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AUTHOR Henderson, L.; And Others
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ABSTRACT

Concept maps drawn by Aboriginal and Torres Strait Islander tertiary off-campus students were examined to determine the effectiveness of interactive multimedia as an instructional medium for teaching and learning in a multiple cultural context that integrates the requirements of academic culture and aspects of the students' cultures. Interactive multimedia in the Remote Area Teacher Education Program (RATEP), "Australian Minorities Today in World Perspective," includes both lecturer and student constructed concept maps. Concept maps are used as an advance organizer, as question-answer-feedback interactions that interrogate how well the students understand presented concepts, and as summaries representing a selective synopsis. Twenty-one RATEP students were asked to construct on paper their own map on the concept of "culture." The quality of the student-generated concept maps was evaluated in terms of hierarchical architecture, progressive differentiation, and integrative reconciliation via labeling and directionality of the inter- and intra-level linkages of the relational arcs. Results indicate that concept mapping through interactive multimedia proved an effective meta-learning strategy. Students produced maps at a level of specificity greater than some of those experienced in the actual interactive multimedia courseware. Concept mapping through interactive multimedia is seen as a tool of empowerment in cross-cultural learning. (Contains 21 references.) (Author/MAS)

Interactive Multimedia, Concept Mapping, and Cultural Context

L. HENDERSON, W. PATCHING, AND I. PUTT
School of Education
James Cook University of North Queensland, Townsville., Qld., Australia.. 4811.
E-mail: edldh@jcu.edu.au

Abstract: Concept maps drawn by Aboriginal and Torres Strait Islander tertiary off-campus students were examined to determine the effectiveness of interactive multimedia as an instructional medium for teaching and learning in a multiple cultural context that integrates the requirements of academic culture and aspects of the students' cultures. The quality of the student-generated concept maps was evaluated in terms of hierarchical structure, progressive differentiation, and integrative reconciliation via labelling and directionality of the inter- and intra-level linkages of the relational arcs. Results indicate that concept mapping through interactive multimedia proved an effective meta-learning strategy. Students produced maps at a level of specificity greater than some of those experienced in the actual interactive multimedia courseware.Concept mapping through interactive multimedia is seen as a tool of empowerment in cross cultural learning.

Racial discrimination, enforced dependency, economic exploitation, minimal sustainable political power, educational marginalisation, land alienation and, for some, geographical remoteness, place minorities, such as Australia's indigenous peoples, in the centre of the equity and social justice debate. One program that seeks to address these two areas is the Remote Area Teacher Education Program (RATEP). RATEP, which is an affirmative action initiative driven by the concepts of social justice, culturally-appropriate education, empowerment, and interactive multimedia information technology, provides access to university by enrolling adult Torres Strait Islanders and Aborigines in the Diploma of Teaching at James Cook University of North Queensland through off-campus study in the students' home communities. Diploma subjects are taught by the same lecturers who teach them on campus, the difference being that the subjects are delivered via the computer, other electronic technology (facsimile, audioconferencing and electronic mail), print material, and on-site tutors.

The Issues

Bruner, Goodnow, and Austin (1977) assert that people categorise all objects and aspects of objects to make sense of the complexities of their environment. Categorising involves identifying and sorting stimuli into classes (concepts) on the basis of common criteria. Once formed, concepts or categories "act as intellectual magnets that attract and order related thoughts and experiences" (Martorella, 1986, p.185). Categorisation is, in fact, the principal method of socialisation in any culture, and it reflects the culture in which the concepts have meaning (Howard, 1987). It is therefore not surprising that first year RATEP tertiary students typically find concept attainment within an academic context problematic. In academic genres, they focus on the examples and lose sight of the concept being clarified and, if asked to define a concept, give examples and fail to concentrate on the main concept categorisations and the links between those concepts (McDonald, 1989). Hierarchical progressive differentiation of concepts, particularly with respect to essay construction, also proves troublesome.

Optimising the construction of knowledge in academic contexts by Aborigines and Torres Strait Islanders through interactive multimedia (IMM) courseware requires teaching through, and providing student-generated avenues for, concept mapping in ways that rationally combine two different cultural logics. The first is the specific requirements of mainstream academic culture. This is expressed through the content to be taught and assessed, the written and oral genres, and culturally–specific ways of promoting cognitive development within a tertiary environment. The second, cultural appropriateness for empowerment and ownership, includes the minority's knowledge and methods and conventions of learning in ways that go beyond tokenism.

