A tool for mindful writing?

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> Computer-based tools can assume part of the intellectual burden by handling lower-level functions of the task, thus enabling learners to work at higher-levels
> (Salomon, G. 1988)

> Thinking emerges naturally from purposeful activity. Mindtools provide a set of computer-mediated activities that foster thinking.
> (Jonassen, D.H. 2000)

> In order to solve the problems of generating content without input from conversational partners, beginning writers must discover alternative sources of cues for retrieval of cues from memory. Once discourse has started, text already produced can provide cues for retrieval of related content. But they are not enough to ensure coherent discourse, except perhaps of the stream-of-consciousness variety.
> (Bereiter, C. 1987).

Abstract

Proverb

By helping students become more accomplished thinkers, we can help them become more accomplished writers.

Abstract in English

The key research question in this small-scale study focuses on ICT-based concept-maps[1], and questions if ICT-based concept-maps provide facilitated means to a degree that a threshold intervention utilizing an ICT-based concept-mapping tool implemented in the process of written composition will lead to significant performance advantages in such a way that the products will be ranged[2] higher when assessed using traditional assessment methods. Using a quasi-experimental design, this study sought to investigate possible benefits of ICT-based concept-maps over paper and pencil approaches in written composition, and possible individual differences in benefits in the light of theory on individual composing strategies. The study proffers a theoretical platform for combining the implementation of ICT-tools as "mindtools" (Jonassen, Salomon, Perkins, Novak, Buzan) with theories about the psychology of written composition (Bereiter, Scardamalia). The study employed a quasi-experimental controlled trial design, control-group and experimental-group consisting of randomly selected subjects from a group of (n = 29) students. Participating students were around 16 years of age, attending Videregående 1, allmennfaglig studieretning (VK1), a college preparatory junior high-school equivalent.

[1] Though it is possible to make a distinction between concept maps (Buzan 2001) and mind maps (Novak 1998, 2006), for the purpose of this study, such a distinction is not emphasized. The term "concept map" is used throughout.

[2] Ordinal rank (grade) given the compositions handed in for assessment.

Suggested facilitated means indicated in the key research question, and detailed in point 2.1, established the main hypothesis:

> Ho_1: There will be no difference in the mean scores on products[3] assessed using traditional assessment methods, between students working with an ICT-based concept mapping tool, and the students working with a pencil and paper equivalent.

Both groups were given identical individual writing-tasks, the only differentiating procedural measure being that the experimental-group was prompted through an ICT-based concept mapping tool, while the control-group was given identical prompts on paper. The compositions produced by both groups were assessed, and cross-assessed, through methods conventional to the institution, providing data for statistical analysis along with the concept maps of both groups and data from a questionnaire. The theories of Bereiter and Scardamalia on composing strategies suggested a secondary research question: Are performance advantages thought provided through an ICT-based concept-mapping approach dependent upon individual composing strategies? A questionnaire was administered as a pre-test devised to approximately identify individual composing strategies to provide data needed to test a secondary hypothesis derived from this research question:

> Ho_2: There will be no difference in performance advantages when factoring in differences in individual composing strategies.

The main null hypothesis (Ho_1) was not rejected, as no difference on a statistically significant level was found between the mean scores on the products of the control group, and the mean scores of the group receiving the experimental treatment. Factoring in individual composing strategies thought to benefit more from the treatment (Ho_2) did not provide significance. Explanations for this result may be found in the fact that this was a small-scale study, both in number of participants and in timescale, but also in the efforts of this researcher to implement a "true to life" approach with strong considerations to limiting factors present in a genuine learning environment through employing a threshold intervention. However, the results show that the group receiving the experimental treatment significantly extended their interaction with the concept-maps when compared to the control-group. This suggests that beneficial effects extended interaction is thought to provide, for example through an ongoing interaction

[3] The ordinal rank (grade) given the compositions handed in for assessment.

between the planning and writing phases in written composition, is strengthened by employing electronic concept-mapping tools. Also, through finding a lower variance of the composition scores in the experimental group, the results suggest that the experimental treatment may have had an effect. These findings suggest that although this study failed to reject the null hypotheses, the foundation for the key research question may still be sound. Consequently, a longitudinal study, based on a similar theoretical platform, but involving a larger population and employing a nested design for strengthened reliability, is recommended for further research based on the findings of this study.

Abstract in Norwegian

Hensikten med dette forskningsarbeidet var å undersøke eventuelle fordeler av bruk av IKT-baserte tankekart sett i forhold til papirbaserte ekvivalenter i skriftlig komposisjon, samt undersøke mulig varians i utbytte sett i lys av teori om strategier i skriftlig komposisjon. Forskningsarbeidet legger en teoretisk plattform til grunn for å kombinere implementering av IKT-verktøy som "tenkeverktøy" (Jonassen, Salomon, Perkins, Novak, Buzan) med teorier om psykologien i skriftlig komposisjon (Bereiter, Scardamalia). Det er et dokumentert behov i norsk skole for klare indikasjoner på øket læringseffekt med, av og gjennom IKT. Spesielt utrykkes det behov for kunnskap om når IKT bør implementeres i læringsstrategier, og hvilke verktøy en kan forvente gir øket læringseffekt. Ved å kombinere teori om hvordan en typologi av IKT-verktøy kan hjelpe elevene til å "tenke bedre", og konstruere kunnskap bedre, med teorier om hvordan vi kan hjelpe elevene til å skrive bedre, søkte dette kvasieksperimentet å eksemplifisere IKT-verktøy "(…)used in mindful ways" (Salomon and Perkins 2005:2) , eller mer eksplisitt; å vise et eksempel på en forbedret skriveprosess gjennom IKT-mediert metodikk.

Bruk av papirbaserte tankekart som kognitiv støtte i skriveprosessen er allment akseptert som god metodikk, noe som kommer til utrykk for eksempel i læreplanene for grunnskolen (KUF 1996 :19). Gjennom analyse av forskningslitteratur som omhandler generelle tenkeverktøy (mindtools), er slike funnet å kunne gi kognitiv støtte i ulike tankeprosesser. Skriveprosessen, slik den er beskrevet teoretisk av Bereiter and Scardamalia (1987), krever en type tankeprosess som trolig vil kunne styrkes gjennom forbedret støtte for sortering, visualisering, omorganisering og gjenfinning av informasjon. Denne indikerte forbedrede støtte utgjør grunnlaget for hovedproblemstillingen:

1. Gir bruk av elektroniske tankekart slike fordeler at et terskeltiltak der elektroniske tankekart blir implementert i skriveprosessen vil føre til signifikant forbedrede resultater når produktene (stilene) evalueres med tradisjonell metodikk?

En nullhypotese er på dette grunnlag konstruert for å teste om IKT-baserte semantiske nettverk faktisk gir forbedret støtte i forhold til papirekvivalenter, slik teori kan indikere;

Ho_1: En vil ikke finne forskjell i gjennomsnittsscore på produktene rangert ved bruk av tradisjonelle evalueringsmetoder, mellom elever som tar i bruk elektroniske semantiske nettverk, og elever som tar i bruk papirekvivalenter.

Bereiter og Scardamalia peker på indikasjoner som sier at IKT-verktøy virker lovende på den måten at de kan gi proseduell støtte mer komplekse strategier i komposisjonen, og framheve visse aspekter av skriveprosessen, men de peker også på at dette trolig ikke vil ha effekt på elever hvis skrivestrategi ikke vil skape behov for en type støtte IKT-verktøy kan gi (Bereiter, Scardamalia 1987 :359). Dette gir grunn til å tro at effekten av slik forbedret støtte IKT-verktøy kan gi vil variere med visse strategier i skriftlig komposisjon. Dette fører til en ny problemstilling:

2. Vil mulige fordeler elektroniske tankekart kan gi avhenge av individuelle skrivestrategier?

På bakgrunn av denne problemstillingen, er følgende hypotese framsatt:

> Ho_2: Effekten av forbedret støtte IKT-baserte tankekart kan gi, vil ikke være tydeligere hos elever med visse individuelle skrivestrategier.

Det ble benyttet et utvalg informanter (n = 29) bestående av elever i en klasse ved videregående 1, allmennfaglig studieretning (VK1) ved en videregående skole. Elevene var rundt 16 år gamle. Undersøkelsen fokuserer på skriftlig komposisjon i norskfaget. Informantene ble tilfeldig fordelt i en eksperimentgruppe og en kontrollgruppe. Begge grupper ble tildelt den same skriveoppgaven og de samme ressurser for skrivestøtte. Variabelen som skiller kontrollgruppe og eksperimentgruppe er at skrivestøtte for eksperimentgruppen sin del besto i et ekspertkart[4] i elektronisk format, mens kontrollgruppen tok utgangspunkt i en papirekvivalent (papir og blyant). Tekstene elevene produserte ble evaluert og kryssevaluert i henhold til evalueringsmetodikk fra læreverket Tekst og tanke (Halvorsen, Jemterud, Lund, Semmen, Stenstad 1991). Dette utgjør datagrunnlaget, sammen med tankekartene produsert av begge grupper, og data fra en spørreundersøkelse.
Ingen av de to framsatte nullhypoteser ble forkastet på et statistisk signifikant nivå. Dette kan ha sin forlaring i det faktum at dette var et begrenset studie, både når det gjelder antallet informanter, tidsaspektet, og de føringer som ble lagt på dette studiet for å sikre et terskeltiltak i form av et scenario for implementering av IKT-verktøy det ville være realistisk å gjennomføre på tross av begrensende faktorer i en reelt læringsmiljø. Observasjonene viser på den annen side en signifikant økt interaksjon med tankekartene hos eksperimentgruppen. Dette indikerer at implementering av elektroniske tankekart bør vurderes i slike situasjoner

[4] Expert skeleton map (Novak 2006). Et tankekart forberedt som skrivestøtte og utgangspunkt for videre arbeid.

der det er antatt at slik øket interaksjon vil gi positive effekter. Videre viser resultatene markert mindre spredning i scoren for karakter på tekstene hos eksperimentgruppen. Observasjonen kan skyldes et mindre antall deltakere i eksperimentgruppen, men kan også tyde på at den eksperimentelle tilnærmingen hadde en effekt. Et longitudinelt studie på et liknende teoretisk grunnlag, men med flere informanter og et nestet design for å styrke reliabiliteten, anbefales på bakgrunn av de funn som er gjort.

Foreword

About the author

The author is a many years teacher and lecturer of K12 and college students, as well as having been employed as a civil servant in The Norwegian Directorate for Education and Training, the executive agency for the Ministry of Education and Research, working within the field of ICT and teacher training. The last few years he has been heading the ICT teacher-training department of Norsk Nettskole AS, a government approved distance-learning institution.

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Attestation

The author is in no way affiliated to, and has received no funding from, software developers or other commercial interest mentioned in this study. My current employer, Norsk Nettskole AS does neither directly nor indirectly benefit economically from sales of the products mentioned.

Table of content

A tool for mindful writing? 1
Abstract 2
Proverb 2
Abstract in English 2
Abstract in Norwegian 5
Foreword 8
Table of content 9
List of figures 11
1. Introduction 13
1.1 Overview 13
1.2 Typology of research 16
2. Theory 17
2.1 Graphical organizers, concept maps and ICT-based concept maps 18
2.2 The psychology of written composition - Knowledge telling and knowledge transforming 21
2.3 Expectations and hypotheses 26
3. Methods 28
3.1 Approach 28
3.2 Participants 29
3.3 Instrumentation 30
3.4 Design 32
3.5 Scoring 32
4 Procedures 36
4.1 Considerations 36
4.2 Preparations 36
4.3 Field study 37
4.4 Data collection 40
5. Discussion 41
5.1 Do ICT-based concept maps actually provide facilitated means? 42
5.2 Are performance advantages dependent upon individual composing strategies? 51
6. Conclusion and recommendations 54
7. Litterature 56

Other resources: 59
8. Attachments 60
Attachment 1: Pre-test questionnaire 61
Attachment 2: Expert concept map used in the design 64
Attachment 3: Evaluation schema for the final compositions 67
Attachment 4: Additional descriptive Statistics 68

List of figures

Figure 1: A graphic and conceptual representation of a giraffe. 18
Figure 2: Key features of concept maps, according to J.D. Novak (From:http://cmap.ihmc.us/) 19
Figure 3: Branch generating order in the Mind Map™ software (From: http://www.mapitsoftware.com/) 20
Figure 4: The knowledge-telling model proposed by Bereiter and Scardamalia (From: Bereiter 1987: 7). 22
Figure 5: The knowledge-transforming model proposed by Bereiter and Scardamalia. (From: Bereiter 1987: 8) 24
Figure 6: Assessor reliability is established (From SPSS). 35
Figure 7: Empirical data needed for analysis. (From: SPSS). 40
Figure 8: Error-bar for methods and the assessor's final grade on the compositions. (From SPSS) 42
Figure 9: Descriptive and ANOVA for methods and the assessor's final grade on the compositions (From SPSS). 43
Figure 10: Means plot for methods and the assessor's final grade on the compositions (From SPSS). 43
Figure 11: Smaller variance in grades within the experimental group (From SPSS) 45
Figure 12: Significantly extended map revisions in the experimental group. (From: SPSS) 46
Figure 13: Means plot of methods and mean of map substance. (From SPSS) 47
Figure 14: Significantly more substance was found in the maps of the experimental group. (From: SPSS). 48
Figure 15: Frequency of groups and the missing final grade for the composition showing that missing data is skewed in disfavor of the experimental-group (From: SPSS). 49
Figure 16: Error-bar for methods and the questionnaire score. (From SPSS) 51
Figure 17: Descriptives and ANOVA for methods and the questionnaire score (From SPSS). 52
Figure 18: Means plot for methods and the questionnaire score (From SPSS). 52
Figure 19: No difference favoring the experimental group was found between the higher scores on the questionnaire and higher scores on the final compositions (From: SPSS). 53
Figure 20: Expert concept map (right side of central node). 65
Figure 21: Expert concept map (left side of central node). 66

Figure 22: The evaluation schema used in assessing the compositions (from Halvorsen & al 1991) 67

1. Introduction

1.1 Overview

My field of research may be described as what Torgersen and Vavik would call "didactical facilitation through ICT" (Torgersen, Vavik 2004: 23 my translation).
The researchers occupation is in the field of teacher training, so I would describe Norwegian teachers and student teaches the audience for the study. In national scientific papers and reports teachers seek tangible evidence of effects with, of and through ICT. Naturally, on some levels they still want to know *how* to use ICT, but this has been addressed extensively (albeit mostly by route teaching strategies). Now, as is evident in various reports, for example reports by the national research organization ITU (Network for IT-Research and Competence in Education, the University of Oslo), teachers and student teachers want to know *when* to use ICT in the learning design, and *what* tools to use *successfully* to enhance their didactical strategies, and to help students reach curricular goals. A consideration not so much derived from research as from directly interacting with teachers, they want these questions answered in a way they can relate to. Research should strive to answer the obvious question; "What's in IT for me?" This last criterion was given considerable thought when planning the approach. This researcher sought to rise to this challenge by conducting "true to life" research with strong emphasis on an approach with strong considerations to limiting factors present in a genuine learning environment. This study seeks to employ a threshold intervention through economically viable instrumentation, and through a realistic timeframe for implementation of new ICT-tools. Thus, in spite of having a sound foundation in theory, this study becomes somewhat of a "leap of faith". Faith initially based on observed positive results from similar, but non-scientific implications of concept maps in learning strategies.

Utilizing paper and pencil representations of concept maps as cognitive support in the process of written composition is widely accepted as sound methodology, for example as evident in the Norwegian national curriculum (KUF 1996 :19). Through an analysis of research literature pertaining to the general typology of mind tools thought to offer cognitive support of a kind beneficial to the process of written composition as described in theory by Bereiter and Scardamalia (1987), concept maps seem to stand out due to the power of ICT-based concept map tools in providing facilitated means of scaffolding, visualizing, rearranging and

retrieving information needed in the cognitive process of written composition (Jonassen 2000). These suggested facilitated means provide basis for the key research question in this study:

1. Do ICT-based concept maps actually provide facilitated means to a degree that a threshold intervention utilizing an ICT-based concept-mapping tool implemented in the process of written composition will lead to significant performance advantages in such a way that the products will be ranged[5] higher when assessed using traditional assessment methods?

