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Computer-Based Concept Mapping as a Prewriting Strategy for Middle School Students

Shu-Yuan Lin, Jane Strickland, Beverly Ray, and Peter Denner

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Abstract

The use of computer-based concept mapping as a prewriting strategy for eighth-grade language art students was compared to paper-and-pencil concept mapping. Computer-based concept mapping was shown to enhance idea generation and the total quality of the students' prewriting concept maps in preparation for a persuasive writing task. Contrary to expectation, the students who generated paper-and-pencil concept maps scored better in persuasive writing according to the criteria contained in the state-authorized writing rubric than the students who generated computer-based concept maps.

Persuasive writing is important for students because it empowers them in their professional, ethical, and political discourse, which is central to a free society (McCann, 1989). National assessments consistently indicate the majority of students across grades 4 through 12 are unable to produce an adequate persuasive essay and that they have more difficulty with persuasive writing tasks than with other kinds of writing (Applebee, Mullis, Latham, & Gentile, 1994). Persuasive writing is challenging for middle school students because it demands higher-level thinking skills and is more difficult to organize into a coherent argument (Brukhalter, 1995; Freedman & Pringle, 1984; Nippold, 2000).

Prewriting has been shown to facilitate the writing process for all types of writing (Brodney, Revves, & Kazelskis, 1999; First & MacMillan, 1995; Hart, 1997). It is considered an important part of the writing process as it plays a vital role in the construction of writing and supports writers in setting goals, brainstorming, organizing ideas, and deciding text structure (Brodney et al., 1999; First & MacMillan, 1995; Flower & Hayes, 1981). Good writers recognize the importance of the prewriting, view it as rehearsal, and spend a longer time in planning during prewriting (Brodney et al., 1999; Hillocks, 1986). A lack of

planning may result in poor writing performance (Bourdin & Fayol, 2000).

Text organization patterns play an important role in writing (Sinatra, 2000; Wong, 1997). Concept mapping, or the creation of idealized graphic representations of text structure, can be used as a prewriting strategy for writing in the language arts classroom (Avery, Baker, & Gross, 1996; Novak & Gowin, 1984; Guastello, Beasley, & Sinatra, 2000; Sinatra, 2000). As a prewriting activity, concept mapping encourages students to "map out" their ideas prior to composing, and it allows students to translate ideas and concepts into a visual, graphical representation for writing assignments (Avery et al., 1996; Sinatra, 2000). In addition, concept mapping can be used to activate prior knowledge and to scaffold cognitive processing by assisting students to see relations among words, ideas, and categories (Sturm & Rankin-Erickson, 2002). Due to its fluency and organizing nature, it has been suggested that concept mapping is a natural tool for prewriting activities (Margerum-Leys, 1999).

The actual process of making a map, however, is the greatest difficulty in integrating concept mapping into the language arts classroom as a prewriting strategy (Anderson-Inman & Zeitz, 1993). The process of constructing a concept map is time-consuming, tedious, and sometimes frustrating for students (Schau, Mattern, Zeilik, Teague, & Weber, 2001). Learning to map effectively requires training and experience. When using paper-and-pencil maps it can also be difficult to make revisions due to the complexity of constructing a concept map. It can be inconvenient for teachers to provide appropriate feedback to students during mapping and concept maps are frequently viewed by teachers as inefficient for evaluation (Chang, Sung, & Chen, 2001) because paper-and-pencil maps are often perceived as untidy or disordered.

Recently, there has been increasing recognition that computers can be used to facilitate the concept mapping process (Anderson-Inman & Zeitz, 1993; Anderson-Inman & Ditson, 1999). The increasing availability of computer technologies in schools means middle school language arts teachers now have the potential to integrate computer technologies into their prewriting instruction. Computer-based concept mapping may be a practical way to integrate concept mapping as a prewriting strategy into the middle school language arts classroom. First, it helps students generate ideas for writing tasks (Anderson-Inman & Horney, 1996; Ditson, Kessler, Anderson-Inman, & Mafit, 2001; Plotnick, 2001). Second, it helps students organize and reorganize their ideas about the topic before receiving further writing instruction (Anderson-Inman & Ditson, 1999). Moreover, electronic concept maps are easy to construct and revise. This approach also allows students (and instructors) to customize maps in ways that are not possible using paper-and-pencil. For instance, errors in describing an idea can be corrected and modified easily and quickly (Anderson-Inman, Ditson, & Ditson, 1998; Anderson-Inman & Zeitz, 1994). In addition, this approach allows the generation of ideas to be recorded rapidly in a highly legible format (Anderson-Inman et al., 1998; Ditson, et al., 2001). Hence, computer-based concept mapping has the potential to overcome most of the disadvantages of paper-and-pencil concept mapping.

