Investigating the use of ICT-based concept mapping techniques on creativity in literacy tasks

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Abstract
The key research question in this small-scale study focuses on the effects that an ICT (information and communications technologies)-based concept mapping intervention has on creativity and writing achievement in 10–11-year-old primary age pupils. The data shows that pupils using a concept mapping intervention significantly improve their NFER non-verbal reasoning age-standardised scores over a control group with a higher baseline whose scores remain constant. Evidence linking this with using ICT-based concept mapping remains inconclusive. Correlation studies show that writing achievement and creativity are linked and that writing achievement and concept mapping connectivity are linked. However, there is no conclusive evidence for linking concept mapping connectivity with creativity. Findings show that concept mapping components increase post-test and that concept mapping ability can be evaluated using a connectivity index that may have some predictive value in assessing writing achievement. The findings suggest that ICT-based concept mapping provides a reliable framework from which to structure writing and that ICT enhances learning and use of this representational technique and provides opportunities for developing innovative and educationally valid practices.

Keywords
concept mapping, creativity, ICT, literacy

Introduction
Creativity and creative learning have become focal issues in educational policy for teaching and learning and the report of the National Advisory Committee on Creativity in Education, ‘All Our Futures’ (NACCE 1999), puts forward the case for developing a national strategy for creativity in education. Heppell (1999) emphasises the creative opportunities new technologies facilitate while McLean (2000) acknowledges the importance of ‘putting teachers at the heart of ICT (information and communications technologies) development in education’. However, Bentley (2002) states that, ‘we are still uncertain about how to develop the tools, practices and environments that make the most of creative potential’. The introduction of new technologies into educational practices requires an evidence base to develop and evaluate innovative, creative and effective practices and this study aims to illuminate whether using ICT-based concept mapping enhances creativity in literacy-based tasks.

Creativity
Creativity is a notoriously difficult quality to define and assess. The DfES describes creativity as an ‘imaginative activity fashioned so as to produce outcomes that are both original and of value’ (NACCE 1999:29). Human creativity is dispersed across many
domains and activities and is expressed in a rich variety of modes and mediums. Craft (2000) introduces a framework reflecting this diversity describing ‘people, processes and domains’ as central nodes in the understanding of creative behaviour. This framework develops the work of Feldman et al. (1994) to provide a situated view of creativity, since previous research tends to focus on creativity through laboratory-based tasks unrelated to real situations (Finke 1990).

Creativity in Craft’s framework is considered to be a ‘natural’ part of life (Cameron 1995) and is based on the concepts of ‘possibility thinking’ and ‘little c creativity’ exhibited by all individuals rather than just by the gifted few (Craft 2000:3). The ‘people’ perspective in the framework refers to individuals attributes; ‘processes’ to conscious and subconscious cognitive processes and to intuitive and emotional factors; and ‘domain’ to all subjects, ‘not only the arts’ (Abbott 1998). This study refers to creativity as ‘little c creativity’ in terms of ‘processes’ involving imagination, creating possibilities that adapt or innovate situation (Kirton 1989), ‘seeing’ connections and relating things involving ‘possibility thinking’.

In a cognitive approach to creativity Boden (1991) states that ideas are created in ‘conceptual spaces’ which are explored using ‘conceptual maps’. Finke et al. (1992) explain creativity in the Geneplore model as a cycle of ‘generative’ and ‘exploratory’ phases (Smith et al. 1993; Ward et al. 1995). This involves the generation or construction of pre-inventive structures or mental representations (Bunge 1983a, b; Schank & Abelson 1977) that promote creative discovery in exploratory phases. Evidence suggests that the quality of exploratory behaviour in pre-compositional work can predict the quality of final products in explicit creative work (Csikszentmihalyi & Getzels 1970, 1971; Kay 1991).

