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CONCEPT MAPPING APPLICATIONS AND ASSESSMENT IN AN AFTER SCHOOL PROGRAM FOR ADOLESCENT STUDENTS

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Abstract. The purpose of this paper is to describe and discuss the concept mapping strategies we used to review and assess 6th grade middle school students' knowledge of a human geography curriculum. We report findings from spring 2010 and spring 2011 assessments and revisions to the curriculum in summer 2010. Concept mapping strategies used in the after school program included student-generated concept maps, the use of gaming to facilitate concept map creation, cooperatively-made concept maps, and student interviews.

1 Introduction

In this paper we describe and discuss the concept mapping strategies used to review and assess 6th grade middle school students' knowledge of a human geography curriculum. The students were participants in an after-school college reach-out program (CROP) first implemented with 6th graders during the 2007-2008 academic year. The overarching CROP goal is to build, within the urban core, a community of students who see themselves as academically able, emotionally ready, and active in their pursuit of positive futures in middle school, high school, and beyond by entering and successfully completing a post-secondary education program. CROP selection criteria includes low achievement on state reading and/or mathematics accountability measures, poverty status, and the potential to be a member of the first generation in their family to attend and complete college. Selected students attend one of two low-performing schools in the urban core of a large Florida school district. More often than not, CROP students have social or academic barriers or both to overcome and, as a result, are reluctant learners—often lacking the motivation to sustain sufficient effort necessary for academic success.

After school learning sessions focus on building background knowledge in human geography and students' self-concept. CROP activities occur weekly in 3-hour sessions led by a certified teacher and undergraduate college students who work with students in small and large group settings. Program design incorporates concept mapping strategies including use by teachers as an instructional strategy and by students as graphic organizers.

In spring 2010 and 2011 we used concept mapping for formative assessment of the CROP students' human geography knowledge (Monroe-Ossi, Wehry, & Fountain, 2010; Wehry, Monroe-Ossi, Cobb, & Fountain, 2012; Wehry, Monroe-Ossi, & Fountain, 2010). In the assessment, an expert concept map, developed by the teacher-researcher, was used to scaffold the learning of the participants. At the end of the review, the task for the students at each grade was to generate concept maps incorporating concepts from the expert map and adding the newly learned concepts. The assessments followed 18 weeks of CROP sessions.

2 Purpose

The 6th grade curriculum was specifically designed to help students understand that they control their path to academic success, and to do so students must first see themselves in charge of their futures. To that end, the 6th grade CROP curriculum begins at the small, local end of the scale continuum with self, family, friends, and community. The 6th grade curriculum requires students to confront their interactions with others as those interactions define their beliefs about themselves. However, self-concept can be studied either as a sterile academic concept that resides outside the learner or through personal introspection of the kaleidoscopic layering of one's life experiences. Our initial interest in the students' knowledge about self-concept was academic because we thought understanding the theoretical construct would help students develop and sustain positive self-concepts. By spring 2011, we realized the importance of our mutual understandings of the factors that actually impact the student's self-concept in their specific neighborhoods.

The spring 2010 6th grade assessment involved the *Friends and Family* unit from the CROP human geography curriculum. Insights gained from the 2010 assessment of the academically-based self-concept lead to revisions to the human geography curriculum during summer 2010. In spring 2011, we again used concept

mapping to enhance our understanding of the 6th graders' knowledge structure relative to the impact of families and friends on self-concept. In spring 2011 we implemented the revised concept mapping activity. The purpose of this paper is to report findings from the spring 2010 6th grade assessment using concept mapping, the summer 2010 revisions to the 6th grade CROP curriculum, and the development and implementation of the spring 2011 6th grade concept mapping activity.

3 Formative Assessment: Spring 2010

In spring 2010, after a review of the *Friends and Family* unit using the associated Master Map, students received supplies (blank chart paper, the 12 concepts on the master map, three additional concepts reviewed but not placed on the Master Map, blank Post-It Notes for original concepts, index cards on which to write linking phrases, a glue stick, and a pencil) to use in constructing individually-produced concept maps depicting the unit's content. Students had 20 minutes to complete the task while the CROP college students interacted with them by providing assistance and monitoring on-task behaviors. Figure 1 provides the Master Map and three examples of student-produced maps.

