in educational design, especially in the area of generic skills, the concepts can be vague. That is, they are difficult to reify in educational activity and particularly in assessment. It was noted above that generic skills are differently conceived in the AQF, CBoK, SFIA, Seoul Accord and in individual university's policies, but in all cases guidance on the way these skills are interpreted and assessed is absent. Bridging the gap between concept and reality is part of the designer's brief, so decisions about how influences will be treated need to be made and included in the design rationale.

Requisite Design

The concept of requisite design surfaces the issues of effectiveness and efficiency in deciding how far to go in the act of specification. In safety critical systems ultimate specification is requisite while framework type specification and guidelines suit situations of low risk, or those with light accountability requirements or where autonomy of action is valued.

Professional-level programs are not safety critical systems and they are not algorithmic computer systems. They are human activity systems conducted in a professional environment. This suggests that designers should avoid detailed and voluminous specification. The academic culture is not responsive to specifications that over-

prescribe their professional and creative work. See Wackademica (Hil, 2012) for a satirical review of situations that go beyond requisite design.

"Everything should be made as simple as possible, but not simpler" Einstein (quoted in Lidwell et al 2010 p.142).

Responsible Design

The model in Figure 1 identifies a feedback mechanism from assessment of student education back through specification and rationales to the influencing source. This mechanism is a key aspect of actual large and complex educational systems that can sometimes be lost. It is, however the key to responsible educational activity that meets the needs of its many stakeholders. It provides accountability while being minimalist so allowing the creativity necessary for true intellectual development.

Responsible design is local; it has to work in the here-and-now with the actual stakeholders (including academics). Each university negotiates and decides for itself what is right for its environment and is responsible to the effects of those decisions.

There are tradeoffs and compromises to be made in design, but these should not be passed on to the operationalisation processes. Responsible design means taking decisions and taking responsibility for them. It is not good enough to pass an incoherent mass of terminology to an educator to see that they make of it.

One response to educational design influences is to see them in terms of 'compliance'. This is an irresponsible approach as it misrepresents the influences and denies stakeholders their legitimate stake in the education system. It is also an opportunity lost, as stakeholder engagement is a resource for ethical and value-creating activity, not a constraint on it.

CONCLUSION AND FUTURE WORK

This paper has examined the complex situation that is the design and conduct of university IS education. It has identified the main influences on program design, presented a model for the incorporation of those influences in design and operational artefacts and presented design principles that lead to efficient, effective and, above all, responsible program design.

While there are many significant areas for future work one stands out - the need for a rigorous ontological examination of the many conceptions of generic skills and the development of effective assessment instruments for them.

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