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A Scaffolding Tool to Assist Learners in Argumentation Abilities

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Abstract: That graphic organization, such as concept mapping and argument maps, could help students develop better argumentation abilities and build. In this study, we designed the "computer-aided argumentative essay writing system" to help students learn argumentation structures to enhance their argumentation. This study conducted an experiment on students in an elementary school in New Taipei City for one semester. There were 11 classes in total, and we divided them into three groups: the argument map group, the concept map group, and traditional argumentative group. we have observed the growth and the change of the argumentation skills of the three groups. For the experimental results, we found the argument map group's argumentation skills better than those of the students in the other two groups.

Keywords: Argument map, argumentation, graphic organization, scaffolding.

1. Introduction

The writing of an argumentative essay is for authors to provide their viewpoints, use persuasive arguments, and persuade readers to support the authors' standpoints. Persky, Daane, and Jin (2003) mentioned in their survey that argumentative writing is not easy for students in elementary, junior high, and even senior high schools, for the incomplete argumentation in their writing could not effectively persuade their readers (Golder & Coirier, 1996). Wingate (2012) was surprised at the fact that the teaching of argumentative writing mostly emphasized rhetorical and linguistic structures but paid less attention to the organization of argumentation. Organization of argumentation is very important in an argumentative essay. Koh (2004) indicated that one of the reasons for students to fail to perform well in argumentative writing is their lack of knowledge about good argumentation; therefore, they cannot integrate related evidence, results, and opinions, and thus they cannot eventually form an argumentative essay.

Evidence indicates that graphic organization may help students develop better argumentation abilities (Buzan & Buzan, 2000). Each set of the graphic organization includes different thinking and building strategies (Santiago, 2011). Graphic organization differs from argument mapping due to their different strategies of self-organization and different methods to present each claim. The arguments for and against the claims are the graphical nodes that could be linked together. Moreover, the relations between these nodes are not cause-effect ones but defense-and-rebuttal ones related to the claims. Therefore, one can always review whether the process of reasoning is logical or evaluate the comprehensiveness and depth regarding the issue to be examined. Two kinds of graphic organization tools—a concept map and an argument map—were used in this study. A concept map was a popular graphical tool that connects a concept and its sub-concepts in a hierarchy and creates a certain relation between them. An argument map is a new argumentation tool that could illustrate a series of supporting and opposing reasons centering upon the claims (Van Gelder, 2002).

The development of information technology has made the formation of graphic organization transcend the limit of printed forms. Users can build or view their digitalized graphic organization any time as long as they have a digital device. In addition, graphic organization contains different colors and shapes to express different contexts and implications. The selection of these colors and

shapes has become the default function of the digital graphic organization, and the function makes it easier for users to build their digital graphic organization (Li, 2015).

Our study aims to help students visualize the thinking process of argumentation formation and build their argumentation effectively. We used the advantages of digital graphic organization to design our systems. We hope to assist novices in building an argumentative structure and learning the argumentation abilities. We also hope to help students understand the process of producing the argumentation for an argumentative topic. One of an argument map's advantages is the map's provision of an argumentative structure (claim, reason, and evidence), and we employed this advantage to design the "computer-aided argumentative essay writing system (CAEWS)" In addition to the graphically organized argument map, we added conspicuous argumentation boxes (claim, reason, and evidence) (see Figure 1). An argumentation box is a tool for students to thought their argumentative structures and to assist them in writing argumentative essays. The main purpose of this study is to discuss the effectiveness of enhancing the argumentation ability by using the CAEWS. The main purpose of this study is to discuss the effectiveness of enhancing the argumentation ability by using the CAEWS. We were provided sixth training activity for the three groups, and we have observed the growth and the change of the argumentation skills of the three groups in the training activity.

