An introduction to *e*Roadmapping: Providing learning paths for students and empowering teachers

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This paper reports on the development of an innovative teaching strategy: an *e*Roadmap. Based on the theory of conceptual mapping, the *e*Roadmap provides an interactive, hierarchical structure for course delivery, using the readily accessible platform provided by Microsoft PowerPoint. For the student, the *e*Roadmap provides a self-paced learning environment which encourages student engagement; for the teacher, it provides an environment for the development of a course framework, and the integration of teaching materials from a variety of sources. Further advantages of the *e*Roadmap from the perspectives of both students and teachers are discussed, and future directions for development, evaluation and research are outlined.

INTRODUCTION

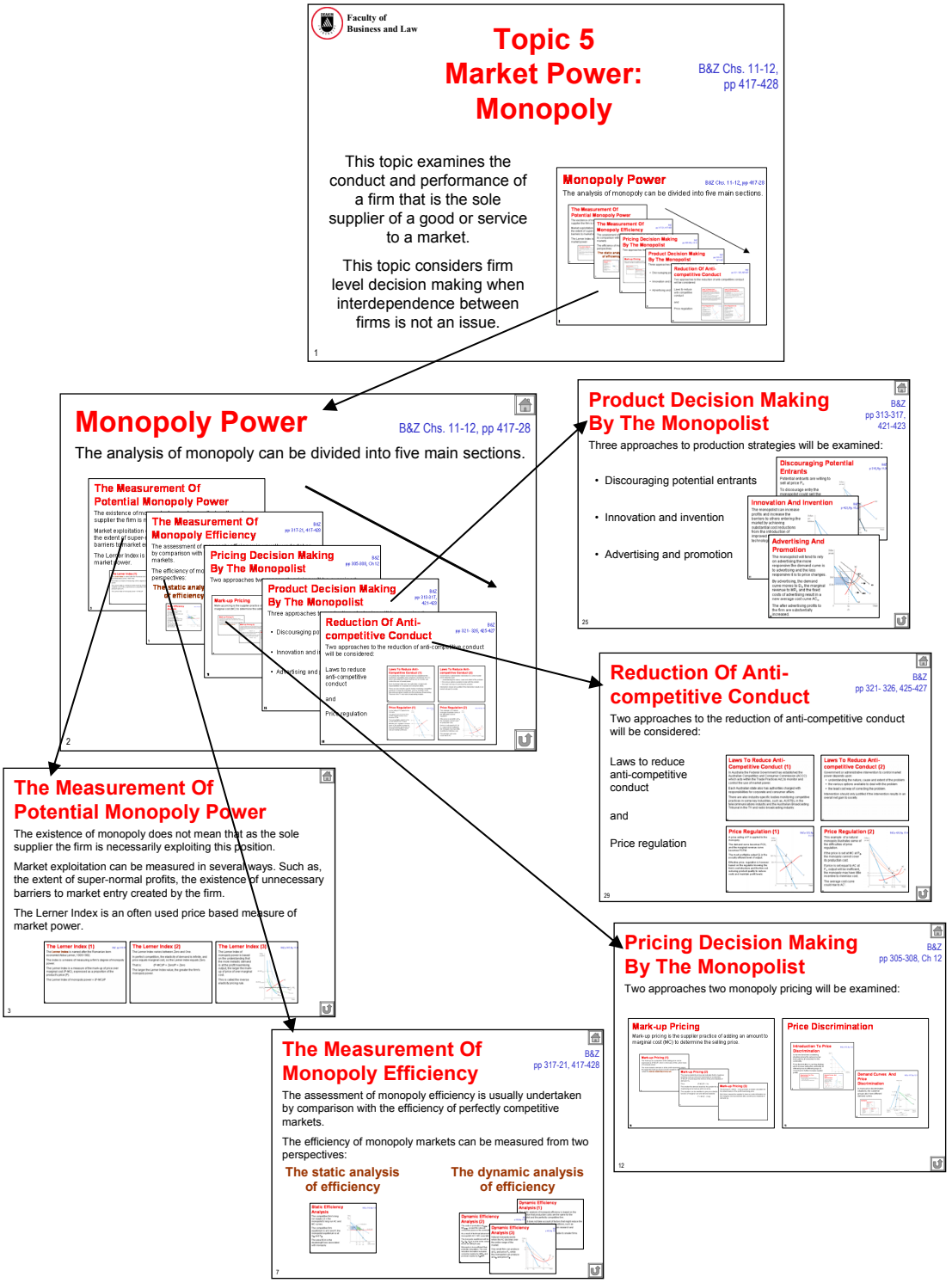
The *e*Roadmap described in this paper was developed over the last twelve months by a team of staff from the Faculty of Business and Law at Deakin University's Warrnambool campus. The combined forces of pressure to develop increasingly online learning programs, and an ever expanding range of learning resources available from a variety of sources, provided the impetus for seeking to develop a suitable electronic framework for presenting an integrated course structure. Compounding these factors was a desire to improve the engagement and interest of students in studying economics.

