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Focus question effect on dynamic thinking in a concept map

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FOCUS QUESTION EFFECT ON DYNAMIC THINKING IN A CONCEPT MAP

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ABSTRACT

A concept map is an educational tool designed to help identify, represent, and categorize relationships between different ideas relating to an overall concept. Relationships or transitions between the ideas are created by students and can either be static or dynamic. Static transitions help to describe, define, and organize knowledge for a given domain. Dynamic transitions show how a change in quantity, quality, or state in one concept causes change in quantity, quality, or state in the other concept. The focus question of the map directs student input of the concepts and ultimately determines what types of transitions are used.

The study by Derbentseva et al. (2006) provides a framework for how to influence students to utilize dynamic thinking in a concept map by directing the focus question toward more analysis of a subject rather than simple description. By changing the wording of the focus question, this study examined the difference in the amount of dynamic transitions used by students to break down a concept. The study was run on two different populations in order to find a trend between the wording of the focus question and the number of dynamic transitions used. Gender, academic level, and methodology were also evaluated and shown to have no effect on the dynamic transitions in a concept map. Overall, when students were asked to answer a "How does…work?" question, they used more dynamic than static transitions to break down a concept. When students were simply presented with a "What is…?" question, their overall thinking proved to be more static in nature. An increase in dynamic thinking means a shift from a recall level of thinking towards a more conceptual level of thinking, which should lead to an increase in student academic gains.

INTRODUCTION

Every year, I am required to attend professional development workshops on the benefits of concept maps to student understanding and analysis of different topics. Our district believes that doing concept map activities in our classrooms will automatically increase student learning. This idea holds true if the concept map is designed to promote dynamic thinking rather than static thinking (Derbentseva *et al*., 2006). I am concerned that simply doing a concept map activity does not guarantee that the student will engage in building dynamic relationships between concepts. I have always held fast to the belief that some rote learning is necessary in the educational process. The ultimate goal is to have students that have critical thinking abilities, but it is impossible for a student to think critically without a minimum level of base knowledge. Once firm base level knowledge is reached, concept maps can be a useful tool in helping students think critically, provided the concept map is constructed in such a manner as to promote dynamic relationships.

New knowledge creation is nothing more than a relatively high level of meaningful learning accomplished by individuals who have a well organized knowledge structure in a particular field and also a strong emotional commitment to persist in finding new meanings. Epistemology is the branch of philosophy that deals with the nature of knowledge and new knowledge creation. There is an important relationship between the psychologies of learning and the growing consensus among philosophers and epistemologists that new knowledge creation is a constructive process involving both our knowledge and our emotions and the drive to create new meanings and new ways to represent these meanings. Learners struggling to create good concept maps are themselves engaged in a creative process, and thus can find the activity challenging, especially learners who have spent most of their lives learning by rote. Rote learning contributes

very little, at best, to our knowledge structures, and therefore cannot underlie creative thinking or novel problem solving (Novak, 1977, 1993, 1998).

The fundamental component of a concept map is a proposition, which is a connection between two concepts to show the relationship between them (Novak and Gowin, 1984). Propositions that represent a functional interdependency between two concepts reflect dynamic thinking. In contrast, a proposition that represents the relative position of the two concepts in the hierarchy of meaning constitutes static thinking (Safayeni, Derbentseva, and Cañas, 2005).

All concept maps begin with focus questions, which make explicit the questions or problems which the maps are meant to address (Novak and Cañas 2008). In this manner, focus questions help direct the learner's attention to the issue under consideration. Since hierarchies among concepts and relationships are highly context dependent, focus questions help establish a specific context within which to rank and relate concepts, thereby guiding concept map construction. The study by Derbentseva *et al*. (2006) provides empirical evidence that the focus question guides the entire map. In their research they compared a focus question asking "What is concept X?" with a focus question asking "How does concept X work?" Their results showed that the "How" condition produced significantly more dynamic propositions than did the "What" condition.

Miller, Cañas, and Novak (2008) present evidence that substantiates the findings of Derbentseva *et al*. (2006), and also adds to those findings. In the study by Derbentseva *et al.'s* (2006), they compared two specific questions, a "What is …" question with a "How does…" question, which belongs to the open-static and open-dynamic categories, respectively of Miller, Cañas, and Novak (2008). In the Miller, Cañas, and Novak (2008) setting, 258 different static and dynamic questions posed by an equal number of subjects were considered. Thus, their data

essentially generalizes the previous result, showing that open dynamic questions generate more dynamic thinking than open static questions holds true, independently of any particular question. They have shown that there is a clear positive association between the type of focus question and the nature of the propositions used. In particular, the more open to personal experience and the more demanding of explanation a focus question, the more explicative the resulting propositions in the corresponding concept map.

There are obvious differences between individual abilities, some of which have been explored by Gardner (1983). While it is true that some students have difficulty building and using concept maps, at least early in their experience, this disconnect appears to result primarily from years of rote-mode learning practice in school settings rather than as a result of brain structure differences. So-called “learning style” differences are, to a large extent, derivative from differences in the patterns of learning that students have employed, varying from high commitment to continuous rote-mode learning to almost exclusive commitment to meaningful mode learning. It is not easy to help students in the former condition move to patterns of learning of the latter type. While concept maps can help in this process, students also need to be taught something about brain mechanisms and knowledge organization; this instruction should accompany the use of concept maps.

The nature of the focus question influences the type and quality of the resulting concept map, as shown in the study by Derbentseva *et al*. (2006). Eighty-one undergraduate university students participated in the experiment. All subjects were enrolled in the same course and were offered a partial credit toward their course mark for their involvement in the study. A typical subject was a second- or third-year undergraduate student. The stimulus for this experiment was a structure with six unconnected boxes arranged in a circle. Only the top box had a concept,

‘‘cars,’’ written in it, and the remaining boxes were empty, to be filled-out and connected by subjects. The experiment was administered to all subjects in a classroom setting. Each subject received an experimental booklet consisting of detailed, step-by-step written instructions and two copies of the structure to be filled-out. There were two conditions in this experiment—one for each focus question. One focus question was ‘‘What is a car?’’ and the other focus question was ‘‘How does a car work?’’ All other instructions and materials were the same for the two conditions.

As the first step in the experiment, the subjects were asked to write a paragraph answering the focus question. Second, the subjects were instructed to circle the important concepts in their paragraph that were helpful in answering the focus question. Third, the subjects were asked to select the five most important concepts and write them into the structure they were given. Last, the subjects were asked to connect the boxes labeling the connections and specifying the direction of the relationships. The step-by-step approach was designed to help the subjects who were not familiar with the construction of concept maps. The subjects were assigned randomly to the two conditions.

Each proposition was assigned a score of 0, 0.5, or 1, depending on the extent to which it reflected the functional relationship between the concepts. Propositions that reflected the propagation of change from one concept to the other were assigned a score of 1. In these relationships, a change in the quantity, quality, or state of the starting concept resulted in a change in the quantity, quality, or state of the final concept. The change in the starting concept must cause change in the next concept of the structure for the proposition to be truly dynamic. If a proposition reflected change, but the direction of the change was against the direction of the arrow, or the relationship was not well specified, then the proposition was regarded as partially

dynamic and assigned a score of 0.5. All propositions were scored independently. A raw dynamic score was computed for each map by summing up dynamic scores of all its propositions. The sum was divided by the total number of propositions to obtain the percentage of dynamic propositions for each map. The dynamic score was used as a measure of the degree of dynamic thinking in a map. Because the requirements of normality for the sampling distribution and equality of the variances were not met, nonparametric statistical tests were applied. The results of the Wilcoxon–Mann–Whitney test showed that the maps in the ‘‘How’’ question condition generated significantly more dynamic propositions than the maps in the ‘‘What’’ question condition ($Z \pm 4.84$, $p<0.001$). This result provided strong support for the hypothesis that the nature of the focus question affects the dynamic thinking in a concept map.