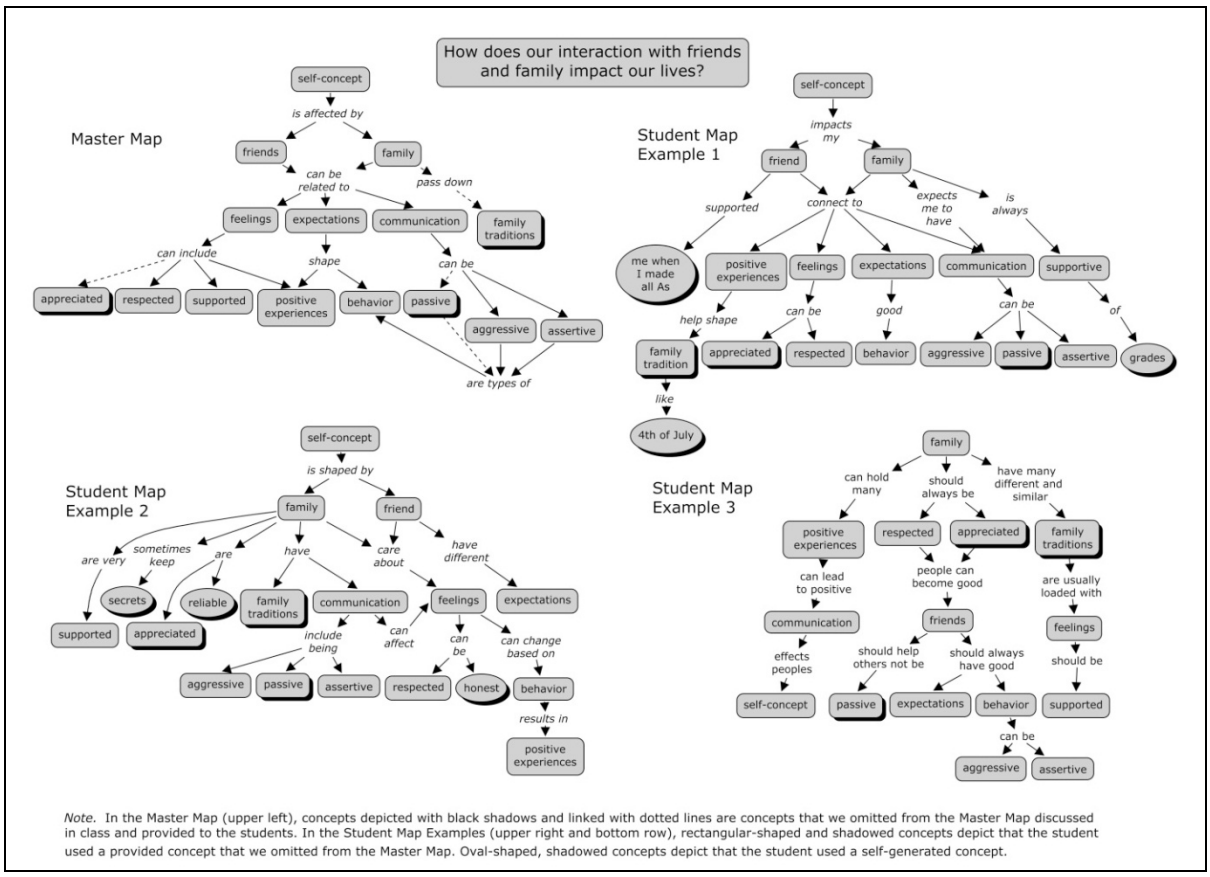

Figure 1: *Friends and Family* unit master concept map and student-produced concept map examples.

