Group Metacognition During Mathematical Problem Solving

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Although various studies have shown that groups are more productive than individuals in complex mathematical problem solving, not all groups work together cooperatively. This review highlights that addressing organisational and cognitive factors to help scaffold group mathematical problem solving is necessary but not sufficient. Successful group problem solving also needs to incorporate metacognitive factors in order for groups to reflect on the organisational and cognitive factors influencing their group mathematical problem solving.

Group metacognition is an essential element of mathematical problem solving within a group. Effective group mathematical problem solving involves not only finding a solution but also metacognitively monitoring the group's problem solving activity (Goos, Galbraith, & Renshaw, 2002). However, most research on metacognition has looked at the role of metacognition as an individual learning process (Flavell, 1976; Pugalee, 2001; Schoenfeld, 1987; Schraw, 2001). By focusing on the individual student, researchers have failed to address the dynamics required for progressive knowledge building by collaborative learning groups (Scardamalia & Bereiter, 1994). Group members need to think about their mathematical problem-solving task and how they are working as a group by planning, monitoring, and evaluating their learning processes within the group context (Goos et al., 2002; Hinsz, 2004).

The corpus of knowledge about group problem solving and learning indicates that students' learning in successful groups can achieve higher cognitive levels than working alone (Johnson & Johnson, 1999). Group members can share ideas, develop common goals, as well as learn from and support each other's learning (Benjamin, Bessant, & Watts, 1997). Solving a mathematical problem as a group gives students access to a wide range of thinking strategies, contributes to students' understanding of the problem, and provides alternative solutions (Cohen, 1994; Gillies, 2000). Group learning improves students' mathematical understanding as well as improving their communication and group skills (Haller, Gallagher, Weldon, & Felder, 2000).

While numerous studies suggest that group problem solving is more productive than individual, merely organising students into groups and telling them to work together does not guarantee they will co-operate and learn as a group (Cohen, 1994; Johnson & Johnson, 1999). It has been noted by researchers in both work and education fields that many groups fail to achieve their potential (Fiore & Schooler, 2004; Johnson & Johnson, 2003). In most classes when students are assigned to group work, they tend to seek information from each other and work in groups rather than as a group (Johnson & Johnson, 1999; Ogden, 2000).

A review of the research literature indicates that organisational, cognitive, and metacognitive factors need to be addressed to provide the conditions necessary for successful group mathematical problem solving.

Organisational Factors

Although several models of group development presented in the literature, most models are based on Tuckman and Jensen's (1977) model. Tuckman and Jensen identified five stages through which groups typically develop: Forming, storming, norming,

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performing, and adjourning. The forming stage of group development involves group members deciding how they will work together. Groups enter the storming stage as conflicts begin to emerge. While resolving the conflict groups move into the next stage of group development, norming. The performing stage is reached as group members become committed to working together. Finally, the adjourning stage involves the group completing the task and allows opportunity to reflect on their group work.

Tuckman and Jensen's (1977) group development model suggests a progression through the stages. However, Langan-Fox (2003) stated that many groups can waiver between stages. Tuckman and Jensen also suggested that most groups fail to achieve and move past the third stage of development, norming, which occurs as groups achieve group cohesion and are able to work productively together. The fourth stage, performing, which involves members working together interdependently, occurs in only a small percentage of groups (Langan-Fox, 2003).

Johnson, Johnson and Johnson-Holubec (1993) suggested that in order for students to work together successfully, five elements must be incorporated into learning activities: 1) Face-to-face interaction; 2) Social skills; 3) Individual accountability; 4) Positive interdependence; and 5) Group processing. Face-to-face group interaction enables learners to encourage and assist each other's learning (Johnson & Johnson, 2003). Group social skills are also an important component of achieving a successful group and include conflict resolution, and communication skills. Individual accountability is where each group member is accountable for the group goal and positive interdependence is where each group member depends on other group members to accomplish the shared task (Johnson & Johnson, 1999). Finally, group processing allows a general assessment of how groups are working together to achieve their goals (Benjamin et al., 1997).

Strategies for Addressing Organisational Factors

The mathematical task directly influences how the group develops and works together (Light & Littleton, 1999). Simple problems that are closed, or only require one answer, require low levels of co-operation as students do not need to discuss how to proceed; nor do they need to restructure their own ideas taking into account other members' perspectives (Cohen, 1994). Whereas complex, ill-structured tasks ensure that groups use taskwork and teamwork in order to solve the problem (Dishon & O'Leary, 1984). Ill-defined or ill-structured problems have vague or unclear goals, multiple solutions, multiple solution paths, multiple criteria, and provide opportunities for students to engage in collective meaning making (Cathcart, Samovar & Henman, 1996).