The paper explores the instructional design of IMM in one RATEP subject, *Australian Minorities Today in World Perspective* (*Minorities*) (Henderson, 1993) to combine rationally the requirements of tertiary academic study with the students' cultural backgrounds and appropriate ways of learning, and to use concept maps as an

instructional and learning tool. Specifically, results of fine grained analysis of student-generated concept maps are reported to demonstrate the effectiveness of these interactional teaching strategies.

Welding IMM, Concept Mapping, and Cultural Context

Concept mapping is used as an instructional and learning tool in the subject, *Minorities*. Research by Dempsey (1990) suggests that students who construct their own matrix as a learning strategy retained less information about the concepts than those who were taught via the teacher's matrix. Willerman and Harg (1991) support this in terms of the expert prepared concept map as an advance organiser. Other research shows positive outcomes of student–prepared concept maps (Novak and Gowin, 1984; Moreira, 1985; Sharples, 1991).

As a result, *Minorities* includes both lecturer and student constructed concept maps. Lecturer-prepared concept maps and schemata are important as models and can provide an initial sense of security. For students, the act of map making reveals their degree of understanding and ability to organise, categorise, and progressively differentiate academic content. Student constructions are also a powerful affirming process when working cross–culturally because they allow RATEP students to map concept relationships in a way that may (or may not) reflect a culturally specific view of the domain being studied. To help ensure that RATEP students constructed their own relational maps, a simple ColorPaint shareware program was utilised rather than concept mapping software such as SemNet. Heeren and Kommers (1992) claim that commercial concept mapping software (devised for mainstream students) requires students to use a certain method of knowledge representation. Levesque and Brachman (1987) warn that there is a trade-off between expressiveness, that is, freedom for users to utilise their own mapping style, and tractability in concept mapping software programs, usually to the detriment of expressiveness.

Concept maps are used in a variety of ways in *Minorities*. One is as an advance organiser. Willerman and Harg (1991) point to the positive learning outcomes of utilising concept maps in this way. Initially the concept map is presented in its completed form. Discussion via text and voice over lead students through the map and explains its nature, purpose, and structure as it relates to the particular domain categorised. Then it is rebuilt as it would have been constructed to emphasise one methodological strategy. The content is then restressed to bring the students back to the interrogation of the concept. Such a presentation beginning with the finished product and utilising the visual and aural characteristics of IMM conforms to studies which suggest that Aborigines and Torres Strait Islanders are traditionally oral/aural learners with cognitive strengths in visual and aural information processing and who prefer material to be presented holistically and then broken into parts for particular mastery (Harris, 1984; Kearins, 1982; Osborne, 1982, 1986).

The subject also involves a variation of the standard structure of a concept map. There is a multiplicity of representations which is important in constructivist pedagogy. Such an instance occurs with a map based on the concept that *cultural change*. A major objective was to address the initial concern that students focus on the examples rather than the concepts they clarify. When the concept and its parts were initially presented, the examples faded out leaving only the concepts. Sound was used to effect, too. One sound accompanied the sequential addition of the concepts and a noticeably different softer sound from that accompanying concepts occurred with each set of examples. This strategy exploited visual and aural clues to help RATEP students realise the relative importance of concepts and examples. Academic expository genre is also reinforced. The culminating screen, with the re-inclusion of the examples that had previously been faded-out, is not only a concept map; it also represents an essay plan of the topic: *Culture is not static*. In this way, the concept map is utilised as a psychological structure of knowledge as well as a logical structure of knowledge (essay plan) (Wandersee, 1991).

Another major use of concept maps in the subject, *Minorities*, is as question–answer–feedback interactions that interrogate how well the students understand the concepts presented. They frequently occur as click–and–drag interactions which seem a simplistic tool for learning. Notwithstanding their rudimentary features, click–and–drag interactions utilising IMM characteristics nevertheless provide effective reinforcement of concept attainment because students have to choose between items that are examples (those that stay in the concept box) or non–examples (those that return to their original place for subsequent selection) of the concept.

Even though the exemplars are programmed to belong to a particular concept category, the interaction demonstrates that concepts and concept systems can have unclear boundaries so that some exemplars could belong to more than one concept. For instance, in the interaction on culture change, *books/literature* could belong to the *ideas* as well as the *artefacts* or *colonisation* categories; the *computer* is an example of both a *technological cultural innovation* as well as a *cultural artefact*. In both examples, categorisation depends on how the item is viewed. The culminating interaction requires the students to critique the finished click-and-drag concept map. It provides them with the opportunity to discuss these aspects of "fuzzy category systems" (Howard, 1987) in the exploration of the programmed and their own hypotheses, and also reinforces the notion

that concepts and schemata are cultural constructions. Literature on concept teaching sometimes ignores its multipurpose nature.