Norma L. Miller, Universidad Tecnológica de Panamá & Proyecto Conéctate al Conocimiento, Panamá and Alberto J. Cañas, Institute for Human & Machine Cognition, USA, (2008) researched the effect of the focus question on the number of dynamic propositions in a concept map. Their research was performed as part of a larger research program that investigated the acquisition of skill in concept mapping by in-service Panamanian public elementary schoolteachers participating in Panama's *Conéctate al Conocimiento* Project (Tarté, 2006). To this end, initial and final concept maps created using CmapTools (Cañas *et al*., 2004) were gathered via the CmapTools Recorder feature (Miller, Cañas & Novak 2008). CmapTools is a software environment developed at the Institute for Human and Machine Cognition (IHMC) that empowers users, individually or collaboratively, to represent their knowledge using concept maps, to share them with peers and colleagues, and to publish them (Cañas *et al*., 2004).

The sample was obtained from 18 different training groups, each taught by different pairs of project facilitators over the course of a 3-month period extending from July through

September 2006, with a total of 258 students. For both types of maps teachers worked individually. Topics for the final map were freely chosen by the teachers; for the initial map, topics were chosen in 14 of the 18 groups, while in the remaining 4 groups, maps were based on an assigned reading. In all cases teachers posed their own focus questions. “Time allotted for map construction varied among training groups, but generally was between 1.5 – 2 hours. However, some teachers stopped before the time was up, while others continued working afterwards. Thus, mean construction time for the first map was 1 hour 32 minutes, and 1 hour 58 for the final map.” (Cañas, Miller, Novak *et al*., 2006) The Conéctate Project developed a taxonomy for concept maps. This process was used to analyze the completed concept maps. The Conéctate Project taxonomy consists of a topological taxonomy (Cañas, Miller, Novak *et al*., 2006), used to evaluate concept maps in terms of their structure, and a semantic scoring rubric (Miller & Cañas, 2008), to evaluate content. Specific elements were reviewed such as focus questions, dynamic propositions, and cross-links. “At the Conéctate workshops focus questions are viewed as an important component guiding concept map construction. They provide not only a context for the map, but a specific query, problem or issue which the map must address and respond to.” (Miller & Cañas, 2008) Along the lines of Derbentseva *et al.*’s (2006) study, the presence of dynamic propositions, specifically causative statements, in concept maps with open-static versus open-dynamic questions were compared.

What is seen is that open-static questions lead to a relatively equal distribution of causative and non-causative propositions, whereas, open-dynamic questions lead to more causative propositions in a ratio of 4 to 1. There is a clear positive association between the type of focus question and the nature of the propositions. In particular, the more open to personal experience and the more demanding of explanation a focus question, the more explicative the

resulting propositions in the corresponding concept map. This finding confirms the result previously obtained by Derbentseva *et al.* (2006). The data from the Panamanian study essentially generalizes the previous result, showing that it holds true independently of any particular question. The results confirm the effect of the focus question on the dynamic nature of propositions in a concept map. Additionally the results show that the more open to individual input and the more demanding of explanation the focus question, the more dynamic (explicatory) the nature of the resulting propositions. This study confirms the hypothesis of my experiment but uses a more general approach with a larger population group.

MATERIALS AND METHODS

This study seeks to initially replicate and expand on the work of Derbentseva *et al.* (2006), but in a school district in Louisiana in 2011 and 2012. Two experiments were performed with two different populations. Experiment 1 involved 94 members of a high school football team, all male. The population group was of the same make up of the school population in Table 1. Experiment 2 involved 34 high school students in an honors Chemistry class, 17 males and 17 females. All subjects were of middle class socioeconomic background. The school and class populations are shown in Table 1.

Table 1. School and Classroom Population

	School	Classroom
White	49.0%	85.0%
African American	49.0%	15.0%
Hispanic	<1.0%	0.0%
Asian	<1.0%	0.0%

In experiment 1, all subjects were males on the football team and were 9^{th}, 10^{th}, 11^{th}, or 12^{th} grade high school students. The subjects have had some previous exposure to concept maps in classes they have taken. The stimulus for experiment 1 was a structure with six unconnected boxes arranged in a circle. Only the top box had a concept written in it and the remaining boxes were empty, to be filled-out and connected by subjects. There were three different concepts administered to the subjects; “atoms,” “cars,” and “government,” each given on a different day. The experiment was administered to all subjects in a meeting room setting. Each subject received an experimental booklet consisting of detailed, step-by-step written instructions and a copy of the

structure to be filled out (Appendices A-F). There were six conditions in this experiment, one for each focus question. There was a “What is …?” and a “How does…?” question for the “atoms,” “cars,” and “government” concepts. All other instructions and materials were the same for the six conditions. As the first step in the experiment, the subjects were asked to write a paragraph answering the focus question. Second, the subjects were instructed to circle the important concepts in their paragraph that were helpful in answering the focus question. Third, the subjects were asked to select the five most important concepts and write them into the structure they were given. Lastly, the subjects were asked to connect the boxes, labeling the connections and specifying the direction of the relationships. The step-by-step approach was designed to help the subjects who were not familiar with the construction of concept maps. The first two conditions, “What is an atom?” (Appendix A) and “How does an atom work?” (Appendix B) were administered on June 18, 2012. The subjects on offense on the football team were given the “What?” condition and the subjects on defense were given the “How?” condition. The second two conditions, “What is a car?” (Appendix C) and “How does a car work?” (Appendix D) were administered on June 20, 2012. The subjects were randomly given the “What?” and “How?” conditions as they entered the meeting room. The third two conditions, “What is the government?” (Appendix E) and “How does the government work?” (Appendix F) were given on June 21, 2012. The subjects with uniform numbers 1-47 were given the “What?” condition and the subjects with uniform numbers 48-94 were given the “How?” condition.

In experiment 2, all subjects were enrolled in a Chemistry I honors class and were offered a partial credit toward their course mark for their involvement in the study. A typical subject was a 10th or 11th grade high school student. The subjects have had some previous exposure to concept maps in the class and in other classes they had taken. The stimulus for this experiment

was a structure with six unconnected boxes arranged in a circle. Only the top box had a concept, “atoms,” written in it, and the remaining boxes were empty, to be filled-out and connected by the subjects. The experiment was administered to all subjects in a classroom setting. The procedure for experiment 2 followed the same step by step approach as experiment 1. The subjects were assigned the “What is an atom?” condition on October 25, 2011 and the “How does an atom work?” condition on November 1, 2011. A student sample is shown in Appendix G.

Each subject completed a map with 5 possible transitions. These maps were then analyzed as a set of independent transitions consisting of two concepts with a linking phrase between them. A list of transitions was constructed, and each was evaluated as to whether it reflected a static or dynamic relationship between the concepts involved.

Each transition was assigned a score of 0 or 1 depending on the extent to which it reflected the functional relationship between the concepts. Transitions that reflected the propagation of change from one concept to the other were dynamic and assigned a score of 1. In these relationships, a change in the quantity, quality, or state of the starting concept resulted in a change in the quantity, quality, or state of the final concept. The change in the starting concept must cause a change in the next concept of the structure for the transition to be truly dynamic. Transitions that reflected no propagation of change or only partial change were static and assigned a score of 0. All transitions were scored independently of the other transitions. A raw dynamic score was computed for each map by summing the dynamic score of all its transitions. The raw dynamic score was divided by the total transitions of the map and multiplied by 100 to give a percentage value. The dynamic score percentage was used as a measure of the degree of dynamic thinking in each map.

RESULTS

The scoring of all transitions was performed by me and an English teacher. This was done to eliminate any bias in scoring due to the knowledge of the origin of the transition. A high degree of reliability (99% overlap) was obtained between the two scores.

The concept maps created using the focus questions “What is a car?” and “How does a car work?” was used to compare the current test subjects to those in Derbentseva’s study (Derbentseva *et al*. 2006). The percent of dynamic transitions for the “car” concept from experiment 1 are shown in Figure 1. The dynamic scores were compared between the two conditions to test the hypothesis. Because the requirements of normality for the sample distribution and equality of the variances were not met, nonparametric statistical tests were applied. The Mann-Whitney test is the nonparametric version of a t-test and gives you the p-value for your data sets. The results of the Mann-Whitney test showed that the maps in the “How” condition generated statistically significantly more dynamic transitions than the maps in the “What” condition, with p-value < 0.001. This result provided strong support for the hypothesis that the “How” question condition provides more dynamic thinking in a concept map than the “What” question condition.

