Metacognition, Multiple Intelligence and Cooperative Learning

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Abstract

Ninety-five ninth grade students from a West Coast high school performed investigations in astronomy using software developed by the Center for Educational Technologies at Wheeling Jesuit University titled, *Astronomy Village®: Investigating the Universe*. Students worked in cooperative groups of three and were assessed each week for three weeks on their contribution to the group. The purpose of this study was to see the relationship between the independent variables of metacognitive awareness and intelligence type (creative, practical, and analytic) and the dependent variable, contribution to cooperative groups. In this study, we found that metacognition and creative intelligence were significantly related to the scores that the students received from other members in their group. After further analysis, we found metacognition to be the better predictor of cooperative learning abilities. From this, we concluded that when students are placed in a unfamiliar, ill-structured situation, they need metacognition to assist them in monitoring, evaluating, and solving problems. Furthermore, creative abilities help students to excel in these situations, which are novel in nature.

Metacognition, Multiple Intelligences and Cooperative Learning

Theoretcal Framework

Cooperative Learning

Many educators who use cooperative learning methods do so because they view their students as active discoverers and creators of knowledge (e.g., Johnson & Johnson, 1989; Johnson, Johnson, & Smith, 1991b; King, 1993). From this perspective, the learning process is viewed as a collaboration between instructor and student, in which the instructor develops students' competencies and critical thinking through the use of active learning methods (Cooper, 1993; Henderson, 1996; King 1993).

Both Johnson, Johnson, and Smith (1991b) and Slavin (1989/90) have indicated that cooperative learning is one of the most thoroughly researched instructional methods. Cooperative learning has found widespread application in kindergarten through grade twelve, and is increasingly being used and accepted in institutions of higher education (Cooper, 1993). Commonly cited outcomes associated with cooperative learning can be sorted into four categories: (a) affective, (b) motivational, (c) social, and (d) cognitive (Abrami, Chambers, Poulsen, De Simone, d'Apollonia, & Howden, 1995; Dansereau, 1985; Johnson et al., 1991b; Slavin, 1989/90). However, little is known about the relationships between metacognition and cooperative learning or multiple intelligences and cooperative learning.

Metacognition

Metacognition has been defined as knowledge or awareness of cognitive processes and the ability to use self-regulatory mechanisms to control these processes (Eggen & Kauchak, 1997). Researchers have found that metacognition is not something that takes place in one area of the mind; rather, it is a part of cognition that controls a large number of functions such as perception and attention. Metacognition itself does not predict achievement, but researchers believe that it may serve as a mediator to learning (Bruning, Schraw, & Ronning, 1995). Highly metacognitive individuals excel in planning, managing information, monitoring, debugging, and evaluating (Schraw & Dennison 1994). These abilities may be essential for learning in cooperative groups.

Multiple Intelligences

Robert Sternberg has studied individual abilities in the context of intelligence. He proposes three types of intelligence: creative, analytic, and practical. He identifies those with creative intelligence as inventors, initiators, and discoverers. Students who tend to have high creative intelligence succeed in situations when there is little instruction such as the drawing of imaginary pictures. Students who are analytic excel in abilities such as judging, defining, and evaluating. Analytic students are successful at defining a problem and monitoring the steps to solving the problem. Such students would do well at scheduling and mapping. Practical students apply, implement, or utilize information learned to real-life situations. An example would be applying the ethical standards learned in a philosophy class and applying them to one's relationships (Sternberg 1997).

Sternberg's Triarchic Abilities Test measures creative intelligence using novel situations. He believes that individuals who are successful at solving novel problems are creative in nature and perform best in unfamiliar situations (Sternberg,1988). The test measures practical intelligence by using aspects of everyday life such as basic math. With such knowledge, students can utlize mathemetical proofs to make common decisions. Analytic intelligence is measured by analogies. Analytic intelligence enables a student to compare and contrast words and patterns.

What characteristics help students succeed in cooperative groups? Our first hypothesis was that students with high metacognitive abilities would be more aware of learning requirements and would, therefore, contribute significantly more than others in a cooperative group setting. Our second hypothesis was that students with high creative abilities would also excel in the cooperative learning environment, lending support to Sternberg's theory that individuals with high creative intelligence perform best at unfamiliar tasks (Sternberg,1988).

Method

Participants

This study was conducted during the fall of 1997. Participants consisted of 95 ninth- grade students (f=52, m=40, did not specify =3) from a West Coast high school. Ethnic backgrounds included Caucasian (n=27), 28%; African American (n=2), 2%; Asian American (n=16), 17%; Hispanic, Latino (n=15), 37%; 19% of the students did not specify ethnic background (n=35).