The exploration and transformation of conceptual spaces involves interplay between environmental and mental processes. Sweller (1994) suggests this interplay is constraint orientated and determined by ‘cognitive load’. Formation of mental representations is one means of reducing cognitive load ‘by reducing the number of interacting elements with which working memory must deal’ (Marcus et al. 1996). Tools that reduce cognitive load and provide environments for developing accurate mental representations or schema may therefore have a beneficial impact on creativity by freeing up creative cognitive resources.

ICT-based concept mapping

Heppell (1999) advocates the use of new technologies in promoting opportunities for creativity but as Loveless (2003:8) points out, new technologies and the digital resources they access only provide opportunities for ‘interaction, participation, and the active demonstration of imagination, production, purpose, originality and value’.

In an analysis of ICT capability and creativity, Loveless (2003:10) generates a set of criteria (Fig. 1) with which to evaluate creative practices using ICT.

Traditional forms of representing concepts and their relations are being challenged by the affordances of new technologies and different modes of expression are being made more accessible. Modes using both graphic and linguistic components (Fig. 2) are the graphic representational techniques of concept mapping and mind mapping. Concept mapping connects concepts with relational links to produce propositions in diagrammatic form using multi-word labels and vectors (Novak & Gowin 1984; Åhlberg 1989, 1997), and mind mapping (Buzan & Buzan 2000) results in linked associations of concepts (Fig. 2).

Representation of meaning changes according to the level of use of vectors and labelled links, with vectors creating visual ‘propositions’ (Kress & Van Leeuwen 1996:57) that enhance connections and impact on the relational interpretations between concepts (Kress & Van Leeuwen 1996:61; Unsworth 2000:73), which may be considered more accurate than the associations formed in mind mapping. The generation of linking features in concept mapping produces complex and intricate arrays that require constant evaluation and revision. The use of traditional media to construct concept maps can inhibit this generation. Concept mapping has evolved from paper-and-pencil to ICT-based tools such as Inspiration®, Mind Manager, SemNet and SmartDraw (Fisher et al. 1990; Gordenstky et al. 1994; Gaines & Shaw 1995; Flores-Méndez 1997).

The provisionality of ICT-based concept mapping facilitates revision of existing work (Anderson-Inman & Zeitz 1993) and provides an environment that improves risk-free creativity (Jonassen 1996; Plotnick
ICT capacity enables storage and revisiting of mapping and automatic functions, and creating concepts and vectors enable immediate linking and labelling that increase the ease and speed of mapping.

ICT-based concept mapping provides a ‘mindtool’ (Jonassen 1996) and a novel form of ‘conceptual’ or creative space for quality exploratory behaviour. This study uses Inspiration® (Inspiration Software Inc, Portland, Oregon) to provide a simple, easy-to-use interface for graphic generation of concepts and vectors suitable to form concept maps. The software is available on desk-top and lap-top computers allowing group work and individual work. A data projector enables whole class and group construction, discussion and evaluation of mapping.

ICT can be used to promote collaborative learning, in group projects (Scardamalia & Bereiter 1994; Forcheri & Molfino 2000) and new approaches to working, learning, and interacting (Balacheff 1993). Knowledge building in structured environments is associated with high-quality work and advances in...

**Using ICT-based concept mapping in literacy**

‘Creative abilities are developed through practical applications: by being engaged in the processes of creative thought production: making music, writing stories, conducting experiments and so on,’ (NACCCE 1999:33). Literacy in the form of text construction involves the use of linguistic knowledge and creative processing to generate communicable linguistic constructions with specific outcomes for relevant purposes. In primary phase literacy lessons, the outcomes are determined by learning objectives designed to raise literacy attainment.

‘Creative processes in all disciplines normally involve an initial phase of drafting: of giving a rough shape or outline’, (NACCCE 1999:34). Moffett (1981) describes drafting as a ‘revising inner speech’ depicted as ‘getting ideas on paper or computer screen, regardless of form, organisation or expression’ (DES 1989, para.17.48). Concept mapping provides a means by which thoughts may be made explicit in the pre-compositional process.