Research regarding complex problems, such as model-eliciting problems, confirms that the use of realistic ill-structured problems allows students to engage in collective meaning making (Lesh & Lamon, 1992; Zawojewski, Lesh, & English, 2003). Model eliciting problems are mathematical-based tasks that present realistic problem scenarios and require students to develop a model that not only can be used to solve the problem situation but also be generalised to other contexts (Lesh & Harel, 2003). With complex problems, such as model-eliciting tasks, students need to be involved in high levels of co-operation, as they work together (Zawojewski et al., 2003).

Cohen (1994) noted that students need to be taught how to work together and specific teaching should deal with the co-operative behaviours that are required by group work. Dishon and O'Leary (1984) divided group skills into maintenance and task skills. Maintenance skills are used in order to maintain the group in working order and task skills are associated with the specific problem-solving task.

Problem-solving task skills can be classified into two categories; skills to help represent the problem and skills to help solve the problem. Skills to help represent the problem include restating the problem, stating the goal of the problem, simplifying the problem, drawing a diagram, making a table, making a list, and acting the problem out (De Corte, Greer, & Verschaffel, 1996; Dominowski, 1998; Malouff, 2008). While skills to help solve the problem include solving a simpler problem, working backwards, guessing and checking, and looking for patterns (Malouff, 2008; Nickerson, 1994).

There is some inconsistency within the literature regarding the teaching of mathematical problem-solving task skills. Some propose explicit teaching of skills (e.g., Hoek, Terwel, & van den Eeden, 1997; Malouff, 2008). Others suggest that choosing appropriate skills is learnt by solving a variety of problems and reflecting on the effective skills used (e.g., Delclos & Harrington, 1991; De Corte et al., 1996). However, there is general agreement in the literature that groups need to learn to monitor and adjust the problem-solving skills they are using as they solve a mathematical problem (Garofalo & Lester, 1985).

Students also need to learn specific group maintenance skills in order for them to work successfully in groups. Cohen (1994) noted that some students have no group strategies other than physical or verbal assault. Students need to learn how to work together and specific teaching should deal with the cooperative behaviours that are required by group work. Group skills need to be explicit and involve basic social skills such as sharing responsibility, discussing group goals, active listening, as well as negotiating conflicts (Cohen, 1994; West, 2004).

Conflict management skills are important for the success of the group (Johnson et al., 1993). Students need to be taught two sets of skills for dealing with group conflicts. First, they need to know how to manage conflicts that occur in their group. Second they must be taught how to negotiate a constructive resolution to any group conflict (Johnson et al., 1993). Students need to be involved in working out reasons for conflict and trying to solve them within their group (Benjamin et al., 1997). West (2004) suggested that in order to avoid destructive conflict group member roles and responsibilities need to be made clear to all group members.

Assigning roles during group problem solving is seen as an effective method for students to learn the specific skills needed for group learning (Cohen, 1994). Group roles can be classified into two distinct categories: Task roles and group maintenance roles (Bales & Cohen, 1979; Hoover, 2002). Task roles relate to the focus of the group toward a solution, while maintenance roles focus on building and maintaining an effective group (Gottlieb, 2003). Task roles include coordinator, summariser, recorder, information and opinion seeker, and checker (Cohen, 1994; Dishon & O'Leary, 1984; Gottlieb, 2003; Hayes, 2002; Tyson, 1989). Team roles include encourager, moderator, supporter, and conflict manager (Bales & Cohen, 1979; Cohen, 1994; Gottlieb, 2003; Johnson et al., 1993; Tyson, 1989).

Cognitive Factors

A degree of shared knowledge is also necessary for teams to work effectively together (Cannon-Bowers & Salas, 2001). This knowledge contributes to the groups' ability to accomplish their task work and ensures that problem solving becomes a co-construction of ideas by group members (Light & Littleton, 1999). When students successfully work as a group to solve a mathematical problem, they develop shared knowledge and understanding about the problem (Lesh, Hoover, Hole, Kelly, & Post, 2000).

