

Connolly, Heather and Spiller, Dorothy (2016) Joining the pieces: using concept maps for integrated learning and assessment in an introductory management course. *Practitioner Research in Higher Education*, 10 (1). pp. 176-191.

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**Joining the Pieces: using concept maps for
integrated learning and assessment in an
introductory management course**

Practitioner Research
In Higher Education
Special Assessment Issue
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University of Cumbria
Vol 10(1) pages 176-191

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Abstract

This paper reports on and evaluates the use of concept mapping as a learning tool in a large first year Management course. The goal was to help students make personal sense of course learning and to build their understanding of links and relationships between key course ideas. Concept mapping was used for three summative assessment pieces, including the final exam, and results indicated that concept mapping enhanced student understanding and personal articulation of connections between course ideas. The integration of concept mapping into all teaching and a number of assessments enabled the teaching team to ascertain students' prior knowledge, monitor progress, and adapt teaching so as to be responsive to learners' perspectives.

Keywords

Concept maps; assessment; integrated learning.

Ethical Approval

This research was conducted as part of a taught course. The material contained within had ethical approval by the Institution. Any student work reported has been approved for use by the students.

Introduction and context

In the contemporary tertiary sector, there is considerable rhetorical emphasis on the need to prepare students for effective participation in the workplace and society. These discussions increasingly prioritise ways of thinking and dispositional attributes. For example, Rowland (2006) develops the idea of the 'critical servant', Barnett (2000) emphasises the need to equip graduates to manage 'super-complexity' and Baxter Magolda (2010) argues for 'cognitive, emotional and social maturity'. The common theme is the importance of developing graduates who can connect personally with their academic learning and use it to respond in a flexible, dynamic and critical way to a rapidly-changing workplace and social environment. In addition to the capacity for personal connection and sense-making, graduates need to draw on knowledge from multiple sources and disciplines to negotiate work and social engagement competently. There is therefore a cogent argument for ways of teaching and learning that encourage students to connect personally with their academic knowledge and to build connections and relationships between ideas.

The question for academics is whether our teaching, learning and assessment regimes promote the development of thinking, and behaviours that equip our students to think in connected and questioning ways, respond to specific and diverse contexts as well as manage multiple perspectives in collaborative work. We argue that teaching and learning approaches in universities often fail to encourage these intellectual and personal dispositions. In some instances, design, teaching methods and assessment may even promote, and sustain ways of thinking about learning that are linear,

Citation

Connolly, H., Spiller, D. (2016) 'Joining the Pieces: using concept maps for integrated learning and assessment in an introductory management course', *Practitioner Research in Higher Education Journal*, 10(1), pp. 176-191.

fragmented and disconnected from context. We approached the review of a large introductory Management course and its assessment with these concerns in mind.

The challenges

The course under discussion is a large first year compulsory Management course which has up to 400 students per semester, with two intakes per year. The course is a 15-point module (150 learning hours), comprised of a 2 hour lecture and a 2 hour tutorial each week, over 16 teaching weeks. Many of the challenges typify courses of this kind. An attempt to give an overview of the main areas often leads to a topic focus, an emphasis on covering the ground and a linear design where classes progress through topics following the format of the introductory textbook. Teaching is often in the transmission model and large classes are sites in which first year students may feel anonymous, and disconnected from the learning and their peers. Additionally, in first year, many students are given no explicit introduction to the notions of managing and organising ideas, and the relationships between them. In this particular course, these familiar challenges were exacerbated by historical factors. Over the years, this course had been managed by different convenors. Each person had brought their own style and introduced some initiatives, but these were often add-ons, and the course and alignment of its parts had not been comprehensively reviewed. Overlaying the large volume of content and topic focus, was an accretion of layers that different teachers brought to the course; it became larger and larger, and the learning outcomes were increasingly blurred.

When the new convenor took over the course, she initially followed the inherited structure. However, the examination results (external assessment) signalled that there were serious problems in relation to the students' learning. While students managed the internal assessments, there was a high failure rate in the examinations and subsequently the course. Results from the examination (specifically the short answer and essay questions) revealed that students struggled to integrate and connect different course topics. This was the prompt for the convenor to review the course design, articulate and simplify the learning outcomes, and align the design, strategies and assessment. Within this reorganizational framework, the convenor selected a number of tools to help students build coherent and meaningful connections between the different parts of their course learning. Concept mapping was one tool to help students make connections and articulate their personal understanding of course learning. This paper reports on the results from the integration of concept mapping as a tool into the course teaching and assessment. The initiative was conducted as an action research project and the research question was:

How can concept mapping help students to articulate and integrate key course ideas?

The next section presents the theoretical background for concept mapping, followed by an explanation of how the tool was integrated into the course, introduced to the students and aligned with assessment. Examples of student maps are then presented, together with student and teaching team feedback, and overall improvement in course grades.

Literature

Theoretical underpinning: connecting and relating through the use of concept maps

The literature on concept mapping supports the use of the tool for promoting an understanding of relationships between concepts, making it an excellent tool for integrating multiple ideas. The active process of concept mapping can also help students connect more personally with course learning. Furthermore, Hill (2005:7) argues that concept mapping is a powerful learning tool because 'it engages complex cognitive structures within the brain'.