Concept maps are also used as summaries and, as such, represent a selective synopsis. They are usually designed as interactions with critiques. They occur during the presentation of a topic as well as at the end of the topic. In this way, they highlight effective metacognitive strategies; they call for the students to think about the appropriateness or otherwise of their learning, and synthesising and categorising strategies, as well as to think about their evaluation of their knowledge of a concept as they progress through the topic.

Anatomy of a Concept Map

A concept map is a map of cognitive structures reflecting the psychological structure of knowledge (Wandersee, 1991). It provides a technique of graphically delineating a two dimensional hierarchical–horizontal linear representation of concepts (lexical nodes) and the relational arcs linking those concepts (Norlin, 1980 cited in Harris & Grandgenett, 1993). Relational arcs connecting lexical nodes form propositions indicating the relationship between the superordinate concept and selected salient subordinate lexical nodes within the structure of a particular domain (Bayerbach, 1988). Sometimes a concept map is a schemata for various concepts; other times it is a map of the attributes and exemplars and non-exemplars of a particular concept (Howard, 1987). Concept mapping relates to such Ausubellian principles as prior knowledge, subsumption, progressive differentiation, and integrative reconciliation; it is a metalearning strategy designed to assist students learn how to learn (Wandersee, 1991, p.927) and teachers to teach.

The major components of concept maps that were investigated in the present study were: (i) the hierarchical structure and progressive differentiation of the lexical nodes and (ii) evidence of integrative reconciliation via labelling and directionality of the inter- and intra-level linkages of the relational arcs.

Research Findings

Twenty-one RATEP students were asked to construct on paper their own map on the concept of *culture*. This task was undertaken two months after the students had completed study of the topic on culture and cultural change in *Minorities*. Immediately before drawing their concept map, the students were required to interact with IMM stimulus material which comprised a modified segment from *Minorities* on cultural change. This involved two of the uses of concept maps discussed previously. Firstly, the sequential build-up on screen of a concept map for *cultural change* involved the progressive differentiation of subordinate concepts and examples linked by unlabelled uni-directional relational arcs. Secondly, the students completed a click-and-drag concept map interaction on the same concept.

The students' concept maps of the concept, *culture*, were examined to address three questions:

1) how effective was IMM as an instructional medium for teaching and learning concept mapping;
2) how effective was the IMM courseware in facilitating learning that reflects teaching for cultural contextualisation; that is, the integration of the academic requirements of the subject and aspects of the students' own culture; and
3) to what degree do the concept maps exhibit technical components of hierarchical structure and progressive differentiation of lexical nodes, and integrative reconciliation as exhibited by the directionality, labelling, and inter- and intra-linkages of the relational arcs.

In focussing on the first two questions, cognisance was taken of Reeves' (1992) contention arrived at after a survey of the literature that qualitative methods as opposed to quantitative methods have much to offer understanding of students' learning as a result of exposure to IMM courseware, particularly in light of "the poor record of quantitative research to advance instructional understanding" (p.11).

To answer the first question, the 21 concept maps were examined to see to what extent the they were informed by three things: (i) the actual IMM subject, *Minorities*; (ii) the immediate IMM stimulus screens; or (iii) the students' own everyday prior experiences. In a subjective rating by the authors, the extent of influence of each of the three inputs was rated as either very strong, moderate or minimal. All three components were present in the 21 concept maps. Ten of the concept maps showed very strong evidence of being informed by the subject, *Minorities*, 5 by the stimulus screen and 6 by prior experiences. Six of the concept maps showed moderate evidence of being informed by the subject while 12 and 13 maps by prior concepts and screen respectively. Five of the concept maps were informed to a minimal degree by the subject and three each by screen and prior experiences. Together, 18 or approximately 86% of the students showed very strong or moderate evidence of being informed by the IMM instructional courseware via either the subject or immediate stimulus screens. One could postulate that the different ways of using concept mapping, as advance organisers, variations of concept map structures, click-and-drag activities, and summaries, as components of IMM instructional design do in fact bring about student learning of concept map construction.