The development of shared knowledge during mathematical problem solving is facilitated by groups developing shared mental representations of both task- and team-related information (Rentsch & Klimoski, 2001). To build an effective shared group mental representation, groups members need to hold a similar shared and accurate knowledge about the components of successful groups and about the problem-solving task (Fiore & Schooler, 2004; Rentsch & Klimoski, 2001; Smith-Jentsch, Campbell, & Milanovich, 2000). The two dimensions of group functioning, the task a group is required to complete and the group as a social unit, need to be focused on in order for groups to achieve a shared understanding of the task and how to work successfully together (West, 2004).

Rentsch (Rentsch & Klimoski, 2001; Woehr & Rentsch, 2003) indicated that the development of shared knowledge by a group can be facilitated by the development of schema similarity among group members. In order to evaluate schema similarity, Rentsch created the construct of Team Member Schema Similarity (TMSS). TMSS is the degree of similar or overlapping team knowledge that members' hold of their team work and task work (Langan-Fox, Anglim, & Wilson, 2004). According to Woehr and Rentsch (2003), team work schema similarity leads to improved team processes, while task work schema similarity leads to improved task performance.

Strategies for Addressing Cognitive Factors

In order to develop a shared understanding and knowledge, group members need to negotiate a shared external representation of the mathematical problem as well as an external representation of how they will work successfully together (Fiore & Schooler, 2004; West, 2004). Groups of students need to develop external representations in order to articulate their thinking, making their group understanding explicit and visible in order to collaborate with group members (Mohammed & Dumville, 2001). External representations facilitate the process of articulating students' thinking and allow group members to formulate an accurate shared understanding (Cannon-Bowers & Salas, 2001; Klimoski & Mohammed, 1994). By sharing their ideas, students are able to gain a joint understanding of not only the problem-solving task they are collaboratively completing but also of how their group needs to work together (Cathcart et al., 1996; King, 1989).

Scaffolds have been identified in the literature as helping students develop shared external representations on their team problem solving process (Klimoski & Mohammed, 1994). The use of strategic questions has been suggested to help scaffold the task and the team process (Gama, 2000; Johnson, et al., 1993; King, 1991). Group members can use the questions to develop shared understandings of the team process and the task by asking other group members to justify and clarify ideas they do not understand (Fiore & Schooler, 2004; Goos et al., 2002; Klimoski, & Mohammed, 1994). Problem solving team questions include group processing questions such as: *What are three things your group is doing well and one thing that needs to improve?* (Johnson et al., 1993). Problem solving task questions include questions about the specific problem, what students want to know about the problem, and what they must learn to solve the problem (Maher, 2004). According to King (1991), students also need to be trained to ask scaffolding questions of each other during group problem solving. King categorised these scaffolding questions into planning, monitoring, and evaluating questions.

Metacognitive Factors

Group metacognition requires the co-operative development of strategies used to plan, monitor, and evaluate group behaviour. Flavell, Friedrichs, and Hoyt (1970) first introduced the concept of metacognition as an individual's awareness, choice, and control of their cognitive processes. Flavell (1976) defined metacognition as "one's knowledge concerning one's own cognitive processes and products or anything related to them" (p. 232). Schoenfeld (1987) focused on metacognition as students' beliefs based on past experiences, knowledge of own thinking processes, and self-awareness of the process of problem solving. The literature highlights that encouraging students to plan how to approach a given task, monitor their progress of the task and finally, evaluate their learning process, improves student learning (Blakey & Spence, 1990; McNesse, 2000; Tombari & Borich, 1999).

The abilities to plan, monitor, and regulate their learning processes are also essential for groups building a shared knowledge (Bereiter & Scardamalia, 1989). However, studies have shown that groups of students do not engage in metacognitive thinking unless they are encouraged to do so (Gillies, 2000; Xiaodong, 2001). Costa and O'Leary (1992) stated that groups of students need to develop co-cognition in order to collaboratively develop concepts and monitor their own group performance. Co-cognition requires the cooperative development of strategies used to plan, monitor, and evaluate team and task behaviour.

Strategies for Addressing Metacognitive Factors

By scaffolding group metacognition students can gradually take responsibility for their own group mathematical problem solving by developing shared understandings regarding effective group work and about the problem-solving task (Hinsz, 2004). Scaffolding can be initially provided to groups in order for them to understand what the mathematical problem is asking, plan how the group will go about solving it, monitor the group's progress towards a solution and finally evaluate the effectiveness of their group problem solving process (Klimoski & Mohammed, 1994).

