Stimulating Intrinsic Motivation for Problem Solving Using Goal-Oriented Contexts and Peer Group Composition

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One important factor related to ill-structured problem-solving success is intrinsic motivation, that is, students' willingness to persist in solving the problem. Goal orientation, a motivational variable, explains reasons why students engage in the activity because they want to either learn or perform. This study investigated the relationship between these two types of goal orientations and their effects on motivation and problem solving by varying three instructional contexts designed to promote one of the two orientations. Heterogeneous and homogeneous peer grouping based on self-efficacy was also predicted to affect intrinsic motivation and problem solving. The results indicated that students in the learning-oriented context had significantly higher intrinsic motivation than those in the performance-oriented context. Students in the heterogeneous peer group had higher scores on monitoring and evaluating problem-solving subskills than those in the homogeneous peer groups. Learning-goal orientation and solution development were significantly related when students participated in the learning-oriented, heterogeneous peer grouping treatment group.

Key words: ill-structured problem solving, intrinsic motivation, goal-oriented contexts, peer group composition

☐ Problem solving is one of the most important learning skills in education. The most commonly encountered problems in everyday practice are ill structured, with vaguely defined goals and unstated constraints that present uncertainty about which concepts, rules, and principles should be used to find those solutions (Ge & Land, 2003). Given that middle school students are in the tran-

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sition period from concrete to abstract thinking, the ambiguity and complexity of ill-structured tasks are likely to decrease their enthusiasm for learning and result in a deficiency in problem-solving skills. Thus, intrinsic motivation is particularly important to young adolescents to help them persist in deriving a solution to ill-structured problems (MacKinnon, 1999). Despite the importance of intrinsic motivation in ill-structured problem solving, little research has investigated strategies that can best facilitate a student's motivation for solving ill-structured problems (Mayer, 1998).

Goal Orientation and Its Relation to Intrinsic Motivation

Goal orientation is a particularly important motivation variable because it explains why learners engage in various learning activities. Although many goal orientations, such as the social goal orientation, have been identified (Urdan & Maehr, 1995), researchers have agreed that there are two primary, contrasting orientations: learning and performance (Dweck & Leggett, 1988; Elliot & Dweck, 1988). Students with a learning-goal orientation focus on learning, mastering tasks, and gaining understanding, whereas students with a performance-goal orientation focus on demonstrating their ability in relation to others, seeking public recognition for high-level performance, and avoiding judgment for low ability (Ames, 1992; Dweck & Leggett, 1988). Many researchers have investigated the relationships between learning and performance goals and outcomes such as level of information seeking, cognitive engagement, self-regulation, persistence, and performance. Most have agreed that, generally, adaptive learning outcomes are linked to learning goals, whereas less adaptive learning outcomes are linked to performance goals (Ames, 1992; Dweck & Leggett, 1988; Harackiewicz, Barron, & Elliot, 1998; Linnenbrink & Pintrich, 2002; Pintrich & Schunk, 2002).

Which type of goal, then, best stimulates students' intrinsic motivation to persist in solving ill-structured problems? Most goal orientation theorists contend that learning goals facilitate a learner's appraisal of challenge, task absorption, self-determination, and a feeling of autonomy, all essential elements in intrinsic motivation (Butler, 1987; Rawsthorne & Elliot 1999). Performance goals, on the other hand, are thought to increase evaluative pressure and anxiety, which may work against intrinsic motivation (Deci & Ryan, 1987; Nicholls, 1989). However, recent studies have questioned the maladaptive description of the performance-goal orientation (Barron, Finney, Davis, & Owens, 2003; Harackiewicz et al., 1998; Midgley, Kaplan, & Middleton, 2001). They have suggested that some aspects of performance-goal orientation, such as the desire to demonstrate high ability, can lead to higher motivation and, as a result, be positively related to learning outcomes. These conflicting views highlight a need for continued research to determine which types of goal orientation are most effective in increasing a student's intrinsic motivation in a problem-solving environment.