Through analysis of the empirical data, emphasizing the qualitative and quantitative assessment of the assessors, this study seeks to establish evidence indicating either that ICT-based concept map tools used in written composition do indeed outperform their paper equivalents, or if they do not. The assumption implicit in the this research question is based on theory and research indicating that ICT-based concept map tools, compared to their paper equivalents, provide facilitated means of scaffolding, visualizing, rearranging and retrieving information needed in higher-order cognitive processes (Novak 1998: 20).
Higher-order cognitive processes needed to support the content problem- and rhetorical problem spaces of "the knowledge-transforming model" (see point 2.2) proposed by Bereiter and Scardamalia in The Psychology of Written Composition (Bereiter 1987) is in turn the key in differentiating between the two models of composing processes proposed. Bereiter and Scardamalia points out that there is evidence that computers show promise as a way of providing procedural support for more complex composing strategies, and for directing attention to particular aspects of the composing task, but they also point out that this supposedly will have little impact on student writers whose composing strategies create no need for the kind of support ICT-tools can provide (Bereiter 1987: 359).
This provides reason to believe that the performance advantage in using ICT-based concept map tools may vary with individual composing strategies. This leads to the second research question raised in this study:

[5] Ordinal rank (grade) given the compositions handed in for assessment.

2. Are performance advantages, thought provided through an ICT-based concept-mapping approach, dependent upon individual composing strategies?

A pre-study involving a questionnaire as basis for an analysis approximately identifying individual composing strategies based on the two models proposed by Bereiter and Scardamalia was administered to provide data needed to test the hypothesis derived from this research question.

1.2 Typology of research

Through literature search involving references in the literature representing the theoretical foundation for this study, RefWorks[6], Google Scholar Beta[7] and Bibsys[8], I have found research of significance both pertaining to the psychology of writing, and various implementation of ITC-based concept maps and related strategies. However, there is considerably less to be found that utilize a combination of the two. Some research is to be found pairing concept-mapping with writing strategy instruction, for example in a study on Computer-Based Concept Mapping as a Prewriting Strategy for Middle School Students by Shu-Yuan Lin (SY. Lin, J. Strickland, B. Ray, and P. Denner 2004). Some research look into a larger variety if computer based tools catering for the cognitive needs of novice writers, as in "The Impact of Computer-Based Tools and Embedded Prompts on Writing Processes and Products of Novice and Advanced College Writers" by Robert B. Kozma (Kozma 1991). There is of course more to be found if one broadens the perspective to include the implementation of ITC-based concept maps in combination with reading comprehension, information search and other more general learning tasks, such as in David H. Jonassen's Computers as Mindtools for Schools (Jonassen 2000). The resources found through the literature search are, even if only marginally related to this study, significant as guides for "does and don'ts" in the research design. I have especially looked for studies using the quantitative approach in that respect.

The methodology in the field of study mentioned fills the entire specter of qualitative and quantitative approaches, so no generalization can be made on what approach best fit the field of study. I have however found that some kind of pre-test, post-test design dominate the quantitatively oriented designs, and that predominantly quantitative studies seem to resort to more qualitative approaches when analyzing the empirical data quantitatively fails to answer questions in the order of "what really happened here?" and "Why did it happen?"

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[6] http://www.refworks.com

[7] http://scholar.google.com/

[8] http://www.bibsys.no/ (Database containing all Norwegian university libraries, the National Library, all college libraries, and a number of research libraries.)

2. Theory

The incentive behind this study was to see ICT ”(…) used in mindful ways” (Salomon and Perkins 2005: 2), in order to measure effects with and through ICT, as defined in “Effects with, of and through technology” (Salomon and Perkins 2005). More precisely, I hoped to find positive effects through the use of mindtools, as defined by Jonassen (Jonassen 2000) in; ”Computers as mindtools for schools”, the focus being on concept maps as mindtools used in the form of planning tools, and tools for structural support. In Jonassen’s theories, creating concept maps engages creative and critical thinking skills, and thereby complex thinking skills (Jonassen 2000: 74), or “higher order thinking” (Novak 1998 :20). An approach to written composition involving concept maps would seem to be to be provisional for the lack of conversational inputs in written composition (Bereiter 1987: 3). More importantly, in light of theory about concept maps engaging creative and critical thinking skills, there are indications that such an approach may foster the development of internal cognition, as called for in; The Psychology of Written Composition (Bereiter 1987 Educational implications: 358-363). Carl Bereiter and Marlene Scardamalia have proposed two structures to describe the cognitive processes of generally more accomplished writers (knowledge transforming) involving more complex cognitive strategies, and generally less accomplished writers (knowledge telling) involving less complex cognitive strategies. Through their theories, Bereiter and Scardamalia offers insight into educational implications that would seem to complement the power of ICT-tools developed to help students think better and construct better.

2.1 Graphical organizers, concept maps and ICT-based concept maps

According to Jonassen, "concept maps are spatial representations of concepts and their interrelationships that are intended to represent the knowledge structures that humans store in their minds" (Jonassen 2000: 58). In a paper by Ray McAleese, concept maps are described to "(...) signify virtual conceptual structures that can exist in an n-dimensional space (McAleese 1998: 6). Tony Buzan is quoted with a visionary description of the phenomena; "The Mind Map is your external mirror of your own Radiant Thinking and allows you to access this vast thinking powerhouse." (Buzan 1996, in McAleese 1998: 1).

Concept maps may be sorted into a typology of ICT-tools generally described as graphic organizers. The National Center on Accessing the General Curriculum (NCAC[9]) defines a graphic organizer as "(...) a visual and graphic display that depicts the relationships between facts, terms, and or ideas within a learning task". Jonassen however, defines concept maps as belonging to a typology of tools labeled semantic organization tools, grouping concept maps with databases when outlining their function as "Mindtools" (Jonassen 2000: 33).

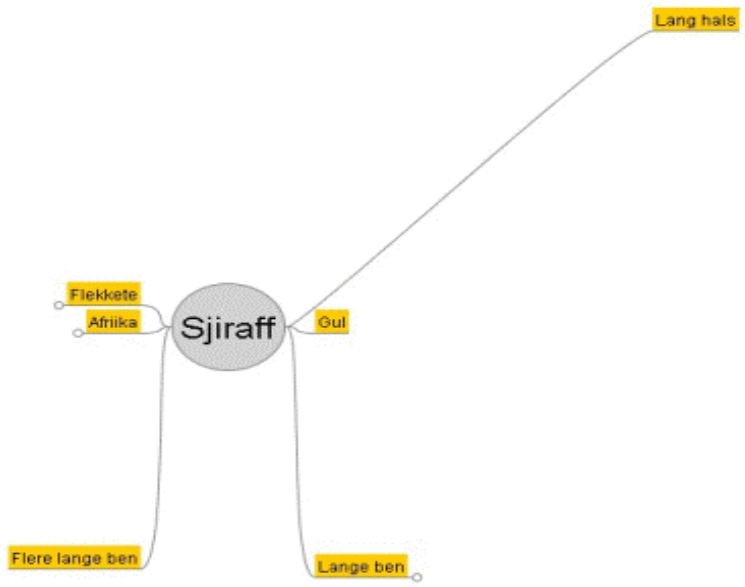

Figure 1: A graphic and conceptual representation of a giraffe.

Jonassen groups concept maps with databases in a typology of tools labeled semantic organization tools. However, the appropriateness of the label "graphic organization tool", and

[9] CAST: NCAC [Online] Available from: http://www.cast.org/policy/ncac/

the floating boundaries between these labels, are evident in the illustration in figure 1[10], effectively depicting a giraffe when outlining the concept in Freemind[11].

Joseph. D. Novak of Cornell University is accredited for developing concept maps in the 1972 based on Ausubel's learning theory (Novak 2006: 2), which places emphasis on the influence of students' prior knowledge on subsequent meaningful learning. Jonassen and Novak are analogue in their descriptions of a concept map as "(...) graphs consisting of nodes representing concepts, and labeled lines representing relationships between them" (Jonassen 2000 :58). Novak himself defines concept maps in The Theory Underlying Concept Maps and How to Construct Them; "Concept maps are graphical tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts. Words on the line, referred to as linking words or linking phrases, specify the relationship between the two concepts." (Novak 2006: 1).

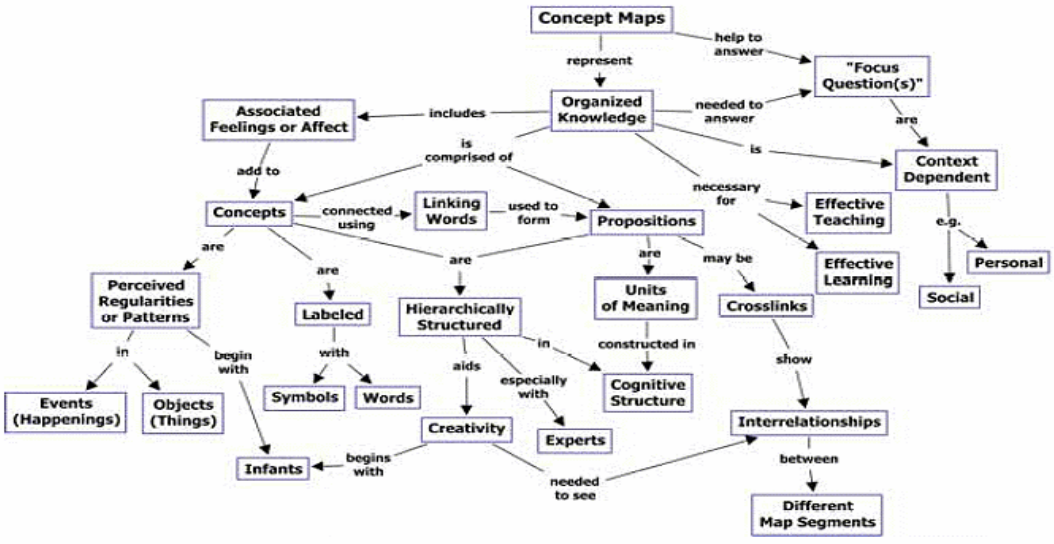

Figure 1. A concept map showing the key features of concept maps. Concept maps tend to be read progressing from the top downward.

Figure 2: Key features of concept maps, according to J.D. Novak (From:http://cmap.ihmc.us/)

[10] A haphazard concept map developed by a teacher in connection with usability testing of the Freemind software, conducted by a student of ICT in learning in fall 2005.

[11] FreeMind concept mapping software. Available from: http://freemind.sourceforge.net/wiki/

This, and somewhat the direction in which the maps tend to be read, provides for a distinction between concept maps and graphical organizing techniques that do not emphasize labeled links between nodes. The graphic organizing technique labeled and trademarked Mind Map™, developed by Tony Buzan (Buzan 2001) provides an example of a mapping technique without labeled links, and with a radiant arrangement of nodes around the central concept/node.

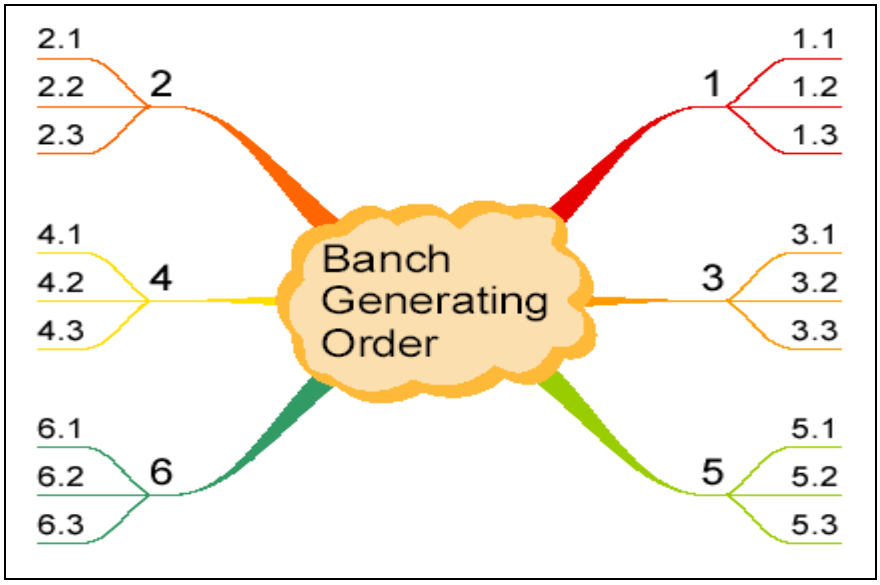

Figure 3: Branch generating order in the Mind Map™ software (From: http://www.mapitsoftware.com/)

The relationships between the nodes are however still obviously evident (see figure 3), represented by connecting lines of varying color and thickness. For the purpose of this study, such a distinction is not emphasized. The term "concept map" is used throughout for a tool that enables visualization of key concepts and summarizes their relationship. The particular ICT-based concept-mapping tool chosen for this study caters for both approaches by providing a high degree of flexibility in how nodes and links are represented graphically. In the approach used in this study, labeling relations between links was not emphasized. Through and through, scientific descriptions of concept maps more than hint at an analogy with biological cognitive operational models, or "how the mind works". The literature search conducted in this study has not lead to strong claims that it is actually so. For instance, MaAaleese notes; "(…) there is no claim made in this paper that concept maps are isomorphic with neural activity" (McAleese 1998: 2). However, there is strong evidence that concept maps are mediating artifacts that support cognitive processes. A meta-analysis conducted by The Institute for the Advancement of Research in Education (IARE) in 2003 funded by a

software developer, summarizes 29 papers pertaining to the use of graphical organizers in education, presenting mainly positive indications for the use of this typology of tools. This researcher has not encountered a meta-analysis pertaining specifically to graphic organizing tools, giving evidence to the contrary, but as mentioned, there are single studies giving negative indications. The reasons explaining what failed when results do not meet expectations are in most cases debated, and it is often pointed out that failure may be due to flaws in research design or implementation, as much as to flaws in the inherent capabilities of the tools themselves, or even in the didactical strategy they are developed to support.

2.2 The psychology of written composition - Knowledge telling and knowledge transforming

The two models proposed by Bereiter and Scardamalia to describe differences in cognitive processes between generally more accomplished writers (knowledge transformers), and generally less accomplished writers (knowledge tellers) provide theoretical rationale for efforts in providing support for a writing strategy that more resembles the knowledge transforming model. The models are supported by predominantly experimental studies reported in the their book; The Psychology of Written Composition (Bereiter 1987). It is in no way implied that the strategies outlined in this study are sufficient to bring about a dramatically different writing style in the participating students. Much less that implementing an ICT-based concept-mapping tool, as opposed to a paper equivalent, will turn “knowledge tellers” into “knowledge transformers”. According to Bereiter and Scardamalia such a categorization of writers cannot even be made (Bereiter 1987: 339). “Knowledge telling and knowledge transforming refer to mental processes by which texts are composed, not to the texts themselves” (Bereiter 1987: 13). However, by providing mindful support for a writing strategy incorporating the more complex cognition attributed to the knowledge telling model, one can hope to facilitate written composition that reflect the qualities attributed to more accomplished writers.

This study proposes ICT-based concept-maps as a possible means of providing said support. Yet, Bereiter and Scardamalia maintains that providing procedural support for more complex composing strategies supposedly will have little impact on student writers whose composing

strategies create no need for the kind of support ICT-tools can provide (Bereiter, Scardamalia 1987: 359). Thus this study proposed a hypothesis to test difference in performance advantages when factoring in differences in individual composing strategies.