In addition, computer-based concept mapping may be particularly useful for

persuasive writing tasks. First, computer-based concept mapping not only engages students in analyzing the text organization patterns about persuasive writing, but also engages them in critical thinking about the topic they are writing (Dabbagh, 2001; Jonassen, 1996; Jonassen, Carr, & Yueh, 1998). Second, it helps students visually organize their ideas and investigate relationships of the ideas during the prewriting phase (Blair, Ormsbee, & Brandes, 2002). It also encourages students to revise or change conceptual relationships in maps and makes easy the arrangement of ideas into a persuasive format (Anderson-Inman & Zeitz, 1993; Ditson et al., 2001)

Although concept mapping has been investigated as a prewriting strategy, research in this area has been limited (Sturm & Rankin-Erickson, 2002, Zipprich, 1995). In addition, these studies have only focused on students with special needs. Furthermore, Sturm and Rankin-Erickson's (2002) study is the only one investigating the effects of computer-based concept mapping on writing. In their study, Sturm and Rankin-Erickson found that concept mapping strategies improved the writing of students qualified for special education when using either computer-generated or hand-drawn concept mapping as a prewriting strategy. To date, however, the use of computer-based concept mapping as a prewriting strategy for regular middle school students in language arts classrooms has not been investigated. In addition, although concept mapping has been investigated as a prewriting strategy for both expository and narrative writing (Sturm & Rankin-Erickson, 2002, Zipprich, 1995), it has not been investigated as a tool for improving persuasive writing. Hence, research is needed to explore further the effects of concept mapping, particularly in a computer-based format, as a prewriting strategy for broader student populations and for its effects on different writing genres.

The major purpose of the present investigation was to examine the effects of computer-based concept mapping as a prewriting strategy for middle school students' persuasive writing in the language arts classroom. In addition, this study sought to examine whether there is a significant difference among students' concept maps between computer-based and paper-and-pencil concept mapping conditions.

Methods

Participants

Participants in this study were 278 eighth-grade language arts/English students enrolled in classes during the spring of 2002 in a middle school in Pocatello, Idaho. All students and their parents or guardians gave written, informed consent prior to being considered for this study. Of the students who participated, 51% were female and 49% were male. No students withdrew from the study after the study began; however, due to absences from school because of illness or other activities, complete data was obtained for only 226 students.

Instrumentation

Two assessment instruments were used in this study: the State of Idaho's Direct

Writing Assessment rubric (DWA) and a concept map rubric developed by the Center of Electronic Studying at the University of Oregon (Ditson et al., 2001). DWA is a holistic scoring procedure using a five-point scoring standard. A rating of five, four, or three indicate that a student is writing appropriately at the grade level and a score of two, one, or zero indicates the writing sample is below grade level (Idaho Department of Education, 1999).

Students' concept maps were assessed quantitatively and qualitatively. First, the *number of ideas* (e.g., reasons, examples) in each student's map was counted. Second, the students' maps were scored qualitatively using a concept-map rubric developed by Ditson et al., 2001. Three dimensions of the quality of the students' concept maps were evaluated: (a) the quality of the thesis statement, (b) the quality of the attention getters, and (c) the total argument quality. The quality of the thesis statements and attention getters for the topic were rated using a five-point scale (0 = not valid, 1 = low, to 5 = high). Argument quality was determined by rating the relationship between reasons and examples for each argument node in the students' concept maps using a 5-point scoring scale (0 = not valid, 1 = low, to 5 = high). Adding the argument quality scores, the thesis statement score, and the attention getter score generated a *total quality* score for each concept map.