2. Literature Review

2.1 Argumentation

Argumentation is a method used to understand issues and reveal the importance of issues (Kuhn, 2005). The major guiding component of the method advanced by Halpern (1998) to develop the critical-thinking ability is argumentation (Beyer, 1995). Effective argumentation requires arguments with supporting and opposing claims (Kuhn, 2005). Related studies indicated that children also have the abilities to express their viewpoints (Anderson, Chinn, Chang, Waggoner, & Yi, 1997) and to understand the argumentative structure (Chambliss & Murphy, 2002). However, some research also showed that most people do not have a good argumentation ability; offering related evidence to support a claim or raising an argument with opposing claims is difficult to them (Kuhn, 2005). Perkins (1985) also discovered that students' argumentation ability does not improve with the growing of their age and knowledge. Researchers of education also noted that it is very difficult for teachers to give the opportunities to improve argumentation abilities to students because they seldom participate in the process of argumentation with students even though the teachers are in charge of the course progress (Newton, Driver, & Osborne, 1999).

2.2 Using Graphic Organization to Learn Argumentation

Argumentation is the process in which a person would provide evidence and illustrate reasoning to support his or her claims when he or she makes claims about certain issues. Many studies indicated that using graphic organization to visualize a thinking process could effectively build argumentation (Hyerle & Yeager, 1995). Graphic organization as concept maps can help students develop good argumentation abilities (Buzan & Buzan, 2000). Lin, Strickland, Ray, and Denner, (2004) used concept maps to help students learn argumentation when writing argumentative essays. Based on cognitivist David Ausubel's assimilation learning theory (Novak & Gowin, 1984), distinguished American educators Joseph Novak and Gowin (1984) developed a technique termed the "concept map" to help students learn, think, and understand the knowledge they acquire. A concept map is a hierarchical cognitive structure with links between the main concept and sub-concepts. Students can construct their cognitive structure with a concept map. The concept map is a popular tool of graphic organization that has been applied to various fields as reading comprehension, writing, the learning of foreign languages, social studies (Santiago, 2011) and so on. Other related studies discovered that argument maps are an effective tool for developing the argumentation abilities (Negari, 2011) that can be used to illustrate a series of supporting and opposing inferences surrounding a claim (Van Gelder, 2002). With the argument map, students can organize arguments in an article to advance their inferences (Butchart, 2009). Arguments are constructed in the shape of a pyramid (Toulmin,

2003). An argument map could direct all supporting and opposing discourses to the claims in colored boxes linked by arrows so that one can realize the relations between claims and discourses. Chiang, Fan, Liu, & Chen (2016) used argument maps to help students build argumentative structures to improve students' reading comprehension of argumentative essays. Although many studies used concept maps or argument maps to help learners learn argumentation, we found very few studies examining the difference between a digital argument map and a digital concept map.

3. System Design and Implementation

Our study aims to enhance writing learners' argumentative abilities in their construction of argumentation. We designed the CAEWS to help the novices of argumentation understand the process of constructing the argumentation of an argumentative topic, establish the structures of argumentation, and finally produce argumentative essays with better argumentation. The system has two major functions: the function to build an argument map and the function to preview an essay (see Figure 1).

Figure 1. A screenshot of the CAEWS.

The function to build an argument map can assist users in constructing argumentative structures. As a tool for students to brainstorm and create argumentative structures, the "digital argument map" could concentrate students' argumentation. The students could not easily lose their argumentation. We used the three basic elements of argumentative essays, "claims, reasons, and evidence," as the framework of the digital argument map. We used the three basic elements as the

linking words of nodes to have writing students think step by step. There is no arbitrary sequence in establishing supporting and opposing reasons and evidence, but teachers could guide students to build a structure successively. In addition, students can use the "save" button to save their latest graphic organization and load the previous argument map for review and revision. Also, the teacher could revise students' works and provide examples.

The function to preview an essay helps users create essays. In order to help writing learners demonstrate their essays immediately after they finish constructing their argumentative structures, the digital argument map provides two functions: "paragraph description" and "paragraph organization." The former focuses on the separate detailed depictions of "claims, reasons, and evidence;" users can either write a complete sentence or a full paragraph. The latter is to help learners transform the established argumentative structures into essays. The order of paragraphs would follow the order of graphical organization, yet learners are free to edit the order. Finally, the "preview" function in the system allows learners to examine the completeness and fluency of their essays. In the meantime, they can read the essay and the argument map together and cross-examine the reasoning of the essay. The demonstration of the essays and the corresponding argument maps displayed at the same time would help others realize the authors' thinking frames; ideas have become visible. The teacher could review and revise students' works, and the students could improve the shortcomings of their essays.

