Further information

A full report of this project will be submitted as a doctoral dissertation at the University of Cambridge during 2007, and prior to that, draft copies of the text are available on request from the author.

Preliminary papers, also available from the project researcher and detailing the findings of the first phase of the research, were presented at the BERA annual conferences in 2004 and 2005.

Correspondence is invited on any theme in this briefing.

The title comes from Maddison, A. (1982) Microcomputers in the Classroom. London: Hodder and Stoughton. He distinguishes between software which gives no indication to the user of the processes being examined, so-called 'black boxes', and those which are relatively transparent, which he calls 'glass boxes' (pp. 66-7).

The warrant

The findings presented in this briefing are based on field studies undertaken during the period 2003 to 2006. Across two different schools, and four repetitions and refinements of the experimental design, a total of more than 200 students participated in the research. The students were all in Years 9 or 10, in urban and suburban settings. The groups were of mixed ethnic composition, and comprised students in the upper quartile of the ability range. The topic question for the concept maps varied between the four studies, but all were drawn from the humanities curriculum. In each repeat of the experiment, the student groups were constructed to be directly comparable.

Comparisons between the groups were determined using population estimates of the effect sizes, and care was taken to ensure that confidence intervals were declared for these statistics. The student motivation data was obtained using a questionnaire survey, previously deployed in a similar international study, and the findings reported in this briefing are significant at the 5 per cent level. Selected students were also interviewed for the study, and extracts of their contributions appear in the study.

Although this project has covered new ground, in blending work on ICT, concept-mapping, collaboration and scoring, the findings are in broad agreement with the associated literature on collaborative learning and on the impact of assessment on motivation.

Project website:

www.tlrp.org/proj/rtfbevan.html

Project team:

Robin Bevan (TLRP Research Training Fellow) under supervision from Dr David Pedder, University of Cambridge Faculty of Education; Professor Mary James, Institute of Education London: Dr Patrick Carmichael. Centre for Applied Research in Educational Technologies, Cambridge

Project contact:

King Edward VI Grammar School, Broomfield Road, Chelmsford, Essex CM1 3SX

RBevan@kegs.org.uk

+44 (0)1245 353510

ISBN-978-0-85473-782-6

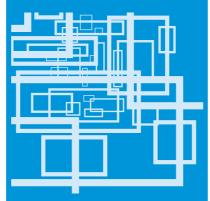


January 2007

University of London 20 Bedford Way London WC1H 0AL



Teaching and Learning



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Professor Andrew Pollard | London Professor Mary James | London Professor Stephen Baron | Strathclyde Professor Miriam David | London e-team@groups.tlrp.org

LRP Programme Office Sarah Douglas | sarah.douglas@ioe.ac.uk James O'Toole | j.o'toole@ioe.ac.uk tlrp@ioe.ac.uk

Institute of Education

Teaching RESEARCH and Learning BRIEFING

January 2007

Number 21

From black boxes to glass boxes

On-screen learning in schools with concept maps

Developing effective approaches to new technology in classrooms has been a constant challenge over the last decade. This project chose to examine the use of on-screen concept maps. Previous studies have demonstrated that computerised concept mapping can be effective. This briefing reports on how the effectiveness of this on-screen activity depends significantly on the strategy adopted by the teacher. This study also investigated the effect of incorporating an automated scoring process into the mapping activity, with surprising results.

- Students who used the on-screen conceptmapping tool alone and with no collaboration with other students achieved no significant sustained learning gain.
- When the class collaborated in developing their concept maps, students demonstrated sustained and improved learning in a

subsequent essay task.

 Providing automated scoring for the concept maps demotivated the weakest students and did not lead to any additional learning gains.

- Despite the promise associated with using new technologies in the classroom, an unmediated switch to on-screen learning is unlikely to lead to improvements in learning.

The adoption of new classroom strategies as new software is introduced can be more significant than the impact of the software itself. Teachers looking for routes to improved learning with on-screen activities need to explore the powerful potential of peer collaboration.

Automated approaches to assessment and instant scoring, often seen as a desirable goal, can exacerbate the limited motivation of lower-attainers.





The research

Background and rationale

The purpose of this project was to develop and assess the effectiveness of classroom approaches with computerised concept-mapping software – specifically the CRESST knowledge-mapper. Many previous studies in a variety of settings have explored aspects of concept mapping. However, this research had a unique focus on collaborative activities and the use of automated scoring feedback for formative assessment.