Design

The design for this study was a 2 (computer-based versus paper-and-pencil concept mapping) by 2 (teacher) by 7 (class) nested factorial design, with teacher and class serving as nested factors. Four teachers were randomly assigned to either experimental or control groups together with their intact classes of students. Under each method, the first teacher taught two classes, and the second teacher taught 5 classes. Because both teachers and classes were considered to be interchangeable with similar teachers and classes, the effects of teacher and class were treated as random effects in this design, whereas the effect for concept mapping methods was treated as a fixed effect. Pre- and postassessments on persuasive writing were administered to all participants. Preassessment scores were used as a covariate in the statistical analyses of the postassessment scores. According to McMillan (2000), this design was appropriate for this type of study and best suited when participants are in intact classes.

The quality of the concept maps generated by the students in the two concept-mapping prewriting conditions was investigated using the same nested factorial design (with no covariate). Separate analyses were conducted for the two concept-mapping measures. In addition, stepwise linear regression analysis was used to determine whether the mapping scores predicted the students' persuasive writing scores on the postassessment.

Scoring

All the raters of the students' persuasive essays were middle school language arts/English teachers working in the targeted school. Each received training in the use of the DWA to score student writing assignments. They also received

specific training in scoring persuasive writing samples. Each language arts teacher scored his/her own students' persuasive writing essays for the pre- and postassessments. In addition to the teachers' scores, a second rater, a retired English teacher from the target school, was asked to score randomly selected samples to assess inter-rater reliability. The reliability coefficient for scoring of the persuasive writing preassessment was $r = .70$ ($n = 78$), $p < .001$, and the reliability coefficient for scoring of the persuasive writing postassessment was $r = .80$ ($n = 76$), $p < .001$. Both coefficients indicate sufficient interrater agreement for the purposes of this study. Thus, the four teachers' scores were used in all analyses.

The students' concept maps were scored independently by two English-major graduate students. Both of these raters had teaching experience in college level writing classes. The two raters received three hours of training from the researcher. Training consisted of two sessions. In the first session, the researcher introduced the components of concept maps and the rubric used for the study. During the second session, the raters were trained to score concept maps using the rubric. Six concept maps were randomly selected from both control and experimental groups. The raters scored the selected maps independently. First, ideas in a given map were identified and counted. Second, the quality of thesis statement and attention getter was validated based on 5-point scoring scale. Third, the quality of relationship between reasons and examples for each argument node were scored. After they finished scoring each map, the two raters compared their results and discussed their viewpoints on the ideas, thesis statement, attention getter, and argument quality scores to maximize their agreement in scoring.

The interrater agreement for the concept-map scores was computed for the two raters using Pearson correlations. The interrater reliability coefficients were: $r = .98$ for the number of ideas, and $r = .87$ for the total quality scores. These reliability coefficients were higher than those obtained by Kessler, Ditson, Anderson-Inman, and Morris (1996) in their two previous investigations of the interrater reliability of this concept map scoring system. Hence, the interrater reliability was sufficient for the purposes of this study. The second rater's scores were selected for all the analyses.

Procedures

This study took one and one-half months. The four steps that established the sequence and delivery of this study were: preinstruction, preassessment, writing instruction, and postassessment.

Preinstruction.

Training in the use of computer-based concept mapping was conducted for both the teachers and students in the experimental group to maximize the treatment fidelity of this study. Teachers in the experimental group received one hour of training in the use of the concept mapping software, *Inspiration*, from the researcher. In addition to learning the technical skills of constructing computer-based concept maps, teachers were trained to integrate a persuasive concept map template for their prewriting instruction. After receiving training in the use of

concept mapping software, teachers then trained their students to use the computer-based concept mapping software during two periods of class time (90 minutes). During the time of training the researcher was in the classroom in case the teachers needed technical assistance in the use of the software.

Preassessment.