The *e*Roadmap provides a framework for developing flexible learning programs which enable and enhance the integration of all materials. It utilises computer software that has appropriate visual capabilities (graphic, numerical, and verbal), and visual building and linking capabilities.

This paper reports on the development of an *e*Roadmap for an intermediate microeconomics unit,[2] Competition and Industry, offered as part of a Bachelor of

Commerce degree. Given the conceptual nature of economics, and the complex inter-relationships that often exist within many units of study in economics, it was felt that an *e*Roadmap could be particularly beneficial to students of economics. Further *e*Roadmaps are being developed for two other economics units, and a number of other business related units offered within the degree program.

Figure 1: Part of an eRoadmap for a topic on market power and monopoly



In the sections that follow, we explain *e*Roadmapping using concrete learning program examples, and relate *e*Roadmapping to the theory of conceptual mapping, and to general educational theory. We then explain how *e*Roadmapping can assist students and empower teachers. Guidance on developing an *e*Roadmap is provided, and the paper concludes with a brief consideration of future developments, in particular the need for formal evaluation.

WHAT IS AN *e*ROADMAP?

Similar to the manner in which a normal roadmap provides an overview of points and the pathways between points within a geographic region, an *e*Roadmap provides an overview of concepts and the linkages between these concepts. A normal roadmap shows the possible paths between points; an *e*Roadmap shows the logical paths between concepts. Users of a normal roadmap can choose the path that best suits their specific needs; the user of an *e*Roadmap (i.e. the student) can choose the path to follow in moving from one concept to another.

Figure 1 illustrates this idea, by showing part of an *e*Roadmap for a topic on market power. This particular *e*Roadmap was developed using the commonly available and familiar Microsoft PowerPoint software as a platform.[3] There are 33 slides in this topic and approximately 200 slides for the whole subject. We have incorporated graphics contained in the recommended text for the subject (Browning & Zupan 2004).[4]

Figure 1 is similar to a traditional concept map, with rectangles representing concepts linked by arrows. The structure is a hierarchical tree-like structure. The rectangles are images of the slides in the PowerPoint file. There are two types of slides: 'parent' slides and 'child' slides. Images of child slides appear on the parent slides. These images are hyperlinked. A child slide is viewed by clicking on its image on a parent slide. Text within a slide can also be hyperlinked. All slides have a standard layout or template, with text references near the top right hand corner, and navigation buttons in the top and bottom right hand corners. Navigation back up the tree is enabled by providing a return button in the bottom right hand corner of each child slide. Quick return to the start, or home, slide is provided by a home button in the top right hand corner of selected slides.