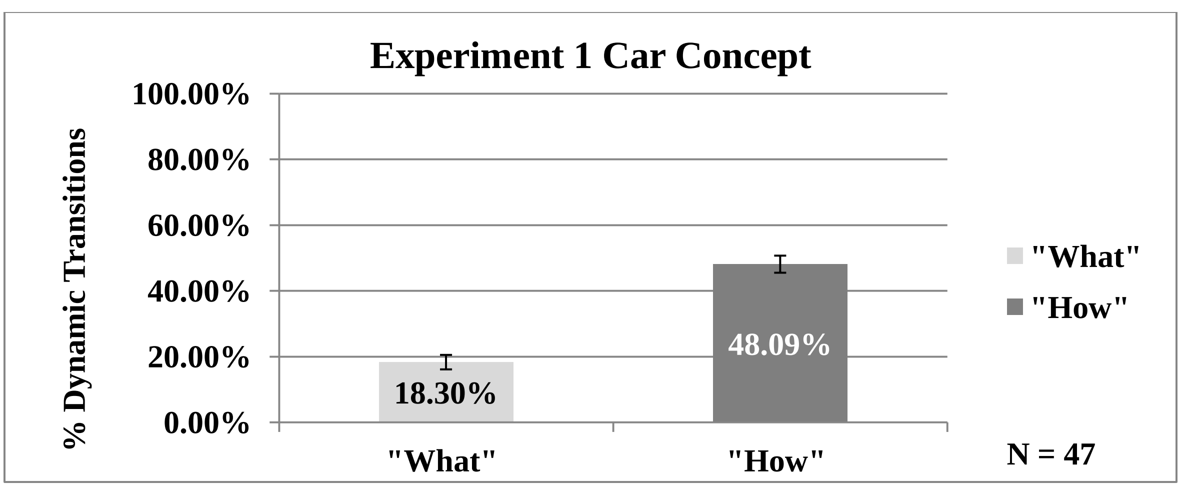

Figure 1. Dynamic Transitions in Experiment 1 Car Concept

Another concept activity was completed using the population of the football team with "atom" as the concept. Atom was used as a concept to bring in a science component to the map activity and to evaluate if the change in concept would produce different results from the car concept. The use of the football team provided similar race demographics to the overall school population. The experiment yielded 11.5±1.8% dynamic transitions in the "What is an atom" question condition and 39.6±3.1% in the "How does an atom work" question condition. The statistics of the results for Experiment 1 are shown in Figure 2. The results of the Mann-Whitney test showed that the maps in the "How" condition generated significantly more dynamic transitions than the maps in the "What" condition, with a p-value of < 0.001. Again this result provides strong support for the hypothesis that the "How" question condition produces more dynamic thinking in a concept map than does the "What" question condition.

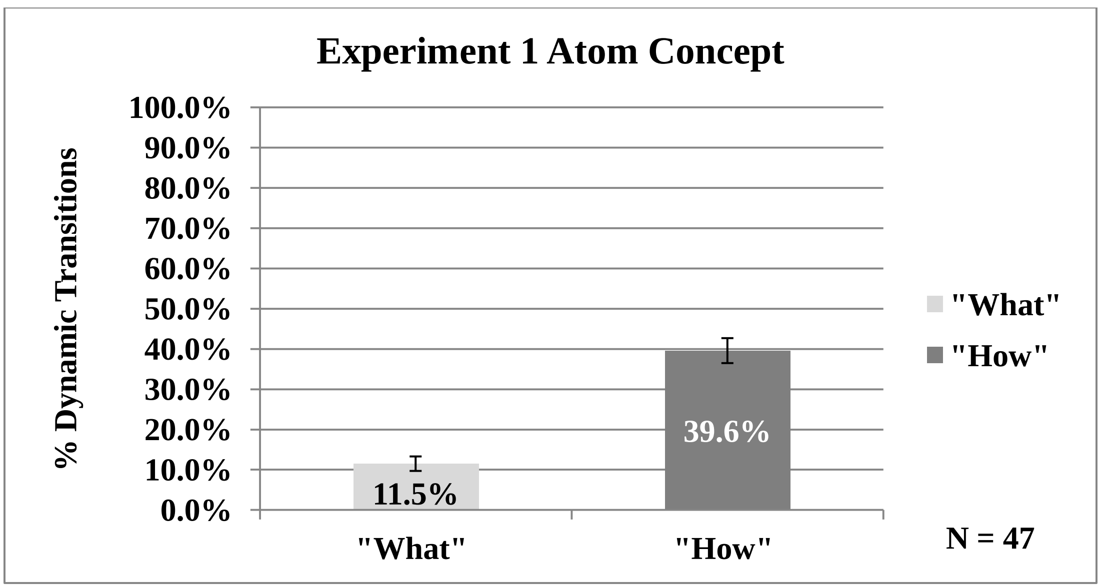

Figure 2. Dynamic Transitions in Experiment 1 Atom Concept

The "atom" concept map activity was given in Chemistry I honors class. The results from concept mapping during the unit on atoms were then analyzed to see how often students used dynamic transitions. The experiment yielded 15.3±2.3% dynamic transitions in the "What is an

atom" question condition and 50.7±5.2% in the "How does an atom work" question condition. The results of the Mann-Whitney test showed that the "atom" concept maps in the "How" question condition generated significantly more dynamic transitions than the maps in the "What" question condition in Experiment 2; p-value < 0.001. Figure 3 shows the results of the activity.

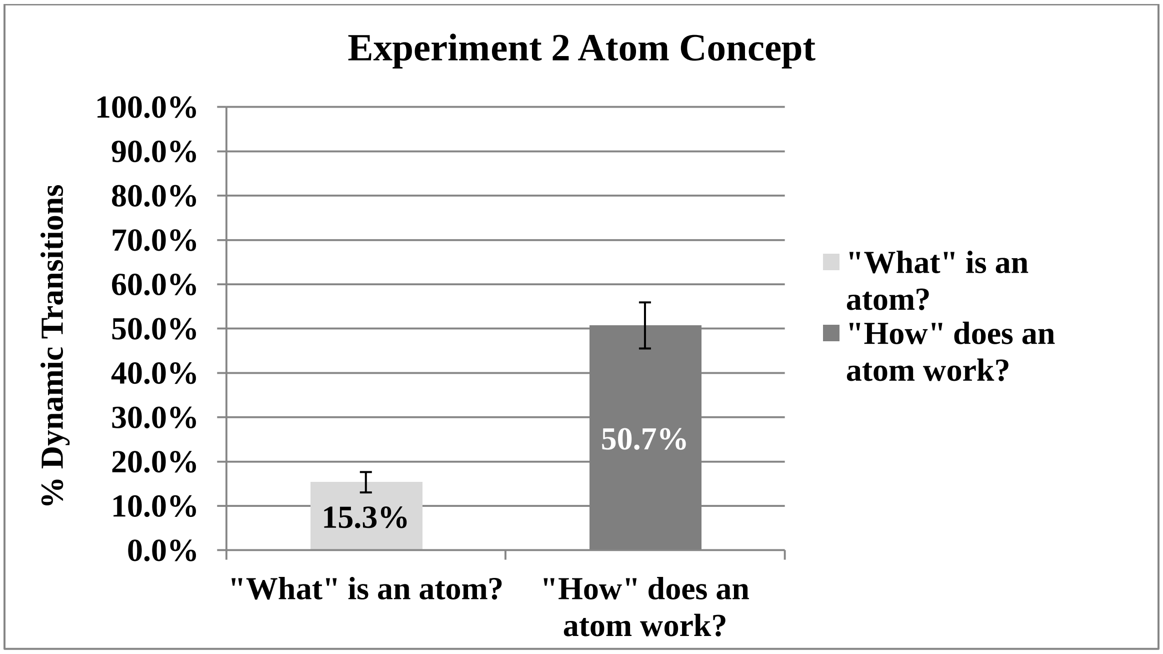

Figure 3. Dynamic Transitions in Experiment 2 Atom Concept

Although mostly all conditions were kept the same, there was a difference in test administration between the "atoms" concept condition in Experiment 1 (football team) and Experiment 2 (Chemistry I honor class). In Experiment 1, half of the population was given the "What" question condition and half of the population was given the "How" question condition, while in Experiment 2, the entire population was given the "What" question condition at one time and the "How" question condition at another time after intermittent instruction. The dynamic scores from Experiment 1 and Experiment 2; were compared regarding the concept of atoms (Figure 4). Even though there was a slight difference in methodology there was no statistical difference between Experiment 1 and Experiment 2. The results of the Mann-Whitney

test showed no significant difference between the “How” question condition in each experiment or the “What” question condition in each experiment; the p-value was > 0.05. The lack of statistical difference between the dynamic transitions in the “How” conditions of Experiment 1 and Experiment 2 indicates intermittent instruction had no effect on the results of the concept map activity. This similarity gives more evidence that the increase in dynamic transitions is due to the focus question, and not to other factors.