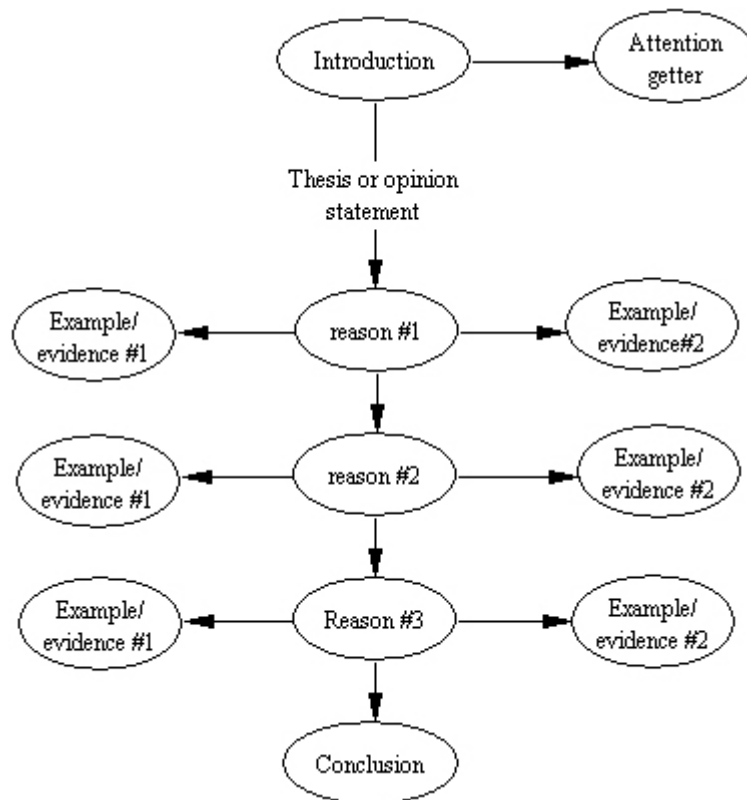
All students wrote their persuasive essays in 90 minutes, which spanned two class periods. The essays were based on a prompt that was mutually agreed upon by all four of the language arts teachers. Students in both groups responded to the writing task using paper-and-pencil. The writing prompt for this task was: Are school uniforms required? Should all middle school students be required to wear uniforms? Why or why not? Support your position with examples, explanations, and details.

Writing Instruction.

This third step provided time for students to build familiarity and skills with the concept mapping prewriting strategy used in the classroom (Jonassen, Reeves, Hong, Harvey, & Peters, 1997). The teachers in the experimental group used computer-based concept mapping as a prewriting activity in writing instruction, whereas the teachers in the control group used hand-drawn concept mapping as a prewriting strategy for persuasive writing instruction.

After receiving instruction in using the concept mapping prewriting strategy, the students in the treatment group then constructed their own concept maps on computers using *Inspiration* software. The control group did not receive the computer-based concept mapping prewriting instruction, but rather produced their concept maps using paper-and-pencil. Students in both groups were asked to construct and elaborate their concept maps based on a persuasive concept map template (see Figure 1). Once the concept maps were created, they were used to complete individual persuasive writing tasks. All students in both groups were afforded the opportunity to practice this concept mapping prewriting strategy for two or three persuasive writing tasks.

Figure 1. Persuasive concept map format.



The writing instruction in both treatment and control groups was identical. In other words, the process-oriented writing (i.e., the skills needed to write a persuasive essay) and the instructional materials were the same, except for the difference in the tool used for the prewriting activities (computer-based versus paper-and-pencil concept mapping).

Postassessment.

The administration of the post assessment was similar to that of preassessment. The writing prompt, which was created by all the four language arts teachers, was given to all the students. Again, students were given 90 minutes to complete the task. Students in the experimental group constructed their concept maps using *Inspiration* for the writing task and wrote their essays using *Microsoft Word* on computers. On average, the students in the computer-based mapping condition took $M = 25.7$ ($SD = 9.3$) minutes to complete their concept maps. Students in the control group constructed their concept maps for the writing task and wrote their essays by paper-and-pencil. On average, the students in the control group took $M = 21.5$ ($SD = 13.2$) minutes to complete their concept maps. The writing prompt was as follows: Argue for one change in your school/community/or country. For example: School-open campus, moving 6th grade up to middle school, activity period, electives; community-levy, taxes, curfews, activities for teens; country-war on Iraq, NASA, cloning, sports utility vehicles.

Results

Students' Concept Maps

The difference in concept maps between computer-based and paper-and-pencil concept mapping was examined based on two concept map measures, the number of ideas contained in the maps and the total quality of the maps, using the nested factorial design described previously. Table 1 presents the means and standard deviations for these measures by method, teacher, and class.

Table 1.