Rather than quantitatively score the student-produced maps, we holistically examined the content and structure of the student-produced maps. As can be seen in Figure 1, the Master Map presents a hierarchical map structure using 15 concepts; however, we removed three concepts from the version of the Master Map used in the unit review and subsequently provided to the students. The student who produced the Example 1 concept map used the 12 concepts, added the three concepts omitted from the Master Map (*family traditions*, *appreciated*, and *passive*), and added three original concepts (*me when I made all As*, *grades*, and *4th of July*). The student maintained the hierarchy of the Master Map. In short, the Example 1 map reflects our expectations and would receive a higher score than the Master Map using almost any scoring system (e.g., Wehry, Algina, Hunter, & Monroe-Ossi, 2008). Similarly, the student who produced the Example 2 concept map used the 12 concepts on the Master Map, the three concepts omitted from the Master Map, and added three original concepts (*secret*, *reliable*, and *honest*). At first glance, the Example 2 concept map looks much like what we expected; however, a closer look reveals that the student deviated from the knowledge structure depicted in the Master Map. The Master Map equally emphasizes interactions of friends and family relative to self-concept while the

concept map in Example 2 shifts the emphasis toward family and away from friends. In contrast, the student who produced the Example 3 concept map used the 12 concepts from the Master Map, added the three concepts omitted from the Master Map, added no original concepts, and turned the concept map's hierarchy upside-down. This student placed *family* at the first, most important level of the concept map, and placed *self-concept* at the lowest level subsumed under *communication* and cross-linked with no other concepts.

The 6th graders, for the most part, did not do as expected—concept map the academic structure of self-concept. Instead, they freely mapped the concepts relative to their personal thoughts and feelings. Actually, our focus question did not specifically ask about self-concept, but self-concept was included in the words provided for the student-generated maps and we assumed the students would use the class map to guide their maps. The framework presented by Ruiz-Primo and Shavelson (1996) describes concept map production as the interrelationship of three map facets: task for the respondent, format of the response, and a scoring system. Task demands for students range from the heavy cognitive demand of student-generated concept maps to the more moderate demands of fill-in type concept maps. Task constraints involve restrictions imposed on the task. The structure of the task results from combining the task demands and the constraints. Our assessment involved the production of student-generated concept maps potentially constrained by the list of concepts and the structure provided by the Master Map. For the most part, the 6th graders were not at all constrained by either feature!

3.1 2010 Findings and Revisions

The 6th grade concept mapping assessment indicated that students generally were not willing to use the Master Map to guide the construction of their concept maps, thus, we reconsidered assumptions made about the students' learning. One assumption we unconsciously made was that in learning self-concept as a theoretical construct, students would achieve the CROP goal of seeing themselves in charge of their futures. Our Master Map reflected an impersonal, theoretical approach, but to achieve our stated CROP goal, 6th graders needed to approach the construct from a personal, reflective perspective. Thus, the student who produced the Example 3 concept map completely reversed the hierarchy of the Master Map to reflect the student's life experiences. In summarizing methods used to assess concept maps for correctness, Kinchin (2000) stated that Ghaye and Robinson (1989) "interpreted maps that exhibited a close match with the teacher's knowledge structure as being indicative of a 'passive and reproductive' learning posture rather than a meaningful learning approach" (p. 41). Thus, we reconsidered our Master Map and how we designed the concept mapping assessment. We took this opportunity to change the focus of the assessment from assessing student knowledge to gaining insights to support student's positive self-concept.

During summer 2010, developers revised the CROP curriculum, including the 6th grade curriculum, to make more explicit connections to the foundational concepts of human geography. Additionally, we learned from the concept mapping assessment that, for the most part, students could produce concept maps depicting their understanding of the relationships between the personal interactions that influence their self-concept but they did not necessarily depict the academic structure of self-concept. In an effort to increase student engagement, CROP revisions focused on using instructional strategies that make academic content more interesting. Curriculum revisions required changes to the assessment of the *Friends and Family* unit.

4 Formative Assessment: Spring 2011

In revising the assessment, we considered two factors that could improve student engagement: motivation and games. Unfortunately, academic motivation tends to decrease as students, particularly adolescents, get older. Thus, we turned our attention to *interest* which Hidi and Harackiewicz (2000) defined as "an interactive relation between an individual and certain aspects of his or her environment (e.g., objects, events, ideas), and is therefore content specific" (p. 152). Situational interest, centering on contextual factors, is created by stimuli that focus attentions. Furthermore, "situational interest should also play an important role in learning, especially when students do not have pre-existing individual interests in academic activities, content areas, or topics" (p. 153).