With reference to research question two, the concept maps were examined to ascertain the degree of alignment that the lexical nodes had with Aboriginal and Torres Strait Islander culture and general academic cultural requirements. Again, the researchers used subjective evaluation that reflected very strong, moderate or minimal cultural contextuality. All 21 showed that to varying degrees they aligned themselves with both the academic and Aboriginal or Torres Strait Islander cultures. Ten of the students aligned the lexical nodes very strongly with their own Torres Strait Islander or Aboriginal culture, seven moderately, and four minimally while nine of the students aligned their nodes very strongly with the general academic culture, seven moderately and five minimally. There are two points worthy of note. Firstly, 85% of the concept maps reflected Aboriginal and Torres Strait Islander concepts to a strong or moderate degree. This cultural influence is in keeping with research that shows that new concept meanings can only be internalised if they are linked meaningfully with pre-existing concepts (Ausubel, 1963; Gagne, 1985; Novak & Gowin, 1984). Secondly, and more importantly, 80% showed evidence of western academic conceptualisation to a strong or moderate degree. Most students, at least in this exercise, show a significant level of bi-culturality with the successful internalisation and linking of academic and indigenous conceptualisation.

In seeking answers for question three, various technical aspects of the concept map construction were addressed as follows:

Hierarchical Structure and Progressive Differentiation

It needs to be stressed that there can be no one *right* concept map. However, the basic notion underlying hierarchical structure is that learners' cognitive structures are hierarchically organised "with more inclusive, more general concepts and propositions superordinate to less inclusive, more specific concepts and propositions" (Novak & Gowin, 1984, p.77). An examination of the 21 concept maps revealed that all showed evidence of hierarchical structuring of the lexical nodes from more general to specific concepts and examples.

Cultural change was presented as the superordinate node in the IMM stimulus material. In this research exercise, students were asked: "Based on your knowledge, develop a concept map about culture". All of the students used culture as the superordinate lexical node. The authors then counted the number of lexical nodes at the various subordinate levels. Twenty-one (100%) had lexical nodes at subordinate level one, 18 (86%) at level two, 16 (76%) at level three, 10 (48%) at level four, four (19%) at level five and one (5%) at each of levels six, seven and eight. This demonstrates that about one half of the students produced lexical nodes over four subordinate levels. It is interesting to note that at levels one, two and, in most cases, three, most students produced concepts for their lexical nodes. At the lower subordinate levels, some at three, and four through eight, students tended to provide examples of concepts. This is an important finding when viewed in the light of McDonald's (1989) research which found that Aboriginal and Torres Strait Islander tertiary students tend to focus on the example rather than the conceptual level. In this study there is strong evidence to suggest that, as a result of the IMM instructional courseware, students were able to conceptualise at progressive differentiating levels and, then, exemplify where appropriate.

Integrative Reconciliation

According to Starr and Krajcik (1990), integrative reconciliation refers to the degree to which learners perceive relationships among concepts as opposed to compartmentalising or isolating concepts. This is shown on concept maps via the linkages between lexical nodes, both hierarchical across levels (that is, between superordinate and/or levels of subordinate concepts) and across branches (that is, between concepts on the same level). In this study labelling and directionality of the relational arcs were also investigated. Evidence in concept maps of integrative reconciliation is significant in that it can lead to "new and more powerful understandings" by students (Novak & Gowin, 1984, p.104).

(a) Labelling

Labelling of the relational arcs was designated as either explicit or implicit. In the former, students actually labelled the arcs while the latter were unlabelled. Concepts linked by relational arcs form propositions; when the arcs are labelled, they create propositional statements. These propositions, along with arrows indicating relationship directionality help to more precisely develop the connection between linked concepts (Starr & Krajcik, 1990; Fisher, 1990). Explicit labelling was judged to be either simple or complex. Simple labelling was characterised by the verb *to be* (for example, *is* or *are*) or a preposition (for example, *of*) while complex labelling involved the use of clauses, phrases or transitive verbs. An examination of the concept maps reveals that two (10%) of the students used explicit labelling only, 10 (48%) implicit labelling only, and nine (43%) used both explicit and implicit labels. Of those who did label, 11 (53%) did so explicitly. More

importantly, of the 11 who labelled explicitly, two (18%) used simple labels, seven (64%) used complex, and two (18%) used both simple and complex labels. That is, 82% of the people who used explicit labels gave complex propositional statements. In total, the concept maps contained 71 complex and 43 instances of explicit labelling, that is, a ratio of approximately 5 complex to every 3 simple labelled relational arcs. Thus, it seems that when students label explicitly, they are more likely to use ones that are complex.

