Program Roadmap – a visual, interactive and self-regulating digital representation of the student learning journey

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Introduction

Students of today are more digitally experienced and self-directed in finding the information they need and the decisions they make based on the information they find. They have expectations of flawless, highly interactive media and demand control over how they spend their time (Hendel-Giller et al, 2011). Furthermore, 'Students learn if they care. They pay attention if they feel encouraged. They engage with others if they feel welcomed' (Gutierrez 2013, 1), Allied with this, students are increasingly becoming self-regulated learners, who use both cognitive and motivational strategies when deciding on, and engaging with, their course of study (Boekaerts, 1997). Consequently, self-regulating has 'become a key construct in education' (Boekaerts and Cascallar 2006, 199). However, recent student feedback at UniSA and adhoc 'What's the point of …' comments from students to Program Directors noted that existing university channels did not allow some students to see the connection between their courses, as well as how such courses related to their future work as professionals.

The research presented in this paper aimed to lever the graphic power of cartography to help inform the UniSA undergraduate Civil Engineering students' learning journey with the creation of a Program Roadmap (PR). The PR was created as a web based platform and was designed to be a motivating self-regulating resource for students, allowing them to easily locate information about their current and future studies, the constructive alignment of the degree and the integral relationship the degree has with industry and alumni. This paper will discuss the PR evolution from its inception to the development and evaluation of a pilot website.

Background

The PR built on key achievements in UniSA Civil Engineering over the preceding years, when the undergraduate Civil Engineering degree underwent a whole of curriculum review in order to meet the needs of the students, UniSA, the Australian Quality Framework (AQF) and the accreditation of the degree with Engineers Australia. A major task carried out in this review was to produce a 'written map' regarding the incorporation of academic literacies and teamwork across the degree in order to create a developmental sequence of them across the 4 year Civil Engineering Program. Using digital technology, the PR developed the Civil Engineering 'written' map into a more comprehensive, user-friendly and visually stimulating 'cartographic' map.

Factors Influencing the Program Roadmap

The field known as 'brain-based learning' encompasses neuroscience, cognitive science and psychology has provided insights into how the brain works, which educationalists have used to inform their practice (Jensen 1998; Hendel-Giller et al. 2011). Hendel-Giller et al. (2011) believed this application of cognitive science in understanding how learning occurs, assisted organisations to achieve a competitive advantage. Emotions are linked to learning (LeDoux

2000; Goleman 1995) and the PR was designed to be a tool to trigger positive emotions in the students, grab their attention and boost their motivation for studying their courses. The Hendel-Giller et al. (2011) identified the need to create a strong enough emotional pull so that the learner wanted to engage with the learning content through such things as visuals, stories, novelty and humour as well as being mindful of the need to establish and maintain learners' mood when developing a virtual environment. Furthermore, good typography leads to good mood, more engagement and improvements in cognitive tasks (Larsen and Picard 2013). The importance of visual images to learning is known (Hendel-Giller et al. 2011; Medina 2010), and Gutierrez (2013) further explained that images would only deliver real value if learners understood their importance in their course. With the increasing shift to more digital formats a key challenge for educators is how to build human interaction in the digital space (Meltzoff et al. 2009). Students become more engaged in the learning process if they can see the relevance of their studies to professional, disciplinary and/or personal contexts, for example through linking learning experiences to the workplace or wider community (University of New South Wales 2015, 1). Equally important, multi-modal or multi-sensory learning using both visuals and speech, supports the assertion of Mayer (2009) that presenting material in two media—pictorial and verbal—is generally superior to presenting material in only a single medium but only as long as the visual/pictorial information is well designed, congruent and on the same page.

Why a (cartographic) Program Roadmap?

'Roadmap', as a term, has its roots in cartography and has been used by a few universities to help students navigate through their degrees. For example, Fresno State has static pdfs and Curtin University has its interactive web based 'mycoursemap'. These roadmaps are useful tools for students, but these are, in reality, flowcharts and not maps in the traditional 'cartographic' sense of the word. Cartography is the art and science of map making, a map being 'a graphic representation of spatial relationships' (Robinson 1984, 1). Historically, maps were always seen as instruments of power (Harley 1989), but in essence as Monmonier (1996, 2) states 'a single map is but one of an indefinitely large number of maps that might be produced for the same situation or from the same data'. So, avoiding bias and including the appropriate information is of paramount importance. Traditionally, maps span many constructs e.g. 1:50000 topographic paper maps through to digital 3D representations such as Google Earth. Due to the familiarity of roadmaps in society and their use to help people chart a course, get directions or find their way, the word has been used in other disciplines, such as business, where people often refer to a process flow chart being a 'Roadmap to …'. Whilst it could be argued that such representations fall into the definition offered by Robinson (1984), they do tend to fall down as an engaging representation for an audience and one that doesn't really expect a user to remain long to peer, reflect and investigate the 'map'. Nevertheless, good maps, in whatever form have always been powerful communication tools, effectively transmitting information to users efficiently and consequently, could be an invaluable companion on a student's learning journey.