For the past 20 years, the case for using concept mapping in the classroom has been strengthened by empirical studies, and by theoretical arguments about the association between mapping and how people learn. Two separate principles have informed the use of concept maps:

- Students have a remarkable mental capacity for retention, recognition and recall when learning is associated with visual stimuli.
- Meaningful learning occurs by anchoring new ideas or concepts with previously acquired knowledge in a non-arbitrary way, and the construction of concept maps makes this process explicit

Concept maps – variously known as 'knowledge maps' and 'semantic nets' – are a specific type of 'mind map'. The knowledge-mapping software allowed students to construct a concept map consisting of:

nodes, which are used to represent facts, statements, principles or ideas; and

links, joining nodes, to demonstrate a relationship. The relationship may, for example, be causal: 'node A' gives rise to 'node B'; it may be a dependency link: 'A is a type of B'; it may illustrate a common feature: 'A and B have X in common', or it may denote a significant difference.

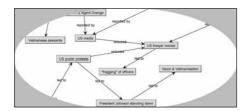


Figure 2: Detail of the student's knowledge map showing the nodes and links

Research design: overview

The research design was developed after a number of pilot studies revealed the need to consider the impact of the knowledge-mapping software, the effect of collaboration, and the consequence of introducing the automated scoring independently of each other.

Figure 3 shows the use of a common pretask, the creation of the four equivalent groups of pupils and the different approaches to learning that each followed, and the final task which preceded the data analysis.

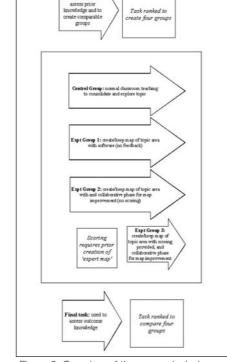
Research design: preparation

For the main studies, two history departments were invited to participate in the research. The seven teachers had varying levels of teaching and research experience, but all were committed to gaining insights into more effective approaches to developing pupils' reasoning in their subject.

All the teachers in the main studies were familiar with the use of concept maps in their classes, and often used graphical approaches for essay preparation and in revision classes. A brief guide to the CRESST knowledge-mapper was provided for each teacher, as well as an explanation of the use of expert maps for scoring pupil maps.

The research was intended to investigate the effectiveness of the knowledge-

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mapper as a tool for developing pupils'

understanding of relationships within a

to be a vehicle for the transmission of

were asked to identify a topic that had

was relatively self-contained, that could

already been addressed in class, that

be appropriately represented using a

knowledge map, and where it was

their intention to engage the class in

reasons for the US failure to win the

Britain caused by World War II.

Vietnam War; and for the second main

study, the change in lives of children in

a consolidation activity as part of their

routine teaching. For example, the history

teachers in the first main study selected

specific area of study. It was not intended

new knowledge. The participant teachers

Figure 3: Overview of the research design

The research design at this stage was an explicit attempt to ensure that the experiment would form a natural part of the real teaching process; so that the comparison between experimental and control groups could be based as specifically as possible only on the introduction of the knowledge-mapper.

The teachers were then invited to draw their expert knowledge maps. This was done as a 'pencil and paper' task. At this stage none of the teachers had been introduced to the authoring element of the CRESST knowledge-mapper. The teachers were free to choose appropriate nodes and links, and went through a series of successive refinements in order to determine their finished map. They were readily able to identify the required nodes, which in the case of the history maps were a set of events, agents and factors. Determining the links took longer. Here the challenge was to find a minimal set of optimal descriptors, in other words a suitably short list of possible relationships such that each pair of connected nodes would have a best

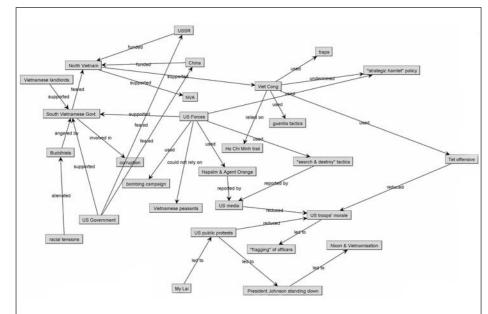


Figure 1: An example of a knowledge map generated by a student during the project

Once they had been captured on paper, the nodes and links were entered into the software using the authoring tool, and the expert maps were created using the knowledge-mapper. They were then ready for use in the scoring of the pupils' maps. At this stage, a decision was taken to limit the available nodes and links to those supplied in the expert map so as not to extend the scope of the research across too many variables.

Research design: student activity

Each of the teachers asked their full class to produce an essay plan, based on the classification of a number of pre-prepared statements, indicating how they would respond to the chosen title. These essay plans would be used as the pre-test data. In the second main study the same effect was achieved by using elements of a previously planned cross-year assessment task.