The shift in education away from passive learning by listening and toward a more student-centered model that emphasizes an active role for the learner also moves learning away from the recall of facts and toward the ability to use information. Games provide opportunities to use information and develop winning strategies. A promising thread of research has provided some evidence supporting the effectiveness of games as a learning strategy even for complex subjects. In using games, the objective is to achieve a motivated learner, one who is enthusiastic, focused, and engaged—interested in what he or she is doing. Intrinsically motivating activities

challenge the learner and frequently engage learners simply because of interest (Garris, Ahlers, & Driskell, 2002).

Game designers should match learning outcomes and game features. Garris et al. (2002) suggested that educational games should activate the game cycle: reactions such as interest, behaviors such as persistence, and system feedback. The cycle is iterative—increased interest leads to behaviors such as more intense effort and greater confidence, which lead to system feedback, which leads to increased interest. Several features, taken together, make games an effective instructional strategy. Games should have clear goals and rules and activities should provide an optimal level of challenge. Furthermore, "Linking activities to valued personal competencies, embedding activities within absorbing fantasy scenarios, or engaging competitive or cooperative motivations can serve to make goals meaningful" (Garris et al., 2002, p. 450). Finally, debriefing processes, a review and analysis of game events, provide the link between the game and the learning outcomes.

4.1 Conceptual Card Game: Spring 2011

Researchers working with the Panamanian project, *Conéctate al Conocimiento*, developed a game to help teachers introduce concept mapping to their students and students to construct better concept maps. The game required a set of cards having concepts on one side and a focus question provided by the facilitator. Student teams selected two cards at random from the deck and used them to form a proposition. The design of this game fostered collaboration as well as competition. The use of the conceptual card game in Panama resulted in the 5th graders producing a group concept map that was structurally and semantically complex (Giovani et al., 2008).

We adapted this game for use with the *Friends and Family* unit, and, similar to the Panamanian study, we did not replace the cards between turns. In addition to the *Friends and Family* cards, we provided a list of possible linking phrases and the focus question, *How do my friends and family impact my self-concept?* (See Table 1.) Consistent with the summer revisions, self-concept appeared only in the focus question.

Concepts		**Linking Phrases**
Emotions	Expectations*	*can be influenced by*
Behaviors	Communication	*effect*
Future	Social skills	*determines*
Goals	Historical events	*include*
Barriers	Family traditions	*relates to*
Likes/dislikes†	Neighborhood	*such as*
Family strengths	James Weldon Johnson	*lessens*
Family weaknesses	Passive	*increases*
Problem solving	Assertive	*can be*
Life experiences	Support	*are*
Outside influences	Respect	
Personal characteristics	Appreciate	

Note. * Class map Example 1 did not use the concept *expectations*. † Class map Example 2 separates likes/dislikes into two distinct concepts, *likes* and *dislikes*.

Table 1: Concept Card Game Concepts and Possible Linking Phrases

After a brief review of concept mapping, students formed two teams and flipped a coin to establish which team would begin the game. After randomly selecting two concepts from the card deck, the teams had 1 minute to form a sensible proposition using the selected concepts. If both teams judged the proposition *correct*, the team scored 2 points and had an additional minute to form two bonus propositions using the selected concepts and concepts already on the map. (At the first turn, bonus propositions are not possible.) Bonus propositions scored 2 points each, but the team must make two bonus propositions to score points. The team's turn was over when members could not make a *correct* proposition using the selected concepts within the allotted minute or when members exhausted the allotted bonus minute or created two *correct* bonus propositions. Figure 2 shows example concept maps from each school.