Means and Standard Deviations for Concept Mapping Measures, and Persuasive Writing Postassessment Scores by Method by Teacher by Class

Measure	Class	n	Number of Ideas		Total Quality		Writing	
			<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Paper-and-Pencil								
Teacher 1	1	12	12.92	2.71	24.00	8.68	3.50	.52
	2	15	12.60	1.84	25.33	6.30	3.07	.80
Total	3	27	12.74	2.23	24.74	7.33	3.26	.71
Teacher 2	1	16	10.44	4.83	17.50	15.28	3.13	.81
	2	15	9.20	4.16	16.53	12.97	3.13	.92
	3	15	8.60	3.07	16.67	10.91	3.33	.62
	4	18	8.67	3.46	17.17	11.40	3.89	.90
	5	13	10.23	3.77	19.38	10.84	3.46	.52
Total	5	77	9.39	3.88	17.39	12.15	3.40	.82
Total	7	104	10.26	3.81	19.30	11.53	3.37	.79
Computer-based								
Teacher 1	1	16	9.13	3.65	15.00	9.63	3.19	.91
	2	15	10.00	2.42	20.20	7.77	2.87	.64
Total	3	31	9.55	3.10	17.52	9.03	3.03	.80
Teacher 2	1	19	10.68	5.41	24.21	20.83	2.68	.82
	2	17	11.59	5.54	17.59	11.52	3.29	.59
	3	20	15.85	5.90	34.60	17.37	2.95	.83
	4	18	12.94	5.76	30.06	15.36	2.89	.90
	5	17	14.76	3.70	32.71	14.39	2.88	.70
Total	5	91	13.20	5.40	28.00	17.14	2.93	.79
Total	7	122	12.27	5.16	25.34	16.11	2.96	.79

The Method III sums of squares ANOVA for the *numbers of ideas* contained in the students' concept maps revealed a statistically significant effect for concept mapping method, $F(2, 1.94) = 42.02$, $MSE = 286.21$, $p = .03$, $\omega^2 = .15$. A statistically significant effect was also found for teacher within method, $F(2, 10.79) = 6.78$, $MSE = 38.26$, $p = .01$, $\omega^2 = .06$. The effect for classes within teacher within method was also statistically significant, $F(10, 212) = 2.24$, $MSE = 17.87$, $p = .02$, $\omega^2 = .11$. The students who developed computer-based

concept maps ($M = 12.27$) generated more ideas ($p < .05$) than the students who developed paper-and-pencil concept maps ($M = 10.26$). This means the computer-based concept mapping facilitated the brainstorming phase of prewriting and idea generation for a persuasive writing task. In addition, the results indicate that teachers influenced the number of ideas generated by their students regardless of the method of concept mapping ($\sigma^2 = 3.92$). The number of ideas generated also varied by class ($\sigma^2 = 1.38$).

The Method III sums of squares ANOVA results for the *total quality* of the students' concept maps displayed a statistically significant effect for concept mapping method, $F(2, 1.92) = 24.53$, $MSE = 1888.18$, $p = .04$, $\omega^2 = .10$, a statistically significant effect for teacher within method, $F(2, 10.85) = 4.82$, $MSE = 357.59$, $p = .03$, $\omega^2 = .04$, and a statistically significant effect for class within teacher within method, $F(10, 212) = 2.10$, $MSE = 178.11$, $p = .03$, $\omega^2 = .10$. The students in the computer-based concept mapping condition ($M = 25.34$) produced higher total quality concept maps ($p < .05$) than the students in the paper-and-pencil concept mapping condition ($M = 19.30$). Similar to the results for the number of ideas contained in the students' concept maps, the total quality findings indicate that teachers influenced the quality of students' concept maps no matter the method of mapping used by the students ($\sigma^2 = 24.20$) and that the quality of the students' concept maps varied by class ($\sigma^2 = 12.20$).

Post hoc mean comparisons using the Tukey-Kramer procedure indicated that the mean performance ($M = 28.00$) level of the students' with the second teacher in the computer-based mapping condition differed ($p < .05$) from the mean performance ($M = 17.39$) level of the students with the second teacher in the paper-and-pencil concept mapping condition. None of the other differences among the teachers were statistically significant. Inspection of the students' concept maps revealed that the students with the second teacher in the computer-based concept mapping condition closely adhered to the persuasive concept map template while the students with the second teacher in the paper-and-pencil concept mapping condition did not adhere as closely to the persuasive concept map template. Hence, the total quality scores were partly affected by adherence to the persuasive concept map template and the teachers made a difference as to whether the students followed the template.