Novak and Cañas (2007:29) define concept maps as ‘graphical tools for organising and representing relationships’ in which ‘linking words or linking phrases specify the relationship between two concepts.’ According to Hay, Kinchin and Lygo-Baker (2008:302) ‘concept maps consist of concept labels that identify specific ideas and the links between them to show how concepts are related to make meaning.’ The words ‘organising’ ‘relationships’ ‘related’ and ‘make meaning’ are particularly pertinent for the authors’ initiative. All suggest that concept maps can be helpful where one of the biggest challenges is the lack of connection amongst people and between ideas, and where the deliberate engagement with ideas in making meaning is often singularly absent. Novak’s development of concept maps is based on Ausubel’s (1968) fundamental idea that learning involves the assimilation of new concepts and frameworks into existing concepts, and propositional frameworks held by the learner (Novak & Cañas 2007). Ausubel (1968) notes that learners have to choose to learn meaningfully (Novak & Cañas 2007) and that teachers do not have direct control over this part of the process. It was hoped that the requirement to develop concept maps could push students into more active and deliberate meaning-making.

These definitions suggest that in the large class concept mapping has potential to render students’ learning progress more visible. To the authors, concept mapping offered a strategy to give teachers insight both into students’ prior knowledge and also ongoing feedback on students’ learning. Additionally, we anticipated that the concept mapping process could encourage students to make their own sense of course material. In both these respects, concept maps offered a tool to make the classroom more dialogical in keeping with constructivist learning principles. Hay, Kinchin and Lygo-Baker (2008:296) extend their argument beyond the immediate prospect of enhanced classroom partnership, to argue that concept mapping and the associated personal meaning-making can enable ‘the emergence of new and individually acquired meaning’ that ‘is a genuinely authentic definition of higher education.’ Working with concept maps may also encourage lecturers to unpack their own assumptions about core course concepts and the relationships between them. As suggested by Kinchin, Lygo-Baker and Hay (2008), while teachers may carry a sophisticated map of core concepts and the relationships between them in their minds, the structure that is frequently shared in lectures is linear, and students are not given access to this network of ideas and relationships between them. The concept mapping process undertaken by both the teacher and their students can help to bridge the gap between the teacher’s mental map and what the students receive. It is also a way for both teachers and students to identify changes in their thinking. Concept maps can be conceptualised as offering another dialogical space for course learning to be articulated and refined.

Constructing concept maps

In addition to providing a rationale for the use of concept maps, the literature provides guidance on construction and implementation. Novak and Cañas (2008) suggest that the starting point should be a domain that is familiar to the students and that this is best constructed as a *focus question*. The next step is to identify 15-25 concepts that are key to this domain and rank them from most general at the top to least general at the bottom. When the learner is new to concept mapping, the teacher can provide *parked concepts*, a list of relevant concepts. However, for meaningful understanding to occur, it is the learners that should be articulating what concepts they consider will assist them to answer the *focus question*. Further, Novak (2010) states that each learner must intentionally relate new knowledge to that which they already know. It is then that a teacher can begin to understand the gaps in learners’ knowledge and refine teaching material to generate new meaning that links to the learners’ prior knowledge.

Once a list of concepts has been developed (or provided as *parked*), the next stage is to construct a preliminary concept map on paper or using software such as cmap (<http://cmap.ihmc.us>). The preliminary map often begins as a hierarchical structure, however, as the learner reflects and develops their map, network and non-hierarchical structures evolve. Cross links or propositions

between concepts are the next stage in concept map development and as the learner builds their understanding of the relationships between concepts they develop their cognitive capacity (Novak & Cañas 2008).

Cañas, Novak and Reiska (2012) note variations in the degree of freedom that students have in developing a concept map. At one end of the spectrum, students can be given a blank sheet with no restrictions. Conversely, students can be given a map they can memorise, or a fill in the gap style map. The degree of freedom should align with how much choice the student has within the course and with learning outcomes. If the goal is to develop personal understanding through concept mapping, then a pre-designed map or a fill in the gaps strategy may not be that helpful; students may *rôte* learn and memorise, rather than develop higher level skills and meaning. Correspondingly, providing a starter *focus question* and inviting students to construct their own concept maps from the question may enhance the learning possibilities.

As well as a learning tool, concept maps can be used to assess knowledge and understanding in formative, and summative assessment (Edmondson 2000). A number of studies have used concept maps in assessment (see Daley & Torre 2010; Kinchin 2014 for more detail), however, generally research indicates the need for caution when assessing concept maps. Evaluating student learning from concept mapping should balance the '*what*' of relationships between concepts (quantitative), with the '*why*' (qualitative) students have created those relationships. Researchers have challenged the initial work of Novak and Gowin (1984) who devised a scoring protocol for concept maps that uses the number of valid links, degree of cross-linkage, amount of branching and hierarchical structure to measure learning. One challenge of this quantitative method is that if only valid links between concepts are scored, then this fails to recognise the learner's processes. A learner may take a particular path, which may link invalid concepts, but through their linkages may actually develop more meaningful learning. Subsequently, it is suggested that there is a need to balance quantitative and qualitative methods in concept map assessment (Pudelko, Young, Vincent-Lamarre & Charlin 2012). It is equally important to recognise the domain of organisation and the field of knowledge in question (Donald 2002; Pudelko, Young, Vincent-Lamarre & Charlin 2012) when designing how and if concept maps will be used in assessment. Cañas, Novak and Reiska (2015) suggest that when determining how good a concept map is, the assessor needs to examine both content and structure, although they caution that it is easier to find a good concept map but hard to evaluate an excellent one based on these dimensions.