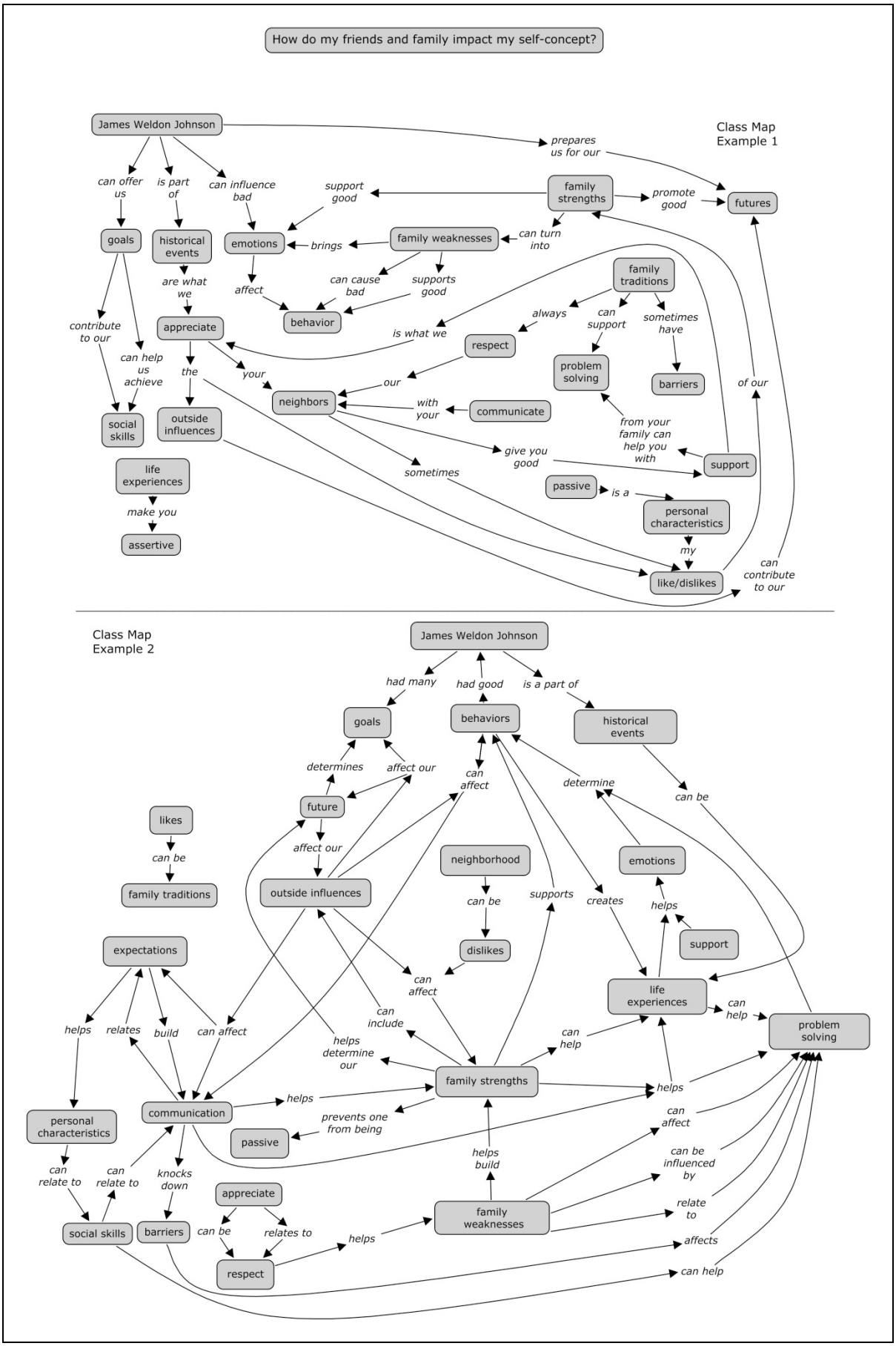

Figure 2: *Friends and Family* class concept maps generated using the Conceptual Card Game.

4.2 Spring 2011 Findings

Concept mapping assessment sessions were recorded allowing researchers to review the implementations of and student engagement during the Conceptual Card Game. This review process allowed us to compare and contrast the students' reaction to the game across the two settings. The students who produced the Figure 2 Example 1 class concept map were highly engaged—the first bonus points came during the fifth turn. Moderated by the teacher-researcher, during each turn, the teams engaged in rich discussions concerning the *correctness* of the propositions. These discussions also provided opportunities for students to edit and review language used in the propositions. After the seventh turn, the students began to acknowledge the list of possible linking phrases as a resource. As the game progressed, the student's engagement increased—it was also easier to make bonus points because the concept map was larger and more connections were possible.

Recordings revealed that students who produced Example 2 strategized earlier in the game than the students who produced the Example 1 map, and the Example 2 students scored the first bonus points during the third turn. The teams collaborated during their team's turn to edit their propositions and strategized during the opposing team's turns about bonus propositions. Team 2 students were more fully engaged earlier in the game than the Team 1 students.