2.2.1 The knowledge telling model

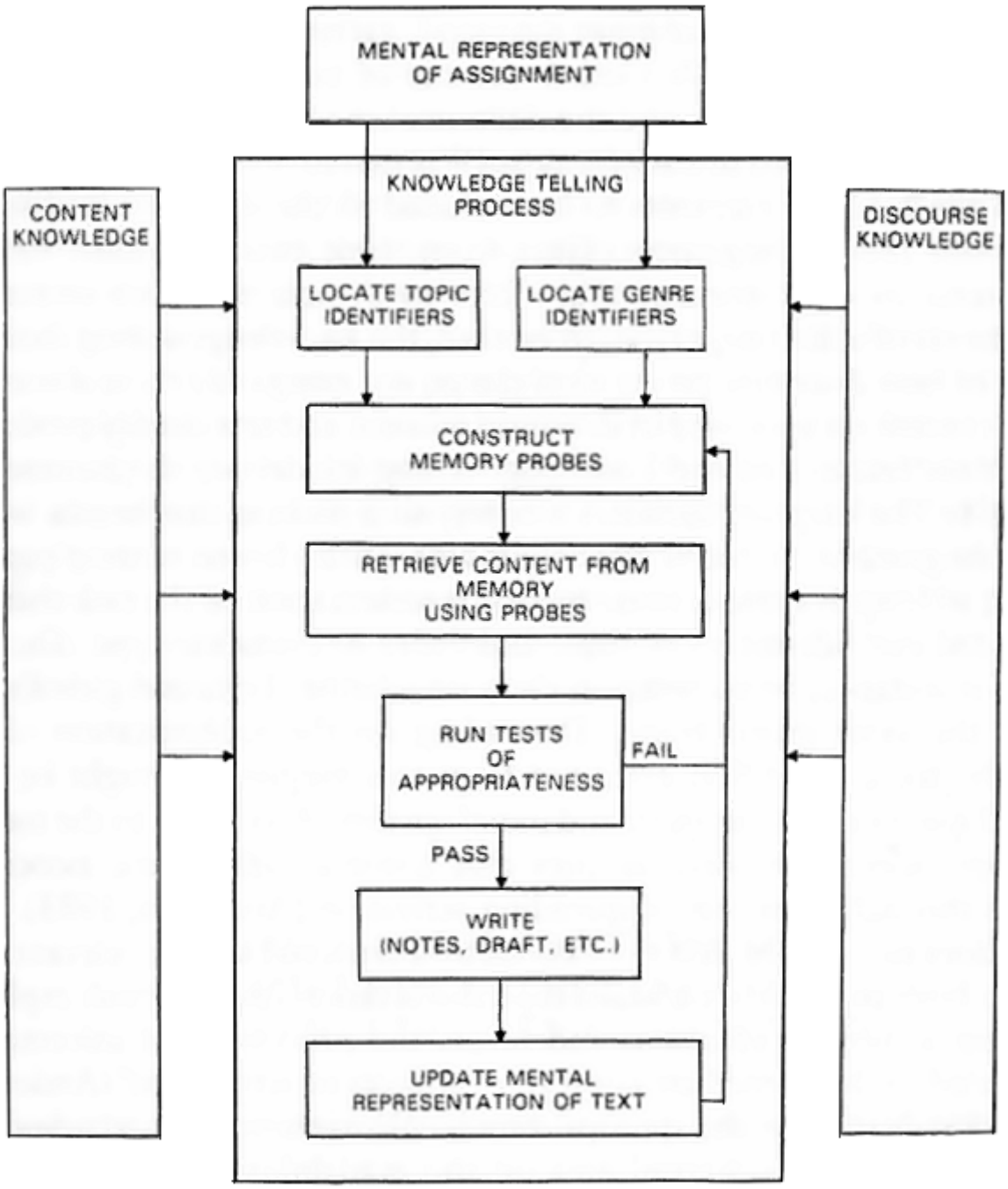

Figure 4: The knowledge-telling model proposed by Bereiter and Scardamalia (From: Bereiter 1987: 7).

The knowledge-telling model refers to the most rudimentary mental schema necessary "In order to solve the problem pf generating content without input from conversational partners" (Bereiter 1987 :7). When producing content, writers must search for alternative sources of cues for retrieving content from memory in order to ensure coherent discourse. These cues are in the knowledge-telling model derived by a linear content generation. Metal probes into content knowledge and discourse knowledge are made as content is generated. Content generated provides additional cues for further probing, and so on. The retrieved content from memory is tested for appropriateness, before it is added to the discourse. According to Bereiter and Scardamalia, "Knowledge telling provides a natural and efficient solution to the problem immature writers face in generating text content without external support" (Bereiter 1987: 9). However, it is maintained, the knowledge-telling approach makes use of readily available knowledge, relying on already existing discourse-production skills, and thus "It preserves the straight-ahead form of oral language production" (Bereiter 1987: 9).

2.2.2 The knowledge-transforming model

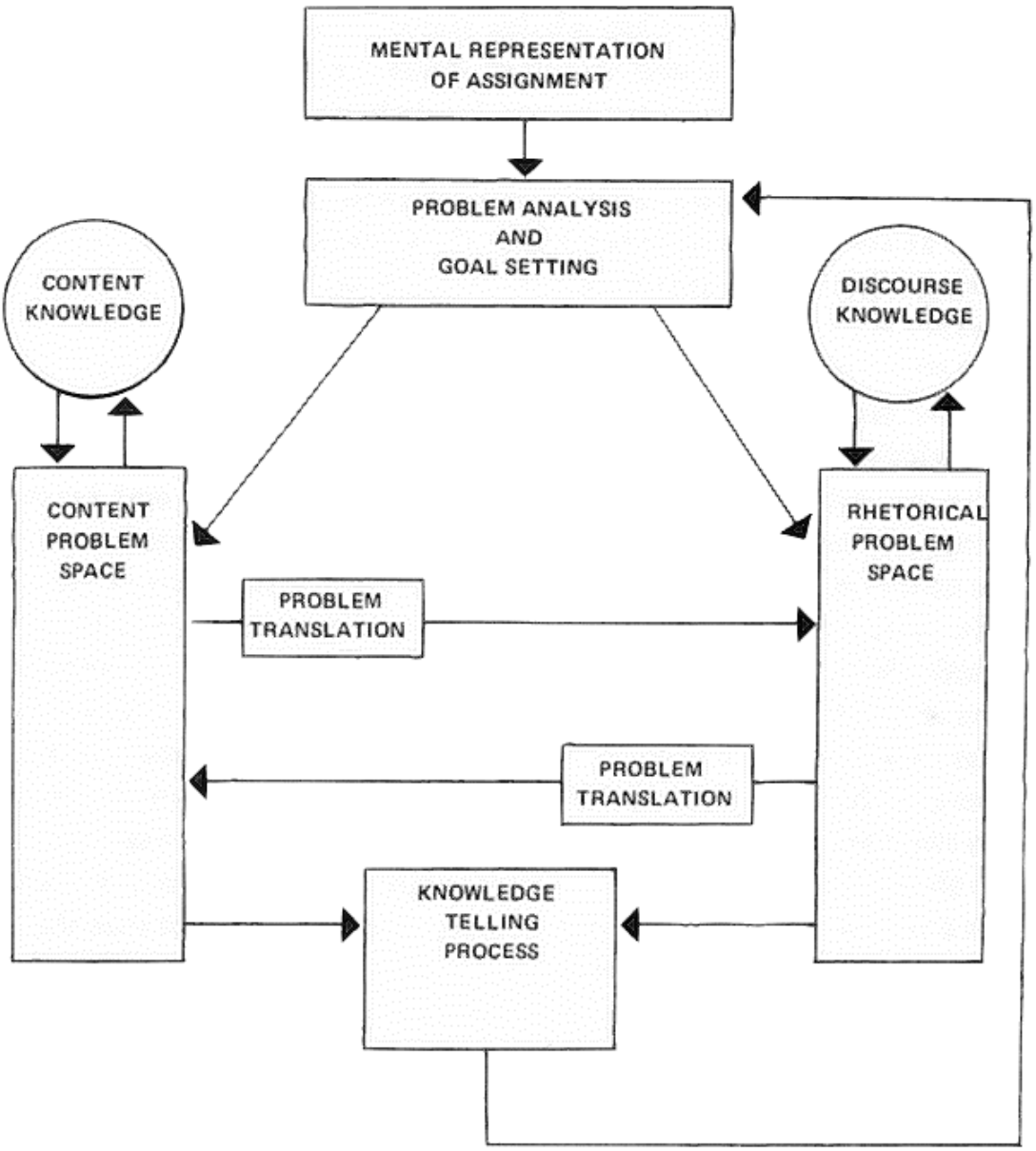

Figure 5: The knowledge-transforming model proposed by Bereiter and Scardamalia. (From: Bereiter 1987: 8)

The knowledge-transforming model refers to a mental schema of a higher complexity. The complexity is necessitated by cognitive strategies that are not supported by the knowledge-telling model, namely the reworking and transforming of knowledge. The knowledge-transforming model adds two different kinds of problem spaces around the knowledge-telling

model, the content problem space and the rhetorical problem space, between which there is a two-way interaction between continuously developing knowledge and continuously developing text. The knowledge-transforming process does not rely on readily available knowledge, and already existing discourse-production skills alone, but knowledge and skills are continuously developed as a result of the composition process.

2.2.3 The Expert skeleton map

This study employed an expert skeleton map as a foundation for the writing task (see attachment 2).

"Expert skeleton" concept maps serve as a guide or scaffold or aid to learning in a way analogous to the use of scaffolding in constructing or refurbishing a building." (Novak and Cañas 2006 :17) According to Novak and Cañas, an expert skeleton map permits both students and teachers to build their knowledge on a solid foundation. In this study, the skeleton map approach was chosen in spite of the added probability of students perceiving the concept map as "a straight-jacket", thereby hampering creativity or even possibly the critical thinking associated with "Mindtols". However, the structure and detail of the skeleton map is subject to other valid considerations, such as "reducing the chance that misconceptions or faulty ideas held by learners or teachers will be reinforced and maximize the chance that they will build knowledge structures that in time remove or diminish misconceptions." (Novak and Cañas 2006 :20).

In this study, design considerations indicated that the expert skeleton map would have to be adapted to the writing task at hand. The writing task was in itself dictated by the curriculum for the subject the given semester, and subject to considerations to recent conventions in formal evaluation. Hence, it was given that the writing task would be in the genre of persuasive texts. A current affairs commentary aimed for a printed medium was settled upon. The topic and specific target[12] was left up to the students to decide upon.

[12] Local newspaper, nationwide newspaper, interest-group newsletter, etc.

2.3 Expectations and hypotheses

The study was designed to possibly provide an example of ICT ”(…) used in mindful ways” (Salomon and Perkins 2005) or specifically, an example of ICT used to facilitate mindful writing. The strategy was to do so by testing the assumption that ICT-based concept map tools implemented in the process of written composition outperform paper equivalents in the way that the products will be ranged higher when assessed using traditional assessment methods. Ultimately, there was some hope that this study would give positive indications that it is possible to help students become more accomplished thinkers through mindful implication of ICT-tools, thus helping them become more accomplished writers.
Based on the key research question on ICT-based concept maps actually providing facilitated means to a degree that a threshold intervention utilizing an ICT-based concept-mapping tool implemented in the process of written composition will lead to significant performance advantages, and the theory presented in this chapter, a main hypothesis was proposed:

> Ho_1: There will be no difference in the mean scores on products[13] assessed using traditional assessment methods, between students working with an ICT-based concept mapping tool, and the students working with a pencil and paper equivalent.

This being a small-scale study, with emphasis on a threshold intervention approach, rejecting one or both hypotheses was somewhat of a “leap of faith” initially based on observed positive results from non-scientific implications of concept maps in learning strategies. I was not convinced that the main hypothesis would be rejected on a statistically significant level, thus I connected greater expectations to finding correlations between better grades on the compositions and students that through analysis of the pre-test questionnaire (see point 3.3.3 and attachment 1) may be identified as have a strategy of planning and revising their text through indications of “knowledge transforming” (Bereiter 1987: 10-12).

[13] The ordinal rank (grade) given the compositions handed in for assessment.

Based on the research question of performance advantages correlating more favorably with certain composing strategies, a secondary hypothesis was established:

> Ho_2: There will be no difference in performance advantages when factoring in differences in individual composing strategies.

A concern put forth by professor Gavriel Salomon[14] pertains to the ICT-based text-outlines of the experimental group produced through exporting the electronic concept-map file to a word-processor. Will the outlines once constructed and exported be a creative constraint, thus hampering knowledge transformation during the final phase of the writing task? Will the entire strategy have to be matched to individual composing strategies? Does one have to find ICT-tools that facilitate knowledge transforming throughout the entire process in order to mindfully implement ICT-tools in the writing process, in effect using another toolset altogether? Hopefully, the results of this research would answer some of these questions, or at least give an indication as to where further research is needed.

[14] In a comment on a draft for this study

3. Methods

3.1 Approach

The literature search has not given any concise indication as to what approach is the most appropriate for the field of study, but there are examples of similar approaches to similar problems.

The problem presented in this study allows for proposing a clear main hypothesis, stating that one mediating artifact will outperform another artifact, thus an approach that would test the hypothesis while limiting interfering variables was needed. Experimental research is a proven method for testing a hypothesis, and a design involving controlled trials is well suited for such a task. A true randomized controlled trial would be preferable, however this researcher had, due to practical limitations such as the timeframe and geography, only access to a limited group of subjects excluding the possibility of a reliable randomized selection, allowing for a quasi-experimental approach only. A pre-test apart from the experiment, designed to aggregate data on some of the significant variables to be measured, was necessary to test the hypothesis on variances in the light of individual composing strategies. Another approach would be standard pre- and posttest measures. A focus on a limited number of measures in an environment of such complexity as the classroom, calls for considerations in the design, especially pertaining to what dimensions of context that are to be measured (O'Donnel 2004: 2). Considerations linked to the format of findings appropriate for dissemination to the target group was also instrumental in deciding upon the approach.

3.2 Participants

The study incorporated an experimental group (n = 12) and a control-group (n = 14). Initially randomly selected from a group of (n = 29) subjects attending Viderekommende 1, allmennfaglig studieretning (VK1), a college preparatory high-school equivalent. Two students did not return a signed information form[15], and one student was absent for the duration of the field-study, bringing the total number of subjects to (n = 26). The subjects were all around 16 years of age. Bereiter and Scardamalia, referencing a longitudinal study by W. Loban 1976, indicate that the turning point where students can produce text at the same proficiency level that they speak occurs around the age of 12 (Bereiter 1987: 6).
Their lecturer in Norwegian (native language) was involved as partner to the researcher in detailing the proceedings to, upon the researcher's initiative, ensure non-intrusive design and procedures. He was also involved in settling on the genre and wording of the writing task, and in deciding the writing prompts in the expert skeleton maps (identical for both experimental- and control groups). He was also used as an assessor. The lecturer is head of the languages and social studies department and an experienced assessor. An equally qualified colleague of the lecturer was brought in to perform a cross-assessment on the students' final texts, to provide reliability for the grading.

[15] Ethical guidelines of the study, and the principle of anonymity

3.3 Instrumentation

3.3.1 The concept mapping software

The choice of ICT-tools within the given typology was in itself far from random. Norway is, by international standards, a rich country[16], but there are several indications that using economically advantageous approaches in ICT-implementation strategies generally facilitate the incorporation of ICT-supported methodology in schools (ITU-monitor 2005). Incorporating software with expensive licenses into the design would thereby hurt the potential disseminative value of this study. Furthermore, Norwegian is a "small language" in a global perspective, and at the time of initiating this study, ICT-based concept map tools translated into Norwegian were not to be found, other than those distributed as open source. FreeMind[17], open source general public license (GNU GPL) concept map software was almost fully translated into Norwegian at the point of initiating this research.
In addition to considerations pertaining to language and economy, FreeMind was considered fairly flexible, yet easy to grasp for students unfamiliar with graphic organization tools. Although not otherwise related to this study, it should be noted that teachers and student teachers tested the FreeMind software prior to this study. The testing, initiated by the researcher, was done in conjunction with assignments given in a collage level course in ICT in learning at Volda University College, Volda, Norway. FreeMind, and to some degree various other concept mapping tools, was evaluated both as a personal study tool, in connection with usability testing, and with learners in actual classroom activities. The students' various reports on this activity, predominantly reporting positive indications, were also of importance to the instrumentation for this study. One of the most important considerations for the choice of tool, was the plausibility of adhering to Jonassen's criteria for the time needed to reach an operational level with the tool, on order to fall into the criteria of "Mindtols" (Jonassen 2000: 19).

16 OECD Factbook 2005 Economic, Environmental and Social Statistics. Downloaded 17. January, Available from: http://oberon.sourceoecd.org/vl=7555864/cl=36/nw=1/rpsv/factbook/

17 Available from: http://freemind.sourceforge.net/wiki/

3.3.2 The statistical software

As a tool for analyzing empirical data statistically, the software-suite SPSS[18] was employed.

