Concept Maps: Theory, Methodology, Technology
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CONCEPT MAPS FACILITATING NOTE TAKING: ADDING KNOW-HOW TO KNOWLEDGE

Alan Brullo
University of Malta, Malta
Email: alanbrullo@gmail.com

Abstract. A concept map has the ability of projecting externally one's knowledge and pattern of thought. The actual process of developing a concept map requires its developer to identify a most inclusive starting point or focus question from which to depart, progressively expanding it through one's own knowledge and comprehension, gradually resulting in a more complex framework. How the concepts are linked within this framework manages to embody a justified associated relationship between concepts, which in turn further contributes to produce further understanding of the linked concepts. Therefore the process of identification and linking of concepts can be regarded not only as a means of illustrating patterns of thought but as an active personal metacognitive process which contributes to further meaningful learning and discovery. These inherent attributions to concept maps allow a myriad of applications. This study focuses on investigating further on the contributed effectiveness of concept maps as a pedagogical tool and as a personal learning tool, with special reference to the practice of note taking within the contexts of teaching biology at secondary level. The research takes a quasi-experimental approach in determining effects on recall, understanding and performance. The findings from test scores suggest that the experimental group exposed to concept maps exhibited superior achievement. Further insight about the students' attitude towards the use of concept maps in teaching, learning and note taking was gained from a focus group session and observations done along the time frame of the research. All the insights gained indicate a very good positive attitude and preference from the students of the inclusion of concept maps in their learning experience. Triangulation of all the data collected, confirm the overall fruitful effects of using concept maps.

1 Introduction

1.1 Concept Maps as Personal Learning Tools

Concept maps can be considered as personal learning tools because they are interpreted differently by individuals (Edmondson, 2000). This inherent characteristic has its implications both for the teacher and learner. What should be really valued are the 'pupil produced maps' since they are able to communicate, identify and clarify misconceptions (Kinchin, 2000). Therefore rather than developing concept maps and teaching students through them, it would be better for teachers to teach with concept maps as examples and allow students to develop their own, facilitating meaningful learning (Henno and Reiska, 2008).

The idea of personalisation does not only involve the learner but also the teacher in producing a tailored pedagogy. This argument is taken more in depth by Henno and Reiska (2008) who noted that being aware of how a metacognitive strategy can be used, is much more important than the strategy itself. The success of a metacognitive strategy is mainly dependent on the approach taken by the user or learner. Kinchin (2003) suggested that teachers and students might be interpreting knowledge differently. Conceptual difference between the two can be merged together using concept maps, helping the teachers identify misconceptions and plan further teaching taking the actual knowledge frameworks belonging to the learner into account. This merging would increase clarification and dialogue between educator and learner (Kinchin, 2003). There is the need of balancing the incongruence in expertise between the teacher and learner by using common organising principles, which can be provided by the use of concept maps. These principles would be elicited rather than dictated, allowing a build-up of knowledge which would yield a shared and more meaningful meaning (Kinchin, 2001).

1.2 Concept Maps and Note taking

Note taking can be identified as a metacognitive process, since note takers need "to actively control what they are doing and to master the way they work." (Makany et al., 2009, p.620). The link between learning and note taking can become even more evident through the process of self-testing (Hoppe and Gabner, 2002). Self-testing involves the retrieval of knowledge; therefore giving a structure to what is recalled and perceived, consequently able to produce more meaningful learning. Novak and Cañas (2009) suggest that although the process of retrieval is able to produce meaningful learning, it can be tedious to implement in combination with traditional methods of note taking and learning practices. Concept maps on the other hand are able to offer a more efficient yet enriching retrieval practice, as opposed to more linear methods of note taking and elaborative practices (Novak and Cañas, 2009).

The use of concept maps for note taking does not only pose cognitive advantages, but also practical ones. Throughout the lesson or speech, the listener can continue to add other ideas that link to the main idea and also

describe the nature of the links. Piolat (2005) considered the fact that when the teacher goes back to an idea that was presented earlier; the listener using concept maps for note taking, can still go back and build on the same. The learner would be able to modify and add without losing important parts of explanations by wasting time in re-structuring his/her notes. The end written result of this would be well structured notes, which in turn would have positive effects on achievement; such relationship was elucidated by Titsworth and Kiewra (2004).

The resources available to students and pedagogies to which they are exposed are constantly evolving. Students are exposed to a myriad of sources of knowledge and teaching styles. In such a scenario one must address the "importance of using cognitively compatible note-taking techniques" (Makanay et al., 2009,p. 619) such as concept maps, which are able to usefully reduce the cognitive load, and maximise the integration of newly acquired knowledge into a framework of what has been already learned.

2 Research

My research revolved around the following question: What would be the results when comparing a traditional pedagogy which does not involve the active use of concept maps, making use of traditional note taking against a pedagogy which actively involves concept maps both in teaching and in note taking? The main considerations were in terms of student achievement and attitudes. Achievement was measured using an end of topic test, and insight of student attitudes towards the inclusion of concept maps was acquired through a focus group session.