The CAEWS designed in this research is a web-based system; users can get access to the system via various digital devices. The structure of the system consists of the front-end and back-end systems. The former is the users' interface, and the latter is the server and database. We used several program languages including HTML5, CSS3, JavaScript, and jQuery to design the front-end interface in order to better interact with users. As to the back-end server, we used ASP.NET to establish the information communication with and the data access to the MSSQL database. MySQL was used as the database server to access the graphical structures, the content of the essays, users' information, and other data.

4. Methodology

4.1 Participants

In this study, we recruited 272 sixth-grade students in 11 classes at an elementary school in New Taipei City to conduct an experiment. The students in the 11 classes were randomly assigned to one experimental group and two control groups. The three groups comprised 113, 81, and 78 students, respectively. Eight students with special educational needs were included in the learning process, but they were not included in the experimental results.

4.2 Design

The traditional argumentative writing system, the concept map writing system, and the argument map writing system were compared in an experiment lasting for one semester. The experiment included argumentative essay teaching, the teaching of different teaching strategies, training and interviews with teachers and students.

We used a nonequivalent posttest design. The posttest scores were used as the dependent variable, and the teaching strategies used served as independent variables. The group using the argument map writing system was labeled Group 1, the group using the concept map writing system was labeled Group 2, and the group using the traditional argumentative writing system was labeled Group 3.

4.3 Materials

Before the training process, the three groups were taught how to build an argumentation structure. Both the researchers and the elementary school teachers designed the teaching materials, which included the tool to teach the organization of argumentative essays and to demonstrate a model

article. The model article was derived from elementary school textbooks of Chinese. In the experiment, all students required some time to learn and familiarize themselves with the operation of the proposed system.