Fisher (1990) argues that the act of labelling or naming relations does not appear to be part of our ordinary, conscious thought processes. We perceive relations but only label them when required to do so for a specific task. In particular domains we develop a shared vocabulary for the concepts but not for describing (labelling) the relational arcs. Thus analysing and labelling relations is "the most difficult step" in constructing concept maps (Fisher, 1990, p.1003). Thus the fact that 10 students used only implicit labels should not be seen too negatively. Nevertheless, the challenging step/act of labelling appears to be an important instructive process as it assists the map maker to clarify relational links between concepts and convey his/her thinking/understanding to the reader. What is significant is the number of students (11 or 53%) who went beyond the IMM concept mapping models to include simple, and most importantly, complex relational naming, particularly as the original and immediate stimulus IMM screens on cultural change did not provide a good model as propositional labelling was implicit.

(b) Directionality

Relational arcs express meaningful relationships, either implicitly or explicitly, between concepts/examples embedded in the concept map. When directionality (either uni- or bi-directionality) is indicated by students through the use of arrows or labelling on the linkages, enhanced clarity of students' understanding of the complexity of these meaningful relationships is expressed. Non-directionality without propositional statements indicates association but not necessarily expressed meaningful relationships.

Of the relational arcs that were implicit, 18 (86%) of the students provided ones that were only non-directional, 13 (65%) only uni-directional, one (5%) only bi-directional, 10 (50%) both non-and uni-directional, and one (5%) whose concept map contained relational arcs that were non-, uni- and bi-directional. Of interest here is the fact that of those students who constructed relational arcs that were implicit, 14 (70%) gave directionality to those arcs. Of the 11 students who provided explicitly labelled relational arcs, one (9%) had concept maps that included only non-directional arcs, 7 (64%) were only uni-directional, none were only bi-directional, one (9%) was both non- and uni-directional, and one (9%) had non-, uni- and bi-directionality. Again, the significance is that 10 (91%) of the students whose concept maps contained relational arcs that were explicitly labelled provided directionality to those arcs thus making clear the students' conceptualisation.

(c) Inter- and intra-level linkages

An examination of the maps showed that by far the majority were inter or cross level linkages with 539 instances of implicit and 114 explicit linkages. There were only 29 instances of intra-level or cross branch linkages. All of these were implicit and provided by only five of the 21 students. This lack of cross branch linkages suggest that the students in this study have not indicated a meaningful understanding of the horizontal relationship between groups of concepts. This is probably a reflection of the IMM concept mapping courseware which did not incorporate elements of cross branch linkages, once again indicating the powerful role modelling plays in the instructional process.

Discussion

Given that all students had not been taught about or learnt through concept maps before studying the *Minorities* subject, the IMM modelling of concept maps has proven successful in a number of ways. There is a variety of student-generated concept maps with no two exactly alike. This is not surprising because, as Novak and Gowin (1984) point out, concept mapping is an idiosyncratic exercise. What is pleasing is that the student-generated concept maps are not replicas of the maps modelled in the IMM courseware or stimulus materials. The variety of concept map types in the IMM courseware would suggest to students that there is no one right concept map and give them confidence to take charge of their own meaning making. This constructivist approach has worked successfully. Students have clearly understood the nature and function of concept maps from the IMM modelling and been able to construct their own representation of the knowledge domain at levels surpassing those presented through the IMM courseware. Their demonstrated ability in concept mapping would now be an advantage when seeking to plan essays on any given topic.

Conclusion

There is little reported work on the instructional design interface between IMM, concept mapping and cultural difference. The proposed paper which combines these three areas adds worthwhile dimensions to the literature. The results from this study indicate that the use of IMM in the subject, *Minorities*, was appropriate as an instructional medium for teaching and learning concept mapping. It was also successful in facilitating learning that reflected teaching for cultural contextualisation. There is additional evidence that the students learned the technical aspects of concept maps, particularly hierarchical structure and progressive differentiation. To a lesser extent integrative reconciliation was displayed even though this was not a feature of the concept maps in the IMM presentations. It would seem that IMM is a powerful tool for the modelling of students' learning concept mapping. Obviously, future IMM instructional design should incorporate aspects that indicate integrative reconciliation, namely complex explicit propositional statements (labelling) and intra-level cross branching.

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