One way to encourage self-evaluation is through the use of scaffolded questions in a journal or learning diary (Blakey & Spence, 1990). Blakey and Spence referred to the diary as a means to develop metacognition as students can write and reflect upon their thinking, making note of inconsistencies and progressively commenting on any difficulties. Writing in mathematics helps students reflect on their work and helps to clarify and deepen understanding (Pugalee, 2001). Writing also helps to develop the vocabulary students need for thinking and talking about their learning (Blakey & Spence, 1990).

Including a checklist in the diary, in which students can monitor their learning, assists students to be reflective learners and scaffolds their metacognitive processes (Blakey & Spence, 1990; Mueller & Fleming, 1994; Wilson & Johnson, 2000). An effective way to develop metacognition is for students to answer a series of metacognitive questions that focus on the planning of the problem task, monitoring progress towards completion, and evaluating the learning process (Kramarski & Mevarech, 2003). Schraw (2001) proposed a checklist for improving students thinking about their learning. The checklist includes questions students could ask themselves during the planning, monitoring, and evaluating stages of their problem solving.

Numerous frameworks for scaffolding individual students' metacognition during mathematical problem solving exist, such as the metacognitive questionnaires developed by Fortunato, Hecht, Tittle, and Alvarez, (1991) and King (1991). The questionnaires used metacognitive strategies to scaffold questions based around the problem solving process. The three main metacognitive scaffolds used in the questionnaires focused on planning, monitoring, and evaluating strategies.

Metacognitive scaffolds such as checklists, diaries, and the introduction of metacognitive strategies, can also be provided in order to promote group metacognition. Applying metacognitive strategies for group problem solving allows students to focus on the organisational and cognitive factors that influence how groups perform their problem solving task and work together as a team. Groups need to plan, monitor, and evaluate skills and strategies specific to their team and to the mathematical problem-solving task. They also need to be able to apply these strategies to develop a shared group understanding.

Conclusion

This review identifies a number of factors that influence how groups work effectively and form a shared understanding, including organisational factors such as how the group develops and resolves conflicts, and cognitive factors such as how the group forms a shared understanding. This review highlights that effective group mathematical problem solving requires groups to think about metacognitive factors as well as organisational and cognitive factors. Groups need to plan, monitor, and evaluate strategies specific to their group team work and the mathematical problem-solving task. They also need to be able to apply these strategies to develop a shared group understanding. Applying metacognitive strategies for group mathematical problem solving allows students to focus on the organisational and cognitive factors that influence how groups perform their problem solving task and work together as a team.

References

Bales, R., & Cohen, S. (1979). *SYMLOG: A system for the multiple level observation of groups*. New York: Free Press.

Benjamin, J., Bessant, J., & Watts, R. (1997). *Making groups work: Rethinking practice*. St. Leonards, NSW: Allen & Unwin.

Bereiter, C., & Scardamalia, M. (1989). Intentional learning as a goal of instruction. In L. Resnick (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp. 361-392). Hillsdale, NJ: Lawrence Erlbaum.

Blakey, E., & Spence, S. (1990). Developing metacognition. *Eric Reproduction Services No. ED327218*. Retrieved January 7, 2008 from EDRS Online: http://www.thememoryhole.org/edu/eric/ed327218.html.

Cannon-Bowers, J. & Salas, E. (2001). Reflections on shared cognition. *Journal of Organizational Behavior, 22*(2), 195-202.

Cathcart, R., Samovar, L., & Henman, L. (1996). *Small group communication: Theory and practice* (7th ed.). Boston: McGraw-Hill.

Cohen, E. (1994). *Designing groupwork: Strategies for the heterogeneous classroom* (2nd ed.). New York: Teachers College Press.

Costa, A., & O'Leary, P. (1992). Co-cognition: The co-operative development of the intellect. In N. Davidson & T. Worsham (Eds.), *Enhancing thinking through co-operative learning* (pp. 41-65). New York: Teachers College Press.

De Corte, E., Greer, B., & Verschaffel, L. (1996). Mathematics teaching and learning. In D. Berliner & R. Calfee (Eds.), *Handbook of Educational Psychology* (pp. 491-549). New York: Simon & Schuster Macmillan.

Delclos, V. R., & Harrington, C. (1991). Effects of strategy monitoring and proactive instruction on children's problem-solving performance. *Journal of Educational Psychology, 83*(1), 35-42.