4.4 Procedure

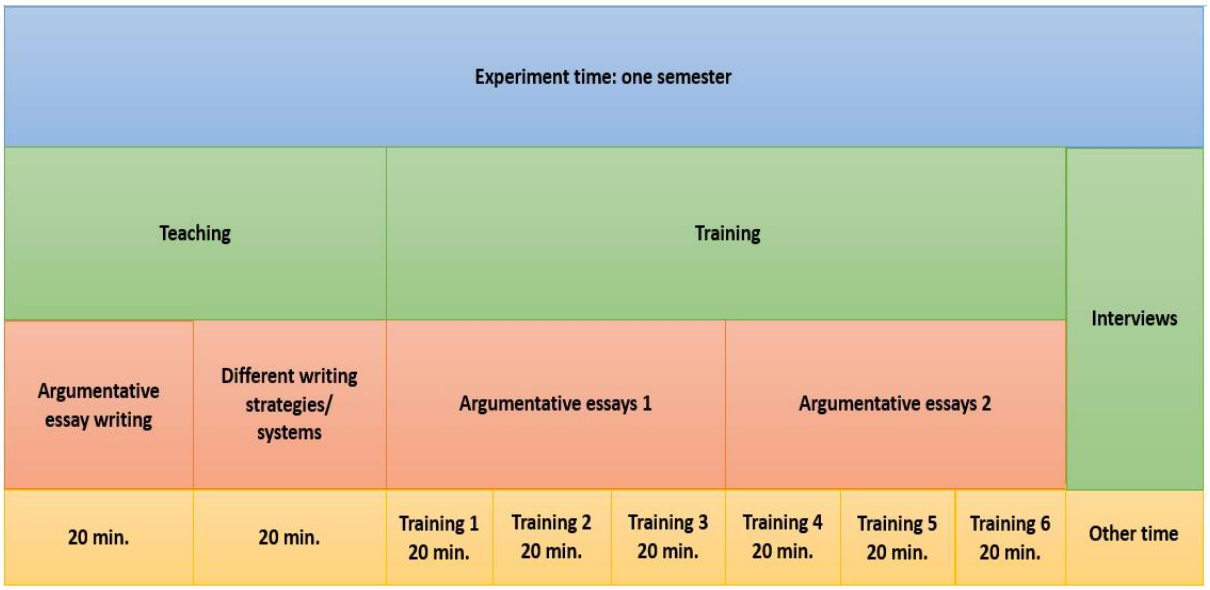

Figure 2. Experimental procedure

Table 1

Grading standards of the six writing exercises

	Score	Comment
Claims	1	Without any claim
	2	With claims, yet claims do not accord with the issue
	3	With claims that accord with the issue
Supporting and opposing reasons	1	Without supporting/opposing reasons
	2	With supporting/opposing reasons, yet the reasons do not accord with the claims
	3	With supporting/opposing reasons that accord with the claims
Supporting and opposing evidence	1	Without supporting/opposing evidence
	2	With supporting/opposing evidence, yet the evidence does not accord with the reasons
	3	With supporting/opposing evidence that accords with the reasons

The experiment lasted for one semester and included the following processes: the teaching of the framework and the demonstration of the organization of argumentative essays (20 min.), the teaching of the system and the explanation of traditional argumentative learning, concept mapping strategies, and argument mapping (20 min.), six training sessions (20 min. for each), and interviews with teachers and students (60 min.) (see Figure 2). All students were randomly assigned to different experimental groups. The Chinese language teachers instructed the students on how to understand the organization of argumentation and presented an article for demonstration in the second week. In the third week, the researchers taught the students in all groups about the traditional argumentative framework, the meanings of concept maps, the usage of concept maps, the operation of the concept mapping system, the meanings of argument maps, the usage of argument maps, and the operation of the argument mapping system. The training class began in the third week. During the training class, the students were instructed in a computer classroom. The teacher guided the students through the article structure once and then instructed them to build an argumentation structure. The teacher and the researchers helped the students solve problems during the self-learning period. This training

course was conducted for 6 weeks. One week after the training course, 11 teachers and 10 students were interviewed for one hour.

The six training course exercises aim to enhance students' argumentation ability. In this study, we would evaluate students' performance on their argumentation ability and examine the improvement. Thus, the grading standards in Table 1 were adopted for the evaluation and the examination.

5. Experimental Data Collection and Analysis

Table 2

Descriptive statistics of the three groups' scores of training

	Training	1st	2nd	3rd	4th	5th	6th
Structures	Group	Mean/SD	Mean/SD	Mean/SD	Mean/SD	Mean/SD	Mean/SD
Claims	Group 1	**1.097/.033**	**2.097/.081**	**2.354/.082**	**2.566/.075**	**2.814/.069**	**2.832/.064**
	Group 2	1.062/.039	2.049/.096	2.222/.097	2.012/.089	2.099/.082	2.519/.076
	Group 3	1.038/.040	1.436/.098	1.987/.099	2.090/.090	2.256/.083	2.359/.077
Supporting reasons	Group 1	1.000/.015	**2.088/.069**	**2.611/.072**	**2.504/.077**	**2.823/.073**	**2.832/.066**
	Group 2	1.049/.018	2.062/.082	2.309/.085	2.247/.091	2.321/.086	2.593/.079
	Group 3	1.013/.018	1.154/.083	1.615/.086	1.756/.093	2.051/.088	2.321/.080
Supporting evidence	Group 1	1.000/.000	**1.779/.062**	**2.204/.070**	**2.221/.057**	**2.540/.057**	**2.566/.070**
	Group 2	1.000/.000	1.296/.073	1.370/.083	1.037/.067	1.012/.067	1.309/.083
	Group 3	1.000/.000	1.064/.074	1.256/.085	1.141/.068	1.346/.069	1.744/.085
Opposing reasons	Group 1	1.000/.000	**1.478/.063**	**2.239/.078**	**1.274/.064**	**2.487/.077**	**2.575/.080**
	Group 2	1.000/.000	1.469/.075	2.062/.092	1.469/.076	1.556/.092	1.864/.094
	Group 3	1.000/.000	1.103/.076	1.179/.093	1.115/.077	1.372/.093	1.577/.096
Opposing evidence	Group 1	1.000/.000	**1.274/.037**	**1.761/.052**	**1.195/.040**	**2.159/.057**	**2.274/.064**
	Group 2	1.000/.000	1.074/.043	1.074/.061	1.025/.048	1.000/.068	1.086/.075
	Group 3	1.000/.000	.962/.044	1.013/.062	1.026/.049	1.090/.069	1.256/.077