Kress and Van Leeuwen (1996:59) suggest diagrams such as concept mapping nominalize meanings, i.e. specific actions or verbs are turned into nouns. The labelling of vectors nominalize relations between concepts and in this way concept mapping provides a framework through which events and actions can be structured into a plot of narrative concepts, rather than sequenced events (Tonfoni 2000). Concept mapping provides opportunities for developing narrative structures from global and local viewpoints (Tonfoni 2000:49–51) and for evaluating plot coherence.

ICT-based concept mapping provides automated construction of ‘scaffolds’ and ‘pre-inventive structures’ reducing cognitive load in terms of the mechanical processes used in construction and revision of mapping and in terms of memorizing compositional structures. This provisionality, automation and capacity enable cognitive resources to be directed to the mental processes involved in creative narrative construction. ICT-based concept mapping may thereby enhance creativity in literacy tasks through increasing the quality of connections between concepts, labelling links and increasing the narrative propositions formed in pre-compositional drafting, leading to higher-quality story writing and general improvement in creativity assessments through an increased ability to visualise and identify connections and relations.

**Method**

This is a small-scale multi-method study used as evaluative and illuminative research into pedagogical issues involved in the development of creative tools and practices. It is practitioner research providing an evidence base for the implementation of innovative practices (Zuber-Skerritt 1996:83). The focus of this investigation is whether ICT-based concept mapping can be used to enhance creativity in literacy tasks. The study uses multi-method triangulation (Denzin 1970) of quasi-experimental design and correlation studies to investigate concept mapping and creativity in writing tasks. The hypothesis being that interventions teaching concept mapping techniques with ICT will enhance creativity and impact positively on writing achievement.

**Sampling**

The study is undertaken at a large primary school in the median range of the local education authority’s National Test Performance Table. The pupils have a wide range of academic ability and social background and the ‘situated’ approach gives rise to ‘ecological validity’ as interventions are conducted within the normal parameters of a Year 6 class.

The subjects are 10–11-year-old (Year 6) pupils (n = 57) in two parallel classes. The teacher-researchers’ class is allocated as the experimental group and the parallel class as the control group. Both classes follow the same Year 6 curriculum and both teachers jointly plan lessons. The control-group teacher is also the school Special Needs Coordinator.

Analysis of Year 5 writing assessment scores suggest that the experimental group have a larger distribution of writing ability than the control group. There is one statement of special needs pupil in each group.

The small sample size is homogenous within the context of a primary year group and as such some experimental controls can be applied. Small sample size is
common in research on educational multimedia (Mann et al. 2002) and in psychological research but there needs to be an evaluation of all possible variable effects.

**Intervention**

The study is 9 months in duration and ICT-based concept mapping took place on a weekly basis, for groups and as well as individuals. Activities (Table 2) are structured to introduce pupils to graphic representation of ideas before specific instruction on concept mapping. Initial mapping instruction and practice takes place in foundation subjects and as ability increases these activities are included in literacy lessons during whole class activities and independent group activities. The use of concept mapping is given as the ‘usual’ method of story and text drafting.

ICT-based concept mapping is conducted using a PC, 5 laptops and a data projector. In using ICT-based concept mapping tools within authentic writing contexts the ‘transparency’ (Lave & Wenger 1991) of the tools is increased, ‘reducing’ (Idhe 1979: 21) possible technological barriers whilst ‘amplifying’ creativity and understanding of the meanings being composed and represented.

The three stages of the intervention occur in the autumn, spring and summer terms, respectively, and the story writing activities correspond with pre-test, mid-term and post-test story writing and concept mapping data collection. The literacy tasks are a range of writing tasks reflecting the genres and range expected at Year 6 in the National Literacy Strategy (DFES 1997), e.g., stories, non-chronological reports and explanatory texts.

One project focus (Table 1, Autumn term: activity 2) was a writing activity included as a 20 min independent group activity during a literacy lesson. Groups concept map a global story plan, as shown in Fig. 3, using a story prompt featuring an event in which characters become ‘trapped’. The learning focus within the writing activity is the development of characterisation using dialogue.