3.3.3 The questionnaire

A pre-test (see attachment 1) involving a questionnaire as basis for an analysis approximately identifying individual composing strategies was applied to the research design to provide data needed to test the secondary (Ho_2) hypothesis; There will be no difference in performance advantages when factoring in differences in individual composing strategies. Bereiter and Scardamalia do not provide a formalized test to be used in order to identify "knowledge tellers" and "knowledge transformers". In fact, due to the models being representations of mental schemas, rather than instruments of categorization (see point 2.2) a formalized test for categorization purposes would be difficult to conceive. In stead, Bereiter and Scardemalia suggests a number of overt indicators of composing processes (Bereiter 1987: 13). These indicators include start-up times, note-making, thinking-aloud protocols and revising. Bereiter and Scardamalia discuss various levels of inquiry in an integrative schema for studying the composing process, suggesting methods favoring the reflecting inquiry (Bereiter 1987 :35) supported by empirical variable testing, and a further four levels of inquiry in a coherent effort " (…) to understand how human minds actually accomplish the act of writing" (Bereiter 1987 :51). However, for the purposes of this study a limited level 2 inquiry, in the form of a questionnaire, was considered satisfactory to provide a handle for testing the hypothesis. The questions were devised to provide the indicators mentioned as far as possible within the framework of a written questionnaire.

3.3.4 Computer equipment and other required software

The school, in which the field-study was conducted, was based on ITU Monitor 2005 (ITU 2005) what can be described as averagely equipped for the type and size of institution. The school had two large computer labs (around 30 workstations each), in addition to smaller labs scattered around the premises. Several students in the selection in addition had privately owned laptops at their disposal. Except for in one instance, there were no problems in providing enough computer time for the purposes of this study. The computers were equipped

[18] Available from: http://www.spss.com/

with Microsoft Windows 2000 operating systems, and the Open Office suite[19]. Having Open Office already installed ensured two conditions vital to the proceedings:
1. The Java RT environment also required to run FreeMind would be present.
2. It would be possible to take advantage of the export to document feature incorporated in FreeMind, as FreeMind only supports Open Office in this respect.

3.4 Design

The design for this study was a controlled trial involving a computer-based experimental-group versus a paper-and-pencil concept mapping control-group. Out of a population of (n = 29), subjects were randomly assigned to either experimental or control groups.
A pre-test questionnaire (see attachment 1) approximately identifying individual composing strategies was administered to all subjects. The quality of the concept maps generated by the students in the two concept-mapping conditions was investigated. The final compositions of the participants were assessed using methods conventional to the institution. Statistical analysis was conducted to determine whether any of the two concept mapping methods correlated more favorably with higher ranging on the final compositions. In addition, an analysis was conducted to determine whether higher ranging on the final compositions correlate more favorably with certain composing strategies.

3.5 Scoring

3.5.1 Assessing and scoring the questionnaire

The scoring of the questionnaire (see attachment 2 and point 3.3.3) devised to identify individual composing strategies was conducted by ranging each answer on an ordinal level using a scale from 1 to 6. The lowest value was given to answers that conveyed no evidence of the indicators mentioned in point 3.3.3, while very strong indications were given the higher values.

[19] An Open Source multi-platform office productivity suite. Available at: http://www.openoffice.org/

3.5.2 Assessing and scoring the concept-maps

The concept maps of both control-group and experimental group were analyzed at the last stage of revision, using a schema based on Jonassen's recommendations for evaluating students' semantic nets (Jonassen 2000: 74) where he lists a large number of criteria that may be used. A selection had to be made based on what the researcher found most relevant to the hypothesis this study was designed to test. Also, the selection follows from considerations as to the standards against which to compare them (Jonassen 2000: 76). Given that this study clearly is aimed at seeking enhanced methods and tools for reaching curricular goals, it is natural to use an approach in which the students' concept maps are compared to course goals. Jonassen states; "More research is needed to verify a consistent relationship between particular criteria for evaluating nets and traditional measures of course performance, such as exams, research papers and case studies." (Jonassen 2000: 77). This study is not tailored to provide such verification, however, it does make things interesting. Course goals in this context are closely related to the elements of both discourse knowledge and content knowledge identified by the maps giving evidence of efforts of providing topic identifiers and genre identifiers.

Given that the expert concept map approach (see point 2.2.3) was chosen for this study, and mutual decisions of the lecturer and researcher led to extensive scaffolding being provided for discourse knowledge and genre identifiers, the larger number of Jonassen's suggested criteria were rendered irrelevant. Most of the suggested criteria pertain to expansions to the maps. Looking for evidence in expansions to the scaffolding only (added nodes and links) would be insufficient, given the scenario. Searching for evidence of students supplying appropriate content to scaffolding provided by the expert concept map is appropriate in order to compare the maps to course goals. As Jonassen states in one of the criterions; "The accuracy of the information included in the net is, of course, the most important criterion" (Jonassen 200: 76). In adherence to this, the information accuracy variable was factored by 2. A simple word-count of words added to the map to assess substance and degree of interaction was administered. Also, any relevant effort to adept or revise the existing discourse/genre-identifier scaffolding provided by the expert concept map to fit personal goals and/or content knowledge and topic identifiers would have to be attributable to complex thinking skills being engaged. In addition, the students were asked to note the last date of revision onto the maps. This measure gives insight into how long the students operated within the framework of the concept map.

These five criteria for assessment were chosen and adapted:

1. Is the information in the nodes correct/relevant? (Factored by 2)
2. Does the map have substance? (Word-count).
3. Have nodes and links been added to the expert scaffolding?
4. Has the expert scaffolding been revised or adapted in an apparently meaningful way?
5. When was the last date of revision?

Each of the criteria was ranged on an ordinal level using a scale from 1 to 6. For criteria 1, 3 and 4, the lowest value was given if no indication was found, while very strong indications were given the higher values. The "Substance" variable (2) was obtained by conducting a word-count of words added to the maps. The actual count ranged from a mere 31 words to 1360. These results were also ranged from 1 to 6. As for the last date of revision (5), the lowest value was given if the noted date of last revision was very early in the two weeks and 3 days timeframe the students were given to work with their compositions, while very late revisions were given the higher values.
A simple mean between the five criteria constitutes the map mean score.

3.5.3 Assessing and scoring the final compositions

The lecturer assessed the compositions produced by both groups. The compositions were also cross-assessed (final grade) by a second lecturer to establish assessor reliability. The assessments were conducted through methods conventional to the institution. These methods are derived from didactical literature pertaining to the subject, more specifically from *Tekst og tanke* (Halvorsen, Jemterud, Lund, Semmen, Stenstad 1991). The method involves a written qualitative assessment, where three separate areas of evaluation pertaining to grammatical and mechanical conventions, discourse and genre identifiers, content and creativity (see attachment 3) are commented. Each of these areas is given a grade from 6 (outstanding) to 1 (fail). The final grade constitutes a mean between the three areas of evaluation. However, the lecturer may deviate from an exact mean through a holistic evaluation. A second assessor graded the final compositions (final grade only) in order to establish assessor reliability.

Correlations

		Final Text grade	Assessor B Final Text grade
Final Text grade	Pearson Correlation	1	,894(**)
	Sig. (2-tailed)		,000
	N	19	19
Assessor B Final Text grade	Pearson Correlation	,894(**)	1
	Sig. (2-tailed)	,000	
	N	19	19

** Correlation is significant at the 0.01 level (2-tailed).

Figure 6: Assessor reliability is established (From SPSS).

4 Procedures

4.1 Considerations

In reviewing procedures, it is important to bear in mind that both design and procedures were intentionally non-intrusive. The reasoning behind this being considerations to the potential disseminative value of the study.

4.2 Preparations

In preparation for the field study, the rationale and preliminary proceedings were presented to the native language department of the school. Although the group displayed keen interest in the study, only the department head found it in his capacity to commit the students he taught personally within the timeframe.

In preparation for the field-study, the lecturer and researcher cooperated in settling on the genre and wording of the assignment for the writing task. Again, it was a design consideration that the final decision be that of the lecturer, and not of the researcher. The measure is not strong enough to be considered in a reliability context, but it is relevant to validity and to the disseminative value of the study. Also, one must take into account that although the researcher has teaching credentials in Norwegian language, the lecturer had a higher level of proficiency. The final expert skeleton maps, with their resources in the form of links[20], writing-prompts and structural support were decided upon mutually between the researcher and the lecturer.
Prior to involving the subjects in the study, the information material, the questionnaire and a declaration pertaining to the treatment of personal data was submitted for approval from The Norwegian Social Science Data Services (NSD[21]). An approval was obtained the 10. of March 2006.

20 The control-group's maps contained printed URLs instead of web-links.

21 The Norwegian Social Science Data Services (NSD) http://www.nsd.uib.no/english/

A final preparatory measure, was to make sure the required software to be used in the experiment was installed, available, and in a satisfactory condition. This was handled in cooperation with the school's technical staff without incident. However, a misunderstanding involving the reservation of the computer-lab for the experimental-group's introduction to the concept mapping software was to have a significant impact on procedures, and possibly the reliability of the results.

4.3 Field study

The part of the study involving students, spanned a three-week period in the spring semester, and hooked onto a writing task already planned for this timeframe. Strict adherence to the schedule was both a design consideration and a matter of necessity, as the writing task had to be completed before a school holiday in order to be assessed in time to be incorporated in the evaluation for the students' semester grade.

4.3.1 Introductions and probing

Before the students were divided into control-group and experimental-group, the lecturer introduced the researcher to the students. The rationale in short, the assignment to be given, and the procedures requiring student involvement were explained and questions answered. Particular weight was put on explaining the ethical guidelines of the study, and the principle of anonymity. This information was also handed out in print, for review and signature. All but two students present returned the signed form. These students took part in the proceedings, but their products are not included in the data collection or analysis of the study. Another purpose of the introduction was for the researcher to assert information given by the lecturer as to the level of familiarity of the students with using different planning strategies in written composition, and in particular concept maps. Although not conducted scientifically, the impression obtained by probing the students, combined with information supplied by the lecturer, was found satisfactory to cater for a consideration introduced by professor Gavriel Salomon in a comment on a design draft for this study: "Students will have to get used to planning an essay with or without the tool before engaging in the study. You don't want to study their childhood diseases".

4.3.2 Instruction in the use of the concept mapping tool

In the original draft for the proceedings, the experimental-group was to receive 1,5 hours of instruction in the open source general public license[22] FreeMind concept-map software prior to engaging into the writing-task. The time limit for instruction was set in order to be well within Jonassen's criterion for the time given to reach an operational level with a "Mind-tool" (Jonassen 2000: 19). However, due to a misunderstanding when booking the computer-lab that had the necessary software installed, the scheduled window in which this instruction was to take place was shut. A provisional arrangement was made, but the actual time spent on instructional activity was reduced to around 40 minutes effective, and some of the subjects belonging to the experiential group received no instruction at all, as they due to prior engagements were not able to attend the rescheduled instruction. There is naturally reason to believe that this may have had an impact on the results of the study.

4.3.3 The composition phase

Both groups were then given the identical individual writing-task settled upon mutually by the researcher and the lecturer as outlined above. Both groups approached the writing task using a concept map, the only differentiating variable being that The experimental-group was prompted through the expert concept map (see point 2.2.3) file created in FreeMind, while the control-group was given identical prompts[23] in paper-format, a printed version of the expert root map attached to an A3-format blank sheet, using paper and pencil to draw and write their maps. Neither of the groups was given a time limit in which to stop developing their concept-maps, but the students were prompted to note the time of last revision within the map.

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[22] GNU GPL, Available from: http://www.gnu.org/copyleft/gpl.html

[23] Identical except for a branch of the electronic concept-map containing keyboard shortcut tips for FreeMind, and instructions for exporting the map to the word-processor.

Both the experimental group and the control group were working with ICT in all aspects other than having access to concept mapping software, limiting a potential "Hawthorne effect"[24]. Both groups had equal access to a word processor[25], and both had full access to the Internet. Although access to equipment, teacher and student general ICT competence remains limitations not to be ignored (Erstad 2005), the actual task of writing out the text in the editor, or browsing the Internet, is not a focus for this study. "(…) there is so far no indication that using a word processor causes students to adopt more sophisticated composing strategies." (Bereiter 1987: 358). However, evidence has been found that "computers are valuable tools for helping students develop writing skills" as concluded in a meta-analysis published in The Journal of Technology, Learning, and Assessment integrating findings from 26 papers on effects of computer word-processing on quality and quantity of text produced (Goldberg, Russell and Cook 2003: 20). Using a word processor and accessing the Internet is, for the scenario of this study, to be considered an established implementation of ICT in schools where there is competence and equipment available.

The experimental group was allowed to export their concept maps to the word processor, while the control group had their drawn maps at hand. One could contend that this gave the experimental group an unfair advantage, and one has to factor in that the students may have seen it so, but the export feature is an advantage inherent to the tool itself, and should be allowed. Using the tool to its full advantage is, after all, not inconsequential in answering the key research question of the ICT-based concept-map approach possibly outperforming the paper equivalents. The timeframe allowed to the students of both groups between being given the assignment and handing in the final composition electronically, was two weeks and 3 days, a timeframe complying with the norm of the institution for this type of assignment. Again, due to the potential disseminative value of this study, this was an important consideration.

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[24] The "Hawthorne effect" is only used here as a label for latent variables connected to biased focus on control-group and experiment-group. The effect in itself is scientifically questionable (http://socserv.socsci.mcmaster.ca/econ/rsrch/papers/archive/91-01.pdf)

25 Open Office Writer

4.4 Data collection

The lecturer collected the actual paper concept maps of the control-group. Electronic copies of the maps of the experimental group, as well as the final compositions of both groups were handed in electronically through uploading to the Learning Management System in use at the school[26]. Answers to the questionnaire were collected similarly, and handed in appropriate formats to the researcher. The researcher photocopied the assessment forms used in evaluating the final compositions.

The material was checked for missing elements by the researcher prior to being de-identified and subjected to analysis. Unfortunately, due to students not handing in elements needed for analysis, including, but not limited to the final compositions, this researcher had to operate with tenuous empirical data, as illustrated below. Only data for the pre-study questionnaire was complete. Furthermore, the missing data were skewed in disfavor of the experimental group.

Case Processing Summary	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Compositions handed in	19	73,1%	7	26,9%	26	100,0%
Questionnaires answered	26	100,0%	0	,0%	26	100,0%
Maps handed in	20	76,9%	6	23,1%	26	100,0%

Figure 7: Empirical data needed for analysis. (From: SPSS).

[26] Fronter. Available at: http://www.fronter.com

5. Discussion

The study was designed to possibly provide an example of ICT "(…) used in mindful ways" (Salomon and Perkins 2005) or specifically, an example of ICT used to facilitate mindful writing. This being a small-scale study, with emphasis on non-intrusive procedures, rejecting one or both hypotheses is somewhat of a leap of faith. Faith initially based on observed positive results from non-scientific implications of concept maps in learning strategies. If the null hypotheses were to be rejected despite the efforts of this researcher to implement a "true to life" approach with strong considerations to limiting factors present in a genuine learning environment, it would have given a strong signal to comparable learning institutions and other researchers. The signal would be that electronic concept maps are indeed tools to be reckoned with in promoting the development of mature composing strategies (Bereiter 1987: 245).
As it stands, the main null hypothesis (Ho_1) was not rejected. No difference on a statistically significant level was found between the mean scores on the products of the control group, and the group receiving the experimental treatment. Factoring in individual composing strategies thought to benefit more from the treatment (Ho_2) did not provide significance. Possible explanations for the results will be discussed in this chapter. Also, points of interest found in the empirical data will be investigated.

5.1 Do ICT-based concept maps actually provide facilitated means?

5.1.1 Facilitated means

Both approaches (paper and pencil / ICT) is assumed to provide support for a writing strategy incorporating the more complex cognition attributed to the knowledge telling model of Bereiter and Scardamalia, thus facilitating written composition that reflect the qualities attributed to more accomplished writers. The key research question of the ICT map approach outperforming maps drawn on paper was founded on the potential of ICT-based concept map tools in providing facilitated and more direct means of scaffolding, visualizing, rearranging and retrieving information needed in the process of written composition. This study proposed that these facilitated means might result in a significant performance advantage expressed by a significant difference in mean scores on the grades on the students' compositions between the experimental- and control groups.