Table 3

ANCOVA results of the three groups

Training	1st	2nd	3rd	4th	5th	6th
Structures	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
Claims	.511	**.000**	**.019**	**.000**	**.000**	**.000**
Supporting reasons	.098	**.000**	**.000**	**.000**	**.000**	**.000**
Supporting evidence	./.	**.000**	**.000**	**.000**	**.000**	**.000**
Opposing reasons	./.	**.000**	**.000**	**.005**	**.000**	**.000**
Opposing evidence	./.	**.000**	**.000**	**.006**	**.000**	**.000**

One major objective of this study was to determine whether the proposed CAEWS could improve the argumentation ability of sixth-grade elementary school students. Table 2 lists the statistical results regarding the six training courses for all groups. Another major objective of this study was to compare Group 1, Group 2, and Group 3 to determine whether they exhibited differences in the improvement of their argumentation ability in the six training courses. Because the students were randomly assigned to different experimental groups, we adopted a nonequivalent posttest design to prevent the students' inherent learning abilities from influencing the scores of training.

Therefore, we used ANCOVA statistical control methods. Table 3 shows the ANCOVA results, indicating that the independent variable (teaching methods) significantly influenced the

dependent variable. Furthermore, the posttest scores were strongly affected by the experimental manipulations applied to the students. Because the ANCOVA result reached statistical significance (0.05). Table 4 lists the post hoc comparison results for ANCOVA. The results revealed that Group 1 demonstrated superior argumentation performance compared with Groups 2 and Group 3.

Table 4

The results of post hoc comparison

		Training	1st	2nd	3rd	4th	5th	6th
Structures	(I) Group	(J) Group	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
Claims	Group 1	Group 2	.489	.703	.303	**.000**	**.000**	**.002**
		Group 3	.258	**.000**	**.005**	**.000**	**.000**	**.000**
	Group 2	Group 1	.489	.703	.303	**.000**	**.000**	**.002**
		Group 3	.678	**.000**	.092	.541	.177	.143
	Group 3	Group 1	.258	**.000**	**.005**	**.000**	**.000**	**.000**
		Group 3	.678	**.000**	.092	.541	.177	.143
Supporting reasons	Group 1	Group 2	.034	.803	**.007**	**.031**	**.000**	**.021**
		Group 3	.584	**.000**	**.000**	**.000**	**.000**	**.000**
	Group 2	Group 1	**.034**	.803	**.007**	**.031**	**.000**	**.021**
		Group 3	.148	**.000**	**.000**	**.000**	**.029**	**.016**
	Group 3	Group 1	.584	**.000**	**.000**	**.000**	**.000**	**.000**
		Group 2	.148	**.000**	**.000**	**.000**	**.029**	**.016**
Supporting evidence	Group 1	Group 2	.	**.000**	**.000**	**.000**	**.000**	**.000**
		Group 3	.	**.000**	**.000**	**.000**	**.000**	**.000**
	Group 2	Group 1	.	**.000**	**.000**	**.000**	**.000**	**.000**
		Group 3	.	**.026**	.337	.278	**.001**	**.000**
	Group 3	Group 1	.	**.000**	**.000**	**.000**	**.000**	**.000**
		Group 2	.	**.026**	.337	.278	**.001**	**.000**
Opposing reasons	Group 1	Group 2	.	.929	.141	**.050**	**.000**	**.000**
		Group 3	.	**.000**	**.000**	.114	**.000**	**.000**
	Group 2	Group 1	.	.929	.141	**.050**	**.000**	**.000**
		Group 3	.	**.001**	**.000**	**.001**	.161	**.033**
	Group 3	Group 1	.	**.000**	**.000**	.114	**.000**	**.000**
		Group 2	.	**.001**	**.000**	**.001**	.161	**.033**
Opposing evidence	Group 1	Group 2	.	**.000**	**.000**	**.007**	**.000**	**.000**
		Group 3	.	**.000**	**.000**	**.008**	**.000**	**.000**
	Group 2	Group 1	.	**.000**	**.000**	**.007**	**.000**	**.000**
		Group 3	.	.070	.483	.989	.353	.115
	Group 3	Group 1	.	**.000**	**.000**	**.008**	**.000**	**.000**
		Group 2	.	.070	.483	.989	.353	.115