The means have been compared to determine focus question effect on dynamic thinking. The distribution of the data sets from Experiment 1 and Experiment 2 were evaluated to determine if the two data sets differ significantly. The results of the Kolmogorov-Smirnov test produced a D-value of 0.2378 with a critical D-value of 0.2739. The D-value is less than the critical D-value which indicates that there is no statistical difference between the data from Experiment 1 and Experiment 2.

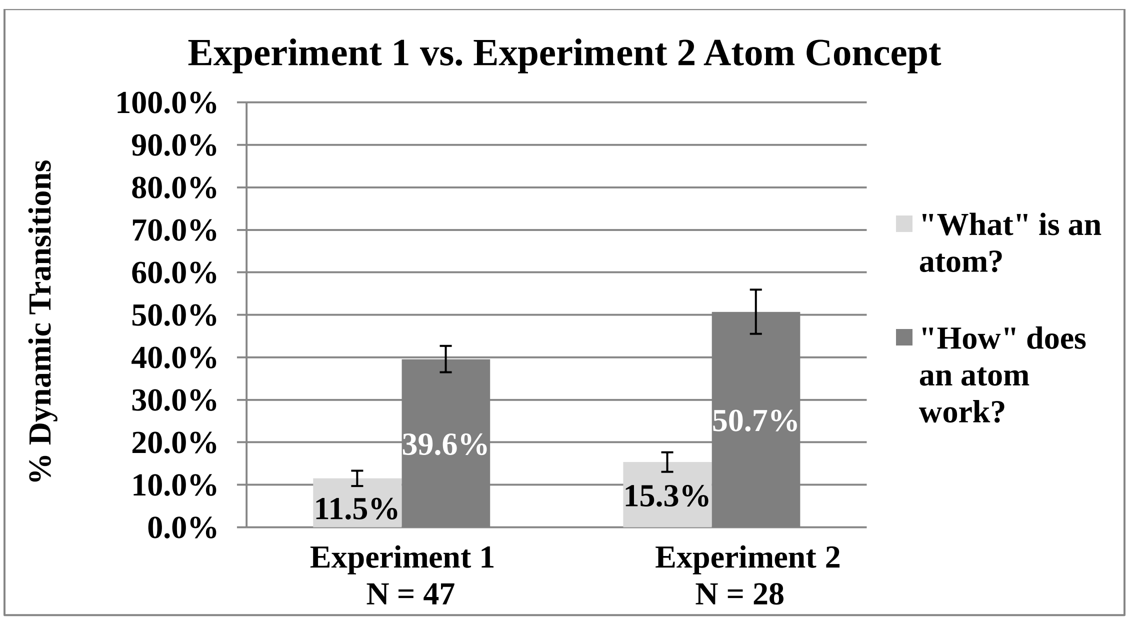

Figure 4. Experiment 1 vs. Experiment 2 Atom Concept

Other factors were evaluated to determine the possible impact on dynamic transitions, such as gender and academic performance as indicated test scores. First, the dynamic scores were

compared between the gender groups in Experiment 2 (Figure 5). The experiment yielded 12.9±2.9% dynamic transitions in the "What is an atom" question condition in the female population and 14.1±3.3% in the male population. In the "How does an atom work" question condition, 42.4±8.0% was yielded in the female population while 41.2±7.6% was yielded in the male population. The Mann-Whitney test showed that the maps in the "How" question condition generated statistically significant more dynamic transitions than the maps in the "What" question condition, for both males and females the p-value was < 0.001.

The Mann-Whitney test showed no significant difference between the male and female "How" question condition or the male and female "What" question condition, p-value > 0.05. Overall Experiment 2 indicates that the gender of the student did not affect the amount of dynamic thinking in a concept map on either condition.

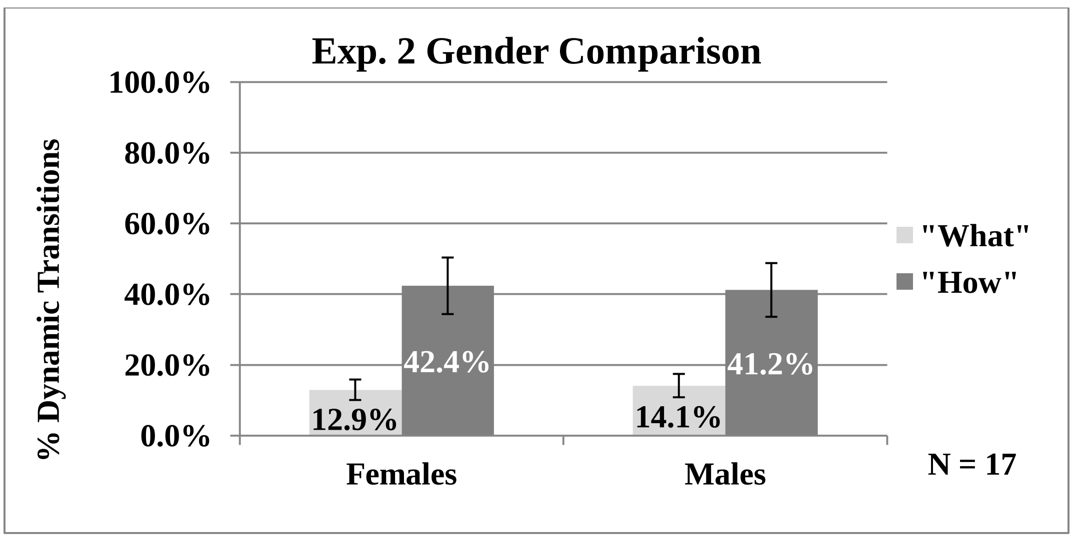

Figure 5. Dynamic Transition between Males and Females in Experiment 2

The next factor evaluated was academic performance on the unit test which was taught before the "How" concept map activity. This evaluation was performed to determine if instruction caused a change in the amount of dynamic transitions. The dynamic transitions generated in the maps on atoms were compared to the unit test scores from the unit on atoms

(Figure 6). The unit test scores were binned into three categories of performance; high achievers (90-99), middle achievers (80-89), and low achievers (70-79). The test scores yielded 16.4±3.6% dynamic transitions in the “What is an atom” question condition in the 90-99 range and 55.6±9.3% for the “How does an atom work” question condition. The 80-89 range yielded 15.4±3.2% for the “What” and 48.6±7.8% for the “How.” Finally, in the 70-79 range, the yield was 20.0±8.2% for the “What” and 55.0±12.6% for the “How.” The results of the Mann-Whitney test showed that the maps in the “How” question condition generated significantly more dynamic transitions than the maps in the “What” question condition in each test score range, p-value < 0.001.

The Kruskal-Wallis test is a nonparametric test used to give the p-value on more than two data sets. The results of the Kruskal-Wallis test showed no significant difference between the “How” question condition in each test score range or the “What” question condition in each test score range, p-value > 0.05. The comparison of test scores of the population in Experiment 2 and dynamic thinking in a concept map indicates that the level of the student is independent of the amount of dynamic thinking in a concept map.