Individuals then expand the group plans using their own ideas (Fig. 4).

Individuals use copies of the group concept maps to extend ideas and then draft the story in handwriting. This extract from a Year 6 boy considered to be working just at the level of attainment expected for this year group (Level 4) shows that the story opening follows pre-compositional ideas as the plot and details develop in the drafting process.

‘Right cadets’, boomed Mr Sutreath, when they first stepped off the coach into the wilderness of Dartmoor for the first time. ‘Into line now, quickly, quickly! This will be your first training for snow without me watching over you! Now get into your set groups of four!’

Tom groaned under his breath as he joined Emma, Shane and James. Mr Sutreath blabbered on for another twenty minutes about the safety supplies.

‘Oops, I must have left ours on the coach!’ muttered Tom sarcastically.

In this attempt the concept mapping proved to be a useful tool in scaffolding ideas and organising them more easily, leaving the pupil to focus specifically on dialogue building and character development. This activity in the study using ICT-based concept mapping, allows the pupils to develop and store the story outline for revision, enabling him to focus on the creative aspects of writing, description and characterisation, exploring newly acquired literacy skills.

**Quasi-experimental design**

Quasi-experimental design with a non-equivalent control group used as random allocation into classes is impracticable (Cohen et al. 2000:214). Equivalence is assessed on comparison of the pre-test scores as a significant difference in means from a \( t \)-test. Two test of reasoning ability that assess similarities, analogies, problems and patterns in unfamiliar designs or sequences are used as indicators of creative thinking ability. The NFER Non-Verbal Reasoning 10 & 11 Test (Table 2) is a repeated measure to assess pre-test and post-test change as the retest period is greater than 6 months. The test employs age standardisation with high reliability (Smith & Hagues 1993:20).