Development

A working group consisting of staff and students debated several map depictions, and an initial brainstorm 'Roadmap' was settled upon, mainly due to the familiarity of maps amongst society and its potential for easy transferability to other degrees. The Bachelor of Engineering (Hons) has 'Civil', 'Civil & Project Management' and 'Civil & Structural' streams and these became separate roads. The PR planned to transition students from pre university (e.g. Year 12) information to degree entry, then through the Bachelor of Engineering (Hons) degree years 1, 2, 3 and 4, before finally exiting at graduation. Along the way, each course within the degree was represented as a building. Initial thoughts for additional information for the students included employer/ alumni videos, assistance through links to referencing help, academic literacies and group work. From such initial meetings, a PR storyline (Figure 1) was created to help the software developers and graphic designers in its' construction. An

important part of this stage was the inclusion of course connectivity and content progression i.e. if a student clicked on a certain course on the website, then a link would appear to see how that course linked (blue lines) to other courses i.e. course dependency. So, for example, if students selected MENG 1012 (Engineering Mechanics), they could see that the knowledge and skills acquired in that course would be used further along the program in 4 subsequent courses. Similar prerequisite information is highlighted in text on existing UniSA degree webpages but it is hard to retrieve and hard to see all the dependent courses together to understand the connectivity from start to finish. In further deliberation, students suggested it would be useful for an identification of what they referred to as 'we wish we would have known that/ it would have been clearer if…' e.g. the need for clarity on work placement requirements.
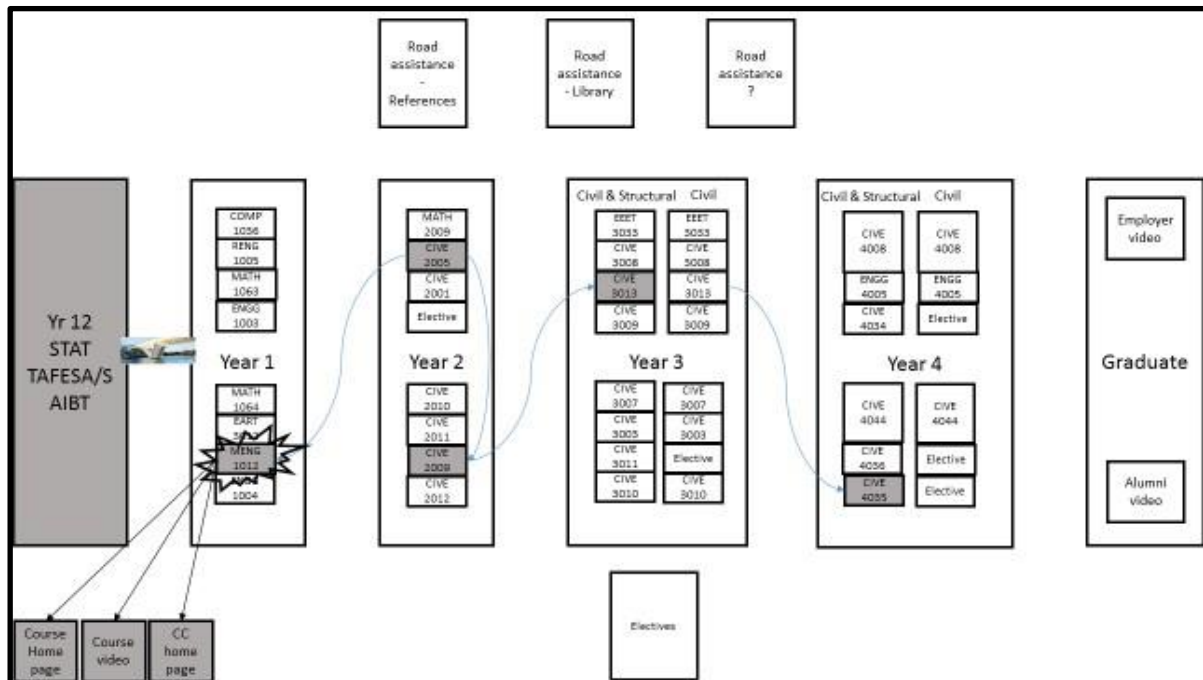

Figure 1: Storyline

Website design

Miller (2011) stated that iterative user-centred design is key to successful development

> *Good Web design goes well beyond evidence of a plan—good Web design is an experience for the user. The best Web design creates an environment where users feel they have just enough control over the experience that they feel empowered, but not so much control that they feel overwhelmed. (Miller, 2011, 24)*

As for design specifics, Lynch, Horton and Morville (2009) recommended 4 universal design principles that should be adhered to when creating a website namely:

- (P1) ensuring equitable use
- (P2) flexibility in use
- (P3) being simple and intuitive to use
- (P4) having perceptible information.