Effect of Concept Mapping Method on Persuasive Writing Performance

The effect of concept mapping prewriting method (computer-based versus paper-and-pencil) on eighth-grade language arts students' persuasive writing was assessed using ANCOVA. The students' scores on the persuasive writing preassessment served as the covariate. Table 1 presents the means and standard deviations for the two concept mapping methods on the students' persuasive writing postassessment scores by method, by teacher, and by class.

Results of the Method III sums of squares ANCOVA showed a statistically significant effect for the prewriting covariate, $F(1, 211) = 108.19$, $MSE = .395$, $p < .01$. The effect of mapping method was statistically significant, $F(2, 5.14) = 47.08$, $MSE = .363$, $p < .01$, $\omega^2 = .17$. The effect of teacher within method was

not statistically significant, $F(2, 10.90) = .52$, $MSE = .72$, $p = .61$, $\omega^2 = .00$. The effect of class within teacher and method was statistically significant, $F(10, 211) = 1.88$, $MSE = .40$, $p = .05$, $\omega^2 = .02$. This means the students' persuasive writing scores varied by class ($\sigma^2 = .02$). Contrary to our expectations, the students who developed their concepts maps using paper-and-pencil ($M = 3.37$) performed better than the students who developed their concepts maps using the computer software ($M = 2.96$).

Relation of Concept Map Quality to Persuasive Writing

Stepwise multiple regression analysis was used to evaluate the relation of the concept mapping measures to persuasive writing. Table 2 displays the correlations among these measures. The stepwise regression was statistically significant, $F = 7.14$, $MSE = .64$, $p < .01$, $R^2 = .03$. Partially due to a high correlation between the total quality of the students concept maps and the number of ideas contained in their maps ($r = .83$), the total quality of the students' concept maps was selected as the only predictor of the students' persuasive writing scores. However, the quality of the students' concept maps accounted for only three percent of the differences in the quality of the students' persuasive writing.

Table 2.

Correlation of Concept Mapping Scores with Persuasive Writing Postassessment Scores (n = 226)

Variable	Total Quality	Postassessment Writing
Number of Ideas	.83**	.12*
Total Quality		.18**

* $p < .05$. ** $p < .01$

Discussion

This study compared the effects of computer-based concept mapping with paper-and-pencil concept mapping as a prewriting strategy for middle school students' persuasive writing. Examination of the students' concept maps revealed the students in the computer-based concept mapping condition generated more ideas than those in the paper-and-pencil concept mapping condition. This outcome supports the findings of the studies by Anderson-Inman et al. (1998) and Ditson et al. (2001) that brainstorming through an electronic method is beneficial for rapid, legible, and organized generation of ideas.

In addition, the students in the computer-based concept mapping condition produced better total quality concept maps than the students in the paper-and-pencil concept mapping condition. Previous studies of computer-based concept mapping (Dabbagh, 2001; Okebukola & Atkinson, 1992; Jonassen et al., 1998;

Jonassen et al., 1997) have shown that computer-based concept mapping can serve as a cognitive tool that enhances students thinking, develops students' problem-solving and reasoning skills, and helps to transfer these skills to a set of similar problems. In concert with these studies, the present investigation showed that computer-based concepts maps, when compared to paper-and-pencil concept maps, enhanced the students' prewriting argument structure in terms of the quality of the students' thesis statements. This approach also improved the quantity and quality of the relationships between reasons and examples and the quality of the planned attention getters. The present findings also extend those of the previous investigations to language arts classrooms where middle school students are engaged in thinking and reasoning in preparation for a persuasive writing task.

In conjunction with the differences in concept mapping between the treatment conditions, we found both the number of ideas generated and the total quality of the students' concept maps were influenced by their teachers. Sinatra (2000) has advocated the use of a scaffolding design or map template when concept maps are used for prewriting purposes. Hence, as part of their training, the teachers for both concept mapping conditions in the present study were provided with a map template for a persuasive argument structure and were asked to train their students to follow the map template during their prewriting. Inspection of the students' concept maps suggested that the locus of the difference between the two teachers under the two mapping conditions was due to how closely their students had followed the persuasive writing concept map template. The students who followed the template had higher quality concept maps and generated more ideas than the students who did not, particularly in the computer-based concept mapping condition. The results support Sinatra's (2000) advocacy of the use of map templates. Clearly also, as noted by Novak and Gowin (1984) and Ferry, Hedber, and Harper (1997), the integration of concept mapping tools in the classroom requires careful instruction.