At the end of the game, the teacher-researcher interviewed students concerning their thoughts about playing the game. The leading question in all interviews was a version of "*Tell me something about the concept card game you played today*." Follow-up questions elicited fuller information from the students. Table 2 provides transcripts of four interviews.

Girl 1 Interview	**Two Boys Interview**
Interviewer: Tell me something about the concept card game that you did today. Girl 1: It was kinda, it wasn't confusing, it was kinda hard because I kept getting frustrated because of the lack of time. Interviewer: What was frustrating about the time? Girl 1: 'Cause I couldn't think that fast in 1 minute—and I tried to get bonuses, but sometimes we wouldn't get the bonuses. I was frustrated. Interviewer: Was there anything you liked about the game? Girl 1: It was exciting because it's like a rush. I like games that you gotta rush and try to hurry up and do things—it's more interesting. Interviewer: Were you surprised about anything that people put on the map? Girl 1: Yea. Interviewer: Can you give me an example? Girl 1: I would get mad because it was super good, it was like better than what we did and I would get mad. Interviewer: Give me an example of something super good that was better than what you did. Girl 1: Like say *expectations* and *respect*. We would think of something all small and then they would think of something all—um what's the word [snapping her fingers]—intelligent. Interviewer: Was it easy or hard or just right? Girl 1: Just right.	Interviewer: Tell me, what did you think about today's card game? Boy 1: It helps your mind think. Interviewer: What makes you say that? Boy 1: … because we had to think of the ways to use two words in one or more sentence. Interviewer: Why do you think that is important? Boy 1: … to have more ways to communicate. Interviewer: Do you think the card game was fun? Boy 1: Yes, because we had to figure out ways to put the words in sentences. Interviewer: What did you think was easy about the card game? Or did you not think that anything was easy? Boy 1: It was both hard and easy. Interviewer: Tell me more. Boy 1: The easy part is that we had to like we could change the sentence. The hard part was making the sentence because uh you had to find out which word… Boy 2: … you had to figure out the words that make the sentence.
Girl 2 Interview	**Girl 3 Interview**
Interviewer: What did you think of the card game? Girl 2: I think it was fun and challenging. Interviewer: Why and how? Girl 2: I think it was fun because, you like got the chance to write and put our thoughts out—of what we think the words mean and how they connect to each other. Interviewer: Why do you think that is important if you think it is important? Girl 2: I think it was challenging. Interviewer: Was it too hard, too easy, or just right? Girl 2: It was just right.	Interviewer: Tell me what you thought about the card game. Girl 3: It was exciting and hard and easy—it sure did make me think. Interviewer: Why do you think that? Girl 3: Well, you had to put the names together like *James Weldon* *Johnson* and *support*—put together really fast to get points. In response to no particular question: Girl 3: I liked the way we could change things and how you could make it better.

Table 2: Concept Card Game Example Interviews

The interviews shown in Table 2 are representative of the collection of interviews and, for the most part, confirm our observations from the recorded lessons. Only one interviewee expressed dislike for the game and she simply did not enjoy team activities, either collaborative or cooperative learning. Girl 1's responses illustrate

the issue of challenge. At one point, she indicates frustrations because of the time limit, and then says she likes to have to rush and hurry up. More than likely she was expressing the challenge of the game (her word: frustration), but that she enjoyed the challenge (her words: exciting and interesting). Girl 2 indicated the importance of having the chance to make their own connections. Surprisingly, two of the interviewees liked the chance to edit their work—this also comes across in the recordings. The students welcomed the opportunity to make their work better. In summary, students thought the game was exciting and interesting, thought the level of challenge was just right, were increasingly engaged, and developed strategies to win the competition.

A causal glance at the class concept maps in Figure 2 reveals differences in the topology of two maps. Neither concept map reflects a hierarchy, which is not uncommon when concept maps reflect processes rather than declarative knowledge. Maps can also contain cycles which show dynamic functional relationships among concepts. "A cycle is built from a constellation of concepts and represents a group of closely interconnected constructs" (Safayeni, Derbentseva, & Cañas, 2004, p.751). Topology can also be used to determine the relative importance of mapped concepts. One simple method is to look at the number of incoming and outgoing links (Leake, Maguitman, & Reichherzer, 2004).