Integrating the use of concept mapping into the course

In setting up concept maps as a core teaching and learning strategy, the authors of this study recognised that the initiative needed to be embedded in the curriculum design and linked to assessment. Kinchin (2014) suggests the potential for dissonant messages about the nature of learning and meaning-making if concept mapping is simply an add-on to business as usual. Therefore, learning outcomes for the course were reformulated and all lectures, and tutorials were redesigned to scaffold the introduction and use of concept mapping.

Introducing concept maps to students

There was considerable scaffolding before students had to produce concept maps for assessment. Concept mapping and the rationale for its use was introduced to students in week 3 of the course. In this class the lecturer covered some topic material and then provided students with *parked concepts* and a *focus question* to answer. Students were asked to work in groups for 20 minutes using the *parked concepts* to develop a concept map. Only a small number of *parked concepts* were provided and they could be arranged into a hierarchical concept map structure. Further, students were asked to include any other prior knowledge that would help them answer the *focus question*. Subsequent lectures built upon the idea of *parked concepts*, as new knowledge was acquired. Each lecture had

time allocated for students to practise and apply their learning through developing concept maps. At the end of each lesson, the lecturer shared her own concept map, thereby making her assumptions visible to the students. Each tutorial supported the content already examined during lectures and students were provided with additional assistance with concept mapping. In one instance, a tutorial was designed to get teams of students to develop a concept map for a small area of management theory, with each team having a different theory to work on. Once teams had developed their maps, each shared their map with the rest of the class and then the tutor placed all maps on the whiteboard, and facilitated class discussion to create linkages between all the maps and associated theories. Tutorials provided time for students to practise and develop their skills in mapping, with feedback from the tutors before any formal assessment was conducted.

Students were informed about the cmap tool, a free to download electronic way of drawing concept maps, that worked on PC, Mac and tablet environments. The software was easy to use, allowed students to create multiple maps and add to previously developed maps, and could be downloaded and printed. However, students could use any method to develop their concept maps, including hand drawn paper maps.

Aligning Assessment

Aligned assessment was developed and concept mapping occurred in three summative assessment pieces: Group Case/Concept Map Application; Individual Concept Map; and as part of the final external individual exam (Table 1).

Table 1. Course Assessment

Assessment	Component	Percentage
Internal (60% weighting)	Group STEPP	5%
	Group DIL	15%
	Group – Case / Concept Map Application	25%
	Individual STEPP	5%
	Individual Concept Map	25%
	Individual Quizzes	25%
External Exam (40% weighting)	Multi-choice	20%
	Matching	10%
	5-Short answer Questions	50%
	Concept Map	20%

Students first developed a concept map as part of their Group Case/Concept Map Application assessment. This assessment required students to apply a topic concept and its sub-concepts and theories (e.g. Control, Organising, Human Resource Management, Motivation, Leadership etc.), to a set case to show their understanding of how theory can be applied. As an appendix to this assessment they provided a concept map which illustrated how the concepts, sub-concepts and theories they had applied were connected (e.g. for the Control topic the concept map would attempt to answer the *focus question* ‘what is control?’). Groups handed in a draft, received feedback from their tutor, made revisions and then submitted the final report for assessment. Student were graded on the initial draft (20%), the final report (40%) and the presentation of their concept application to their tutorial class (40%). Each tutorial class had 5 groups, with each team applying a different concept to a pre-set case.

The second concept map assessment, due at the end of the course, required students to complete an individual concept map on a topic that their team had not applied. As part of this assessment

students handed in their concept map and also completed a two-page written reflection. The reflection included how they developed their concept map and also how concept mapping had assisted them with their learning throughout the course. The final concept map assessment occurred in the external exam where student had to answer a set *focus question* using at least 20 concepts and linking terms. Students were informed prior to the exam of the exam structure and that there would be a broad concept map question that would replace the essay question used in previous exams.

Rubrics adapted from the work of Chan (2009) were developed for each piece of assessment (see Table 2 for the rubric for the Individual Concept Map). Each rubric included organisational structure aspects such as, appropriate concepts, providing a clear picture of how the map answered the *focus question*, how concepts were linked together, as well as content aspects, supporting the recommendations of Cañas, Novak and Reiska (2015). The rubrics also included a subjective aspect to allow the marker to include marks for a student's thinking and ideas behind their concept map, recognising the personal nuances of concept mapping. For the Individual Concept Map assessment, the rubric also included marks that related to the short supporting reflective essay.