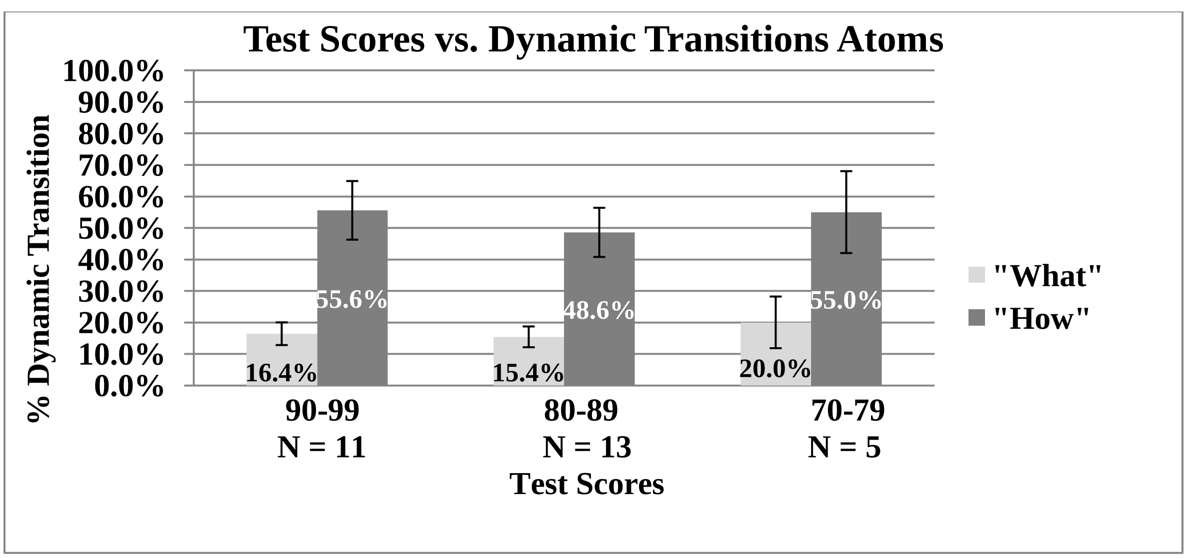

Figure 6. Test Scores vs. Dynamic Transitions in Experiment 2

One final concept map activity was performed on a generically generated concept to verify that the focus question generated the difference in dynamic thinking. The concept of “government” was chosen because the entire population would have previous exposure to this topic in a civics course. The experiment yielded 14.9±2.1% dynamic transition in the “What is government” question condition and 45.1±2.1% in the “How does government work” question condition (Figure 7). The results of the Mann-Whitney test showed that the “government” concept maps in the “How” question condition generated significantly more dynamic transitions than the maps in the “What” question condition in Experiment 1; p-value < 0.001.

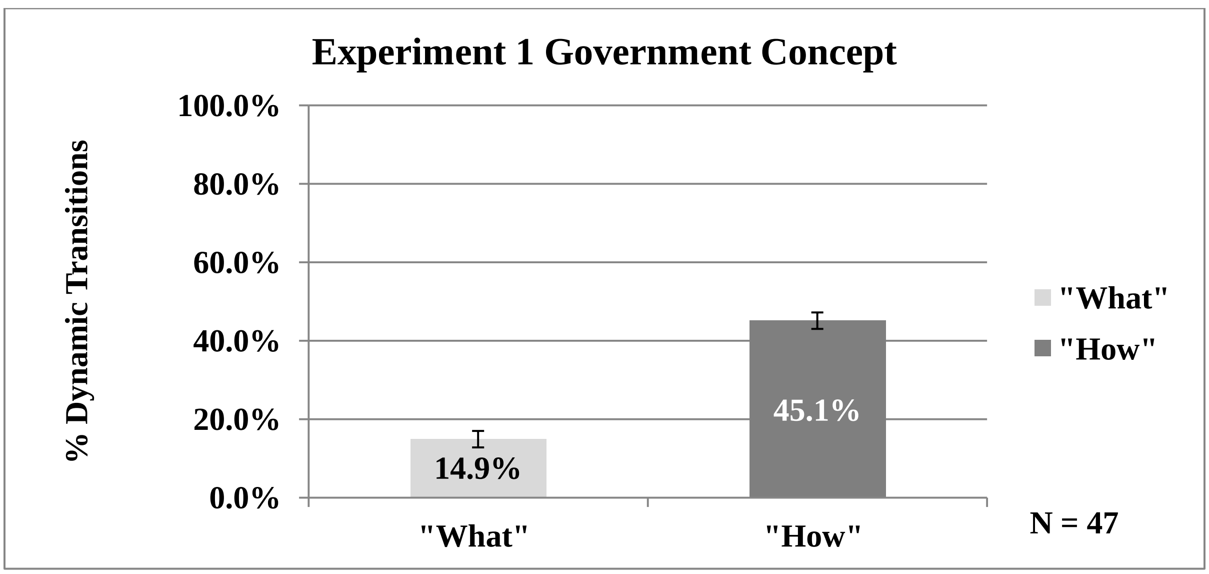

Figure 7. Dynamic Transitions in Experiment 1 Government Concept

The dynamic scores of the “atom,” “car,” and “government” concepts from Experiment 1 were compared (Figure 8). The results of the Kruskal-Wallis test showed no significant difference between the “How” question condition in each concept of Experiment 1 or between the “What” question condition in each concept of Experiment 1, p-value > 0.05. This statistical similarity provides strong support for the hypothesis that the focus question affects the amount of dynamic thinking in a concept map independent of topic.

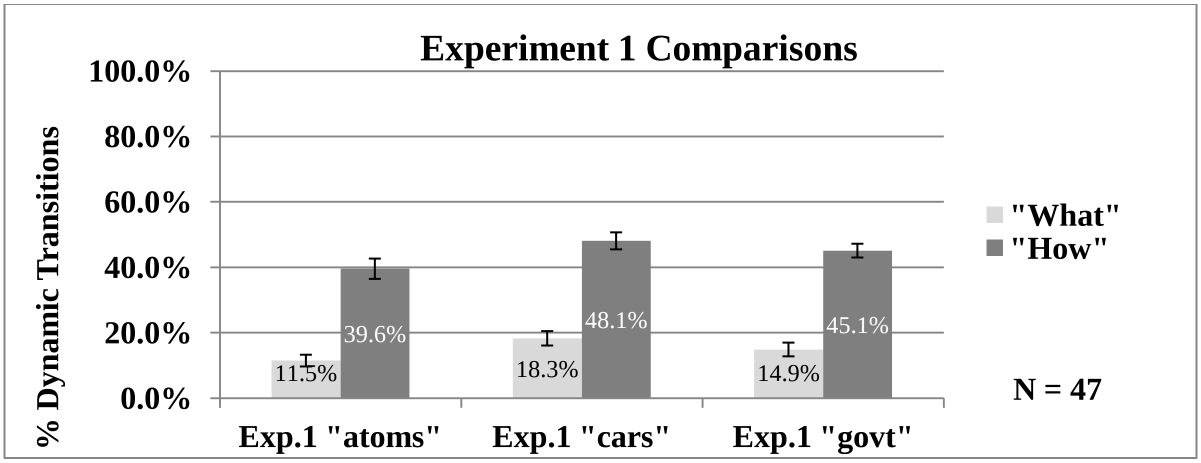

Figure 8. Comparison of "Atom," "Car," and "Government" Concept from Experiment 1

In this study, different concepts were tested using concept map activities along with different methods of administering a concept map to facilitate dynamic thinking in concept mapping. The findings show there are similarities in the means of the Derbentseva experiment and the Orgeron experiments conducted in both the "What" and the "How" conditions. Table 2 presents a summary of the descriptive statistics for all experiments. The findings also show levels of dynamic thinking only depend on the focus question, not on demographics of the students, scholastic ability, instruction, or subject matter.