The NFER AH2 and AH3 Parallel Tests of General Reasoning assess change from mid-term to the post-test. The age-standardised scores for the NFER Non-Verbal Reasoning 10 & 11 Test and the raw scores for the NFER AH2/AH3 parallel Tests of General reasoning are analysed using a parametric two-tailed \( t \)-test in two ways: for repeated measures to analyse change within each group, between pre-test and post-
<table>
<thead>
<tr>
<th>Table 1. Concept mapping intervention activities used with experimental group</th>
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<tr>
<td><strong>Activities</strong></td>
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<tr>
<td><strong>Introduction to concept mapping (Autumn term)</strong></td>
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<tr>
<td>1. Introduction to concept mapping Nominalization of concepts - Forming word hierarchies - Cloze Procedures in simple hierarchies - Forming relations between concepts - Propositions as islands and bridges (metodix.com) in demonstration of Inspiration 6 - Linking propositions to form a simple story with Inspiration - using temporal or causal connectives - Concept mapping pupil’s personal world (pen and paper) - Linking concepts in Roman history topic (using symbols &amp; words using Inspiration)</td>
</tr>
<tr>
<td><strong>2. Global Narrative drafting using Inspiration</strong></td>
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<tr>
<td>Linking concepts in Roman history topic (using symbols &amp; words using Inspiration)</td>
</tr>
<tr>
<td>Demonstrate concept mapping in story outlining through developing and modelling character relations</td>
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<tr>
<td>Demonstrate concept mapping in story outlining through plot development</td>
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<tr>
<td>Using ICT-based concept mapping to plan a story for ‘a writing test entitled ‘Trapped’. Story adapted from group planning</td>
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<tr>
<td><strong>Developing Practice (Spring term)</strong></td>
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<tr>
<td>3. Collaborative Group knowledge building – ROMANS in BRITAIN - Class build up pre-topic knowledge into an improved concept map using Inspiration</td>
</tr>
<tr>
<td>- Groups are allocated one sub-topic to expand</td>
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<tr>
<td>- Groups research topic from references and expand maps</td>
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<tr>
<td>- Groups allocate parts of sub-topic to individuals to construct a multimedia page in MS Publisher</td>
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<tr>
<td>- Groups link pages via hyperlinks derived from concept map connections</td>
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<tr>
<td>- Individual children produce concept maps to evaluate their learning and write report</td>
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<tr>
<td><strong>4. Poem commentary composition and drafting using Inspiration</strong></td>
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<tr>
<td>Group production of ideas for a commentary after whole class discussion</td>
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<tr>
<td>Class ideas condensed into a 4-spoke template using Inspiration</td>
</tr>
<tr>
<td>Groups then expand the template with their ideas</td>
</tr>
<tr>
<td>Children are taught to use each spoke as a paragraph and to use the sub-branches to form scaffolds for sentences</td>
</tr>
<tr>
<td>Individuals are using copies of group concept maps to compose and draft a commentary on a poem</td>
</tr>
<tr>
<td><strong>5. Global Narrative drafting</strong></td>
</tr>
<tr>
<td>Using concept mapping with pen &amp; paper to draft and plan a story for a writing test entitled ‘If Pictures Could Speak’</td>
</tr>
<tr>
<td><strong>6. Local Narrative composition using Inspiration</strong></td>
</tr>
<tr>
<td>Using Inspiration projected on screen whole class constructs a concept map to associate and then develop aspects of story writing into an organised format</td>
</tr>
<tr>
<td>Resultant map are divided into components of beginning, middle and end to act as a frame for story writing</td>
</tr>
<tr>
<td><strong>Developing Independent Practice (Summer term)</strong></td>
</tr>
<tr>
<td>7. Local Narrative Story drafting by concept mapping</td>
</tr>
<tr>
<td>Using concept mapping with Inspiration on data projector analyse the beginning, middle and end (BME) of ‘Harry Potter and the Philosophers Stone’. Whole class analyse ‘Potter’ (BME) then groups working on PCs or laptops analyse and produce maps of ‘Matilda’ Both plot ‘kernels’ are compared, contrasted and the maps evaluated for concise and relevant plot directions. Teacher leads discussion of how plot development leads from beginning elements to middle and to the ending</td>
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<tr>
<td>Using concept mapping with pen and paper to draft and plan a story for a writing test entitled ‘A Secret Door’</td>
</tr>
<tr>
<td><strong>8. Collaborative concept mapping of ‘Migration’ topic</strong></td>
</tr>
<tr>
<td>Using Inspiration to concept map ideas about human migration to produce improved concept maps to explain reasons for migration to be used in a display</td>
</tr>
<tr>
<td>Maps are used to provide scaffolds for writing a non-chronological report on migration</td>
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</tbody>
</table>
test; and for independent samples to analyse change between the two groups, between pre-test and post-test.

**Correlation studies**

*Connectivity, writing and creativity correlations*

Correlations are made with experimental group data using Pearson’s correlation coefficients ($r$). A correlation matrix is constructed using the variables:
- (a) narrative creative writing assessment scores,
- (b) connectivity scores,
- (c) creativity (NFER non-verbal reasoning) scores,
- (d) creativity (NFER AH 2/3-general reasoning) scores.

Narrative creative writing tasks are presented as curriculum writing assessments using formats and prompts from National Test story writing tasks, using pencil and paper for concept mapping due to ICT resource constraints. The writing is assessed according to moderated criteria established through the Local Education Authority Literacy Advisory Team 2000 Handbook for narrative-writing assessment and numerical grades were given.

Concept maps are analysed in accordance with procedures taken from the Impact2 study (Somekh et al. 2000):
1. **nodes** (each concept counted as one)
2. **links** (links emanating from each node counted and totalled)
3. **connectivity index** (number of links divided by number of nodes).

Creativity assessment is explained as the NFER Non-Verbal Reasoning (10 & 11) and NFER AH 2 and 3 test scores.