Table 2. Individual Concept Map Marking Rubric

TRAITS	Excellent (A - A+)	Proficient (B+ - A)	Average (C - B+)	Poor (<C)
Organisation:	Well organised. Provides a very clear big picture of the ideas. Contains an appropriate number of concepts including the key ones. Excellent linkage and integration to concepts outside of the selected topic. Follows standard map conventions. Concepts are short and clear.	Thoughtfully organized. Provides a big picture of the ideas. Contains most of the main concepts. Good linkage to some concepts outside of the selected topic. Follows the standard map conventions. Concepts are clear.	Somewhat organized. Provides a picture of the ideas. Contains an adequate number of concepts. Limited linkage to concepts outside of the selected topic. Follows some of the map conventions but inconsistent in application. Some concepts are un-clear.	Choppy and confusing. Provides a scattered picture of some ideas. Contains a limited number of concepts. No linkage to concepts outside of the selected topic. Fails to follow map conventions. Concepts are too long and unclear.
Links:	Links are precisely labelled. Simple and complex relationships	Links are labelled. Relationships are mapped.	Links are not labelled. Some ideas, concepts are linked but not distinctive.	No links. Difficult to follow relationships.

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	are mapped effectively.			
Thinking and Ideas:	Includes concepts that are extremely suitable for the topic and that show original or creative thinking. All ideas, themes, theories and framework are thought through.	Most or all concepts are suitable for the topic. Some ideas, themes, theories and framework are thought through.	Most concepts satisfy the basic requirements for the topic, but some do not directly relate to the topic. Adequate ideas, theories and framework are thought through, although not clearly shown.	Many concepts are inappropriate for the topic. Thinking process is not clear.
Supporting Essay:	Clearly defines and explains the overall concept map development and linking factors with a high level of understanding. Clear reflection on use of tool for the course.	Defines and explains the concept map development with good understanding of linking factors. Some reflection of tool use for the course.	Somewhat explains the concept map development and linking factors with minimal understanding. Minimal reflection of tool use for course.	Minimal explanation of concept map development with unclear linkage demonstrating minimal effort or understanding. Lacks reflection.
Written Expression:	Excellent layout and flow of writing with no grammar errors.	Good layout and flow with few grammar errors.	Poor layout with grammar errors.	Difficult to read as absent of layout and flow. Marred by grammar errors.

Evaluation, Findings and Discussion

To evaluate the impact of concept mapping on student learning, a number of approaches were used. First, as mentioned above, summative assessment of concept mapping occurred three times in the course – Group Case/Concept Map Application, Individual Concept Map and the final Exam. Second, student feedback was collected through the reflective essay component of the Individual Concept Map assignment and the end of semester course appraisal. Third, tutors were asked to provide feedback on the challenges and benefits of implementing, and assessing concept mapping. Finally,

the perspective of the lecturer and past experience with teaching the course were incorporated into overall evaluation of the initiative.

Student Concept Map Structures

The group and individual concept map assignments revealed that students had multiple ways of constructing concept maps, no two were identical. This supports the notion that we learn differently and the way that a learner's current knowledge is organised can have an important impact on their learning (Hay & Kinchin 2006; Kinchin, Hay & Adams 2000). One interesting finding from our initiative was that we could categorise the student concept maps into three types: spoke; network; and cyclical/cross-linkage. Our categories are similar to the earlier work of Kinchin, Hay and Adams (2000) who found three types of mapping structures – spoke, chain and network.

A large majority of students used a spoke and often hierarchical style approach to mapping, showing knowledge connections that were still developing from the novice to the expert (see Figure 1 for an example). Even though representation of concepts for this type of map were structured in a linear manner, students were still showing a good appreciation of how various sub-concepts linked, and the propositions used were appropriate. Hay and Kinchin (2006) consider that this type of structure indicates learning readiness, where the learner is amenable to change in their course of learning. It should be noted that whilst still using a spoke style approach, some student maps were less hierarchical in their structure.