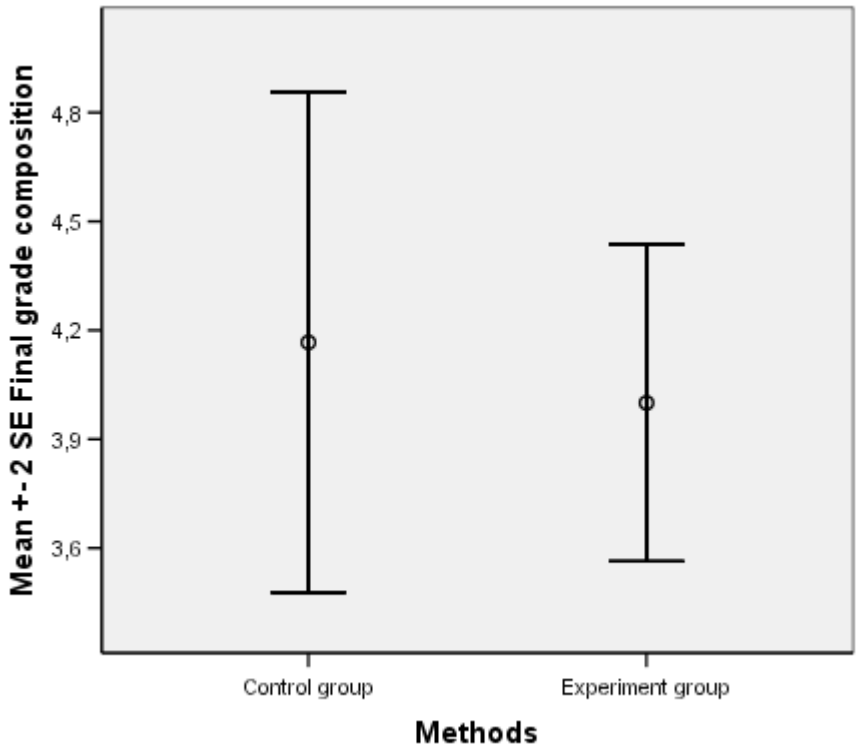

Figure 8: Error-bar for methods and the assessor's final grade on the compositions. (From SPSS)

Final grade composition

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Control group	12	4,17	1,193	,345	3,41	4,92	2	6
Experimental group	7	4,00	,577	,218	3,47	4,53	3	5
Total	19	4,11	,994	,228	3,63	4,58	2	6

ANOVA

Final grade composition

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,123	1	,123	,118	,735
Within Groups	17,667	17	1,039		
Total	17,789	18			

Figure 9: Descriptive and ANOVA for methods and the assessor's final grade on the compositions (From SPSS).

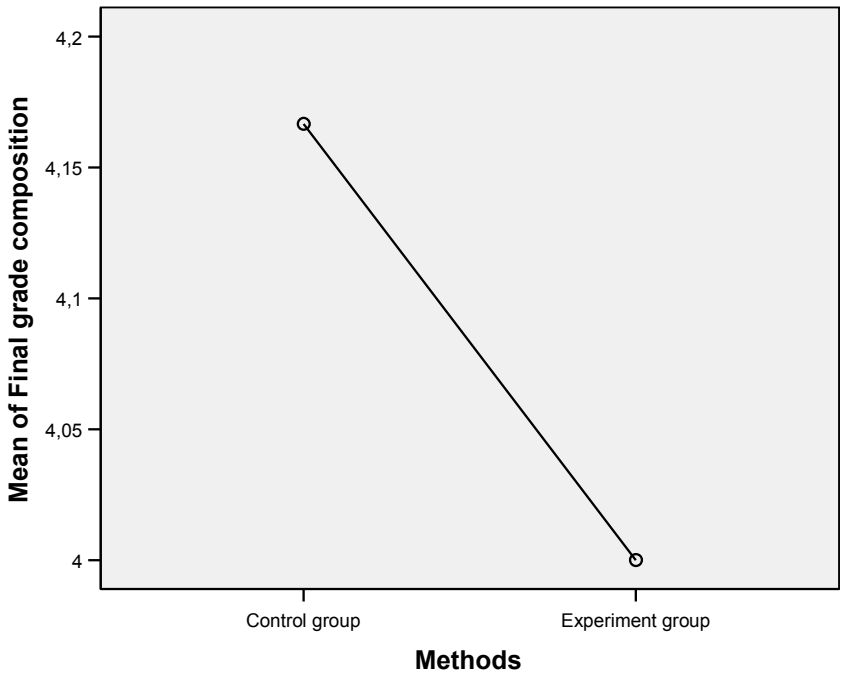

Figure 10: Means plot for methods and the assessor's final grade on the compositions (From SPSS).

5.1.2 The rationale behind the assumption

The rationale behind the assumption that the Ho_1 hypothesis might be rejected was much the same as in a comparison between writing text by hand and using a word-processor. In a meta-analysis study by Robert L. Bangert-Drowns, published in Review of Educational Research, 32 studies that compared two groups of students receiving identical writing instruction but allowed only one group to use word processing for writing assignments, the following quote can be found in the abstract: "Word processing in writing instruction may provide lasting educational benefits to users because it encourages a fluid conceptualization of text and frees the writer from mechanical concerns" (Bangert-Drowns 1993). The same mechanical concerns would be applicable to a hand-drawn concept map. For example, the need to move a particular concept from one node to another would require use of an eraser to remove the original, and the recreation of the concept in it's new location. In an ICT-based concept mapping tool, a simple drag and drop action would complete the process. Facilitated means of making revisions and additions is however but one of the comparable similarities. In the mentioned meta-analysis, it was also found that "Word processing students wrote longer documents" (Bangert-Drowns 1993). One can go back to example of moving the concept and add another dimension. It is safe to assume that the threshold for moving the concept would be comparatively higher using a hand-drawn concept map than the ICT-based map if the concept was comprehensive and lengthy. Based on the facilitating properties of ICT-based concept mapping tools, this study assumed that students would "stay longer" within the framework of the concept map, thus reaping the benefits of the scaffolding provided.

5.1.3 A significantly smaller variance

While the experimental group did not obtain better grades on their compositions than the control group, the variance within the experimental group is significantly smaller, although the explanation may be found in the experimental group numbering fewer subjects. This finding suggests that the experimental treatment had an effect in reducing the role of individual differences (see also figure 9).

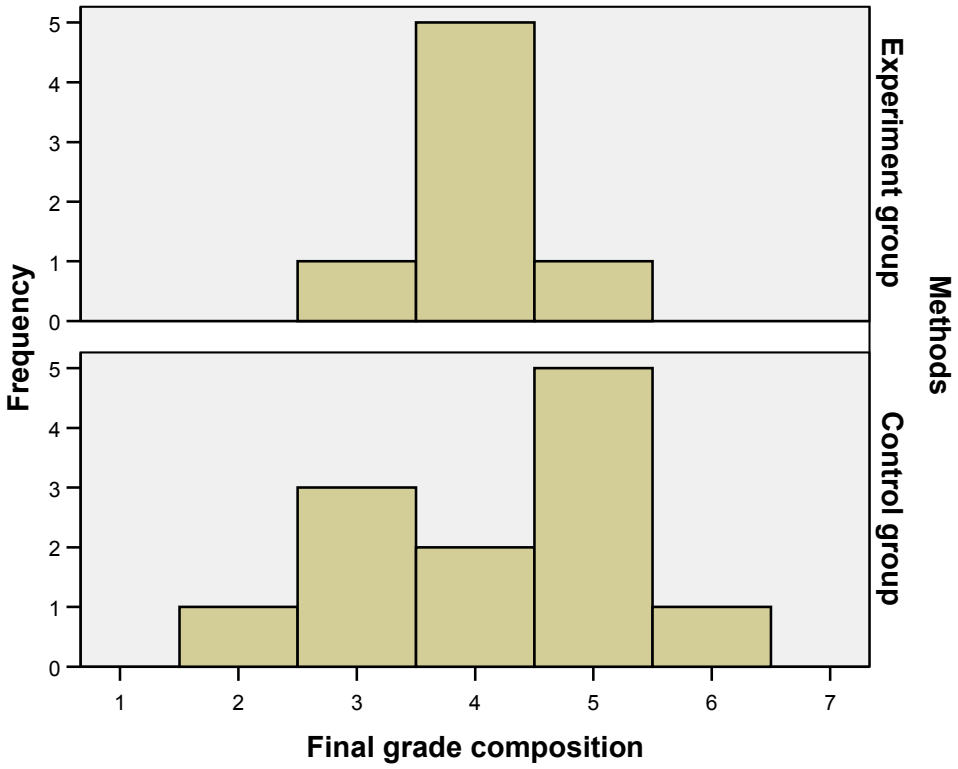

Figure 11: Smaller variance in grades within the experimental group (From SPSS)

5.1.4 Extended interaction

One other statistically significant observation made in this study was that students in the experimental group indeed did stay longer "with" their maps, measured by the noted, and/or electronically obtained last date of revision.

Map -Date of last revision

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Control group	11	1,73	,905	,273	1,12	2,33	1	3
Experimental group	8	4,88	1,246	,441	3,83	5,92	3	6
Total	19	3,05	1,900	,436	2,14	3,97	1	6

Map -Date of last revision

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	45,891	1	45,891	40,938	,000
Within Groups	19,057	17	1,121		
Total	64,947	18			

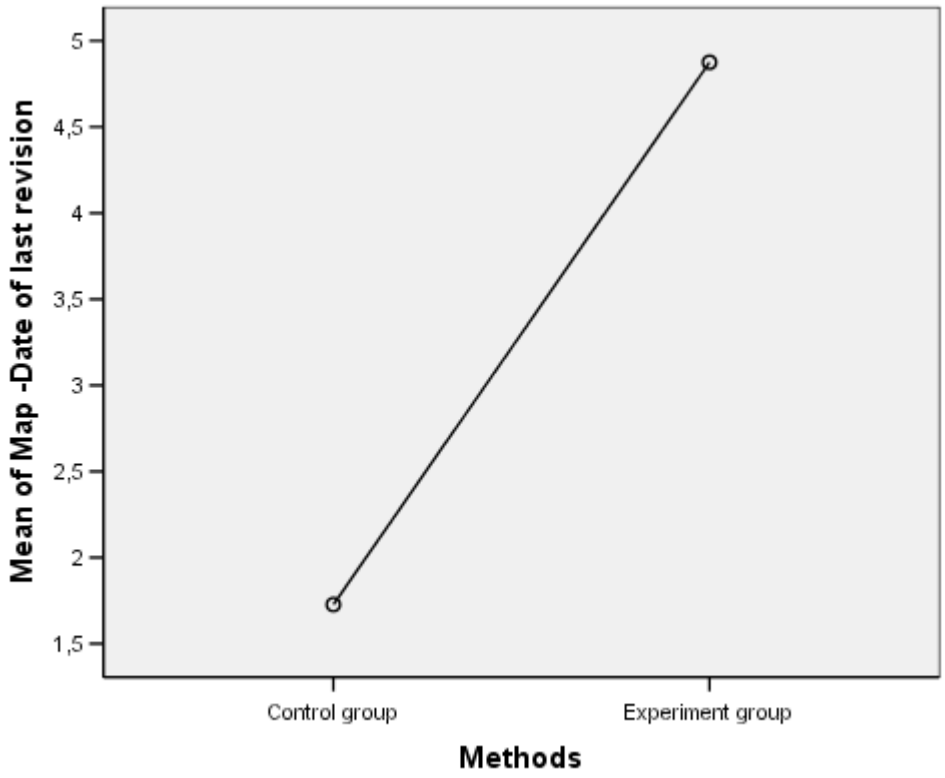

Figure 12: Significantly extended map revisions in the experimental group. (From: SPSS).

Thus, in this study, the much used label; “pre-writing stage” as investigated by Shu-Yuan Lin (SY. Lin, J. Strickland, B. Ray, and P. Denner 2004), is not sufficient to span the process in which the participants employed the concept-mapping tool. Most of the participants in the experimental group, using the ICT-based concept-mapping tool, extended their direct interaction with the tool all the way into the revision stage of the writing process. This may only be attributed to the methods variable. There is no other explanation for this finding except functionality in the tool facilitating such a strategy, thus this study finds that employing ICT-based concept maps extends the interaction with the maps. Even though this extended interaction did not result in the null hypothesis being rejected, this finding gives a relatively strong indication for the use of ICT-based concept-mapping tools in learning strategies where extended interaction with the concept map is considered to yield probable advantages.

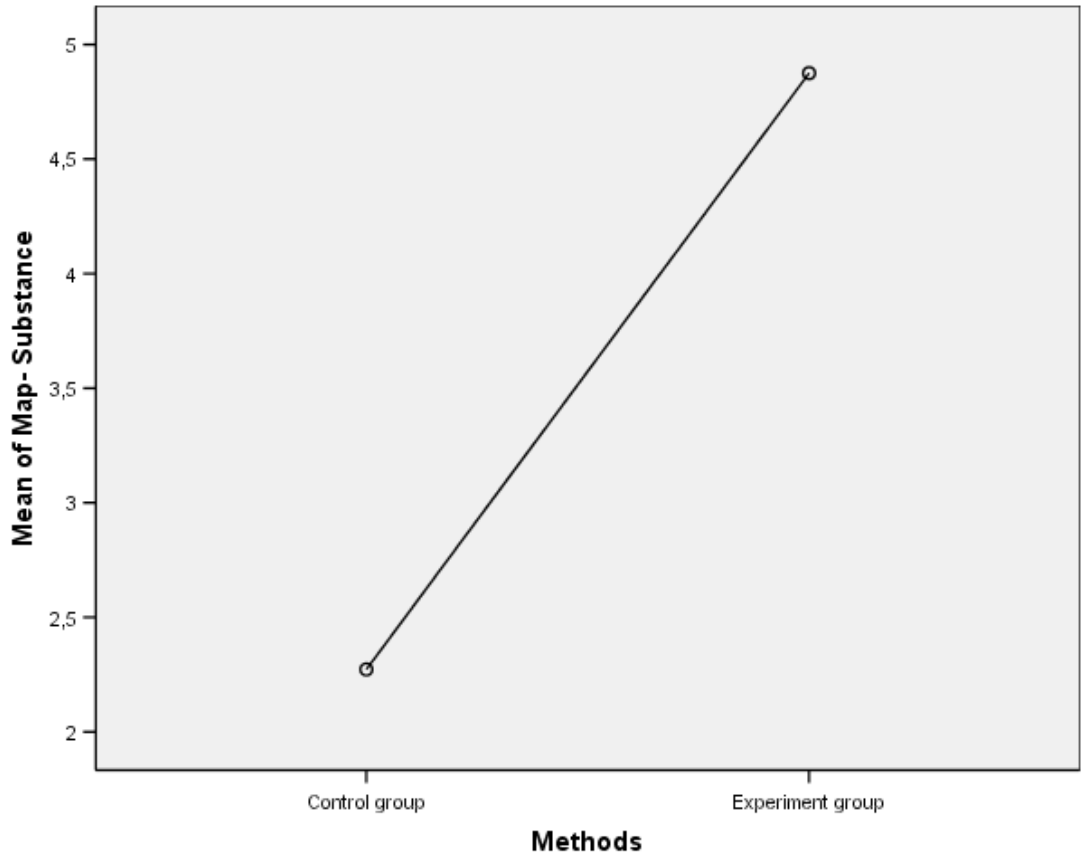

Figure 13: Means plot of methods and mean of map substance. (From SPSS).

Another interesting observation supporting this reasoning was found in the variable "Substance". As indicated in point 3.5.2, the word-count of words added to the maps showed large differences, ranging from a mere 31 words to a maximum of 1360 words. The mean square within and between groups was distinct.