6. Discussion

In this study, we used a traditional argumentative writing system, a concept map writing system, and an argument map writing system to improve students' argumentation ability. The experimental results (Tables 2, 3, and 4) revealed that Group 1 demonstrated superior results compared with the two control groups regarding the improvement in argumentation abilities. This result is explained as follows. In table 4 show, group 1's argumentation skill have different growth of other groups in second to sixth training. The argument map writing system helped students direct their thoughts and effectively focus on the topic of interest. Furthermore, with teachers' guide that divides a major problem into several smaller ones, students could solve those problems step by step. Through argumentation frameworks, students can use argument maps to graphically guide and organize their thoughts.

In the interviews, some students in Group 2 expressed that using the concept map strategy to build argumentation was appealing, but the rules of concept maps distract their attention away from the topic of discussion. Therefore, the distraction led to their failure to produce a complete argumentation structure. Furthermore, these students expressed concerns about the difficulty of learning concept map strategies, which reduced their learning motivation. The traditional teaching strategy applied to Group 3 was an answering system. In the interviews, many students mentioned that the traditional teaching strategy involving only typing on computers is no different from the traditional teaching strategy involving only teachers' instruction. Although concept mapping is a method of graphical organization, it is limited by complex rules of graphic organization and thus tends to distract students' attention. In the table 2 show, group 2's average was not more than group1, and group 3's average has lowest. These problems may decrease students' learning motivations and consequently make them lose focus. However, argument maps can reveal the entire process and the direction of arguments and reasons. Therefore, students can focus on certain blocks and relations. In addition, using argument maps to study argumentation can help students focus on the topic of discussion; this is because such maps restrict students' attention to the topics being discussed. Most of the students expressed that argument maps were easy to construct and that they did not experience any difficulty in using argument maps to construct the architecture of argumentation. The teacher expressed that it was easier to guide students to build an argumentation structure with argument maps. This means students could easily adjust to this learning strategy. The table 4 show, group 1 growth has fast more than other groups.

7. Conclusion

In order to determine an effective graphic strategy for improving students' argumentation ability, this paper proposes the CAEWS. The experimental results revealed that the proposed CAEWS significantly improved the sixth-grade students' argumentation ability. The statistical analysis indicated that the differences between the experimental groups reached statistical significance (see Table 4). A comparison of the traditional argumentative writing system, the concept map writing system, and the argument map writing system showed that the argument map learning system significantly improved the students' argumentation ability; however, no significant difference in the students' argumentation ability was observed between the traditional argumentative learning system and the concept map learning system. The experimental results can be explained as follows. Regarding the concept mapping strategy, students experienced difficulty in constructing the structure of argumentation because of the complexity of the rules of graphic organization. Furthermore, the concept mapping strategy made students lose focus on the topics of argumentation. However, the argument mapping strategy helped the students focus on the essay topics because it entailed dividing bigger problems into smaller ones, and this simplification enabled the students to easily answer the questions. Moreover, the argument mapping strategy helped the students intuitively and clearly build relations between claims, reasons, and evidence, enabling them to easily build the entire structure. The CAEWS containing essential elements of argumentation developed in this study could effectively assist students in establishing better structures of argumentation. Most teachers in this experiment also held positive attitude toward the application of the system in enhancing students' argumentation abilities. However, they were concerned that there are not many information appliances in traditional classrooms. The instructors suggested that the system should become accessible with mobile devices such as smart phones and pads; wider accessibility of the system will largely increase their willingness to use the system. The teachers mentioned in their interviews that collaborative learning activities could better motivate students. We would endeavor to improve the system in the aspects of the accessibility on smart devices and the function for collaborative learning in the near future.