Being conscious of these web design principles, the software developers decided not to use any special browser-based plugins in order to provide the best compatibility across the browsers and devices. Thus, the PR was designed and implemented based on the D3.js, a javascript-based 3D rending engine, which supports nearly all mobile and desktop browsers. Interactivity similar to Google Map's navigation system such as pan, zoom and rotate was provided and the PR utilized a pre-built 3D model with simple rendering to increase processing speed.
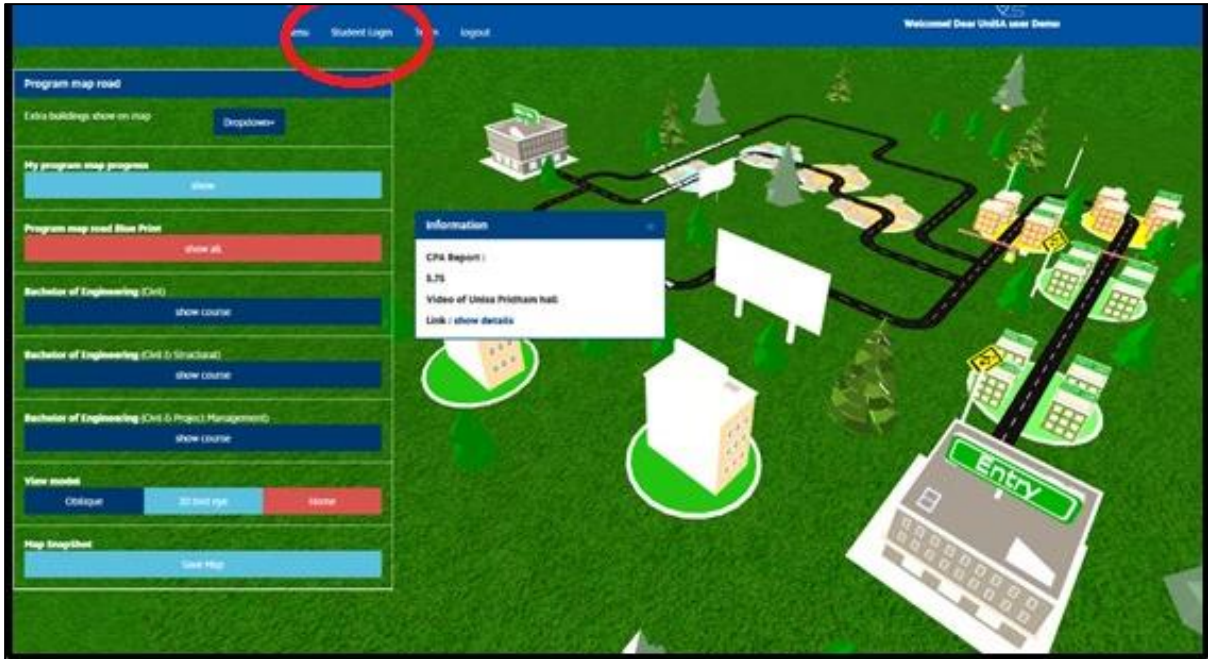
The PR's first design element was to create a landing page (Figure 2) where all the program information was displayed i.e. a marketing viewpoint. On the landing page, a number of metaphors were used:

- Buildings - represented courses/ subjects, and were grouped into four to create a 'suburb' (i.e. semester/ term – highlighted by a disc)
- Sign posts represented the year levels
- Checkpoint barriers - represented stages within the degree where students needed to be aware of and undertake an activity e.g. work experience
- Multiple roads - represented alternative Bachelor of Engineering (Hons) streams
- Other buildings i.e. 'Road Assistance' - represented student resources e.g. Entry (to University), Library and Great Hall (Graduation)

Figure 2: Landing page (oblique 3D view)

On the landing page, such features allowed access to more information e.g. clicking a building produced a dialog containing hyperlinks to the course website, Course Coordinator and Welcome Videos, as well as the course's constructive alignment with visual links to prerequisites and also subsequent courses. A final feature on the landing page was the ability to activate a menu that allowed a student to change the view to show a 2D bird's eye view, an Engineering stream individually and save the PR.