Map- Substance

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Control group	11	2,27	,905	,273	1,67	2,88	1	4
Experimental group	8	4,88	,991	,350	4,05	5,70	3	6
Total	19	3,37	1,606	,368	2,59	4,14	1	6

Map- Substance

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	31,364	1	31,364	35,412	,000
Within Groups	15,057	17	,886		
Total	46,421	18			

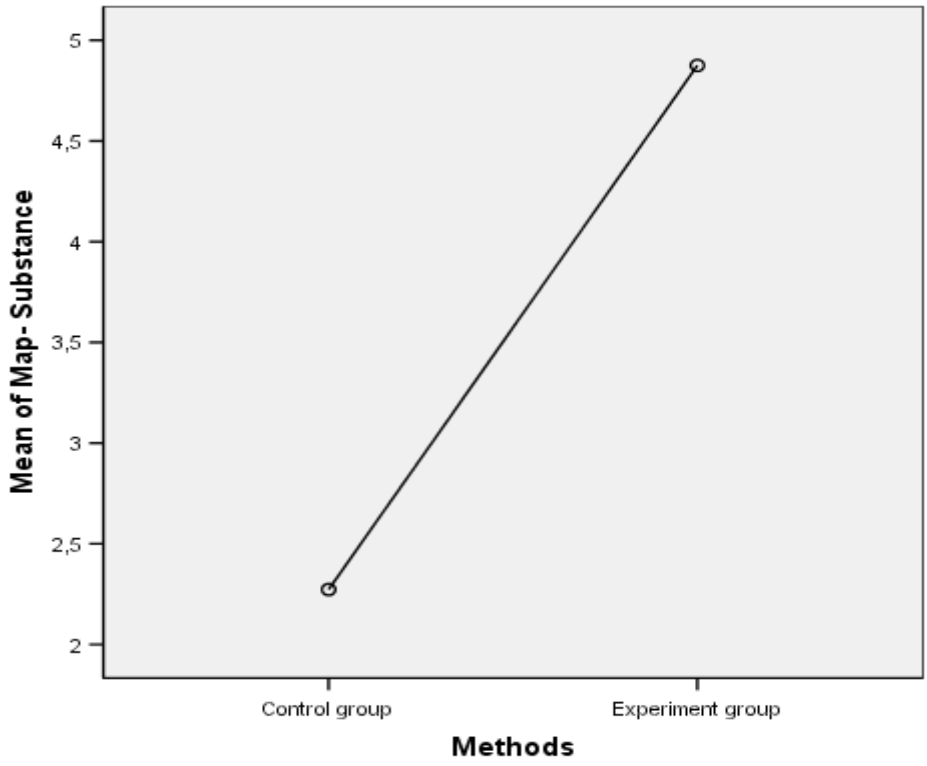

Figure 14: Significantly more substance was found in the maps of the experimental group. (From: SPSS).

5.1.5 Possible explanations for the results

Although it is inherently disadvantageous to the reliability of this study, the limited number of subjects a possible factor on the outcome has to be considered. The students were randomly assigned to either control-group or experimental group, but the possibility of the selection being skewed remains high. When taking into account the fact that the experimental-group due to students being absent represented a selection (n = 12) and the control-group represented a selection (n = 14), as well as missing data being skewed in disfavor of the experimental group, the possibility of arbitrary results is intrinsic.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Control group	14	53,8	53,8	53,8
	Experimental group	12	46,2	46,2	100,0
	Total	26	100,0	100,0	

	Control-group (1) Experimental-group (2)	Cases					
		Valid		Missing		Total	
		N	Percent	N	Percent	N	Percent
Final grade composition	Control group	12	85,7%	2	14,3%	14	100,0%
	Experimental group	7	58,3%	5	41,7%	12	100,0%

Figure 15: Frequency of groups and the missing final grade for the composition showing that missing data is skewed in disfavor of the experimental-group (From: SPSS).

Procedures for this study were intentionally designed to be non-intrusive., A “true to life” approach, with strong considerations to limiting factors present in a genuine learning environment and the implementation of ICT-tools in a learning institution, were by this researcher considered crucial to the potential disseminative value of the study. Successful adoptions of new ICT-tools in learning institutions depend upon such considerations. Documentation for this assumption is to be found for example in a European Commission report on Synergy between Practitioners' needs and opportunities, Research orientations and Decision Making on the usage of ICT in primary and secondary education (European Commission DG-Research 1993). The findings of this study suggest that a first priority appears to be the strengthening of the relation between school contexts and the research community in a direction where innovation is addressed from a holistic perspective.

> ICTs-related teaching/learning innovations in schools, as any innovation indeed, are inextricably linked with the concepts of change and risk taking. They are justified on the basis of the relative advantages they have to offer over what is the current practice but are not value free (economic or technological considerations, as well as adopted educational perspectives play an important role)
> (European Commission DG-Research 1993: 39).

One of the measures due to the mentioned considerations that may have affected the result the most, was that the study was limited to the timeframe that was already planned for this particular writing task. This timeframe was to include instruction in the use of the tool, and the students making themselves comfortable with its use. As mentioned in point 4.3.2, a misunderstanding when booking the computer-lab that had the necessary software installed, resulted in some of the students in the experimental-group not receiving instruction. This study was to adhere to the time limit for instruction in order to be well within Jonassen's criterion for the time given to reach an operational level with a "Mind-tool" (Jonassen 2000: 19), but due to this glitch in procedure, it is safe to assume that some of the students did not reach said operational level, thereby not fully reaping plausible facilitating means provided by the tool.

5.2 Are performance advantages dependent upon individual composing strategies?

5.2.1 Individual composing strategies

Bereiter and Scardamalia maintains that providing procedural support for more complex composing strategies supposedly will have little impact on student writers whose composing strategies create no need for the kind of support ICT-tools can provide (Bereiter, Scardamalia 1987: 359). Thus this study proposed that performance advantages in using ICT-based tools correlate more favorably with certain composing strategies. As related in point 3.5.1, a pre-test (see attachment 1) questionnaire was administered as basis for an analysis approximately identifying individual composing strategies.

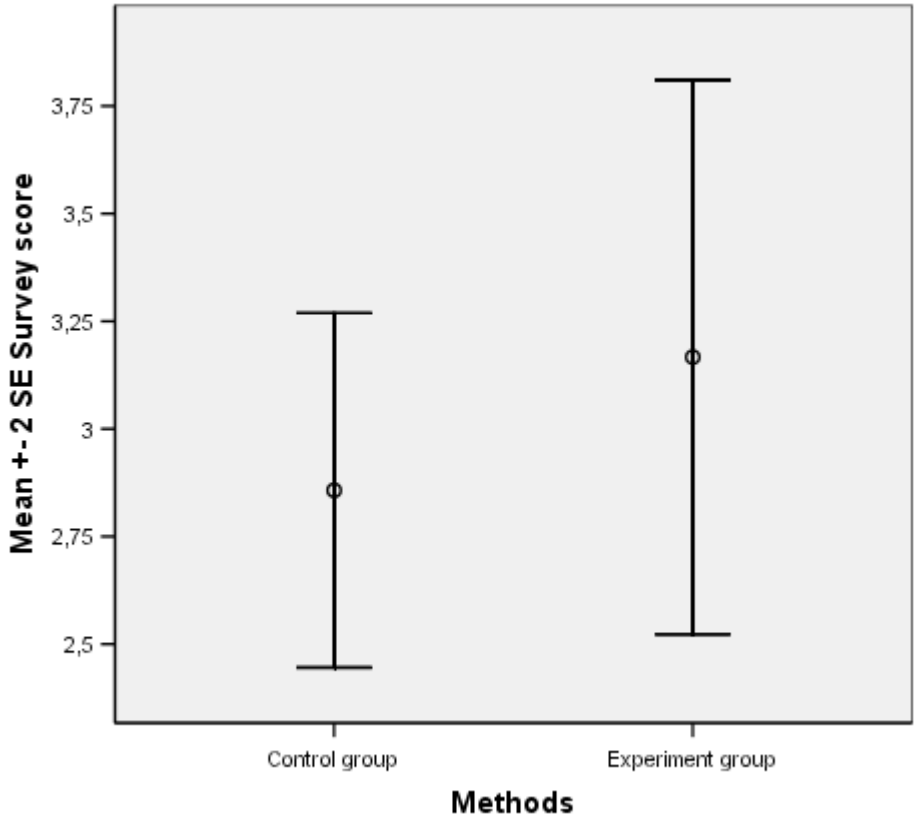

Figure 16: Error-bar for methods and the questionnaire score. (From SPSS)

5.2.2 Possible individual differences in benefits

Questionnaire score

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Control group	14	2,86	,770	,206	2,41	3,30	2	4
Experimental group	12	3,17	1,115	,322	2,46	3,87	2	5
Total	26	3,00	,938	,184	2,62	3,38	2	5

Questionnaire score

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,619	1	,619	,695	,413
Within Groups	21,381	24	,891		
Total	22,000	25			

Figure 17: Descriptives and ANOVA for methods and the questionnaire score (From SPSS).

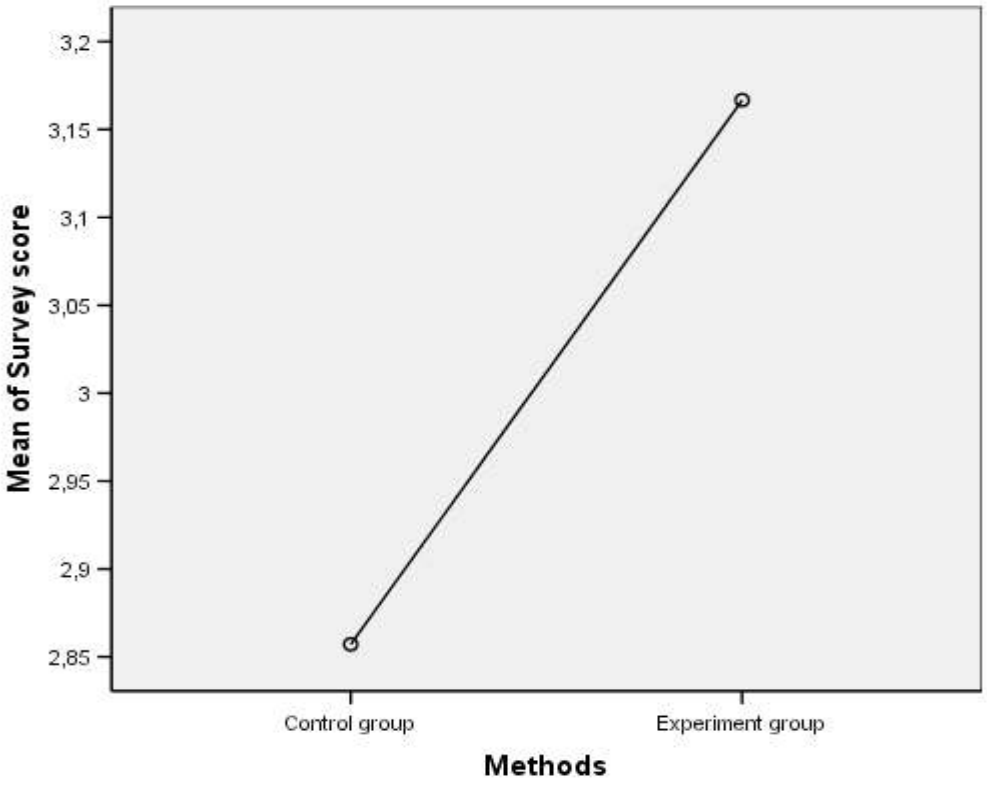

Figure 18: Means plot for methods and the questionnaire score (From SPSS).

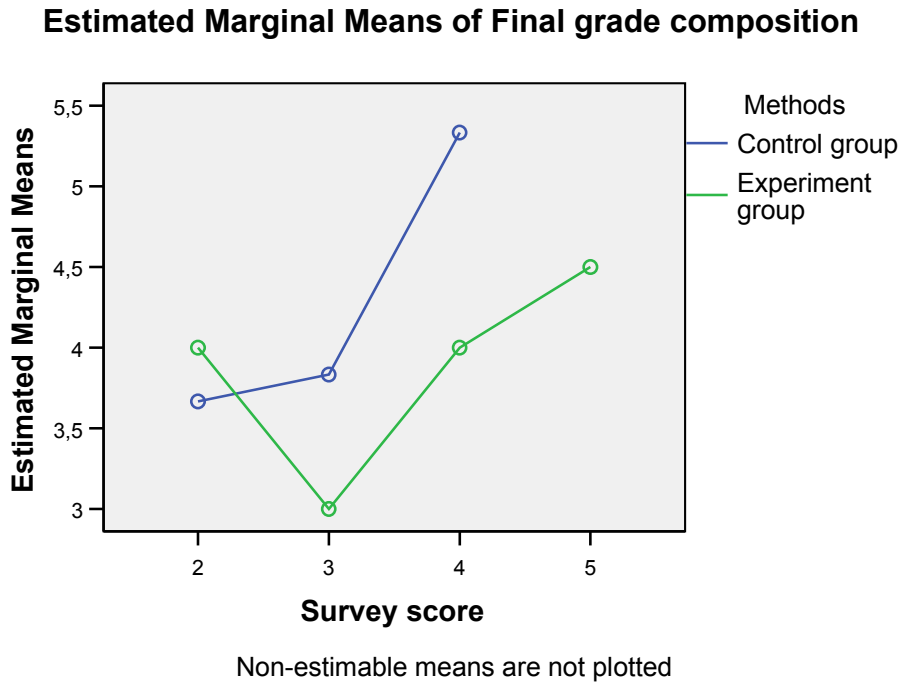

Figure 19: No difference favoring the experimental group was found between the higher scores on the questionnaire and higher scores on the final compositions (From: SPSS).

5.2.3 Possible explanations for the results

Many of the probabilities discussed in point 5.1.4 as explanations for the results may of course be applicable to the rejection of the secondary (Ho_2) hypothesis. The low number of subjects in the experimental-group available for this analysis ($n = 7$) has to be taken into account, thus expressing individual benefits from the experimental treatment statistically is difficult, and the reliability of interpretations questionable. Also, there is also reason to question to what extent more complex composing strategies may be identified within the framework of a written questionnaire, as discussed in point 3.3.3.

6. Conclusion and recommendations

This study was designed to possibly provide an example of ICT "[…]*used in mindful ways*" (Salomon and Perkins 2005) or specifically, an example of ICT used to facilitate mindful writing. This being a small-scale study, with emphasis on a non-intrusive design, rejecting one or both null hypotheses was somewhat of a leap of faith initially based on observed positive results from non-scientific implications of concept maps in learning strategies. If despite the threshold intervention approach employed, the hypotheses were to be rejected on a statistically significant level, it would have given a strong signal to comparable learning institutions and other researchers. The signal would, bar limitations of the reliability mostly due to the small number of subjects included in the research, be that electronic concept-maps were indeed tools to be considered for implementation into a learning design involving written composition.

As it stands, the main null hypothesis (Ho_1) was not rejected. No difference on a statistically significant level was found between the mean scores on the products of the control group, and the group receiving the experimental treatment. Factoring in individual composing strategies thought to benefit more from the treatment (Ho_2) did not provide significance. It must be noted however, that this study found strong indications that the experimental approach led to extended interaction with the maps, so even though this extended interaction did not result in the main null hypothesis being rejected, this finding gives a relatively strong indication for the use of ICT-based concept-mapping tools in learning strategies where extended interaction with the concept map is considered to yield probable advantages. For example through benefits of an ongoing interaction between the planning and writing phases in written composition. Explanations for the hypothesis being rejected may be found in the fact that this was a small-scale study, both in number of participants and in timescale, but also in the efforts of this researcher to implement a "true to life" threshold intervention approach with strong considerations to limiting factors present in a genuine learning environment. Such factors are among others; limited ICT infrastructure limited lecturer/teacher ICT-proficiency, limited student ICT-proficiency and limited time to implement new strategies and learn to use new ICT tools. Also, through a glitch in procedure, it is assumed that some of the students belonging to the experimental group did not reach an operational level with the ICT-based concept-mapping tool, thereby not fully reaping plausible benefits from facilitating means provided by the tool.

The incentive lent to this study by observed positive results from non-scientific implications of electronic concept maps, the research literature encountered, and theoretical platform provided, are never the less still valid. The findings showing an ongoing interaction with the concept-maps in the group receiving the experimental treatment adds to the incentive. Consequently, a longitudinal study based on a similar theoretical platform, but involving a larger population and employing a nested design for strengthened reliability, is recommended for further research based on the findings of this study.

7. Litterature

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8. Attachments

Attachment 1: Pre-test questionnaire[27]

The questions are based on Bereiter and Scardamalia's two models of composing strategies (Bereiter 1987). The questionnaire is intended to function as basis for an analysis attempting to approximately identify individual composing strategies for use in testing the secondary (Ho_2) hypothesis. The subjects answered the questionnaire electronically[28]. The questionnaire is in Norwegian, but a translation into English is provided below.

27 Both groups took part in a pre-study in the form of a survey designed to identify individual writing styles.

28 Utilizing a survey-tool available through the Learning Management System in use at the school (Fronter) Available at: http://www.fronter.com

Kva tenkjer du når du skriver?

Dette er ei spørjeundersøking til bruk i eit forskingsarbeid om bruk av IKT-verktøy i skriveprosessen. Dette er ikkje ei prøve. Svar det som fell deg inn utan å tenke for mykje over det. Det er viktig at vi får vite kva du tenkjer, så ver venleg ikkje berre svar ja eller nei.