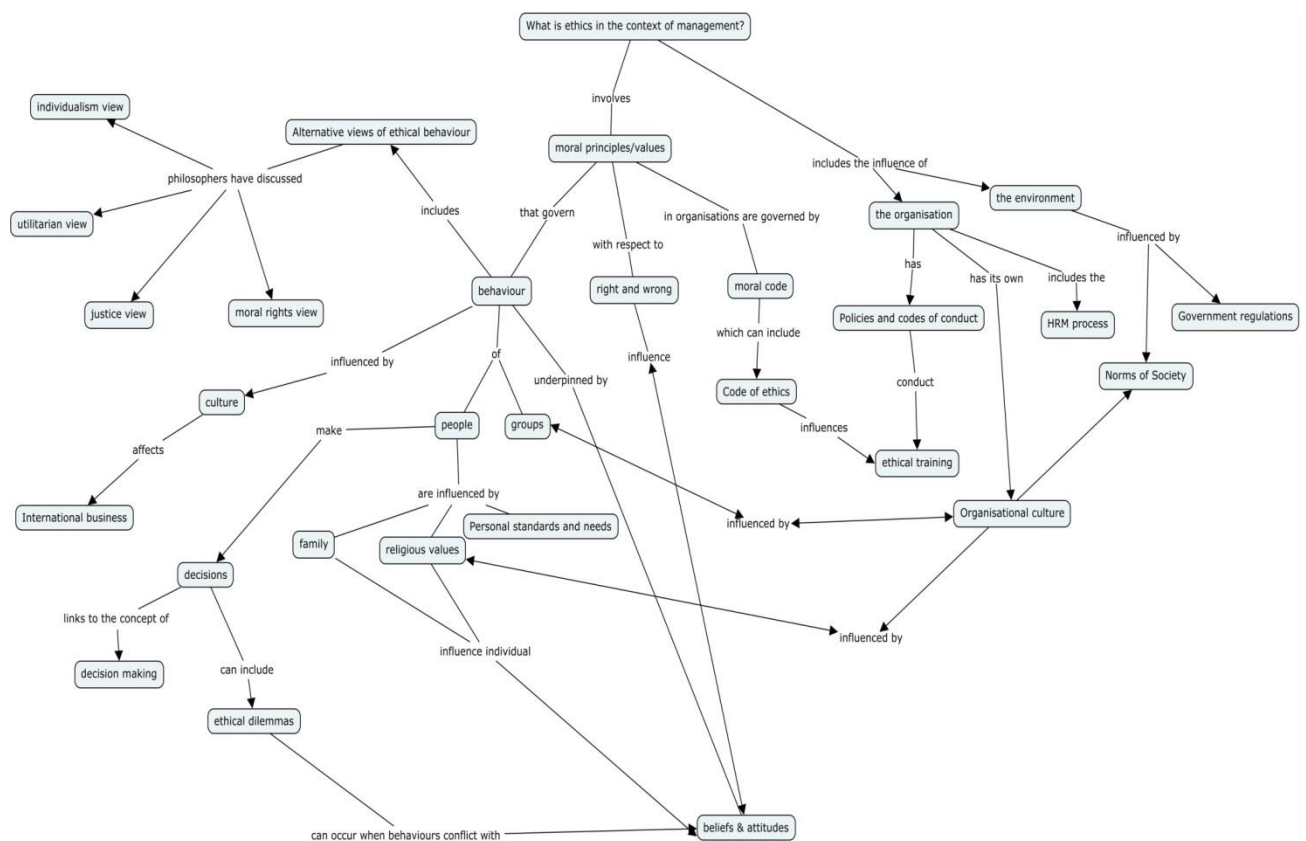


Figure 1. Spoke

Another style that surfaced from the concept maps was network. This style of concept map showed a highly integrated and hierarchical network which demonstrated a deep and rich understanding of the topic (Kinchin, Hay & Adams 2000). This style of mapping revealed how students could integrate blocks of ideas. Students who used this structure began to show cross integration and connection of knowledge. For example, in Figure 2 the student showed how they did not have to go back through

the key concept of Human Resource Management to link sub-concepts together. The student provided examples to support their understanding, illustrated as end points and also showed the beginnings of linkage to other Management concepts e.g. Control, Planning. Unfortunately, this student used terms that were too long for a number of concepts, which does not conform to mapping standards. In general, concept maps that could be categorised as a network type, illustrated more complex thinking and showed how a student was developing multiple routes to connect their knowledge.