There are many concepts, links between concepts, and ways of traversing the body of knowledge contained in the *e*Roadmap illustrated in Figure 1. All learners are expected to cover the material in its entirety, but it is useful for them to have the opportunity to take the path which best facilitates their learning. The *e*Roadmap allows this. There is the preferred path that has been recommended by the teacher (moving from monopoly power to the measurement of potential monopoly power, to efficiency, pricing, et cetera), but students can choose other paths if they wish. The idea is to show the 'big picture', and to allow students to drill down to the base level slides to obtain further information if they wish. If students already have an understanding of some parts of the material, they can proceed to the particular sections which require further attention.

The drilling-down sequence illustrated in the *e*Roadmap of Figure 1 is similar to the linear content structure presented in the table of contents of many textbooks (e.g. Browning & Zupan 2004, chapters 11, 12, and 15, pp. xviii–xx). However *e*Roadmapping provides a more efficient form of learning flexibility than textbooks.

In an attempt to provide topic and concept linkages, and learning flexibility to readers, many textbooks supplement the table of contents with verbal references in the text to other relevant sections of the book, a subject index at the rear of the book, and a section in the preface describing alternative ways of combining the contents of the book. However, because of its hard copy format, the constant turning of pages to reach different sections of a text can be cumbersome, distracting, and time consuming.

*e*Roadmapping provides a computer driven, click-on-icons method of efficiently overseeing and navigating the topic material, using a wide variety of instantaneously activated conceptual linkages.

CONCEPT MAPPING AND THE LEARNING PROCESS

The *e*Roadmap is a development which is broadly based on *concept mapping* (Novak 2005), a technique for visually representing the structure of information, and the interrelationships between concepts.

Concept mapping

Concept maps are tools for organising and representing knowledge. Novak (2005) claims that to the extent that concept maps serve as a template to help organise and structure knowledge, they are powerful for the facilitation of meaningful learning. A concept map is based on the learning psychology of David Ausubel (Ausubel 1963; Ausubel et al. 1978), whose fundamental idea is that learning takes place by the assimilation of new concepts into existing propositional frameworks held by the learner. In essence, learning new knowledge is dependent on what is already known. New knowledge gains meaning when the learner chooses to substantively relate it to a framework of existing knowledge, rather than being processed and filed in isolation according to more or less arbitrary criteria. Meaningful learning needs three conditions (Novak 2005):

- Meaningful material: The learner has to have relevant prior knowledge.
- Understandable content: The information has to be conceptually well-defined, and presented with examples in a language that the learner can relate to their existing knowledge base.
- Motivation: The learner must be motivated to consciously and deliberately choose to learn, and to incorporate new concepts into their prior knowledge, rather than memorising the concepts.

The teacher can encourage students to engage in the learning process by using tools such as the *e*Roadmap. The *e*Roadmap can both identify general concepts prior to more specific instruction, and can assist in the sequencing of explicit learning tasks anchored to the conceptual framework.

Although little is known about the memory processes and the incorporation of knowledge into the brain, Novak (2005), claims research supports the proposition that the brain organises knowledge in hierarchical frameworks and that learning approaches that facilitate this process enhance the learning capabilities of all learners. As discussed in the previous section, the *e*Roadmap provides a hierarchical structure.

*e*Roadmapping is also consistent with the views of Schau and Mattern (1997), who suggest that for knowledge to be accessible from long-term memory, it must be organised, or structured. If connected understanding is lacking, students will be unable to apply the concepts being studied. A hierarchical structure, where the material is organised from general to more specific information, serves to encourage and enhance meaningful learning. An overall view of a unit can be portrayed, followed by details of specific topics and concepts.

While *e*Roadmapping is an application of the general principles of effective concept mapping and structuring theory, clearly many different conceptual maps, and thus many *e*Roadmaps, can be generated from the same body of information. The matrix in Table 1 illustrates how several economic concepts and market performance possibilities can generate many options (matrix cells) that could be used in the development of an *e*Roadmap with respect to monopoly power.