Dishon, D., & O'Leary, P. (1984). *A guidebook for co-operative learning: A technique for creating more effective schools*. Holmes Beach, FL: Learning Publications.

Dominowski, R. (1998). Verbalization and problem solving. In D. Hacker, J. Dunlosky & A. Graesser (Eds.), *Metacognition in educational theory and practice*. (pp. 25-45). Mahwah, NJ: Lawrence Erlbaum.

Fiore, S., & Schooler, J. W. (2004). Process mapping and shared cognition: Teamwork and the development of shared problem models. In E. Salas & S. Fiore (Eds.), *Team cognition: Understanding the factors that drive process and performance* (pp. 133-152). Washington, DC: American Psychological Association.

Flavell, J. (1976). Metacognitive aspects of problem solving. In L. B. Resnick (Ed.), *The nature of intelligence* (pp. 231-235). Hillsdale, NJ: Lawrence Erlbaum.

Flavell, J. H., Friedrichs, A. G., & Hoyt, J. D. (1970). Developmental changes in memorisation processes. *Cognitive Psychology, 1*, 323-340.

Fortunato, I., Hecht, D., Tittle, C. K., & Alvarez, L. (1991). Metacognition and problem solving. *The Arithmetic Teacher, 39*(4), 38-40.

Gama, C. (2000). *The role of metacognition in problem solving: Promoting reflection in interactive learning systems*. Sussex, England: University of Sussex.

Garofalo, J., & Lester, F. (1985). Metacognition, cognitive monitoring, and mathematical performance. *Journal for Research in Mathematics Education, 16*(3), 163-76.

Gillies, R. (2000). The maintenance of cooperative and helping behaviours in cooperative groups. *The British Journal of Educational Psychology, 70*(15), 97–111.

Goos, M., Galbraith, P., & Renshaw, P. (2002). Socially mediated metacognition: Creating collaborative zones of proximal development in small group problem solving. *Educational Studies in Mathematics, 49*(2), 193-223.

Gottlieb, M. (2003). *Managing group process*. Westpoint, CT: Praeger.

Haller, C., Gallagher, V., Weldon, T., & Felder, R. (2000). Dynamics of peer education in cooperative learning workgroups. *Journal of Engineering Education, 89*(3), 285-293.

Hayes, J. (2002). *Interpersonal skills at work*. Sussex, England: Routledge.

Hinsz, V. B. (2004). Metacognition and mental models in groups: An illustration with metamemory of group recognition memory. In E. Salas & S. Fiore (Eds.), *Team cognition: Understanding the factors that drive process and performance* (pp. 33-58). Washington, DC: American Psychological Association.

Hoek, D., Terwel, J., & van den Eeden, P. (1997). Effects of training in the use of social and cognitive strategies: An intervention study in secondary mathematics in co-operative groups. *Educational Research and Evaluation, 3*(4), 364-389.

Hoover, J. (2002). *Effective small group and team communication*. Orlando, Fl: Harcourt.

Johnson, D., & Johnson, R. (1999). Making cooperative learning work. *Theory into Practice*, 38(2), 67-73.

Johnson, D., & Johnson, R. (2003). Training for cooperative group work. In M. A. West, D. Tjosvold, & K. G. Smith (Eds.), *International handbook of organizational teamwork and cooperative working* (pp. 167-183). West Sussex, England: John Wiley & Sons.

Johnson, D., Johnson, R., & Johnson-Holubec, E. (1993). *Cooperation in the classroom* (6th ed.). Edina, MN: Interaction Book Company.

King, A. (1991). Effects of training in strategic questioning on children's problem-solving performance. *Journal of Educational Psychology, 83*(3), 307-317.

Klimoski, R. J., & Mohammed, S. (1994). Team mental model: construct or metaphor? *Journal of Management, 20*(2), 403-437.

Kramarski, B., & Mevarech, Z. (2003). Enhancing mathematical reasoning in the classroom: The effects of cooperative learning and metacognitive training. *American Educational Research Journal, 40*(1), 281-310.

Langan-Fox, J. (2003). Skill acquisition and development of a team metal model: An integrative approach to analysing organizational teams, task and content. In M. A. West, D. Tjosvold & K. G. Smith (Eds.), *International handbook of organizational teamwork and cooperative working* (pp. 321-360). West Sussex, England: John Wiley & Sons.

Langan-Fox, J., Anglim, J., & Wilson, J. (2004). Mental models, team mental models, and performance: Process, development, and future directions. *Human Factors and Ergonomics in Manufacturing, 14*(4) 331-352.