*Concept mapping component data and correlations*

Concept mapping used in the writing tasks is analysed according to the total number of links made, the number of links labelled, the number of concepts

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**Table 2. NFER Reasoning Tests standardized scores and mean frequencies for experimental and control groups**

<table>
<thead>
<tr>
<th></th>
<th>NFER Non-Verbal Reasoning Test 10 &amp; 11</th>
<th>NFER AH2 Tests of General reasoning</th>
<th>NFER AH3 Tests of General reasoning</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Pre-test</td>
<td>Post-test</td>
<td>Pre-test</td>
</tr>
<tr>
<td>Experimental Group (X)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw scores</td>
<td>$n = 25$</td>
<td>2320</td>
<td>$n = 21$</td>
</tr>
<tr>
<td>Means</td>
<td>92.8</td>
<td>99.84</td>
<td>46.29</td>
</tr>
<tr>
<td>Control Group (O)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw scores</td>
<td>$n = 22$</td>
<td>2244</td>
<td>$n = 20$</td>
</tr>
<tr>
<td>Means</td>
<td>102</td>
<td>101.77</td>
<td>53.83</td>
</tr>
</tbody>
</table>

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formed, the number of propositions constructed and the connectivity index as described. The correlation of labelled links to propositions should be significant if concept mapping is constructed correctly (see Fig. 5). The labelled links between the concepts ‘the picture’ and ‘Elisha’ form correct propositions.

The label between the concepts ‘pictures talk’ and ‘the picture’ does not represent a proposition. The concept ‘Elisha hears’ in the link indicates that the starting point for the map ‘pictures talk’ has not been revised to ‘the picture’. There is no label between the concepts ‘the picture’ and ‘family’ and no association is implied by the vector, which suggests a connection for convenience.

Using the Pearson correlation coefficient ($r$) statements can be made on the degree of the relationships between concept mapping components that may be illuminative.

**Writing assessment**

The writing test scores from the 2002 National Tests for 11-year-olds are used for post-test comparison between groups and are provided as an independent assessment of writing achievement.

**Results**

The results are presented according to the data collection strategy employed, presented as independent data and analysed through methodological triangulation (Cohen et al. 2000:113) in the discussion.

**Quasi-experimental design**

The standardised mean frequencies from the NFER non-verbal reasoning (NVR) scores in the experimental group are lower than that of the control group in the pre-test and the post-test. The NFER AH2 and AH3 mean scores in the experimental group are lower in the mid-term, but are similar to the control group post-test. The repeated measures NFER NVR standardised scores achieve significant difference in the experimental group ($t = 3.768; df = 24; P < 0.05$) and in repeated measures NFER AH2/AH3 scores for both the control ($t = 1.843; df = 19; P < 0.05$) and experimental groups ($t = 3.185; df = 20; P < 0.05$). The independent samples NFER NVR scores between the control and experimental group achieve significance pre-test ($t = 2.379; df = 45; P < 0.05$) but not post-test. No significant differences are found in the independent samples for the AH2/AH3 test scores.

Results show the experimental group significantly improve their non-verbal reasoning post-test scores. The experimental group have significantly lower baseline non-verbal reasoning scores than the control group in the pre-test. No difference in non-verbal reasoning scores is found in the post-test. Both groups improve their mid-term to post-test general reasoning mean scores with no significant difference between the groups. These results suggest an improvement in non-verbal reasoning scores in the experimental group only. Improvement from mid-term to post-test in both groups suggest that improvements made by the experimental group occurs from the pre-test to mid-term of the study.

**Correlation studies**

**Connectivity, writing and creativity correlations**

Significant positive correlations are observed between creativity and writing task scores throughout the study (Table 3). In the mid-term and post-test, significant positive correlations are observed between concept mapping connectivity scores and writing. There is
significant correlation between connectivity and general reasoning in the mid-term. These correlations suggest that creativity is strongly linked with story writing ability and that concept mapping connectivity is linked to writing ability. A small positive correlation between concept mapping ability and general reasoning occurs mid-term.

**Concept mapping component data and correlations**

The concept mapping component data shows a numerical increase in components from pre-test to post-test. There is a greater increase in the mid-term than post-test although proposition scores increase throughout the study.