Table 2 Descriptive Statistics for all Experiments

Focus Question Condition	*N*	Map Dynamic Score "What" question		Map Dynamic Score "How" question	
		Mean	Std. Dev.	Mean	Std. Dev.
Derbentseva "car"	40	21.00%	0.21	55.00%	0.30
Experiment 1 "atom"	47	11.49%	0.12	39.57%	0.21
Experiment 1 "car"	47	18.30%	0.15	48.09%	0.18
Experiment 1 "government"	47	14.89%	0.15	45.11%	0.15
Experiment 2 "atoms"	28	15.33%	0.13	50.71%	0.27

DISCUSSION

Table 3 shows a comparison between Experiment 1 and Derbentseva's original experiment. It is beneficial to us to compare these two experiments as an initial first step to show it is the focus question generating the change in dynamic transitions. Although not all of Derbentseva's data is available, we are able to compare population sizes, the means, and the standard deviation for both experiments. The comparison shows there is a strong similarity between the two "car" concept conditions; population sizes and mean of the "What" question condition and the "How" question condition. There appears to be a difference in the standard deviations between the "How" question conditions perhaps to a population effect.

Table 3. Comparison of Derbentseva *et al*. (2006) and Orgeron (2012) Experiments

Focus Question Condition	*N*	Map Dynamic Score	
		Mean	Std. Dev.
"What" question Derbensteva	40	21.00%	0.21
"How" question Derbensteva	41	55.00%	0.30
"What" question Orgeron	47	18.30%	0.15
"How" question Orgeron	47	48.09%	0.18

The effect of the focus question is not only limited to dynamic thinking but also on concept selection emerged in the data evaluation process. The concepts used in the concept map were obtained from the paragraph the student wrote answering the focus question for that activity. Table 4 shows how often different concepts were used in each condition. In both experiments, the terms "Bond" and "Combines" were not used in the "What" condition but were used in the "How" condition. Consequently, "Neutrons," "Electrons," and "Protons" were used considerably more in the "What" condition with a substantial reduction of use in the "How"

condition. This difference in use of different terms can somewhat confidently be explained by the difference in the focus question. Novak and Gowin (1984) recognized the important role of the focus question in the selection of concepts, which provides another reason to pay more attention to the focus question when constructing a concept map.

It is interesting to note that the two experimental groups had such varied backgrounds and exposure to the concept of atoms. The Chemistry class was primarily focused on atoms at the time of the experiment. Although not all of the football players participated in the same Chemistry class, all were previously enrolled in Physical Science, which teaches the basic concept of an atom. Despite the difference in training certain concepts appeared quite frequently in both groups; electrons, protons, neutrons, subatomic and nucleus. This is not unexpected as these would be the main concepts in the lessons on atoms in both Physical Science and Chemistry. The Chemistry students did use the concepts of ions and bonds more than the football team, this is not unexpected due to the difference in the level of instruction they received. Table 4 summarizes the observed frequencies of some of the concepts for each of the two conditions.

Table 4. Percent Student Use of Concept in the Maps of the Two Conditions

Concept	**Percent of Concepts**		**Percent of Concepts**	
	Exp.1 ”What”	**Exp.1 ”How”**	**Exp.2 “What”**	**Exp.2 “How”**
Electrons	68%	26%	71%	32%
Protons	66%	26%	71%	24%
Neutrons	57%	19%	65%	24%
Subatomic	38%	9%	41%	12%
Nucleus	34%	26%	35%	15%
Smallest	26%	4%	32%	3%
Compound	9%	30%	6%	26%
Ion	4%	10%	6%	21%
Combines	0%	23%	0%	21%
Bond	0%	10%	0%	15%

The impact of the study conducted on concepts maps shows that the focus question, directs the use or nonuse of dynamic thinking, but also determines what concepts subjects use to complete the maps. An increase in dynamic thinking was generated in usage of the “How” question condition more so than found in the “What” question condition. In doing concept map activities, one needs to assure the composition of the focus question will cause the students to utilize more dynamic thinking during the activity. The focus question will also determine the concepts the students use during the activity. Additionally, appropriate focus questioning could generate a larger vocabulary in the concept map activity. An appropriate focus question does not necessarily need to contain a “How” to generate dynamic thinking; open dynamic questioning will generate the same type of dynamic thinking as the “How” question condition.

The analysis of concept maps can be applied to the classroom as a whole. Classroom and test questions that are more open and dynamic questions will increase the amount of dynamic thinking among students. This type of questioning will lead students away from the most basic knowledge level on Bloom’s taxonomy, and into higher levels like analysis, synthesis, and evaluation.

Benjamin Bloom is credited with developing a way to categorize levels of reasoning skills in the 1950s. His taxonomy of questions is a widely accepted framework used by many teachers to guide their students through the learning process (Neal, n.d.). Though not necessarily sequential, the hierarchy of Bloom’s Taxonomy is often depicted as a pyramid with simple knowledge-based recall questions at the base. Questions higher on the pyramid are more complex and demand higher cognitive skills from the students. The students will reflect on their learning through higher-level thinking processes such as analysis, synthesis, comparison, or summation. The “What” condition favored words in the knowledge level of Bloom’s taxonomy

in both experimental groups while the “How” condition shifted the vocabulary towards the higher levels of the taxonomy.

The role of the teacher is to use questioning to guide the student down the journey of learning, correcting misconceptions, inaccurate and incomplete positions along the way, and eventually end up with the student having a more accurate understanding of the material (Merritts and Walter, n.d.). The pedagogical foundation for the journey is the movement through the levels of Bloom’s Taxonomy.

According to Whiteley (2006) the Socratic approach basically follows Bloom’s Taxonomy. In this approach the student is asked a series of questions about the situation or about how the student has responded. The questions can focus on the student’s knowledge then move the topic through each level ending up with the best solution to the problem.

The same principles that apply to questions on a concept map can be applied to the classroom as a whole. Asking secondary students open and dynamic questions has many benefits for the professional teaching practice. Whether the response in intended to be written, spoken, dramatized, or conveyed in some other manner; it will provide feedback on how successful the lesson was on stimulating their thought processes. Students are more likely to remember what they have learned when they explore the implications of their learning.

SUMMARY AND CONCLUSIONS

Concept mapping provides meaningful learning in the educational setting by offering clear structure and detailed organization during the process by which students gain knowledge. "Concept mapping does not replace traditional educational systems; it only provides a conduit for better learning, wider discussions, and more positive advancements within those environments" (Atkins, n.d.).

The results of this study showed the effect of the focus question on dynamic transitions in a concept map. There was a significant difference between the number of dynamic transitions in the "What" question condition and the "How" question condition. Meaning the "How" question condition produced maps with more dynamic thinking during the activity. The results indicate how robust and persistent this benefit was across various scenarios. Increased dynamic thinking by a student means moving away from knowledge level (static) thinking and towards more conceptual level (dynamic) thinking which should translate to increased student performance in the classroom setting. The results of Saouma BouJaoude and May Attieh (2008) suggest that concept maps were successful tools in helping low achievers improve their grades. The results of his study are not conclusive due to the small population size but do provide a basis for others to follow. More research is needed in this area to show that dynamic thinking in concept maps has a direct impact on an increase in student academic gains.