Table 1: Conceptual mapping options for a topic on market power

Concept	Performance	Outcome		Regulation
		Perfect competition	Imperfect competition	
Measurement of monopoly power	Pricing indexes	1*	10	19
	Concentration ratios	2	11	20
Allocative efficiency	Static	3	12	21
	Dynamic	4	13	22
Pricing	Mark-up	5*	14	23
	Discrimination	6*	15	24
Production	Entry	7	16	25
	Innovation	8	17	26
	Advertising & promotion	9*	18	27

** Cell not relevant.*

Depending upon the background and abilities of the students and the objectives of the learning program, the body of knowledge relating to monopoly power could be conceptually mapped in many ways. For example from Table 1, a simple introductory approach might consider the concept of monopoly power in terms of a brief comparison of perfect and imperfect competition with respect to concentration ratios, static efficiency, price discrimination, and barriers to entry (cells 2 & 11, 3 & 12, 15, 7 & 16). A more detailed analysis could include a consideration of what is meant by monopoly power and its measurement, a comparison of static and dynamic efficiency, and an explanation of mark-up pricing and technical innovation as it relates to barriers of entry (cells 10, 3 & 4, 12 & 13, 16 & 17). Consideration of market regulation could also be introduced, for example in relation to market concentration, efficiency, innovation

performance, and barriers to entry (cells 19 & 20, 21 & 22, 25 & 26). A comprehensive analysis would also include a more detailed analysis of the performance and regulation aspects of pricing, and advertising and promotion (cells 14 & 23, 24, 18 & 27).

The remainder of this section provides a brief explanation of the conceptual mapping process undertaken in developing the market power topic illustrated in Figure 1. The first important factor is to develop the framework with the relevant student body in mind. In this instance, the market power topic is taken from an intermediate microeconomics unit for second-year bachelor of commerce students. Some students will not undertake further studies in microeconomics within their degree program. The unit is designed for students with limited algebraic background; hence the explanation and analysis of economic concepts are reliant upon verbal, arithmetic and descriptive geometry techniques. The *e*Roadmap was also designed with reference to the chosen text and with copyright approval to use diagrams from that text. This ensured that the *e*Roadmap was consistent with, and fully integrated with, the hardcopy materials recommended to the student.

The initial aspect of the conceptual mapping was horizontal. The objective was to establish the general relationships between market structure, performance, and regulation. The main components of the market power topic were determined to be the measurement of potential monopoly power, the measurement of monopoly efficiency, pricing decisions, product (or output) decisions, and market regulation.

The second aspect of the conceptual mapping was a vertical or drilling down analysis of the constituent parts of each component. The objective was to ensure that the complexities within each component were delineated. Under the measurement of potential monopoly power component, the aim was to examine mark-up and demand price elasticity measures of market power. Under the measurement of monopoly efficiency component, the aim was to examine comparisons between competitive and monopoly market structures in terms of production (cost) and allocative efficiency, not only in static but also dynamic (technological advance and economies of size) settings. Under the pricing decision making component, the aim was to analyse mark-up pricing and evaluate various types of common price discrimination practices. Under the product decision making component, the aim was to analyse firm based strategies to discourage competitor entry, and to increase innovation, invention, product promotion and advertising. Under the reduction of anti-competitive conduct component, the aim was to provide an introduction to the rationale for Commonwealth legislation to reduce anti-competitive conduct and regulate prices.

The third aspect of the conceptual mapping was again horizontal. The objective was to ensure that some of the complex interrelations between the components are examined. For example, the theoretical, informational and legislative requirements to establish and maintain workable competition and long run public interest. In many instances, the three aspects of conceptual mapping are not necessarily conducted sequentially, but follow an iterative process. For example, a static vertical analysis of the allocative efficiency of less competitive markets may result in a different market performance evaluation and horizontal public policy recommendations than one provided by a more dynamic vertical analysis that takes into consideration such factors as research expenditures, innovation, and economies of size.