Goal-Oriented Contexts and Intrinsic Motivation Related to Problem-Solving Tasks

How, then, do instructional designors or instructors facilitate the development of a learner's goal orientation to increase intrinsic motivation in a problem-solving environment? One approach is to provide students with contextual factors that encourage a particular goal orientation, such as environmental cues (Elliot & Dweck, 1988; Gabriele & Montectinos, 2001; McNeil & Alibali, 2000; McWhaw & Abrami, 2001; Schunk, 1996). However, common limitations of these past studies are that they have focused only on single factors and have failed to holistically take into account the combinations of factors that may affect one's goal orientation. As Pintrich (2000) pointed out, goals, in goal-orientation theory, are assumed to be "representations of knowledge structures" (p. 102) that encompass a number of related beliefs about purpose, competence, success, ability, effort, and standards. Therefore, it may be difficult to develop or change them by merely manipulating one contextual factor.

Previous studies have identified three such contextual factors (Ames, 1992; Fuchs et al., 1997; Maehr & Midgley, 1991; Song, 2004): (a) task design, (b) distribution of authority, and (c) recognition or evaluation of student practices. Task design refers to organizing the patterns of learning activities. Providing students with messages that emphasize the intrinsic value of learning may help them to adopt learning goals (Becker, 1995; Pintrich & Schunk, 2002), whereas providing them with messages that stress the importance of performance may lead them to focus on performance. The second factor, distribution of authority, refers to how much opportunity students have to determine their own learning process (Ames, 1992). When students are allowed to make decisions, their interest in learning is likely to be increased. On the other hand, when students participate in carefully sequenced learning activities that walk them through the most efficient learning path, they are likely to develop performance goals. Finally, the third factor refers to the basis for student evaluation. When evaluation is based on self-referenced information, it is predicted to help students develop learning goals. However, when evaluation information is based on normative standards and social comparison, students will be more likely to focus on performance goals (Harackiewicz, Abrami, & Wageman, 1987; Song, 2004). Given that there are two types of goal orientations (learning and performance), two different types of contexts exist to orient students toward the corresponding goal orientations. Thus, one of the main purposes in this study is to investigate which type of goal-oriented context will be most effective in developing intrinsic motivation and problem-solving skills.

Peer Group Composition and Intrinsic Motivation in Problem-Solving Tasks

Another approach to stimulating goal orientation is peer group learning. To facilitate the development of goal orientation, researchers suggest that group learning should not be rigidly set but rather be fluid and adaptive (Becker, 1995). Peer group composition is one way to provide such flexibility. Traditionally, researchers have recommended that peers be grouped heterogeneously rather than homogeneously; heterogeneous peer grouping prompts interpersonal collaboration by providing an atmosphere in which students of both high- and low-ability levels can share diverse experiences and multiple viewpoints (Brophy, 2004; Singhanayok & Hooper, 1998). Despite the alleged benefits of heterogeneous peer grouping, few empirical studies have examined the effect of peer group composition as an instructional strategy for developing goal orientation (Pintrich & Schunk, 2002).

In addition, previous studies of peer groupings have mainly focused on using ability level for group assignments (Hooper & Hannafin, 1988; Hooper, Temiyakarn, & Williams, 1993; Singhanayok & Hooper, 1998). In testing the effectiveness of peer group composition in various contexts, researchers should consider personal characteristics other than ability level (Hooper et al., 1993). One such personal characteristic, related to the interest in intrinsic motivation in this study, is self-efficacy. Self-efficacy refers to a person's belief in his or her own effectiveness or confidence in his or her ability to perform an academic task successfully (Lent & Brown, 1986). According to Schunk (1996), when students see themselves as effective learners, they are highly motivated, work harder on learning tasks, expend more effort, and display more self-regulatory behaviors. The level of self-efficacy, therefore, may be related to students' intrinsic motivation to persist in carrying out a learning task and thereby, affect their ability to develop problem-solving skills. These predicted relationships warrant further research (Hagen & Weinstein, 1995). Heterogeneous peer grouping by self-efficacy was expected to be more effective than homogeneous peer grouping. This hypothesis is supported by previous studies that identified two main benefits of heterogeneous peer groups: (a) active information processing and (b) modeling (Hooper & Hannafin, 1988). Students with high self-efficacy, who have more strongly self-regulated learning strategies, can experience deep information processing while explaining things to their peers, whereas low self-efficacy students can benefit from cross modeling by observing the learning attitudes expressed by their more efficient peers.