The methodology chosen can be defined as having a quasi-experimental design done from a naturalistic epistemological viewpoint. The quasi-experimental approach chosen for this research had a non-equivalent group, post test only format, in which one of the groups functioned as a control group. The experimental and control group consisted of two separate Form 3 biology classes which were not streamed and present in the same school. The implementation was carried out as a continuation of their normal syllabus and routine, in their familiar learning naturalistic environment. The Form 3 biology topic which was taught along the study was related to classification, more specifically microorganisms. The topic was not purposely chosen, since the research question was not aimed at evaluating knowledge of a particular topic, but rather aimed at trying to evaluate the effectiveness of using concept maps as a pedagogical tool and study aid, more specifically in note taking. No pre-test was used to measure the knowledge on the topic of the two groups since prior to the post-test all the participants would have been exposed to the same revision session, allowing the students to take down notes in the form of concept maps as regards the experimental group and in traditional format as regards the control group. Only the notes produced during this session were allowed to be used as reference during the post-test and only content covered during the revision session was examined.

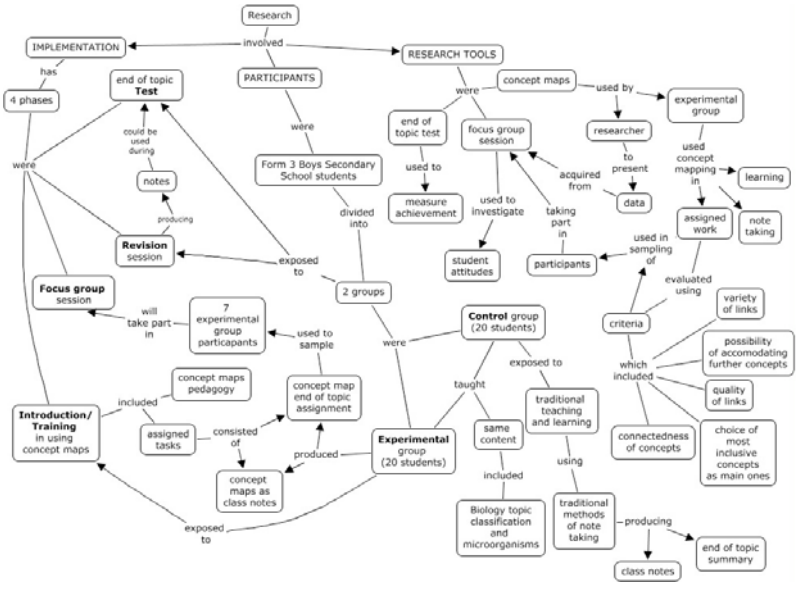

Figure 1: concept map illustrating the research method.

The implementation was divided chronologically into four phases, all illustrated in the adjacent figure 1. The first phase involved teaching both groups the same content for the duration of approximately twenty biology lessons, with the exception that the experimental group was constantly being exposed to the use of concept maps. The second phase consisted of the focus group session, for which participants were purposely chosen according to their level of expertise in producing good concept maps in their assigned tasks, in order to have a homogenous group of participants with similar expertise who could take the discussion in depth. The quality of their concept maps was evaluated according to the criteria identified by Kinchin (2001) which included; the choice of the most inclusive concepts as the main ones, connectedness of ideas, quality of links, variety of links, and whether the concept maps had the potential to allow the accommodation of further ideas. The third phase consisted in having both groups attend the same revision

session, during which they could take down notes, and use them as reference during the final phase, which was the post test. (refer to figure 1: concept map illustrating method used).

3 Findings and Conclusions

3.1 Test Results

Groups	Lowest mark	Mean	Highest mark	Median	Mode
Experimental	44%	74.4%	91%	77%	76.5%
Control	22%	42.5%	69%	43%	53.3%

Table 1: Tabulated test results

For the purpose of this data analysis, graphs were plotted using frequency of students against marks. Since both histograms resulted asymmetrical, and due to the presence of outliers, the mean and standard deviation were not used to make a comparison, therefore no T-test was used. Only the mode was considered.

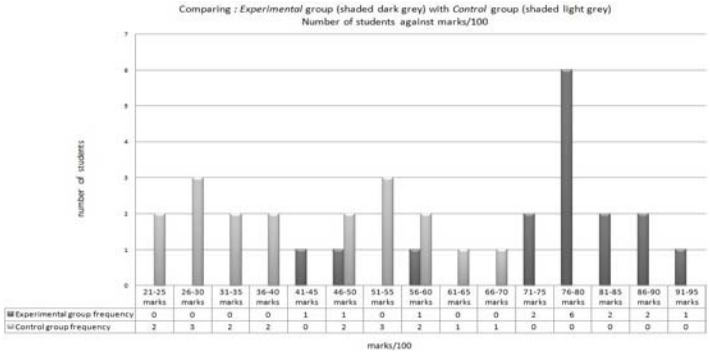

Figure 2: Graph comparing post test scores of Experimental group with Control group