Finally, we examined the effects of computer-based concept mapping versus paper-and-pencil concept mapping on the quality of the middle school students' persuasive writing. Contrary to our expectation, students in the paper-and-pencil condition obtained higher persuasive writing scores than the students in the computer-based concept mapping condition. This finding is troublesome in light of the fact that the students in the computer-based concept mapping condition were better prepared for the persuasive writing task in terms of both the quantity and the quality of their prewriting preparation.

The unexpected result might have been due to how the students allocated their time during the phases of the writing task. The task of persuasive writing is highly linguistically and cognitively demanding (Knudson, 1992, Nippold, 2000). Not only must students be prepared to write persuasively, they must also have sufficient time to produce their essays with careful attention to the mechanical and linguistic aspects of their writing. In this study, the students in the computer-based mapping condition spent four minutes more on average in prewriting than did the students in the paper-and-pencil mapping condition. This may have been due in part to the longer time needed for keyboarding compared to hand writing (presumably the latter would be faster for most students). In addition, the fun of

using the computer software for the prewriting activity may have distracted and delayed some students from the persuasive writing task itself. Because it was important to keep the total amount of time constant for both of the treatment conditions in this study, the entire persuasive writing task was constrained to ninety minutes, which is also the time limit set for the state's Direct Writing Assessment for middle school students. However, this meant the students in the computer-based concept mapping condition may have spent less time in their actual writing of their persuasive essays than the students in the paper-and-pencil concept mapping condition, which may have led to the difference in their persuasive writing scores.

The unexpected result might also have been due to the criteria used to judge the quality of the students' persuasive writing. In this investigation, we employed the state rubric for persuasive writing required for middle school students. Although the rubric employs holistic writing categorizations, it specifies focused criteria as the basis for the categorizations. The focused criteria called for the assessment of many factors such as spelling, punctuation, word choice, grammar, use of figurative language, the overall ease of reading, and whether the details and examples were interesting. Unfortunately, the logical development of the argument was addressed as only a single criterion. Almost no credit was given in the state rubric for the number of ideas the students used to support their persuasive arguments or for the quality of the relationships between the students' reasons and examples offered in support of their positions on the issues. Hence, in general, the criteria focused more on the mechanics and the surface linguistic aspects of writing than on the quality of the students' persuasive argument structures and critical reasoning in support of their arguments. Zipprich (1995) found the use of a concept map as a prewriting activity did not make a difference to students' sentence structure or to the mechanics of their writing, although it did enhance their writing in terms of the components of a good story. Clearly, the state rubric used in this investigation may not have given the students sufficient credit for the key elements of their persuasive writing preparation that were enhanced by the computer-based concept mapping format.

Further investigation is needed to explore the effects of computer-based concept mapping as a prewriting strategy for persuasive essays using different writing assessment rubrics. For example, Toulmin's (1958) criteria may better capture the nature of persuasive writing. Unfortunately, even if computer-based concept maps are shown to have a positive effect on persuasive writing when different scoring criteria are used, it is unlikely teachers will decide to take the time to use computer-based concept mapping if they are primarily accountable for their students' writing performance quality when scored using the state's rubric. Hillocks (2002) has termed this problem as "the testing trap," whereby state assessments control both students' learning and teachers' writing instruction.

About the Author

Shu-Yuan Lin is a visiting instructor and coordinator of the Instructional Materials Center in the College of Education at Idaho State University. She

received her doctoral degree from Idaho State University in Educational Leadership with a focus on Instructional Technology. She is past chairperson of the Applied Foreign Languages Department at Chin Min College in Taiwan. She also taught English there for several years. Her research interests include technology integration in language arts and cultural-linguistic aspects of English language learners.

Send Correspondence to:

College of Education
Box 8059
ISU
Pocatello, ID 83209

or

Email:
linshu@isu.edu

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