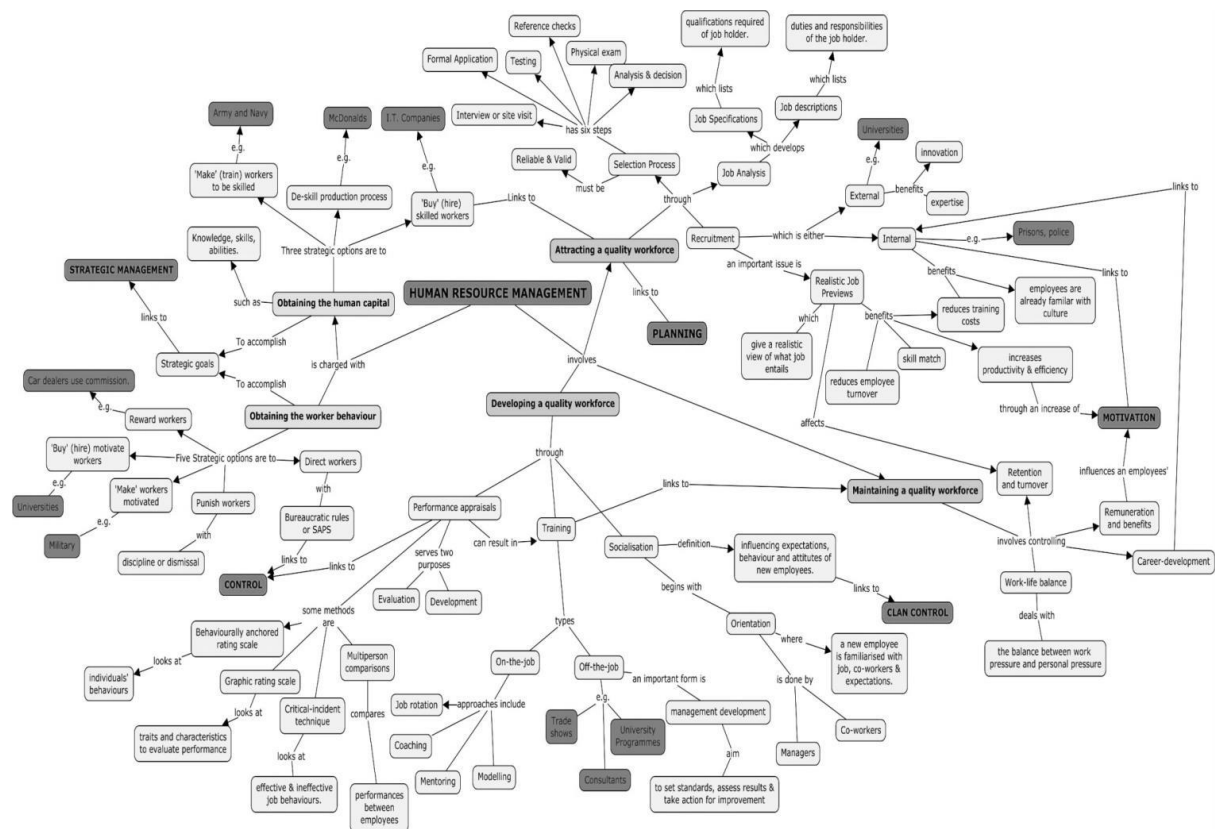


Figure 2. Network

The final category of maps was those where students showed a good understanding of linkage across concepts and showed high levels of critical thinking, illustrated through cyclical linkages. Figure 3 shows how a student cross-linked into Leadership, Control, Motivation and Human Resource Management, concepts that went beyond the immediate purpose of the concept map and *focus question* ('what is organising?'). A negative in this particular map example is the difficulty of following the flow. However, for the purpose of our initiative – to assist students to develop meaningful knowledge connections, – this type of map generally illustrated stronger critical thinking from students compared to the other two types of maps.

[illegible]

Student Feedback

'I understood the thought-processes between the different boxes and can recall where everything is.'

In the anonymous end of course appraisals, which were not compulsory, students were asked to comment on how they thought concept maps helped their learning. Although the response rate was only 37%, students' comments were generally consistent around a number of themes, including the ability to create good links, personal understanding, time and effort and support for exam study. Students' comments included:

'It helped me see the many links and connections between topics more clearly. I found this extremely helpful with my overall understanding of management as a whole, instead of only understanding little bits.'

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'I've always struggled to learn the traditional route, so having a visual way of connecting the ideas was great and effective.'

Some students noted that maps were time-consuming to develop, a challenge which has been observed by Daley and Torre (2010):

'I initially did not touch them because they seemed really time consuming, but after doing it for the individual assessment it really helped me to link ideas and concepts together.'

'I found them to take up a lot of time, but they helped to see connections of the overall topics.'

A number of students commented they used concept mapping to assist them to study for exams:

'I have used concept maps previously to study. In regards to this paper, they have helped me to remember information, develop a more in-depth understanding and identify links within and between concepts.'

Inevitably, not all students enjoyed the concept mapping process as typified in the following comment:

'I did not enjoy concept mapping. I can see the benefits and I felt like they helped with my learning as it triggers you to realise the connections between concepts. However, they are not fun to create.'

One interesting recommendation, which was subsequently implemented in a future iteration of the course, was to offer students the choice for the individual assignment of either constructing a concept map or demonstrating their knowledge connections through writing an essay.

Results from the Exam and Final Course Grades

Student grades improved noticeably (Figure 4), with an overall course pass rate (combined internal assessment and exam) of 90% compared to averages for previous iterations ranging between 78-82%. The exam grades were a considerable influence on the overall course grade, with a pass rate for the exam of 84%, again up on previous iterations (students had to receive a grade of 40% or higher in the exam to be eligible for their combined grades to be calculated, with a final C grade or better to pass the course).