Lesh, R. & Harel, G. (2003). Problem solving, modeling, and local conceptual development. *Mathematical thinking and learning: An international journal, 5*(2/3), 157-190.

Lesh, R., Hoover, M., Hole, B., Kelly, A., & Post, T. (2000). Principles for developing thought-revealing activities for students and teachers. In R. Lesh & A. Kelly (Eds.*), Handbook of research design in mathematics and science education* (pp. 591-645). Mahwah, NJ: Lawrence Erlbaum Associates.

Lesh, R., & Lamon, S. (1992). *Assessment of authentic performance in school mathematics*. Washington, WA: American Association for the Advancement of Science.

Light, P., & Littleton, K. (1999). *Social processes in children's learning.* New York, NY: Cambridge University Press.

Maher, P. (2004). *All you need to teach problem solving ages 5-8: Turning problems into solutions*. South Yarra, Australia: MacMillan Education.

Malouff, J. (2008). *Fifty problem solving strategies explained*. Retrieved July 7, 2008 from: http://www.une.edu.au/psychology/staff/malouffproblemsolving.php.

Mohammed, S., & Dumville, B. (2001). Team mental models in a team knowledge framework: Expanding theory and measurement across disciplinary boundaries. *Journal of Organizational Behavior, 22*(2), 189-106.

Mueller, A., & Fleming, T. (1994). Cooperative learning: Listening to how children work at school. *Journal of Educational Research, 94*(5), 259-265.

Nickerson, R. (1994). The teaching of thinking and problem solving. In R. Sternberg (Ed.), *Thinking and problem solving* (pp. 409-449). San Diego, CA: Academic Press.

Ogden, L. (2000). Collaborative tasks, collaborative children: An analysis of reciprocity during peer interaction at key stage 1. *British Educational Research Journal, 26*(2), 211-226.

Pugalee, D. (2001). Writing, mathematics, and metacognition: Looking for connections through students' work in mathematical problem solving. *School Science and Mathematics, 101*(5), 236-246.

Rentsch, J., &. Klimoski, R. (2001). Why do 'great minds' think alike? Antecedents of team member schema agreement. *Journal of Organizational Behavior, 22*(2), 107-120.

Scardamalia, M., & Bereiter, C. (1994). Computer support for knowledge-building communities. *The Journal of the Learning Sciences, 3*, 265-283.

Schoenfeld, A. (1987). What's all the fuss about metacognition? In A. Schoenfeld (Ed*.), Cognitive science and mathematics education*, (pp. 189-215). Hillsdale, NJ: Lawrence Erlbaum Associates.

Schraw, G. (2001). Promoting general metacognitive awareness. In H. Hartman (Ed.), *Metacognition in learning and instruction: Theory, research and practice* (pp. 33-68). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Smith-Jentsch, K. A., Campbell, G. E., & Milanovich, D. M. (2001). Measuring teamwork mental models to support training needs assessment, development and evaluation: Two empirical studies. *Journal of Organizational Behavior, 22*(2), 179-190.

Tombari, M., & Borich, G. (1999). *Authentic assessment in the classroom: Applications and practice*. Upper Saddle River, NJ: Prentice-Hall.

Tuckman, B.W., & Jensen, M.A. (1977). Stages of small group development revisited. *Group & Organization Studies 2*(4), 419-427.

Tyson, T. (1989). *Working with groups*. Melbourne: MacMillian.

West, M. A. (2004). *Effective teamwork: Practical lessons from organisational research.* (2nd ed.). Malden, MA: Blackwell Publishing.

Wilson, J., & Johnson, P. (2000). Students thinking about their learning: Assessment to improve learning. *Educational Research Quarterly, 24*(2), 10-20.

Woehr, D., & Rentsch, J. (2003). *Elaborating team member schema similarity: A social relations modeling approach*. 18th annual meeting of the Society for Industrial/Organizational Psychology, Orlando, FL.

Xiaodong, L. (2001). Designing metacognitive activities. *Educational Technology, Research and Development, 49*(2) 23-40.

Zawojewski, J., Lesh, R., & English, L. (2003). A models and modeling perspective on the role of small group learning activities. In R. Lesh & H. Doerr (Eds.), *Beyond constructivism: A models and modeling perspective on mathematics problem solving, learning, and teaching* (pp. 337-358): Mahwah, NJ: Lawrence Erlbaum.