The learning process

A logically-based perception of how students learn is essential for facilitating good teaching, and ensuring quality in learning. Learning outcomes, both qualitative and quantitative, are determined by a complex interaction between teaching procedures and student characteristics (Biggs & Collis 1982). Quality learning depends on factors both extrinsic and intrinsic to the learner. Extrinsic factors often relate to issues of instructional design, while intrinsic factors usually include motivation, previous knowledge, and the developmental stage of the learner.

The intrinsic factors of the motives and strategies adopted by the student can determine the student's approach to learning. Student approaches to learning can be understood as a continuum, extending from surface or shallow processing to deep and achieving analysis (Biggs 1987). Table 2 provides a brief summary of the common ways in which students see their task, and organise their resources within each learning approach.

Table 2: Motives and strategies in approaches to learning and studying

Approach	Motive	Strategy
Surface	Meet requirements minimally: a balance between working too hard and failing.	Reproductive: limit target to bare essentials and reproduce through rote learning.
Deep	Intrinsic: study to actualise interest and competence.	Meaningful: read widely, inter-relate with previous relevant knowledge.
Achieving	Competition and ego-enhancement: obtain high grades regardless of interest in material.	Based on organising one's time and working space: 'model' student.

Source: Biggs (1987, p. 11).

Similarly, Simkins (1999) claims that research on cognitive learning suggests that while individual students learn in different ways, all meaningful learning (i.e. learning that emphasises understanding and the acquisition of knowledge) requires active participation on the part of the learner.

Economics has often been cited as lagging behind other disciplines in implementing instructional innovations that actively engage students in the learning process (Becker 1992; Katz & Becker 1999; Simkins 1999). The *e*Roadmap tool is an extrinsic factor affecting the student's quality of learning. It provides an alternative (or additional) way of presenting material, and engaging students in the learning process. Its use in economics education can help to overcome student fears or negative pre-conceptions, improve cognitive learning, and generate broader student interest in and motivation for economics.

The *e*Roadmap offers additional entry points into the study of economics for students with different learning motivations and interests. For example, it caters to the 'point and click', electronic visual game-playing generation who constitute a major component of the student body today. It is also flexible, and provides a more interactive learning environment. For example, students can follow the preferred pathway recommended by

the teacher, or choose quite different pathways. The *e*Roadmap can also be used as a framework to analyse situations not covered in the standard economics program. The *e*Roadmap is a vehicle that has the potential to actively engage students in their learning process and in so doing it can provide an environment that encourages a deeper approach to learning. As previously noted, knowledge that is learned meaningfully is knowledge that the learner can control, and knowledge that can be utilised in new contexts be recalled over longer periods of time (Novak 1998).

ENHANCING THE LEARNING ENVIRONMENT FOR LEARNERS AND TEACHERS

In developing an *e*Roadmap, we feel that the potential benefits, for both teachers and learners, are many and varied. Although the literature focuses on concept maps that have been generated by the learner, there is also much to be gained from concept maps that have been developed by the teacher. Feedback from students of economics has highlighted the difficulty they experience in determining the relevant concepts and analytical techniques to apply in solving problems (e.g. 'which graphs to use?'). The *e*Roadmap developed here is an attempt to overcome some of these difficulties.

The learners' perspective

An *e*Roadmap can provide the learner with a number of benefits. The clear overall visual perception of the key components of a topic provides the student with a clear structure of the body of knowledge to be covered. This assists the student in organising the material into a logical framework that aids the understanding, memory and recall processes of the mind. For example in Figure 1, the key components are provided in the first and second slides.

The structure also aids recognition of how a topic and its key components are related to previous knowledge and learning. For example in Figure 1, the performance measures of productive efficiency and allocative efficiency, previously applied to perfectly competitive markets, are now applied to evaluate monopoly performance. The *e*Roadmap also helps to develop an understanding of how the key components relate to one another, and similarly for component sub-groups. For example in Figure 1, the relationship of price elasticity of demand to mark-up pricing, the Lerner index measure of monopoly power, and to the efficacy of price discrimination.