1. Kva er det første du tenkjer når du får ei skriveoppgåve utdelt?
2. Veit du i regelen (ser du for deg) om lag kva du vil skrive nesten med ein gang du har lest oppgåva?
3. Leiter du etter idear til kva du skal skrive før du tek til på sjølve skrivinga? Om ja, korleis går du fram (tenkjer berre på det, skriv stikkord, lagar tankekart)?
4. Tenkjer du over kven som skal lese det du skriv før du tek til med skrivinga? Om ja, kva tenkjer du om det?
5. Tenkjer du over korleis du skal disponere det du skriv, altså til dømes kva som skal høyre til innleiing, hovuddel og avslutning? Om ja, kva tenkjer du om dette?
6. Får du nye idear til kva du skal skrive medan du skriver?
7. Hender det at du stopper opp fordi du ikkje veit kva du skal skrive? Om ja, korleis går du fram for å få idear til kva du skal skrive?
8. Hender det at du stopper opp for å lese det du sjølv har skreve? Om ja, kvifor?
9. Hender det at du stopper opp fordi du ikkje veit korleis du skal skrive noko, sjølv om du veit kva du skal skrive? Om ja, kva tenkjer du for å finne ut korleis du skal skrive det?
10. Er det andre grunnar til at du stopper opp? Om ja, gje døme på kva desse grunnane kan vere (sett bort frå slike ting som at du er svolten, trøytt, eller kunne tenkje deg å gjere noko anna), og korleis du då tenkjer for å kome i gang att.
11. Les du over det du har skreve? Om ja, kvifor? Gje døme på kva du ser etter når du les.

What do you think about when you write?

This is a questionnaire developed for a research-project focusing on ICT-tools in written composition. This is not a test. Answer what comes to your mind without thinking your answers over too thoroughly. It is important to us that we find out what you are thinking, so please refrain from answering the questions merely with yes, or no.

1. What are the first things that come to mind when you are handed out a text-assignment?
2. Do you generally know (envision) what you are going to write almost right away after reading the assignment?
3. Do you search for ideas as to what to write before you start the actual writing? If so, how do you go about doing so (just think, write down clues, make a mind-map)?
4. Do you make considerations as to the receiving audience of your text (who will be reading?) before you start the actual writing? If so, what are those considerations?
5. Do you plan the composition of your text, for instance what would go into the beginning, the body or the ending? If so, what are generally your thoughts on this?
6. Do you find you get new ideas on what to write as you are doing the actual writing?
7. Do you find that you stop writing because you don't know what to write next? If so, how do you go about getting new ideas?
8. Do you read back your text as you write? If so, why?
9. Do you find that you stop writing because you don't know how to write something, even though you know what to write? If so, how do you go about finding out how to write?
10. Do you find that you stop writing for other reasons? If so, please give examples of such things (not including things like you being hungry, tired, or would prefer to be doing something else), and how you go about getting back on track.
11. Do you read your own text after you are finished writing? If so, why? Please give examples of what you look for when revising your text.

Attachment 2: Expert concept map[29] used in the design

Once the writing task to be given was settled upon in cooperation between the researcher and the teacher, the design of an expert-map was worked out. The complexity of map was a subject for debate (and should be for any given assignment, dependent upon both the learning goals and the genre of text to be written). The experimental group was "handed out" the actual FreeMind file[30], while the control group was handed out a printed version attached to an A3-format blank sheet. The maps of both groups were identical except for a branch of the electronic concept-map containing keyboard shortcut tips for FreeMind, and instructions for exporting the map to the word-processor. The map was broken into two parts (right and left of the central node) over the next two pages for the purpose of this attachment.

29 See point 2.2.3.

30 The file was made available through the Learning Management System in use at the school (Fronter) Available at: http://www.fronter.com

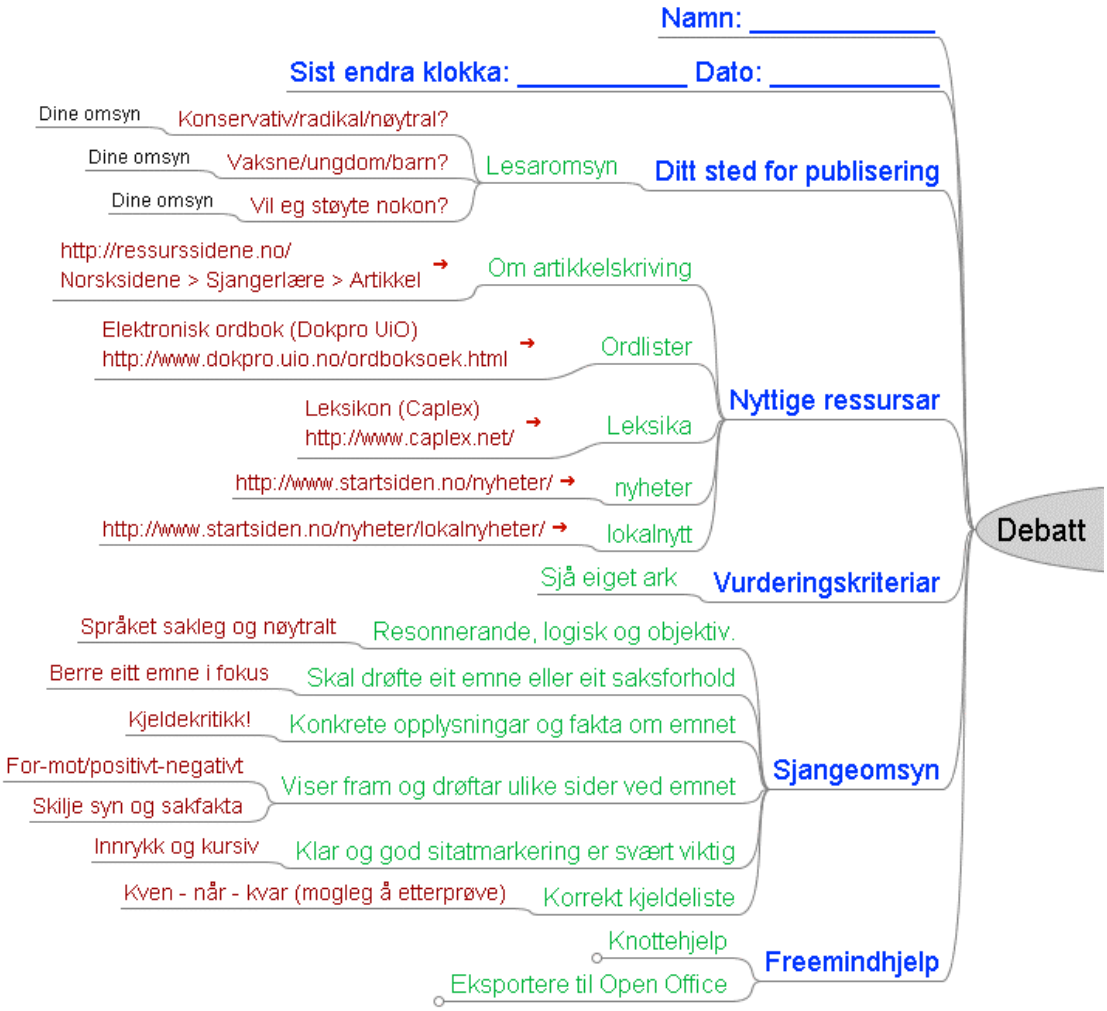


Figure 20: Expert concept map (right side of central node).

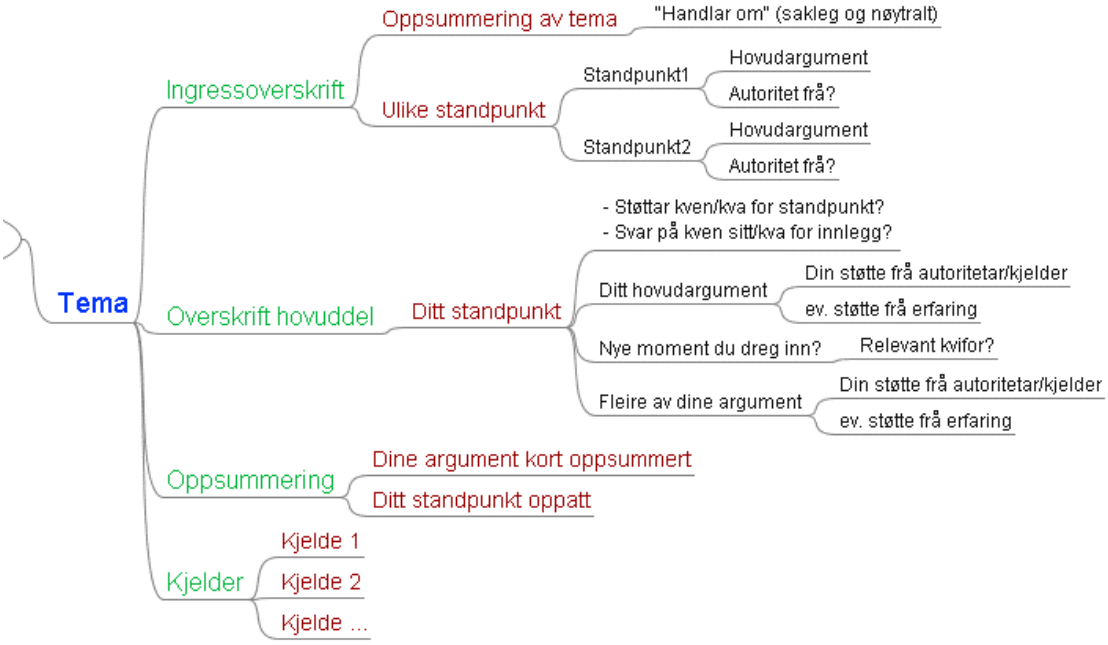


Figure 21: Expert concept map (left side of central node).

Attachment 3: Evaluation schema for the final compositions

Kopieringsoriginal

Vurderingsskjema for resonnerende tekst (artikkel, drøfting, utgreiing)

Navn:	Dato:

		Over middels (6–5)	Middels (4–3)	Under middels (2–1) (0)	Kommentarer
	Helhet/råd for videre arbeid				
		Over middels (6–5)	Middels (4–3)	Under middels (2–1) (0)	Kommentarer
Tilnærming	Originalitet/ kreativitet/ selvstendighet				
Innhold	Alle spørsmål besvart/ stoffmengde/ innsikt og perspektiv				
	Begrunnede påstander/ balansert framstilling				
Utførelse	Disposisjon/ tekstsammenheng (innledning, avslutning, logisk rekkefølge av momenter, indre sammenheng)				
	Ordvalg (variasjon, presisjon, ordforråd)				
	Inndeling i avsnitt/ syntaks				
	Ortografi/ tegnsetting/ formverk				

Figure 22: The evaluation schema used in assessing the compositions (from Halvorsen & al 1991)

Attachment 4: Additional descriptive Statistics

Frequencies

Methods

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Control group	14	53,8	53,8	53,8
	Experimental group	12	46,2	46,2	100,0
	Total	26	100,0	100,0	

Sex (M1) (F2)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	9	34,6	34,6	34,6
	Female	17	65,4	65,4	100,0
	Total	26	100,0	100,0	

A Text Approach - Creativity and autonomy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	5	19,2	26,3	26,3
	4	8	30,8	42,1	68,4
	5	6	23,1	31,6	100,0
	Total	19	73,1	100,0	
Missing	System	7	26,9		
Total		26	100,0		

B Text Content - Cogency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	3,8	5,3	5,3
	3	6	23,1	31,6	36,8
	4	5	19,2	26,3	63,2
	5	6	23,1	31,6	94,7
	6	1	3,8	5,3	100,0
	Total	19	73,1	100,0	
Missing	System	7	26,9		
Total		26	100,0		

E Text Execution - Disposition and composition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	5	19,2	26,3	26,3
	4	7	26,9	36,8	63,2
	5	6	23,1	31,6	94,7
	6	1	3,8	5,3	100,0
	Total	19	73,1	100,0	
Missing	System	7	26,9		
Total		26	100,0		

F Text Execution - Vocabulary and diction

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	3,8	5,3	5,3
	3	4	15,4	21,1	26,3
	4	7	26,9	36,8	63,2
	5	6	23,1	31,6	94,7
	6	1	3,8	5,3	100,0
	Total	19	73,1	100,0	
Missing	System	7	26,9		
Total		26	100,0		

G Text Execution - Structure and syntax

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	3,8	5,3	5,3
	3	2	7,7	10,5	15,8
	4	11	42,3	57,9	73,7
	5	4	15,4	21,1	94,7
	6	1	3,8	5,3	100,0
	Total	19	73,1	100,0	
Missing	System	7	26,9		
Total		26	100,0		

H Text Execution - Grammar and spelling

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	3,8	5,3	5,3
	3	6	23,1	31,6	36,8
	4	5	19,2	26,3	63,2
	5	6	23,1	31,6	94,7
	6	1	3,8	5,3	100,0
	Total	19	73,1	100,0	
Missing	System	7	26,9		
Total		26	100,0		

Final grade composition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	3,8	5,3	5,3
	3	4	15,4	21,1	26,3
	4	7	26,9	36,8	63,2
	5	6	23,1	31,6	94,7
	6	1	3,8	5,3	100,0
	Total	19	73,1	100,0	
Missing	System	7	26,9		
Total		26	100,0		

Assessor B Final grade composition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	3,8	5,3	5,3
	3	5	19,2	26,3	31,6
	4	7	26,9	36,8	68,4
	5	5	19,2	26,3	94,7
	6	1	3,8	5,3	100,0
	Total	19	73,1	100,0	
Missing	System	7	26,9		
Total		26	100,0		

Questionnaire score

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	9	34,6	34,6	34,6
	3	10	38,5	38,5	73,1
	4	5	19,2	19,2	92,3
	5	2	7,7	7,7	100,0
	Total	26	100,0	100,0	

Map Relevance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	3	11,5	15,8	15,8
	3	3	11,5	15,8	31,6
	4	5	19,2	26,3	57,9
	5	8	30,8	42,1	100,0
	Total	19	73,1	100,0	
Missing	System	7	26,9		
Total		26	100,0		

Map Expansion

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	7,7	10,5	10,5
	2	5	19,2	26,3	36,8
	3	9	34,6	47,4	84,2
	4	3	11,5	15,8	100,0
	Total	19	73,1	100,0	
Missing	System	7	26,9		
Total		26	100,0		

Map Revision

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	3,8	5,3	5,3
	2	1	3,8	5,3	10,5
	3	7	26,9	36,8	47,4
	4	5	19,2	26,3	73,7
	5	4	15,4	21,1	94,7
	6	1	3,8	5,3	100,0
	Total	19	73,1	100,0	
Missing	System	7	26,9		
Total		26	100,0		

Map- Substance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	7,7	10,5	10,5
	2	5	19,2	26,3	36,8
	3	4	15,4	21,1	57,9
	4	2	7,7	10,5	68,4
	5	4	15,4	21,1	89,5
	6	2	7,7	10,5	100,0
	Total	19	73,1	100,0	
Missing	System	7	26,9		
Total		26	100,0		