The pre-tasks were rank-ordered by a non-participant teacher to create four equivalent groups. Students were assigned randomly (by stratification according to a known variable – the pre-test result) to the various groups.

For the control samples, the pupils continued to work with an experienced subject teacher. The teacher was asked to organise two lessons of 'normal classroom' revision, consisting of discussions, research and presentations with their usual subject teacher.

For the three experimental groups:

(a) The researcher introduced the students to the knowledge-mapping software. This was made possible through the development of on-line animated tutorials. All the pupils were fully conversant with the software within five minutes.

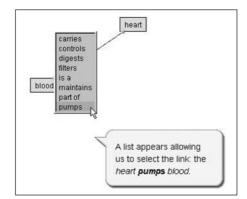


Figure 4: A screenshot from the animated tutorial

(b) Students created their first knowledge map in response to the essay title.

(c) After approximately forty minutes, students saved their knowledge map.

Group 1 was then free to continue to work individually to enhance their maps.

Group 2 students could then collaborate to compare, revise and improve their maps.

Major implications

Throughout this study, and in all phases of the research, it became consistently clear that the development of computerised approaches in the classroom would not of itself bring about sustained learning gains. Indeed, in two of the experiments the students who did not use on-screen learning outperformed those with access to the software. Despite the promise associated with using new technologies in the classroom, an unmediated switch to on-screen methods is unlikely to lead to improvements in learning.

The findings from this project demonstrated further that the difference in sustained learning gains is an outcome of the way in which the classroom is managed and the software deployed. The differential effects of individual work, collaboration and scoring are critical to understanding this. An emphasis on effective e-pedagogies is clearly as important as an emphasis on the technology. Adapting classroom strategies as new software is introduced can be more significant than the impact of the software itself.

The evidence of this project is even more specific. Teachers looking for routes to

improved learning with on-screen activities need to explore the powerful potential of peer collaboration. The historical tendency to view computer-based learning as occurring in an individualised environment, and the view that this is a beneficial feature of on-screen methods, need to be challenged in favour of approaches that allow more interaction between students.

This project also provides useful insights into the impact of scoring on learners' motivation. Elements of this effect have also been seen in other studies. This research shows strikingly that although the scored and non-scored groups showed similar final results in their essays, this coincided with a polarising effect on learners' motivation. In the non-scoring group those most needing to learn were most enthusiastic, whereas the exact opposite occurred in the scoring groups. The impact of this effect is most likely to emerge over the longer term, where sustained use of scoring would be likely to undermine the determination of some students. Automated approaches to assessment and instant scoring, often seen as a desirable goal, can exacerbate the limited motivation of lower-attainers.

Group 3 obtained feedback scores, based on an automated comparison between their own maps and the teacher's expert maps. The scores were explained briefly to the pupils, so that they could gauge their own progress and identify others in the group who had advanced more successfully. Students worked together to compare, revise and improve their maps.

After completing their final knowledgemaps, students from all groups completed an evaluation questionnaire. Results from the questionnaire were analysed to determine pupil attitudes towards the software and to aspects of knowledge mapping.

All students produced a final essay in response to the original title. This final essay served as the post-test, and was the most appropriate way for the pupils to demonstrate the links in their knowledge. The choice of a final essay was intended to reflect the context in which these students would ordinarily have been assessed by their teachers, and the form of their later public examinations.

The essays were rank ordered and the relative gains of the groups compared. The data collected from the pre-test tasks, post-test essays, and evaluation questionnaires were then analysed.

Research findings

Collaboration is the reason why it is better because you get to improve on your own work but through yourself even though it is not yourself.

(Student comment)

In both of the two main studies, experimental groups 2 and 3 experienced substantial benefits relative to experimental group 1, which had no scores and no collaboration. This can be accounted for by the addition of the collaborative phase for groups 2 and 3, since the additional availability of scoring in group 3 did not lead students in that group to any sustained advantage over group 2.

Collaboration was the main thing, and not necessarily the scores. You can be changing something you get right. More collaboration for learning together and not the scores.

(Student comment)

In group 2, where no scoring was available, participants with lower positions on the pre-rank expressed more positive views about continuing to use the knowledge-mapper, and about the helpfulness of discussing their maps with their peers. Indeed, those students who were most enthusiastic about discussing the maps tended to have the lower individual map scores and, therefore, perhaps the most to gain in the peer-collaboration phase.

In contrast, once the scoring was introduced, those students with the higher individual map scores were consistently, and across all the measures, the most positive about their experiences of knowledge mapping and the benefits to be gained from it. Specifically, those participants who secured the higher scores on the collaborative maps were most keen about aspects of knowledge-mapping, including being the most enthusiastic about discussing the maps with their peers.