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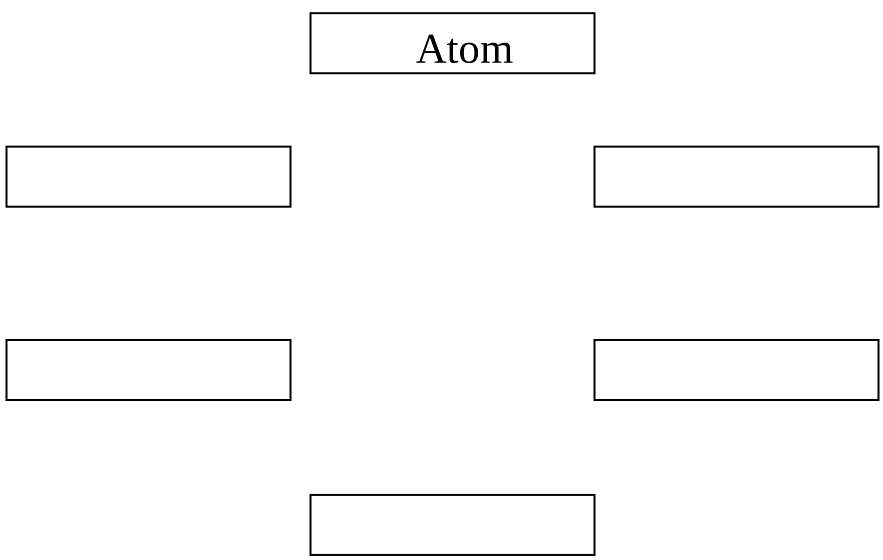
APPENDIX A

Atomic Concept Maps

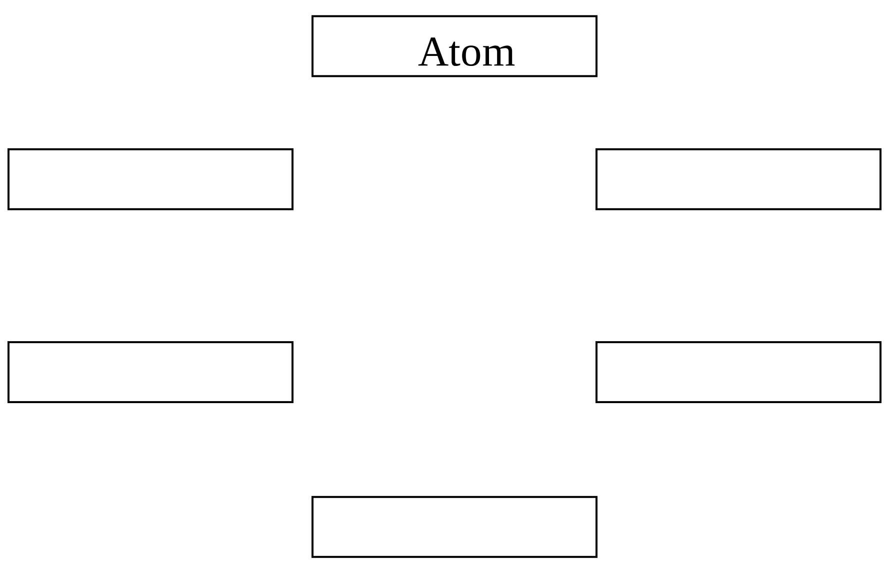
1) Write a paragraph answering the focus question; “What is an atom?”
2) After writing the paragraph, circle the important concepts in the paragraph that were helpful in answering the focus question.
3) Select the five most important concepts and write them into the concept map structure.
4) Connect the boxes labeling the connections and specifying the direction of the relationships.



APPENDIX B

Atomic Concept Maps

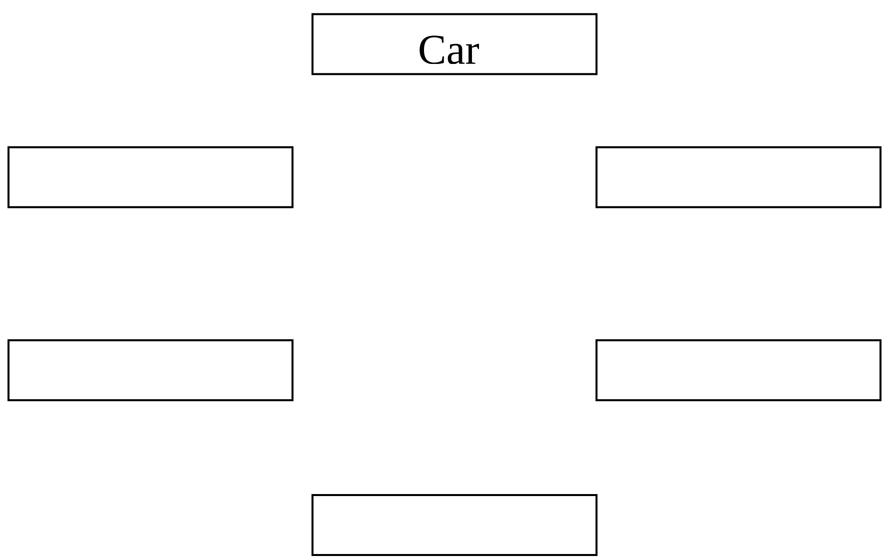
1) Write a paragraph answering the focus question; “How does an atom work?”
2) After writing the paragraph, circle the important concepts in the paragraph that were helpful in answering the focus question.
3) Select the five most important concepts and write them into the concept map structure.
4) Connect the boxes labeling the connections and specifying the direction of the relationships.



APPENDIX C

Car Concept Maps

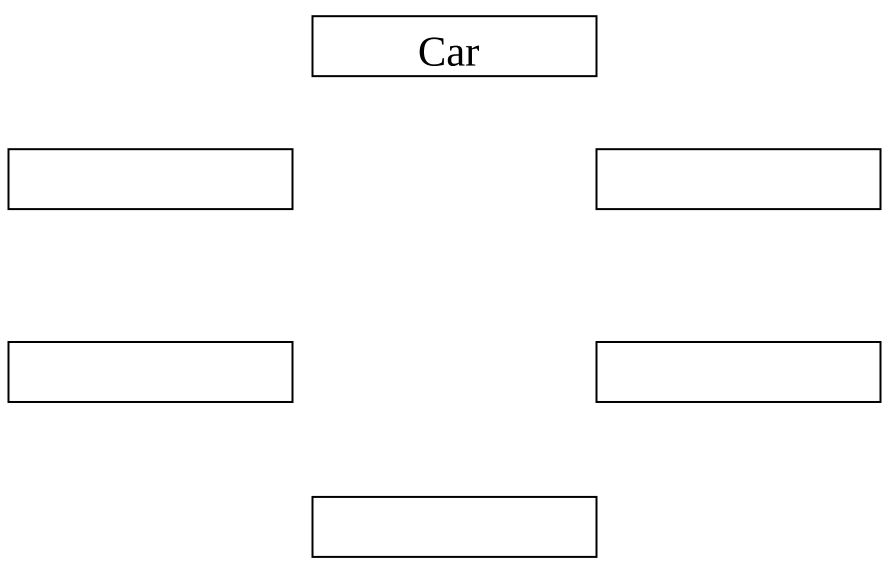
1) Write a paragraph answering the focus question; “What is a car?”
2) After writing the paragraph, circle the important concepts in the paragraph that were helpful in answering the focus question.
3) Select the five most important concepts and write them into the concept map structure.
4) Connect the boxes labeling the connections and specifying the direction of the relationships.



APPENDIX D

Car Concept Maps

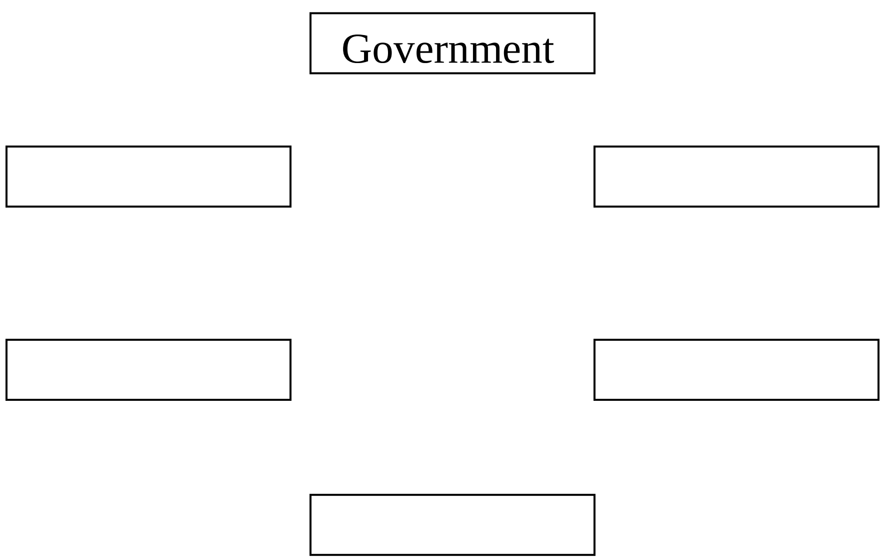
1) Write a paragraph answering the focus question; “How does a car work?”
2) After writing the paragraph, circle the important concepts in the paragraph that were helpful in answering the focus question.
3) Select the five most important concepts and write them into the concept map structure.
4) Connect the boxes labeling the connections and specifying the direction of the relationships.