Within Figure 2, the Example 1 map has simpler topology (with respect to important concepts when judged by the number of incoming and outgoing links) than the Example 2 map. The most important concept in Example 1 is *neighbors* which is involved in five cross-links: two incoming and three outgoing (5/2/3) for the number of links/incoming/outgoing, respectively. *Family strengths* (4/1/3), *family weaknesses* (4/1/3), *appreciate* (4/2/2), *likes/dislikes* (4/3/1), and *emotions* (4/3/1) form the second tier of important concepts. The Example 1 map exhibits only one cycle: *neighbors* give you good *support* is what we *appreciate* your *neighbors*. In contrast, the Example 2 map has three most important concepts: *family strengths* (9/3/6), *communication* (8/4/4), and *problem solving* (8/7/1). Additionally, Example 2 has two other important concepts: *behavior* (6/7/3) and *outside influences* (6/3/3). The Example 2 map also exhibits numerous cycles: a simple example involving all three most important concepts is *family strengths* help *problem solving* determines *behavior* can affect *communication* helps *family strengths*.

5 Discussion, Limitations, and Future Research

Discussion of the concept mapping activities focuses on the use of a game to motivate CROP participants to fully engage in a review of the impact of their friends and families on their self-concept. From the perspective of the game cycle, students expressed interest in the game and most indicated that they thought the game was exciting, fun, and challenging. The recorded lessons revealed that interest increased over time as indicated by student engagement, which lead to feedback from the game. As the game progressed students were able to score more bonus points (feedback) which in turn created more interest. Students, through their interviews and actions, indicated that the *correctness* discussions after the placement of every proposition was feedback as the review process provided affirmation as well as voice to their thoughts about the concepts. Students expressed that the challenge of the game was *just right*. Two students expressed that the required thinking provided the game's challenge.

The difference between the Figure 1 and 2 concepts maps is dramatic. Most concept maps produced in spring 2010 exhibited a hierarchy with few cross links or cycles. The spring 2011 group concept map did not exhibit a hierarchy and represented more causation. Both activities would be useful in review of the *Friends and Family* unit. The differences between the two Figure 2 concept maps might be explained by the differing contexts of the two schools. While both schools enrolled high percentages of minority students from low-income families, differences existed within the neighborhood attendance boundaries. Neighborhoods of the school enrolling the Example 2 concept map students encompass the most extreme forms of poverty—bringing with it high crime, drug trafficking, sex workers, and gangs. The CROP students at this school chose not to be involved in their neighborhoods; thus, it is not surprising that their concept map expressed *family strengths*, *problem solving*, and *communication* as the most important concepts rather than *neighborhood*.

Our findings are limited by the conceptual content of the game, the settings which supply the situational interest, and the differences in the parking lot of concepts used across schools in the 2011 activity. We feel that the card game was successful in activating students' thinking about how their friends and families influence self-concept. Because our settings created situational interest, others may or may not find similar usefulness when using different content and/or settings.

As can be seen in Figure 2, mapped concepts are not the same across examples. The games were played using the same deck of cards; however, parking lots were created during the initial review and the words used were not checked for correctness. It was only in the review of the resulting maps that we discovered the games were not exactly the same. Additionally, in many instances our labels for concepts were noun-forms of words more often used as verbs. More care in selecting labels for concepts might produce less unplanned difficulty. Our label choices combined with our suggested list of linking phrases, in too many instances, prompted passive voice which can be problematic.

Areas for future research include the influence of the rules of the game on the outcome map. The order in which the concepts are selected influences the concept map's topology. For example, students who produced Example 1 selected *communicate* during the games' third turn and *neighbors* during the fifth turn. Students who produced Example 2 selected *communication* and *neighborhood* during the sixth turn. Would the Example 2 map been different if the students had selected *neighborhood* earlier in the game and not with *communication*? Also, how would outcomes differ if bonus propositions were not limited to connections between selected concepts and concepts already on the map but rather the rules permitted bonus propositions between any two concepts on the map? Opening up this rule has the potential for reducing bias caused by the order of concept selection.

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