Overall looking at the histograms of both groups (figure 2), it is clearly visible that the members of the experimental group performed consistently well with marks of 70% and above. The control group histogram resulted rather flattened with the frequency of marks ranging equally from 20% to 70%, indicating that there was no consistent high mark. Overall the experimental group performed much better than the control in the test, giving an indication that the use of concept maps was translated in a significantly enhanced academic achievement. Another significant observation was that in contrast with the control group, the experimental group managed to answer all the questions in time. This could be attributed to two main reasons. The first of which could be the ease and time efficient accessibility which notes in the form of a concept map give. The second and most plausible deeper reason for this could have been the fact that students who wrote their notes using concept maps would have already gone through enough reasoning during the actual construction of the concept map. This allowed them to focus their time and energy on answering rather than trying to restructure the knowledge needed to answer questions during the actual test. This was exhibited by the fact that experimental group participants barely consulted their notes during the occurrence of the test. This second assumption is reinforced by the data collected, as I shall explain. For the occurrence of the test, three members of the experimental group forgot to bring with them the notes taken during the revision session, therefore had no notes whatsoever to consult during the test. Two of these students still managed to get a mark higher than 70%, showing that concept maps were also beneficial in terms of recall. The marks of the students who did not have the notes with them for the test were not included in the graphs to keep a fair comparison.

3.2 Insights from Focus Group Session: Students' Attitudes towards Concept Maps

A lot of issues were prompted and tackled during the focus group session. There were many issues related to practicality and time management which I will not directly expand but can be found illustrated in figure 3. Students specifically pointed out that when they were using concept maps when studying, they were gaining a feeling of confidence, since any perspective a homework task or test question would take, they would be able to understand it and answer it with more ease. This managed to reduce their perceived stress towards different teaching styles and tests/exams. Interestingly students make a connection between concept maps and avoiding the tendency to procrastinate. They pointed out that many times they postponed studying because they had got discouraged from trying to make sense of the given notes provided by teachers and also from starting to read their own notes if they were not neat or organised. They identified concept maps as a solution for the latter problem, by identifying that concept maps offered them the ability to write a framework without even consulting notes, and then expanding only what they reckoned they did not understand properly. This proves the fact that the actual construction of a concept map is constituted by an active learning process, in similarity to this were the thoughts of Dror (2007; 2008) who identified note taking as a cognitive technology and learning tool. Conclusively the students' overall attitude about concept maps was one in which they acknowledged that

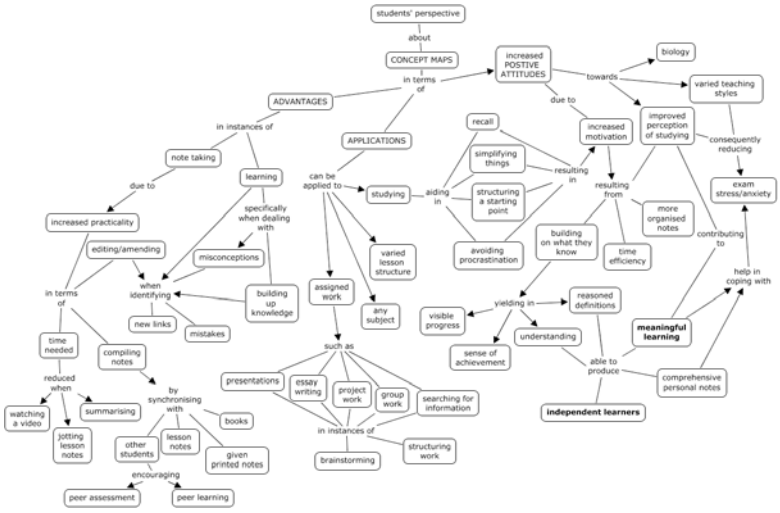

Figure 3: Results from Focus Group Session Summarised in a Concept Map

concept maps are compatible with their way of studying, acquiring, and organising knowledge. Overall, note taking using concept maps resulted in being more efficient and productive than other traditional methods. Note taking using concept maps cannot be directly correlated with the better test scores achieved by the experimental group students, since the totality of inclusion of concept maps in their holistic learning experience has to be considered. Albeit this, when students produce their notes using concept maps, they have the added benefit over traditional note taking, of going through an actual metacognitve thought process, which by itself, facilitates learning, as noted by Kapricke and Blunt (2011). Concept maps also offered an overall increased amount of reciprocal clarification and dialogue between teacher and student, evident from the high level of student engagement observed during lessons. The dialogue component in the classroom is identified by Kinchin (2001) as a central constituent for meaningful learning. In conclusion, I would like to make a final statement epitomizing the whole theme of the research; teaching might be happening in a classroom but actual learning is always a personal matter.

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