APPENDIX E

Government Concept Maps

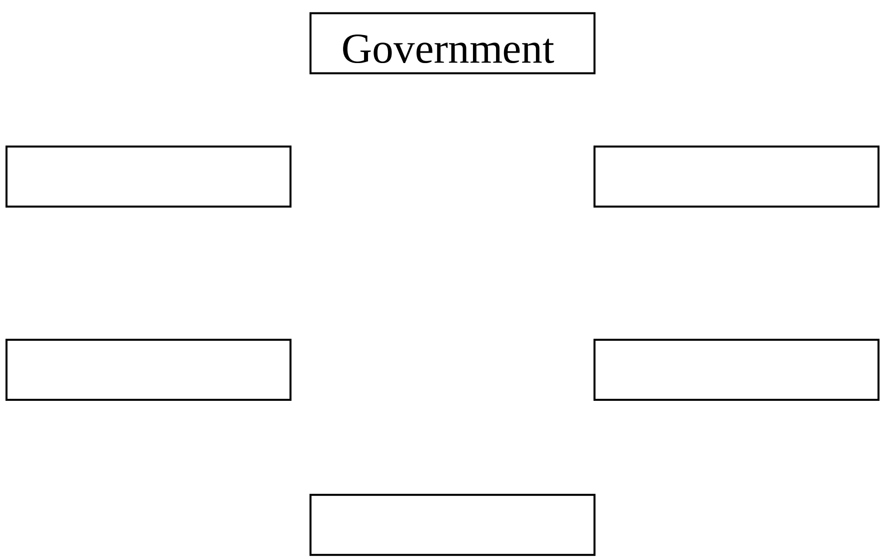
1) Write a paragraph answering the focus question; "What is the government?"
2) After writing the paragraph, circle the important concepts in the paragraph that were helpful in answering the focus question.
3) Select the five most important concepts and write them into the concept map structure.
4) Connect the boxes labeling the connections and specifying the direction of the relationships.



APPENDIX F

Government Concept Maps

1) Write a paragraph answering the focus question; “How does the government work?”
2) After writing the paragraph, circle the important concepts in the paragraph that were helpful in answering the focus question.
3) Select the five most important concepts and write them into the concept map structure.
4) Connect the boxes labeling the connections and specifying the direction of the relationships.

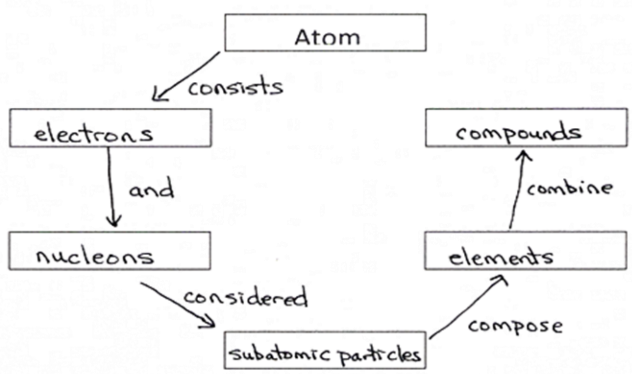


APPENDIX G

Student Sample Concept Map

Atomic Concept Maps

1) Write a paragraph answering the focus question; "How does an atom work?"
2) After writing the paragraph, circle the important concepts in the paragraph that were helpful in answering the focus question.
3) Select the five most important concepts and write them into the concept map structure.
4) Connect the boxes labeling the connections and specifying the direction of the relationships.



APPENDIX H

Application for Exemption from Institutional Oversight

LSU
Institutional Review Board
Dr. Robert Mathews, Chair
131 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.6792
irb@lsu.edu
lsu.edu/irb

Unless qualified as meeting the specific criteria for exemption from Institutional Review Board (IRB) oversight, ALL LSU research/ projects using living humans as subjects, or samples, or data obtained from humans, directly or indirectly, with or without their consent, must be approved or exempted in advance by the LSU IRB. This Form helps the PI determine if a project may be exempted, and is used to request an exemption.

-- Applicant,Please fill out the application in its entirety and include the completed application as well as parts A-E, listed below, when submitting to the IRB. Once the application is completed, please submit two copies of the completed application to the IRB Office or to a member of the Human Subjects Screening Committee. Members of this committee can be found at http://www.lsu.edu/screeningmembers.shtml

-- A Complete Application Includes All of the Following:
  (A) Two copies of this completed form and two copies of part B thru E.
  (B) A brief project description (adequate to evaluate risks to subjects and to explain your responses to Parts 1&2)
  (C) Copies of all instruments to be used.
    *If this proposal is part of a grant proposal, include a copy of the proposal and all recruitment material.
  (D) The consent form that you will use in the study (see part 3 for more information.)
  (E) Certificate of Completion of Human Subjects Protection Training for all personnel involved in the project, including students who are involved with testing or handling data, unless already on file with the IRB. Training link: (http://phrp.nihtaining.com/users/login.php.)
  (F) IRB Security of Data Agreement: (http://www.lsu.edu/irb/IRB%20Security%20of%20Data.pdf)

1) Principal Investigator: Dana Browne **Rank:** Professor

Dept: Physics & Astronomy **Ph:** (225) 578-6843 **E-mail:** phowne@lsu.edu

2) Co Investigator(s): please include department, rank, phone and e-mail for each

Blake J. Orgeron, MNS Graduate Student
(985)992-0500
blake.orgeron@yahoo.com

IRB# E5602 LSU Proposal # ______
⊗ Complete Application
⊗ Human Subjects Training

3) Project Title: The Effect of Focus Questions on Dynamic Thinking Concept Maps

Study Exempted By:
Dr. Robert C. Mathews, Chairman
Institutional Review Board
Louisiana State University
203 B-1 David Boyd Hall
225-578-8692 | www.lsu.edu/irb
Exemption Expires: 8-17-2014

4) Proposal? (yes or no) NO **If Yes, LSU Proposal Number** ______

Also, if YES, either ◯ **This application completely matches the scope of work in the grant**

OR ◯ **More IRB Applications will be filed later**

5) Subject pool (e.g. Psychology students) Chemistry Honors Students at Lutcher High School

*Circle any **"vulnerable populations" to be used:** (children <18; the mentally impaired, pregnant women, the ages, other). Projects with incarcerated persons cannot be exempted.

6) PI Signature [signature] **Date** 6/30/11 (no per signatures)

**** I certify my responses are accurate and complete.** If the project scope or design is later changes, I will resubmit for review. I will obtain written approval from the Authorized Representative of all non-LSU institutions in which the study is conducted. I also understand that it is my responsibility to maintain copies of all consent forms at LSU for three years after completion of the study. If I leave LSU before that time the consent forms should be preserved in the Departmental Office.

Screening Committee Action: Exempted √ Not Exempted ____ Category/Paragraph 1

Reviewer Mathews **Signature** [signature] **Date** 8/18/11

VITA

Blake J. Orgeron was born in Raceland, Louisiana, in January 1969. He attended lower elementary, upper elementary, and junior high school in Lockport, Louisiana. He graduated from Central Lafourche High School in May 1987. The following August, he entered Louisiana State University Agricultural and Mechanical College. In January 1988, he entered Nicholls State University and earned his degree in Secondary Education. He entered the Graduate School at Louisiana State University Agricultural and Mechanical College in June 2010 and is a candidate for a Master of Natural Sciences. He taught high school Science in St. Mary Parish for 11 years and has currently taught in St. James Parish for the last 9 years at Lutcher High School, where he is the head girls' softball coach and assistant football coach.