

Linkages between Courses: A Holistic Approach to Programmes

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***Abstract:** All of us have had the experience of asking a class “Remember this...?” and receiving blank stares in response. One demotivator for students to utilise deep learning techniques is a failure to attach value to the concept being learned. In order to encourage students to attach value to concepts, it is suggested that as fundamental, threshold concepts are being taught, they are explicitly linked to other future concepts requiring the fundamental one. This is proposed, not just on an ad hoc basis, but so that the explicit portion of the course should be correctly referenced inside the study material. This idea extends beyond foundational concept building towards more complex concepts within a course, but also providing linkages—both forwards and backwards—between courses. This paper will explain the proposed methodology to develop a representation of the mathematical concepts spanning the Engineering and Surveying courses at the University of Southern Queensland, and the proposed means for linking this information into course materials.*

Introduction

A common problem in education occurs when a staff member assumes that students have prior knowledge that the students appear to lack. This prior knowledge may stem from earlier in that course or from a completely different course—often formally designated as a prerequisite course. To continue with the current material, the staff member is faced with an unpalatable choice: temporarily stop teaching the current material to revise the foundational material; or continue with the current material and hope the students catch up. This split-second decision is generally made by weighing up a number of factors, including:

- The importance of the new material to the course
- The time required to teach the foundational material
- The remaining time in the course to teach the rest of the material; and
- The apparent receptiveness of the students in the class to learning at that moment.

This approach to teaching (building upon prior knowledge) is implicit in the constructivist theory of learning (Gunstone, 2000), even if constructivist theory is not explicitly used as a teaching paradigm.

The implications for students not learning material deeply extend beyond difficulties in advanced courses. It has been found that enrolment retention rates are affected when students fail to see the applicability of their foundational learning to their engineering degree or career (Froyd and Ohland, 2005).

One method of overcoming this difficulty in student retention of knowledge is to use an integrated curriculum, whereby faculty members deliberately structure the programme curriculum so that linkages between topics or courses are emphasised. The level of integration attempted and what is actually integrated can vary significantly (Froyd and Ohland, 2005). Some methods that have been used are:

1. Extensive redesign of the courses to become completely interdependent upon each other (Everett, Imbrie and Morgan, 2000, Olds and Miller, 2004, Zastavker *et al.*, 2006)

2. Additional courses to draw material together through Problem-Based Learning (McNair and Borrego, 2009, Parthasarathy and Jollands, 2009, Bell, Galilea and Tolouei, 2010) or a capstone project (Noble, 1998)
3. Usage of learning communities outside the standard class environment (Olds and Miller, 2004, Mickelson, Harms and Brumm, 2007, Gibbings and Brodie, 2008)
4. Creating pairwise linkages between courses (Hinds et al., 2005, Natale and Sora, 2010)
5. Staging the insertion of topic material into different courses (Ryan and Sweeney, 2007, Ihsen and Gebauer, 2009)

The first two methods can be described as being “horizontal”, because they deal with integration of all courses running concurrently in a particular semester or year, potentially having them truly run in parallel. This is in contrast to the standard approach, where each course runs essentially independently and the major structure imposed is serial: prerequisite courses are run before other courses requiring the prerequisite.

The final method can be described as being “vertical”, because it is a design of linkages through the duration of the programme, not necessarily focussing on integrating courses running concurrently.

Methods 3 and 4 can be horizontal and/or vertical, depending on their implementation. For instance, learning communities need not be restricted to the current cohort of students studying a course: there may be some interaction with students at subsequent levels of their programme to act as mentors. Also, pairwise linkages can be used between any two courses in a programme, and are not necessarily restricted to linkages across courses: linkage to topics within a course can also be beneficial.

Proposed Methodology

The authors propose to use method 4 to achieve course integration. This is largely necessitated by the large cohort of external students that study part-time at the University of Southern Queensland. Full-time enrolment (the standard pattern for on-campus students) consists of four courses per semester; external students typically are enrolled in only two per semester. While efforts are made when designing recommended enrolment patterns to pair courses together that may interact, there is no guarantee that students will comply with this. This may be due to exemptions or articulation from one degree programme to another. As such, interdependence via a horizontal method of integration is rendered impracticable, since it is impossible for a part-time student to fully engage in all courses.