Students can also benefit from the freedom to choose different learning pathways. This will depend on their level of understanding of the material, their interests, and their objectives. For example from Figure 1, in preparing for an exam the student may wish to revise the major graphs, and would therefore select the slides and pathways that provide illustrations and explanations of graphs.

In providing an analytical framework that assists the organising and structuring of knowledge, the *e*Roadmap means that new information can be more readily assessed and assimilated. For example from Figure 1, the cost effects of technological change upon monopoly performance can be readily incorporated into the current structure within the efficiency section as dynamic efficiency.

Finally, this development may enhance the student's ability to apply current knowledge to understand and interpret everyday events and solve unique problems. For example

from Figure 1, the analysis of an extensive product promotional campaign by a large corporation can be analysed in terms of the major components as provided in slide 2. As the student gains an increased mastery of the subject content, its application and development, it is hoped that they will develop a greater interest in the subject. The subject has added value to the student.

The teachers' perspective

In developing the *e*Roadmap, the teacher benefits from establishing a clear, overall visual perception of the key components of the topic. The teacher is challenged to identify and focus on the important concepts, and the ways these are interrelated. Our experience is that this takes considerable skill and imagination, as the teacher must first identify the concepts they wish students to learn, and then link them in a manner that best shows their relationship to other concepts. The *e*Roadmap is a useful visual tool to assist the instructor in developing the structure, content and presentation of the material.

*e*Roadmapping also assists in the logical development of major streams of study and skill enhancement in an overall learning program, for example the development of an economics major in a Bachelor Degree. This recognition of how the topic and its key components are related to previous knowledge and learning is crucial to course development.

The provision of an analytical framework assists new information and material to be readily assessed and included in the learning program. *e*Roadmapping allows for ongoing development of the learning resources. Once a structure has been determined and a basic *e*Roadmap has been produced, it is possible to add additional base-level slides, or links to other learning resources, without disrupting the fundamental structure. For example in Figure 1, we might wish to enrich the material on monopoly pricing by including a video interview with a theatre owner who is directly involved in price setting. Alternatively, whole topics can also be added, if they are added from a higher-level or 'parent' slide.

The *e*Roadmap can also be seen as a framework to continuously develop and improve over time. The same structure need not be adopted in each teaching period. The structure could change with each iteration, giving the roadmap an advantage over a textbook, which tends to stick to one linear structure. It also allows for continuity in the teaching of the unit. Staff changes, or the taking of leave by individual staff members, need not impact on the teaching of the unit, since a framework for the unit can be developed irrespective of individual staff members.

Another consideration is the efficient and effective use of staff resources. *e*Roadmapping is an ongoing development that can be carried out by a team of teachers. If necessary, teachers can separately create additional slides, or resources to add to slides, without disrupting the overall structure. Individual teachers can contribute in a significant and meaningful way to the whole product. Such additions can be carried out iteratively over time, as resources permit, and if a particular extension does not get added the *e*Roadmap as a whole is still intact and useful.

In addition, *e*Roadmapping provides a method of integrating and using the many learning resources that are available to teachers and students, such as the supplementary teaching materials provided by publishers with their texts. The aim is to add value to existing

materials, not to replace them. Materials such as PowerPoint slides and lecture notes, or online material, or further exercises using platforms such as Excel or webMathematica can be integrated into an *e*Roadmap. The integration of all of the teaching materials should assist students to use them more effectively, and to appreciate how knowledge, teaching methods and assessment are incorporated within the learning program.

Accessibility is also a particularly important consideration in a multi-campus university, where similar sets of materials must be available to all students to maintain student equity. Furthermore, given the drive for flexible learning in educational programs, there is an increasing demand for study programs to be available online. An *e*Roadmap can be accessible to all students via a web site. It provides freedom to select different learning pathways, depending on staff and student interest and the level of student understanding, while at the same time ensuring that all the designated material is covered.