Significant positive correlations are observed between labelled links and the number of propositions throughout the study with pre-test at $r = 0.763 \ (P < 0.01)$ and post-test at $r = 0.912 \ (P < 0.01)$. The total number of links correlates significantly throughout the study with the number of concepts, at $r = 0.780 \ (P < 0.01)$ pre-test, and $r = 0.858 \ (P < 0.01)$ post-test. In the mid-term there are significant correlations between labelled links and concepts ($r = 0.591; \ P < 0.01$) and total links and concepts ($r = 0.882; \ P < 0.01$). In the post-test, there are significant correlations between labelled links and concepts ($r = 0.694; \ P < 0.01$) and total links and concepts ($r = 0.858; \ P < 0.01$). Mid-term significant correlations are observed between labelled links and connectivity ($r = 0.719; \ P < 0.01$), and between total number of links and connectivity ($r = 0.701; \ P < 0.01$).

Correlations show the mid-term provides a greater intensity of mapping with an increase in positive correlations between all components. Mid-term and post-test indicate higher incidences of correlations between links, concepts and propositions (Table 4). There are consistent significant correlations between labelled links and propositions and between total links and concepts. The mid-term and post-test show increases in correspondence between total links and propositions, and between labelled links and number of concepts. Connectivity scores only have significant correlations mid-term.

The number of significant correlations mid-term suggests the intervention has an increased impact on concept mapping skills during this term. The raw scores indicate a general increase of all concept mapping components post-test, although the mid-term

<table>
<thead>
<tr>
<th>Table 3. Pearson correlation coefficients between creativity, writing and connectivity in pre-test, mid-term and post-test</th>
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<tbody>
<tr>
<td><strong>Pearson correlation coefficient</strong></td>
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<tr>
<td><strong>(n) two-tailed test</strong></td>
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<tr>
<td><strong>Pre-test</strong> (Creativity using NFER AH2 test)</td>
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<tr>
<td><strong>n = 20</strong></td>
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<tr>
<td><strong>Post-test 1</strong> (Creativity using NFER AH2 test)</td>
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<tr>
<td><strong>n = 20</strong></td>
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<tr>
<td><strong>Post-test 2</strong> (Creativity using NFER AH3 test)</td>
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<tr>
<td><strong>n = 14</strong></td>
</tr>
<tr>
<td><strong>Creativity with writing</strong></td>
</tr>
<tr>
<td><strong>Significant</strong> $r = 0.636 \ (P &lt; 0.01)$</td>
</tr>
<tr>
<td><strong>Significant</strong> $r = 0.854 \ (P &lt; 0.01)$</td>
</tr>
<tr>
<td><strong>Significant</strong> $r = 0.628 \ (P &lt; 0.01)$</td>
</tr>
<tr>
<td><strong>Significant</strong> $r = 0.641 \ (P &lt; 0.05)$</td>
</tr>
<tr>
<td><strong>Creativity with connectivity</strong></td>
</tr>
<tr>
<td><strong>Significant</strong> $r = 0.178 \ (P &lt; 0.05)$</td>
</tr>
<tr>
<td><strong>Significant</strong> $r = 0.561 \ (P &lt; 0.05)$</td>
</tr>
<tr>
<td><strong>Significant</strong> $r = 0.388 \ (P &lt; 0.05)$</td>
</tr>
<tr>
<td><strong>Significant</strong> $r = 0.474 \ (P &lt; 0.05)$</td>
</tr>
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indicates a greater increase of components in all but propositions.

Writing assessment

There are no significant differences between the experimental and control groups in the National Test writing tasks according to a $t$-test ($t = 0.651; df = 53; P < 0.05$) and the test level distributions are of a similar order across all levels.

Discussion

The goal of this study is to establish whether teaching interventions using ICT-based concept mapping techniques enhances creativity and impacts on writing achievement in 10–11 year old children in their school setting.