The PR's second design element was to facilitate self-regulated learning. Therefore, a fictitious student was created to use as an exemplar and using a student login (Figure 3) students could then access and use an extra menu facility that displayed their progress (i.e. complete courses = complete buildings; courses to do = building foundations), and then by clicking the Great Hall obtain their current Grade Point Average (GPA).

Figure 3: Menu options Student progression (Entry building view)

Student evaluation

The pilot website was presented to 3rd year students (n=29) as they were well positioned within the degree to comment on the early stages whilst also being able to comment on what aspirations they still had. The survey consisted 10 Likert scale questions followed by two opened ended questions. As shown in Figure 4, overall, students were highly receptive to the PR and its underpinning rationale with 9/10 questions receiving >75% agreement of its various uses. A particularly pleasing response was in relation to university transition with 86% of responses stating it was useful degree information for prospective students and that it provided a good overview of the 4 year degree. The students definitely liked the communication style as 89% of them thought it provided useful information both on the website itself and the subsequent links to specific courses information and that 83% agreed it allowed them to see how courses were connected throughout the program. Over 70% of students felt the PR was visually appealing, relatively easy to navigate and would assist in how they would select future courses. And finally, over 60% suggested that it could aid in the choice of which stream to enter after first year, and they would use the PR.
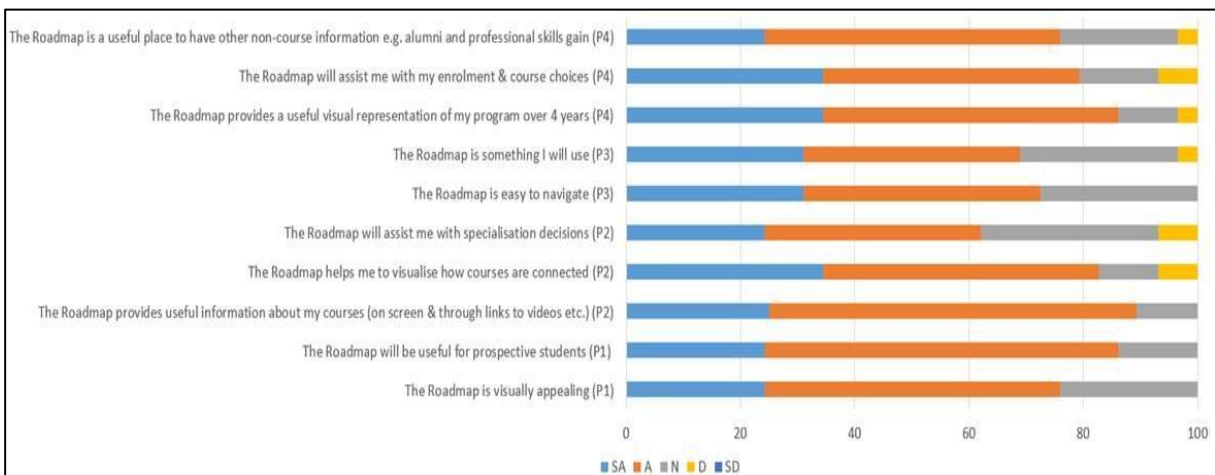

Figure 4: Student survey responses

The open ended question responses were categorised into the four design principles (P1-P4)

Principle 1 (P1): *Equitable use* - Students commented that the PR was an appealing, attractive and engaging platform, through its use of colour, structure and visual representation – it was 'cute'. They stated that such an approach engendered a clear and friendlier interface than existing university formats. Students suggested improvements such as allying map symbology to the degree e.g. a bridge for structural analysis instead of a building and being more positive by having a bridge between years, rather than a checkpoint. Also, to possibly make the roadmap even clearer, students suggested using straight roads, the use of rendered 'real' buildings and within the student login version, making the current year of study more pronounced. A couple of comments were received questioning the use of roads for the map e.g. maybe the use of a building with 4 floors (one representing each year level) would be better.

Principle 2 (P2): *Flexibility in use* - Students appreciated the high level of interactivity to the level that they stated it was almost like a game and it also addressed important factors such as being reminded that they needed to do extracurricular work through the use of the checkpoint. Students also valued being able to click buildings to reveal course connection and then being able to interrogate individual courses to glean more information through videos. All this contributed to students being able to plan and regulate their own study far more easily. As for improvements, students wanted even more interactivity e.g. having the ability to move buildings (courses) around the map to reflect study pattern changes. Also, students would have liked an option to show the electives (including intensives) more clearly.