Finally, the *e*Roadmap could provide a new student assessment tool. In addition to being a learning tool and useful for instructional planning, concept maps can also serve as a useful assessment tool (Novak 1998). It is possible that the *e*Roadmap concept could also be included as part of an assessment package. For example, students could be assessed on their ability to apply aspects of the *e*Roadmap to analyse and interpret a given situation or set of data. At higher levels, students could be required to produce *e*Roadmaps of topics they have researched or explored.

DEVELOPING AN *e*ROADMAP

For a teacher to develop an *e*Roadmap, they need to:

- Develop/create the concepts.
- Provide links and pathways between the concepts.
- Provide an overall structure giving the ‘big picture’.

Hence, the construction of an *e*Roadmap requires the developer to have a thorough knowledge of the subject matter and its component parts, and the ways in which the components may be arranged to facilitate ease of understanding for students of varying backgrounds and learning abilities.

We have found that there are two main ways in which teachers build *e*Roadmaps. There is the ‘top-down’ approach, where the developer starts with the big picture and ‘drills down’, as a student would, by adding in lower-level slides, and ending by providing the base-level slides.

The other method is the ‘bottom up’ method, where the teacher starts with a set of base-level slides – often a set of linearly-organised slides that they have used previously, or that were supplied by a publisher. This type of roadmapping progresses by grouping the slides into concepts, themes and onward up to a whole topic or unit. In developing the *e*Roadmap in Figure 1, we used a mixture of both these methods.

Our experience is that the development process is quite iterative, as developers try one structure then upon reflection try another. It also seems to help to have an ‘interviewer’ present, who is able to ask questions of the expert to prompt the creation of themes and links between concepts.

Our experience has also shown that there are many important 'tricks of the trade'. For example, if different developers work on different topics, it is important that they adopt common formatting styles, such as the use of colours. Also, although it is possible to do the linking 'by hand' using the tools provided in PowerPoint, working this way can be too slow. As mentioned in the previous paragraph, in many cases the development process relies on developers being able to try one structure and then, if they are not satisfied with it, to discard it and try another. To automate this process, we used a set of macros written in PowerPoint; the tool we used can be downloaded from http://www.deakin.edu.au/~rodneyc/RoadmapTools.ppt. This resource also contains many other practical hints and suggestions for *e*Roadmapping.

Finally, we recognise the need to involve as many of the staff who will be using the tool as possible in the development of the *e*Roadmap. As with the selection of a textbook, the teaching staff need to agree with the framework being developed, otherwise it is unlikely the tool will be used.

CONCLUSION

To date, our *e*Roadmapping experience has been confined to the development of basic conceptual maps of the standard descriptive graphics content of an intermediate microeconomics program.

The next stage of development is to generate hyperlinks to:

- Existing study guides and tutorial exercises written by staff.
- Other online resources, such as government departments and regulatory authorities, newspaper sources, and journal articles.
- Short films, interviews, discussions, lectures, and the development of interactive tutorials using descriptive graphics. Some rudimentary examples are provided in the supplementary exercises to the Browning and Zupan (2004) text.

In addition, measurement tools for the evaluation of the added value to staff and students of *e*Roadmapping need to be developed. The next stage in the development phase will be to conduct an evaluation of its usefulness to both students and teachers.

NOTES

1. Authors listed in alphabetical order by family name.
2. A unit refers to a one semester period of study, within a degree program.
3. Microsoft PowerPoint was used as the platform because of its familiarity and widespread use among both academic staff and students. Many teachers already have teaching material on PowerPoint, enabling them to easily adapt the material to an *e*Roadmap. PowerPoint files can also be viewed by all students, no matter what platform they are working from. A free PowerPoint viewer is available from Microsoft if necessary.
4. For copyright reasons, we are unable to provide the complete *e*Roadmap for the monopoly pricing topic electronically. However, working examples of simple *e*Roadmaps are available from http://www.deakin.edu.au/~rodneyc/RoadmapTools.ppt. The *e*Roadmap for the unit including monopoly pricing is available to students on CD-ROM.

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