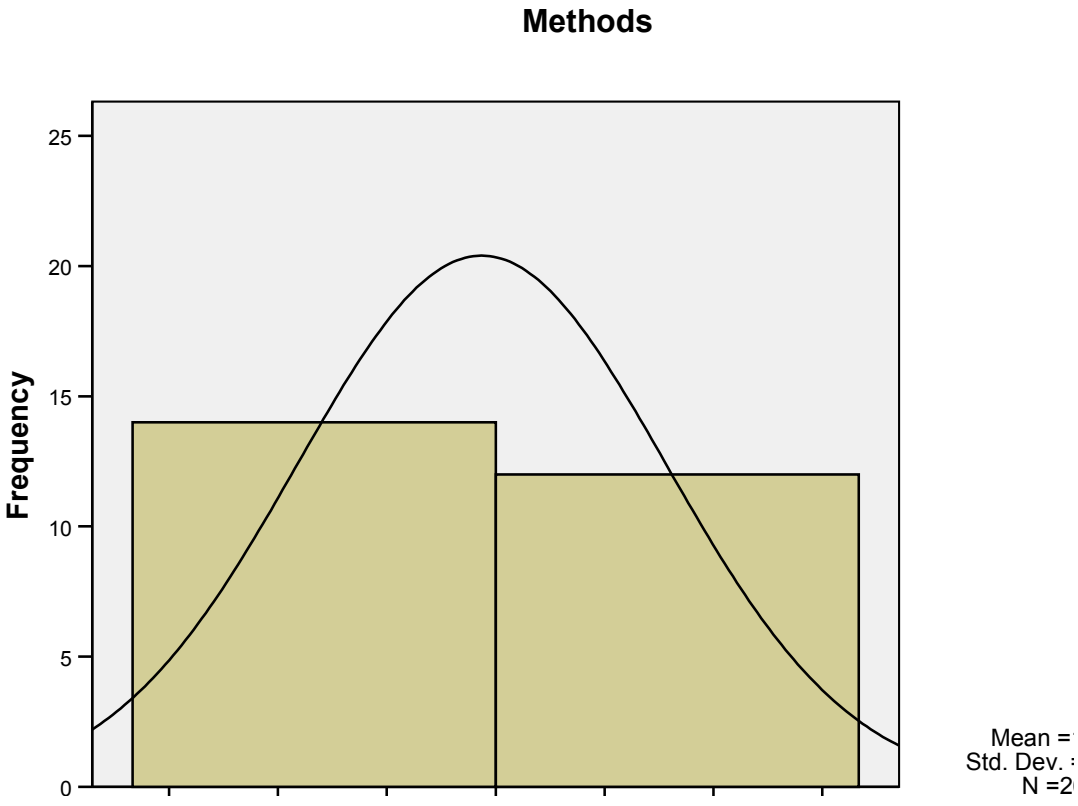
Map -Date of last revision

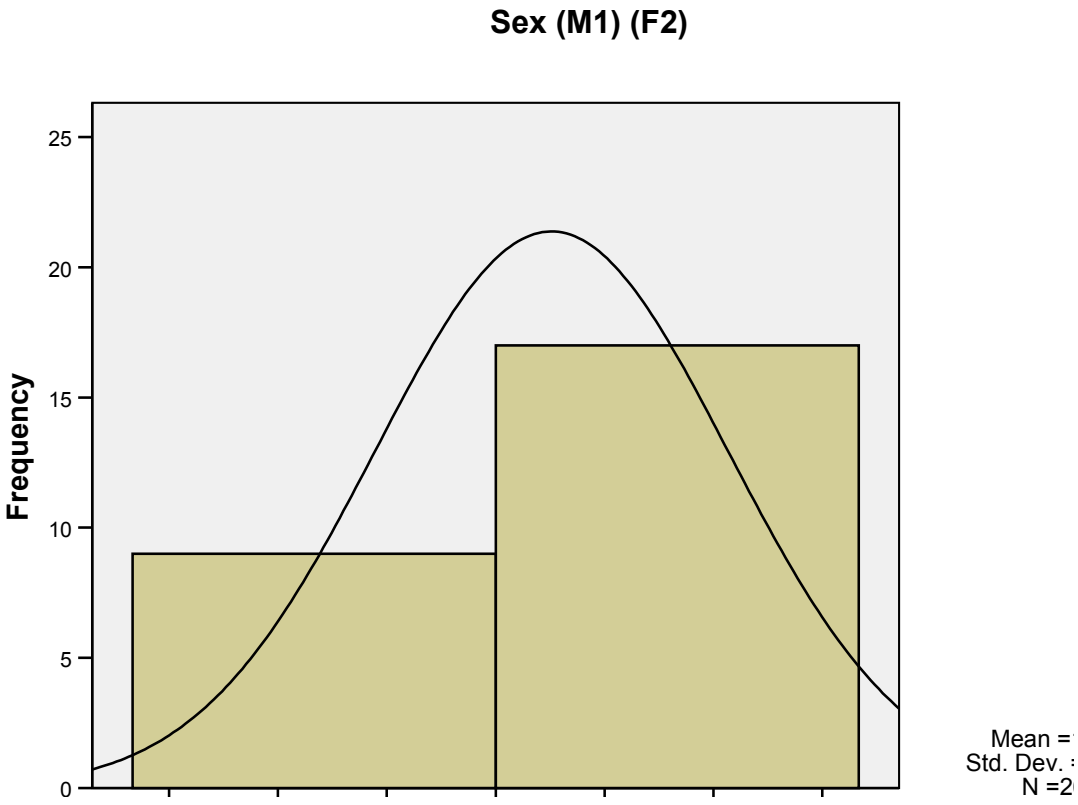
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	6	23,1	31,6	31,6
	2	2	7,7	10,5	42,1
	3	5	19,2	26,3	68,4
	5	3	11,5	15,8	84,2
	6	3	11,5	15,8	100,0
	Total	19	73,1	100,0	
Missing	System	7	26,9		
Total		26	100,0		

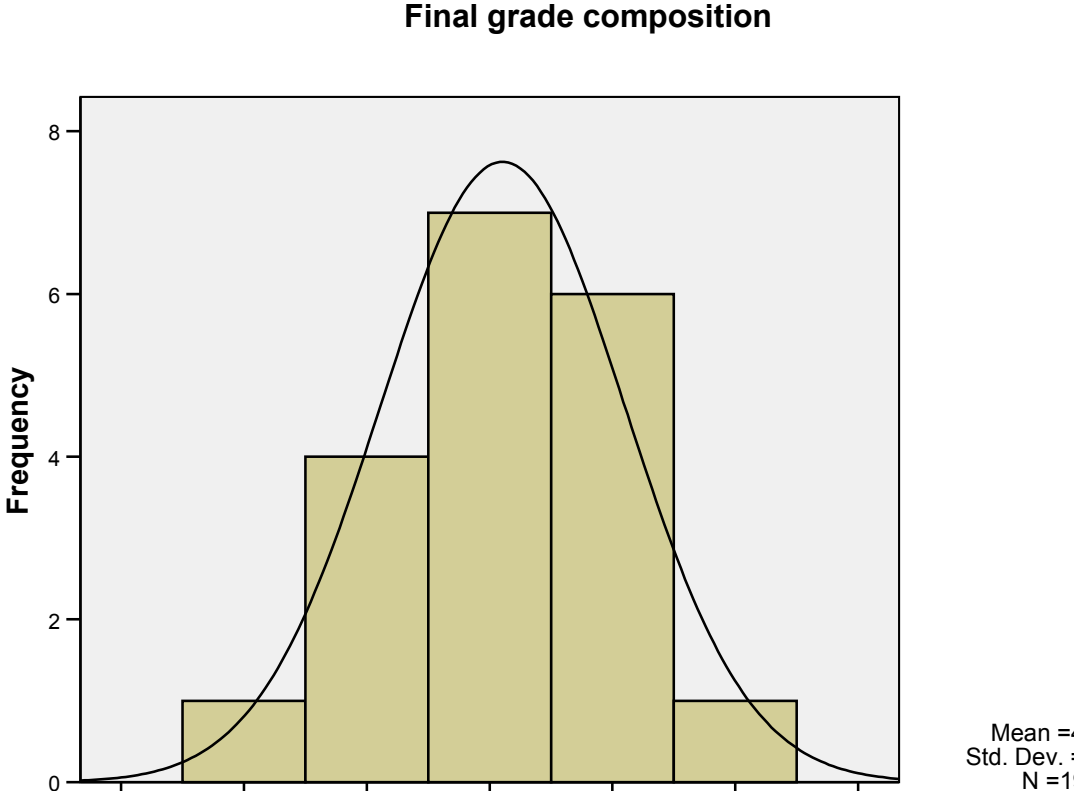
Map Mean Score

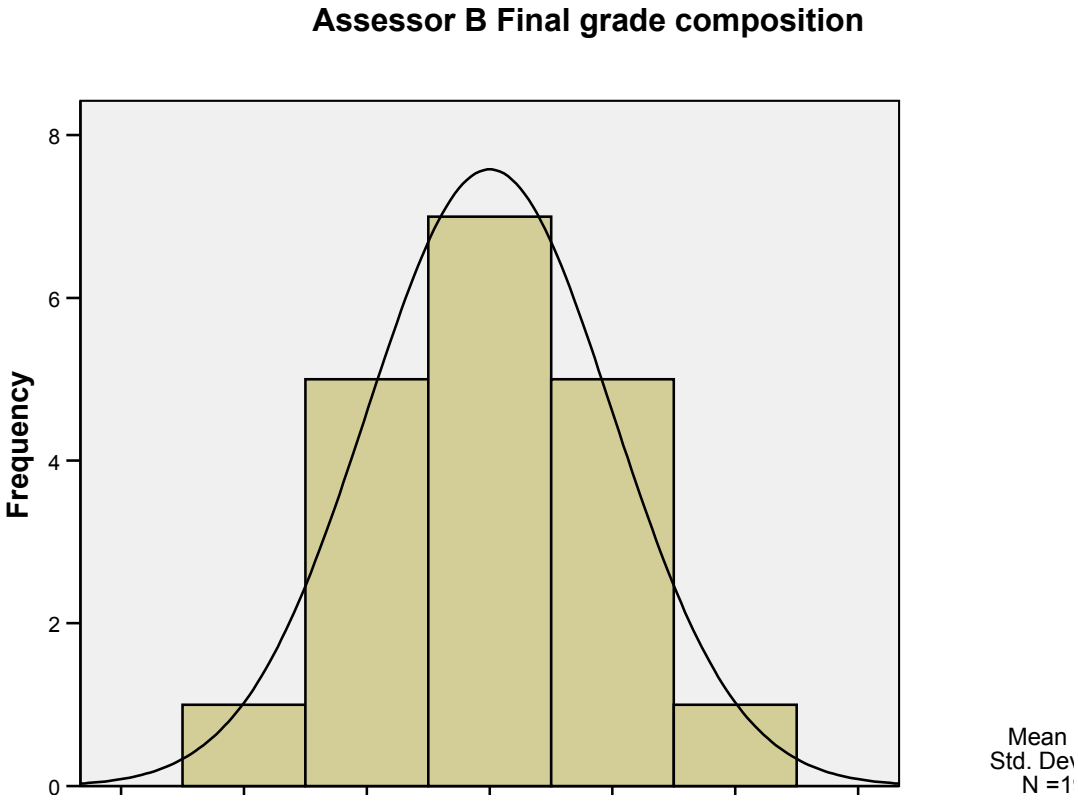
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	2	7,7	10,5	10,5
	3	3	11,5	15,8	26,3
	4	9	34,6	47,4	73,7
	5	5	19,2	26,3	100,0
	Total	19	73,1	100,0	
Missing	System	7	26,9		
Total		26	100,0		

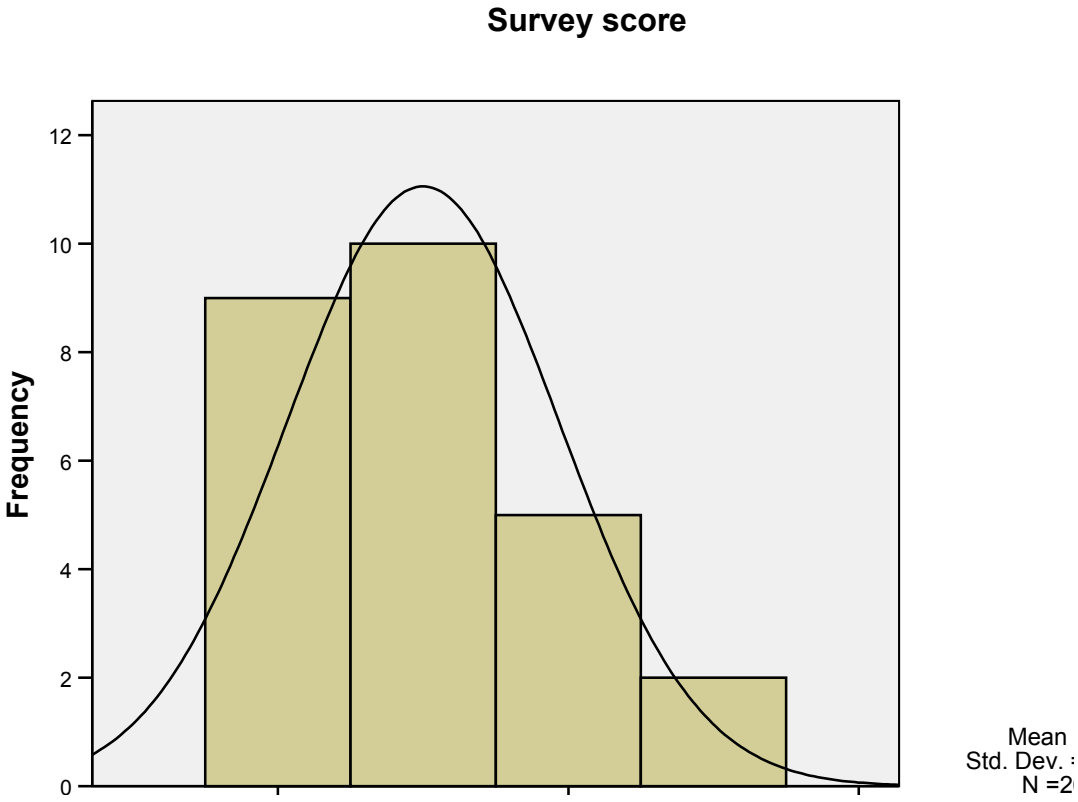
Bar-diagrams/Histograms for central data

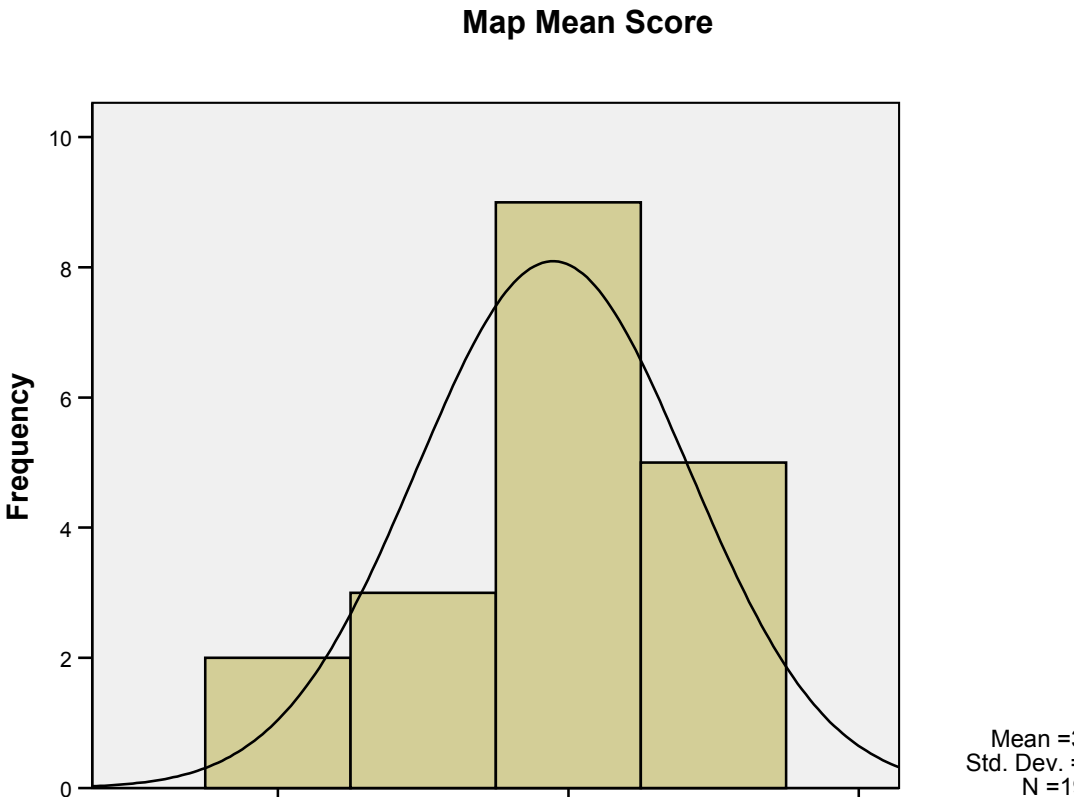



Sex (M1) (F2)
Frequency
25
20
15
10
5
0
Mean =
Std. Dev. =
N =2


Final grade composition
Frequency
8
6
4
2
0
Mean =
Std. Dev. =
N =1


Assessor B Final grade composition
Frequency
8
6
4
2
0
Mean
Std. De
N =1


Survey score
Frequency
12
10
8
6
4
2
0
Mean
Std. Dev.
N =2


Map Mean Score
Frequency
10
8
6
4
2
0
Mean =
Std. Dev.
N =1