The first stage of the linkage creation is between the mathematics courses and those courses run by the Faculty of Engineering and Surveying; the second stage is to link the courses within the disciplines. The method of creating the linkages which has been devised is to:

- a) Identify the topics covered within the courses
- b) Create a dynamic list of courses using each topic
- c) Insert references in the course material that a particular topic is learned/used in another course, cited by its course code
- d) Insert examples in foundational courses that are taken from subsequent courses and explicitly identified as coming from that particular course

Step (a) will commence with a faculty-wide survey of academic staff, followed by analysis to create two lists: one showing all the topics covered in a course and the other showing all the courses using a topic.

During the natural process of course revitalisation (be that incremental or extensive), the appropriate references can be inserted into the course material. As a fundamental component to providing distance education, the university mandates that a “StudyBook” is produced for every course; this is available in electronic form to every enrolled student. For technical courses, this is typically formatted to provide summaries of the important course material with some worked examples and references to the set textbook for the course. Therefore, there is a natural vehicle for including the linkages and it is possible to actively contain hyperlinks in an electronic form of the document.

Finally, it is hoped that component (d) will provide sufficient motivation for the students studying a foundational course to recognise that a particular topic which seems abstract and dull is useful in their future studies and ultimately their careers. There is already support by examiners of key courses for this proposal; it now requires the effort of collating the data and requesting the specific examples that are required.

Current technology using electronic media and hyper-linking enables further exploitation of the linkages that are identified. For instance, at any point in the text that “differentiation” appears, the word “differentiation” could be made a hyperlink that points to the appropriate supporting material. Where critical threshold concepts are identified, these could be listed in the summary section of the course material and appropriate hyperlinks embedded. The Learning and Teaching Support Unit (LTSU) at the University of Southern Queensland has a repository of learning objects targeted at scaffolding concepts which have been identified as being critical to a substantial number of courses. It is expected that in advanced courses, identified linkages to topics need not be restricted to the corresponding foundational course (for which exemptions may have been granted and therefore access is not available). Instead, these linkages could be also directed into the LTSU repository to access learning objects directly as students require any supplement to their understanding.

The greatest challenge to the success of this proposal is the maintenance of the dynamic linkage record. While an academic staff member might hold enthusiasm for the concept and attempt to keep the record current, eventually the system is liable to collapse if the enthusiasm is not shared by those responsible for including the links in the courses. Ultimately, it would probably require an administrative staff member, advised by an academic staff member, to be responsible for the task in order for it to continue in perpetuity. This could still be at the whim of the job description unless the system proves to have sufficient success that it becomes embedded as a core component of the teaching material.

Evaluation

Evaluation of the success of this programme will require a significant longitudinal study of the key courses involved: the maths courses and the Engineering & Surveying courses supplying examples. From the perspective of studying student perceptions, it is suggested that this could be commenced immediately by surveying students who have already completed the courses without these embedded examples to obtain a baseline for the pre-intervention situation. Then students could be surveyed over a period of a number of years to capture intermediate effects (those taking advanced courses with the linkages, but completed introductory courses beforehand) and then final effects (students only being exposed to the full linkages). This longitudinal study would also investigate any variation in grade, with care required to account for additional factors that may influence this variation such as a change of teaching staff. Staff can be surveyed and/or interviewed to ascertain the effects on student behaviour in their course(s) due to the linkages that are provided.

Conclusions

Deliberately linking topics between courses has been found to improve student motivation to understand material, thereby improving grades, and also cause them to see long-term purpose in their degree programmes and careers, improving enrolment retention rates. The authors intend to implement a pairwise linkage model whereby topics inside a course are linked to topics in other courses. This is the most practicable method of linking course content given the large cohort of part-time students at the University of Southern Queensland. The intention of including examples in foundational courses builds upon the pairwise linkage concept so students can see applications of the topic to their future studies. Advanced courses can also benefit from a separate repository of supplementary learning material which can be directly hyper-linked within the course material, overcoming access difficulties for students with exemptions to foundational courses.

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