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References

Anderson, R. C., Chinn, C., Chang, J., Waggoner, M., & Yi, H. (1997). On the logical integrity of children's arguments. *Cognition and Instruction, 15*(2), 135-167.

Beyer, B. K. (1995). *Argumentation ability*. Fastback 385. Phi Delta Kappa, 408 N. Union, PO Box 789, Bloomington, IN 47402-0789.

Buzan, T., & Buzan, B. (2000). *The concept map book*. London: BBC Worldwide Ltd.

Butchart, S. (2009). Improving argumentation ability using web based argument mapping exercises with automated feedback. *AJET, 25*(2), 268-291.

Chambliss, M. J., & Murphy, P. K. (2002). Fourth and fifth graders representing the argument structure in written texts. *Discourse Processes, 34*(1), 91-115.

Chiang, K. H., Fan, C. Y., Liu, H. H., & Chen, G. D. (2016). Effects of a computer-assisted argument map learning strategy on sixth-grade students' argumentative essay reading comprehension. *Multimedia Tools and Applications, 75*(16), 9973-9990.

Golder, C., & Coirier, P. (1996). The production and recognition of typological argumentative text markers. *Argumentation, 10*(2), 271-282.

Hyerle, D., & Yeager, C. (1995). *Thinking maps: Tools for learning.* Raleigh, NC: Innovative Services.

Halpern, D. F. (1998). Teaching argumentation ability for transfer across domains: Disposition, skills, structure training, and metacognitive monitoring. *American psychologist, 53*(4), 449.

Li, L. Y. (2015). Development and evaluation of a Web-based e-book with a concept mapping system. *Journal of Computers in Education, 2*(2), 211-226.

Lin, S. Y., Strickland, J., Ray, B., & Denner, P. (2004). Computer-based concept mapping as a prewriting strategy for middle school students. *A Middle School Computer Technologies Journal, 7*(2).

Koh, Y. C. (2004). *The impact of scaffolding via online asynchronous discussions on students' thinking skills in writing argumentative essays* (Unpublished master's thesis). Nanyang Technological University, Singapore.

Kuhn D. (2005) *Education for thinking*. Cambridge, Mass: Harvard University Press.

Negari, G. M. (2011). A study on strategy instruction and EFL learners' writing skill. *International Journal of English Linguistics, 1*(2), 299.

Newton, P., Driver, R., & Osborne, J. (1999). The place of argumentation in the pedagogy of school science. *International Journal of Science Education, 21*(5), 553-576.

Novak, J. D., & Gowin, D. B. (1984). *Learning how to learn.* Cambridge, UK, Cambridge University Press.

Novak, J. D., & Cañas, A. J. (2010). The universality and ubiquitousness of concept maps. In J. Sánchez, A. J. Cañas, J. D. Novak (Eds.), *Concept Maps: Making Learning Meaningful,* Proceedings of Fourth International Conference on Concept Mapping, Viña del Mar, Chile.

Perkins, D. N. (1985). Postprimary education has little impact on informal reasoning. *Journal of Educational Psychology, 77*(5), 562-571.

Persky, H., Daane, M., & Jin, Y. (2003). *The nation's report card: Writing*. Washington, DC: U.S. Department of Education.

Santiago, H. C. (2011). Visual mapping to enhance learning and argumentation ability skills. *Optometric Education, 36*(3), 125-139.

Toulmin, S. E. (2003). *The uses of argument*. Cambridge University Press.

Van Gelder, T. (2002). Argument mapping with reason! Able. *The American philosophical association newsletter on philosophy and computers, 2*(1), 85-90.

Wingate, U. (2012). 'Argument!' Helping students understand what essay writing is about. *Journal of English for Academic Purposes, 11*(2), 145-154.