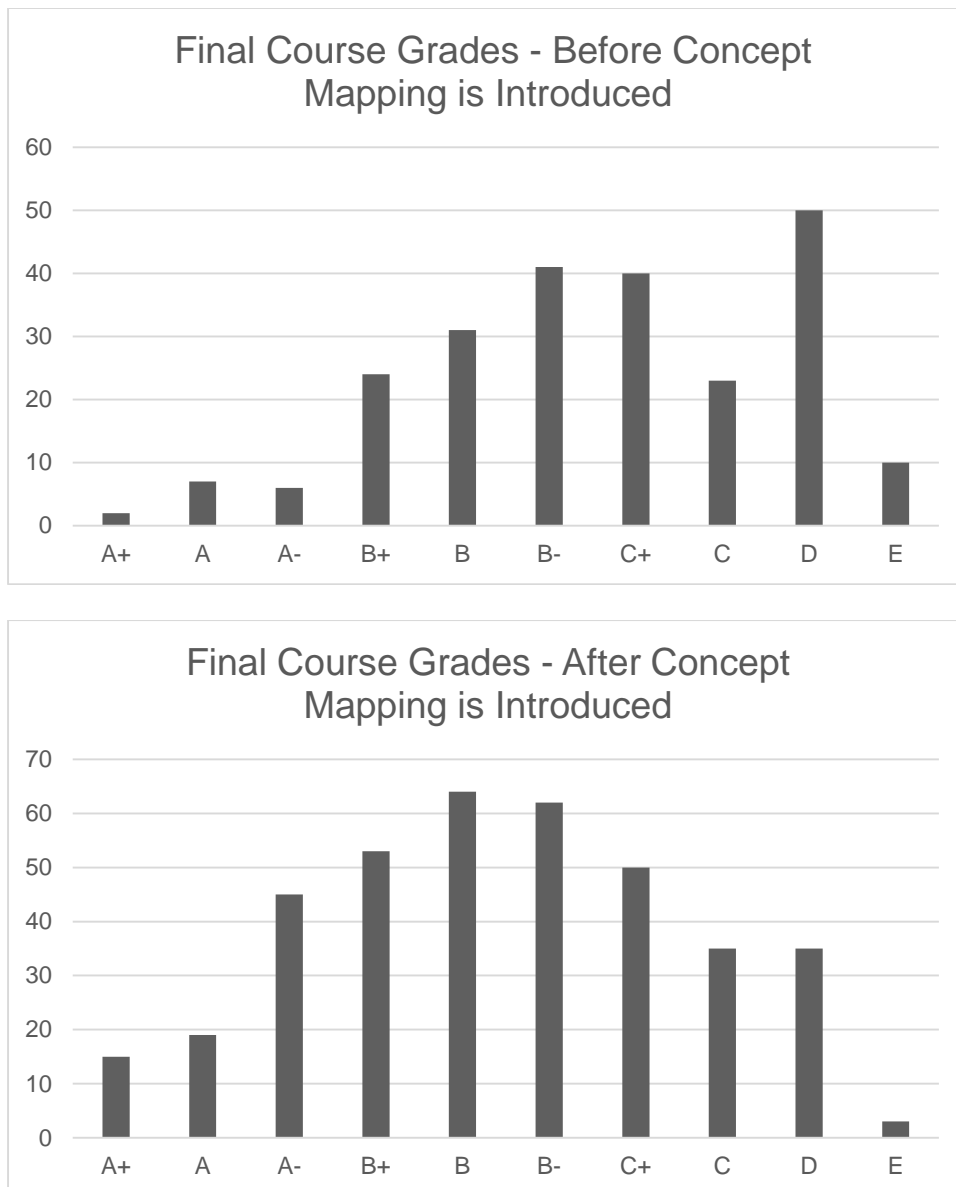


Figure 4. Course Grades

When analysing the exams there were two areas where students showed significant improvement. The first was in the concept map question, which had replaced an essay question. The detail and quality of the concept maps that students used to answer the *focus question* surpassed all expectations of the teaching team. Some students had quite simple maps, spoke in style, with correct mapping structure and good content (meeting the question requirement of using 20 concepts and 20 linking terms). Such maps received high marks as they met the content-structure marking criteria. A number of students presented maps that were even more complex, illustrating a cyclical style that often surpassed the question requirement. Although there were no additional marks provided to these students, the teaching team could see how these students were interconnecting concepts across the course in a more mature complex manner.

The second noticeable improvement in the exam results came from responses to the short answer questions. In past exams students had struggled to compare and contrast theories and concepts in short answer questions. Anecdotal evidence from the exam suggested overall improvement in the learning from the class, given the quality of responses to the short answer questions. Students that

were high achievers showed greater interconnection of concepts when comparing and contrasting theories. Those that were middle-of-the-road, had better quality responses than in the past which revealed greater understanding of theories. However, it was the category that could be classified as lower achievers where the greatest improvement in answers was shown. These students, who in the past often failed to even recall a theory, let alone contrast ideas, provided responses that were of a satisfactory level to receive a pass grade. Possibly this is a result of the integration of concepts maps within the course to improve knowledge connections and support more meaningful learning.

Lecturer and Tutor Feedback

Concept mapping was new to all the tutors and with this came the challenge of both teaching concept mapping and grading the concept map assessments. Tutors were introduced to concept mapping during pre-semester teaching meetings, where they were provided reading material and also concept maps developed by the lecturer for a number of the course topics. During subsequent meetings, concept maps were used as a tool to support discussion about how to facilitate learning around a topic and create the connections between the theories that we eventually wished students to develop and learn for themselves. During these meetings the lecturer and tutors collaboratively designed the tutorial class content, how the tutors would facilitate the learning and how concept mapping would integrate in, and flow on from the lecture through to the smaller size tutorial classes. For each tutorial class there were deliberate strategies developed to scaffold student learning on concept mapping, with formative feedback integrated into the learning space.

A number of tutors developed their own concept maps on a topic and shared these with the teaching team. This unpacking of the tutors' own knowledge enabled them to voice their knowledge connections and organisation, thereby making their conceptual frameworks more visible to their students (Kinchin & Hay 2007). Through getting their students to practise and share their concept maps in tutorials, tutors had immediate access into how students connected new knowledge with their prior knowledge. One tutor noted:

'In my classes I got students to create concept maps in groups and as a class on the board. I could see what they had learnt and how they were arranging their knowledge. This made it easier to discuss how we could expand their map to include other course material we had already covered'

(Tutor 2).