Procedure

Three inventories were administered by the teacher prior to using the software, *Astronomy Village: Investigating the Universe.* Students were then assigned to cooperative groups and spent the next three weeks investigating a research question in astronomy. Cooperative learning assessment took place at the end of each week.

Materials

Astronomy Village®: Investigating the Universe. The Village software, aimed at ninth-graders, consisted of 100 astronomy-related articles, 335 Earth- and space-based telescope images, and 10 investigations that attempted to motivate students to learn concepts in astronomy while engaging them in scientific inquiry. Student cooperative learning groups progressed through five phases of inquiry: background research, data collection, data analysis, data interpretation, and presentation of results. Given that the software required students to perform investigations while learning relatively new scientific concepts, it was fair to say that the assessment instrument measured performance on tasks that were unfamiliar to the students.

Metacognitive Inventories. Metacognition was measured using two inventories, the Junior Metacognitive Awareness Inventory (JrMAI) (Dennison, et al., 1996), and "How I Solve Problems" (Fortunato et. al., 199). The recommended procedure for combining the results into one measure is outlined in Howard (1998). The JrMAI is designed to measure student knowledge of cognitive factors. "How I Solve Problems" is designed to measure what metacognitive strategies are being implemented while solving problems. Both measures utilize a 5-point Likert scale.

Contribution to Cooperative Learning Measure. This instrument was developed by Howard (1997) and took approximately 1-2 minutes to complete. Each week, the students rated themselves on how much they contributed to the cooperative group (self-ratings). Then the students rated the other members of the group (peer ratings). Student contributions were rated on a five point scale, (e.g., 1=did not contribute, 5=contributed very much).

Sternberg's Triarchic Abilities Test. This test is made up of twelve different subscales (the three intelligences measured across four domains: quantitative, verbal, figural, and essay). Each domain had four questions. Essay domains were not used.

Results

The first hypothesis was that students with higher metacognitive abilities would be more aware of the learning requirements and thus would contribute significantly more in a cooperative group setting. The second hypothesis was that students with high creative abilities would also excel in the cooperative learning environment. An analysis of correlations provided support for each hypothesis. These results appear in Table 1. Level of metacognitive ability was found to be significantly related to self-ratings (r=.3602, p=.001) and peer-ratings (r=.3228, p=.005). Also, creative intelligence was found to correlate significantly to peer-ratings (r=.2202, p=.044).

There was no significant relationship between metacognition and creative intelligence. Therefore, a regression analysis was performed to see which variable would best predict high self- and peer-ratings. Metacognition was found to be the better predictor (*B*=.258, p=.0104). These results are shown in Table 2.

Discussion

These findings have many implications in educational psychology. From this study we can infer that creative students are perceived by other students as contributing more to cooperative learning. Results also support the notion that metacognition is important for cooperative learning. Since researchers have found few direct relationships between metacognitive abilities and classroom achievement, why would metacognition be needed in this environment? It could be that cooperative learning is novel, and thus unfamiliar, creating the need to monitor cognition. Thus, metacognition may not be needed in typical classroom learning situations, in which the learner is familiar with the requirements of the learning task. But when the learning task becomes unfamiliar, student metacognition is needed, and thus would predict greater success.

The next step in this research would be to run another study with variables such as intrinsic motivation and science attitudes to see how well metacognition predicts cooperative learning abilities compared to these variables. Also, it would be beneficial to run a causal model to see the extent to which metacognition is connected to cooperative scores and achievement. Such findings would be important in helping students become self-regulated learners, using metacognitive abilities to plan, monitor, and evaluate their learning.

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Table 1: Correlations between variables examined

		Metacognition	**Analytic**	**Practical**	**Creative**
Cooperative Learning	**Self-ratings**	**.4770***** *n=77*	-0.0171 *n=86*	0.015 *n=86*	-0.0272 *n=86*
	Peer-ratings	**.3228**** *n=75*	0.047 *n=84*	0.2096 *n=84*	**.2202*** *n=84*
	Analytic	-0.2094 *n=74*			
	Practical	-0.0465 *n=74*			
	Creative	0.0736 *n=74*			

*=p.<.05/ **=p.<.01/ ***p.<.001

Table 2: Regression analysis results

Variable	**B**	**SE B**	***Beta***	**Sig T**

Creative	.490	.258	.188	.0602
Metacognition	.084	.032	.258	**.0104***
(Constant)	14.25	4.59	3.11	