Principle 3 (P3): *Simple and Intuitive to use* - The majority of students were particularly pleased with the PR. 72% of students indicated it was easy to see information, navigate and retrieve it Furthermore, such information was deemed to be easy to interpret and understand, e.g. 82% of students stated that the visual links made prerequisites easier to recognise. There was only one generic comment for improvement - that the PR information could be even more explicit if it were in 2D i.e. the 3D perspective added an unnecessary complication.

Principle 4 (P4): *Perceptible Information* - Students noted that the design of the PR was more complete that existing modes of university communication and that it provided a comprehensive guide e.g. showing the different study paths was deemed particularly useful and it enabled them to prepare for the later years in the degree and identify what was needed to succeed. They liked the ability to track their course progression through the degree, especially as it was a visual. Improvements within this realm included an option to accommodate mid-year starters and how course credits would be shown. Students also suggested that it may be prudent to have just one year level shown or emphasized so as not to distract attention from current studies. Finally, extra 'extra-curricular' help was also suggested e.g. 'Will it show us how to stay up to 5am to get assignments done'.

Discussion

The student evaluations align with the notion that students of today are comfortable with digital technology, as there were no comments berating the use of the PR as a digital interface. Furthermore, being able to be in control was a bonus for the students surveyed, a finding that reflects the latter assertions of Hendel-Giller et al. (2011) that students have high expectation of flawless interactive media and demand how they spend their time. Students appreciated the PR's self-regulating aspect, reflecting the assertion of Boekaerts and Cascallar (2006, 199) that self-regulating has 'become a key construct in education'.

As for map style, some student commentary indicated that a 2D approach with a direct progression along a straight road could be more intuitive. So, it could be interpreted that some non-map experts are still more comfortable with 2D rather than the 3D maps, and therefore, the PR may have veered a little off course for some students and not fully grasped successfully Gutierrez's (2013) comments in relation to the value of images for learners'

understanding. Nevertheless, the PR reinforced that emotions are linked to learning (LeDoux 2000; Goleman 1995) with the majority of students commenting that it was visually appealing and a friendlier (and familiar – being a map) interface.

Overall, the student evaluation tended to support the theory that maps are an effective and efficient way to transmit information (including the addition of links to videos) and thus endorsed the view of Hendel-Giller et al. (2011) and Medina (2010) as to the importance of visual images in learning. Even with it being a 3D version, the majority of students found it relatively straight forward to navigate and found it engaging and an improvement on existing text based options at UniSA. The ability to be able to activate a link between courses was seen as valuable – and thus students could begin to answer the question perennially given to Program Directors of 'What's the point of…' themselves. In addition, the video links to industry reflect the 6th Guideline on Learning that informs teaching i.e. 'Relevance' (UNSW 2015) and also provided a second mode of communication to reinforce that presenting well designed material in two media—pictorial and verbal—is advantageous (Mayer 2009). Hence their curriculum, as a whole, became more relevant and alive. A number of presentations in relation to the PR were given during its development and many suggestions were made as to extra features that the PR could contain. However, to complete the pilot of the project, it became a process of keeping the project within scope rather than taking on too many ideas for the developmental timeframe allowed. The same occurrence eventuated with the student feedback, as the students were more constructive with their comments as to what else could be included, rather than being over critical and indicating the project wasn't necessary. For example, the suggestions were made to include the PR as part of UniSA suite of mobile apps to aid easy navigation to the PR, to have the ability to move courses around the PR (as they studied courses sometimes out of kilter with the preferred routes) and furthermore, have more study hints and tips.

The student evaluation has, in general, supported the literature about the value of engaging, visual and interactive study support mechanisms. The student evaluation aligns with the project team's feelings that there is still more work to be undertaken and that the PR has proved the concept. The PR may not replace textual versions, but it can be an alternative choice for students that may prefer a visual and interactive way of representing and regulating progression along their student journey.

Conclusion

The PR created a digital, dynamic and graphic educational environment where students could easily locate information about their current and future studies. The PR enabled students (both current and future) to shine a light on the constructive alignment of the Civil Engineering degree courses and illuminate how those courses and allied professional skills were relevant to industry. There are many avenues that the PR could take to improve, both in appearance and additional functionality e.g. assignment grades could become building floors. The PR could also develop into a career management tool helping students change degrees if needed based on the courses they have completed. Taking it to an extreme, the PR could be developed into a Virtual Reality environment where students become Avatars. In summary, students beginning a university degree could be analogous with explorers entering uncharted territory, they need guidance, support and a helping hand to prosper. Such information is readily available in written form via university and course websites, but the PR offers a potentially more engaging, visual and interactive way.

Acknowledgments

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