Another tutor who admitted to not being a visual learner, struggled initially with concept mapping, but at the end of the paper reflected that the skill in mapping out concepts and interconnecting them, assisted both her own and student learning. Interestingly, one tutor did not see concept mapping as a tool that was additional to course content learning:

'Rather than a new concept, or even a tool, concept mapping is showing students how to link and how to organise how they think, so they can do the learning themselves'

(Tutor 4).

The first marked assessment on concept mapping occurred as part of the group assignment. Using the marking rubrics, student work was moderated by tutors pairing up, discussing grading and then sharing their findings with the whole teaching team in the weekly meeting. The lecturer also marked with the tutors:

'I found it good to buddy mark to see if I was on track'

(Tutor 3).

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A number of tutors noted that it was interesting that some teams allocated the concept map component of the assignment to one or two members, whilst other teams work collaboratively as a whole to complete the concept map component. In terms of outcome one tutor said:

'I definitely had the best maps from students who worked collaboratively in their team to produce the concept map, compared to those who allocated the task to 1-2 team members to complete alone'

(Tutor 2).

It took the teaching team a longer period of time to mark the first concept map assessment, owing to the time required to collectively discuss the idiosyncratic nature of the personal aspect of concept mapping. There was consensus however, that it was easy to mark good or bad concept maps, however, the bulk in the middle were more problematic:

'A good concept map was usually easy to mark; a bad concept map was always easy to mark. It's the middle ground that proved some difficulty – do they actually know what they're talking about?'

(Tutor 1).

'In terms of marking, I found it easy to distinguish the really well put together concept maps and those that really did not show much. It was the group in the middle that were a bit harder to mark and mainly it then came down to the level of depth and linkages illustrated'

(Tutor 3).

The depth and level of linkages or propositions was a theme that the tutors continued to discuss during the course debrief:

'In my opinion, connecting words [propositions] were paramount for a good concept map'

(Tutor 5).

'The value in a concept map lies in the ability to identify relationships between the concepts. Either students got this, or they didn't. Those that did, usually got an easy and good grade. But everyone sees linkages in different ways'

(Tutor 6).

The feedback from the tutors supported the work of Cañas, Novak and Reiska (2015:15) who note that poor concept maps often have 'propositions and linking phrases that are completely irrelevant to the focus question'. Tutors provided significant feedback on how poor and average maps could be improved prior to the Individual Concept Map assessment. This included refining structural layout of maps, use of appropriate propositions and selecting suitable knowledge from both the students' prior knowledge base and that learnt from the course. The result was improved maps (both in structural and content quality) for the Individual Concept Map assessment. One tutor compared the learning outcome from the Individual Concept map to that of the Individual Essay that had been used in prior iterations of the course:

'Concept maps definitely helped my students learn the theories and how they all relate together. I noticed a clear improvement in overall content knowledge and the ability to link the theories together compared to previous years'

(Tutor 2).

One issue that did arise when marking the Individual Concept Map assignment was the use of a particular medium and subsequently the quality of maps. Students had been allowed to submit their concept maps either hand drawn or through the use of any drawing technology, inclusive of the recommended cmap software. Some of the handwritten concept maps were very poorly developed and hard to read, whilst others, that used general software to draw boxes, became very large in size and difficult to follow. It was noted:

'A major factor was how it was presented (e.g. handwritten or on the computer). Good software can be a great help. Using software doesn't mean they would instantly get a good grade – but I think there is a lot of implicit value on how the information is displayed. If it isn't clear or legible, there isn't anything the tutor can do'

(Tutor 1).

Future iterations of the course took this feedback on board and stipulated the software that had to be used for designing concept maps. Tutors also recommended that a weight percentage was placed on each section of the concept map marking rubric so that students could see where emphasis was being placed – on organisation, linkage and thinking, and ideas. This recommendation was implemented in the next iteration of the course.

Conclusion: Lessons Learnt and Future Directions

This initiative, the use of concept mapping for learning and assessment, has added to the growing body of evidence on the effectiveness of concept mapping as a strategy to promote more meaningful learning (see Daley and Torre, 2010). Like Daley, Shaw, Balistrieri, Glasenapp and Piacentine (1999), we focused on concept mapping as both a learning and assessment tool. Our experience, evaluation data and student work showed that the introduction of concept mapping in the learning and assessment processes had a discernible impact on the quality of students' learning. Furthermore, anecdotal results as demonstrated in assessments, suggest that the learning from concept mapping led to overall improvement in students' ability to create meaningful knowledge connections and structures.

This was supported by feedback from students and tutors, which highlighted that the most significant effect was to improve students' capacity to see connections and relationships between ideas, a claim made for concept-mapping in the literature. It is important to note that the mode of thinking and conceptualising required in concept mapping was supported by the design of classroom experiences, and that classroom practices and feedback linked precisely with assessment. The ongoing concept map work undertaken by the students provided prompt and readily accessible information about students' learning progress. In this way the quality of the students' understanding was rendered visible. Likewise, both the lecturer and the tutors shared their conceptual processes with the students in the teaching of concept mapping. Overall the findings from student grades and feedback, and teaching team feedback, suggest that concept maps can assist students to improve their knowledge connections between course concept, theories and ideas. One caveat from this experience, is that some students resist this type of learning and perhaps need other options for building connected knowledge.

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