The reliability of this study is challenged through the use of a control group and in making claims of comparative sampling. The NFER reasoning scores for creativity suggest that in some way the experimental group have improved their creativity up to the level of the control group from a lower base-line. It is difficult to suggest that this is solely due to the ICT-based concept mapping intervention, but a small significant correlation between concept mapping connectivity and creativity does occur in the mid-term, which corresponds with an increase in concept mapping intensity observed through concept map component correlations. There is a wide literature about the advantages of published tests and there is a strong claim for the reliability of these findings (Cohen et al. 2000:319); however, the standardised scores (Table 3) suggest that it may be easier for the experimental group to achieve higher scores on retest due to the smaller sample size of the control group and their higher baseline score pre-test. The attrition rates during the study contributed to uneven sample sizes across several data fields and this affects reliability as smaller groups may have mean scores skewed by one or two poor performances. The use of correlation coefficients is an attempt to establish a consistency throughout the study.

Correlation coefficients show a strong link between creative ability and writing ability, and there is consistent evidence promoting the link between concept mapping connectivity and creative writing ability. To imply that concept mapping enhances writing cannot be wholly sustained as innate cognitive abilities may determine both writing ability and concept mapping ability. The analysis of concept mapping components attempts to address this issue and there is evidence that concept mapping increases in terms of numbers of links and concepts. The most consistent increase was in the number of propositions being formed, which triangulates with significant correlations between connectivity scores and writing scores in the mid-term and post-test.

The hypothesis that labelling links would be a primary creative force in establishing relations between concepts appears to be subordinate to the forging of visual connections between concepts using unlabelled vectors. There are higher correlations between total links produced and concepts, than between labelled links and propositions.

The use of ICT-based concept mapping produces a wide range of graphic organisation strategies, from mind mapping to concept mapping.

ICT-based concept mapping already complies with some features of ICT and the NAACE framework for creativity within the Loveless model (Fig. 1) and can be seen to enhance the ICT National Curriculum strands; developing ideas; exchanging and sharing information; reviewing, modifying and evaluating work as it progresses.

As a drafting strategy, the data do not highlight any inherent negative aspects in using ICT-based concept mapping techniques. Creative behaviour appears to be determined more by concept formation and making connections between concepts than by proposition formation with proposition formation arising as a secondary process. Concept mapping techniques do appear to provide a stable framework in which to structure writing and to scaffold information.

The correlation data indicate that concept mapping connectivity has predictive qualities in assessing writing ability, supporting the idea that evaluating ex-

| Table 4. Concept mapping component raw scores ($n = 21$) |
|-----------------|-----------------|-----------------|-----------------|
|                  | Concepts | Links | Labelled links | Propositions |
| Pre-test         | 166      | 218   | 138            | 111           |
| Mid-term         | 360      | 372   | 245            | 184           |
| Post-test        | 278      | 330   | 200            | 191           |

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plorative behaviour in pre-compositional work can predict creative outcomes (Csikszentmihalyi & Getzels 1970, 1971; Getzels & Csikszentmihalyi 1976; Kay 1991). This provides some validation for using the connectivity index (Somekh et al. 2000) as a means of evaluating concept mapping in numerical terms. The ICT features of provisionality and capacity enable creation, adaptation and storage of concept mapping.

The notion that concept mapping with ICT enhances creativity in literacy tasks has not been explicitly demonstrated in this small-scale study, but there is evidence to suggest that a larger more-defined study may prove otherwise. The use of ICT is hampered by resource availability to individuals, but the use of laptops in pairs and small groups does enable inclusion, participation and talk, and appears to motivate and captivate the pupils within the tasks. The use of ICT-based concept mapping in the interventions enhances learning of this new representational technique as the increase in number of concept mapping components and connectivity correlations throughout the study period shows. A larger study would provide more reliable data with which to define the exact nature of the impact of concept mapping techniques within creative tasks.

This study provides evidence to support the introduction of new technologies into educational practice. ICT-based concept mapping and graphic representational software provide innovative tools through which creative and effective practices that have educative value can be developed.

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References


Use of ICT-based concept mapping