Purposes of the Study

The purposes of this study were to examine the effects on intrinsic motivation and problem-solving skills by (a) type of goal-oriented context, and (b) peer groups composed according to self-efficacy level. It was also expected that students working in a learning-oriented context in heterogeneous peer groups would be more intrinsically motivated and effective problem solvers than students in the other types of groups. In addition, it was expected that there would be a positive correlation between the learning-goal orientation and the outcome variables of intrinsic motivation and problem-solving skills for students working in the learning-oriented, heterogeneous peer groups, because learning-goal support should help students focus on an interest in learning (Wolters, 2004). No correlation was expected between the performance-goal orientation and the outcome variables of intrinsic motivation and problem-solving skills for students working in the performance-oriented, homogeneous peer groups (Ames, 1992; Harackiewicz et al., 1998; Linnenbrink & Pintrich, 2002). To test these assumptions, the following research hypotheses were generated for this study:

1. Students working in the learning-oriented context will demonstrate higher intrinsic motivation scores and better problem-solving skills than students working in the performance-oriented context.

2. Students working in a heterogeneous peer group will demonstrate higher intrinsic motivation scores and better problem-solving skills than students working in homogeneous peer groups.

3. Students working in the learning-oriented context in heterogeneous peer groups will demonstrate higher intrinsic motivation scores and better problem-solving skills than students in all other treatment groups.

4. There will be a positive correlation among perceived learning-goal atmosphere, learning-goal orientations, intrinsic motivation, and problem-solving skills in the learning-oriented, heterogeneous peer groups.

METHOD

Research Design

The 2×2 factorial design used in this study was a quasi-experimental design. The independent variables were: (a) type of goal-oriented context (learning, performance), and (b) type of peer-group composition (heterogeneous, homogeneous). Dependent variables were intrinsic motivation and three components of problem-solving skills: (a) problem representation, (b) solution development, and (c) monitoring and evaluation of solutions. Students within each intact class were assigned randomly to one of four treatment groups: (a) learning-oriented, heterogeneous peer group; (b) learning-oriented, homogeneous peer group; (c) performance-oriented, heterogeneous peer group; or (d) performance-oriented, homogeneous peer group.

Participants and Context of the Study

The participants were recruited from 6th-grade students from four intact classrooms of 23–25 students each in a single rural middle school located in the northeastern United States. Informed consent was obtained from 96 students. Parents of 2 students did not grant them permission to participate. These students were assigned to the same peer group and their data were not used in the analysis. The sample was further reduced by 4 students because of absences. The final sample included 90 students—47 boys and 43 girls. The participating classes were mostly ethnically homogeneous, with students across all four classes classified as European American (96%), and African American (4%). Achievement scores such as grade point averages and national achievement scores were not available within the time frame of the study. Thus, it was not known how the classes were composed because of the limitation of collected data. However, the results of the self-efficacy pretest showed that no significant difference was found between participating classes. The study was conducted in the students' regular classrooms during science classes. The classrooms were of the same size and equipped with the same types of Internet-connected laptop computers, desks, and other facilities. One laptop was provided to each pair of students.

Material

A Web-based tutorial was adapted and redesigned from 1 of the 26 lesson plans in a supplementary Web-enhanced problem-based learning (PBL) science curriculum, Kids as Airborne Mission Scientists (KaAMS; http://www.higp.hawaii.edu/kaams/kids/index.html). The lesson selected was "Developing the Mission Flight Plan." The main problem in the lesson challenged students to determine the optimal flight plan for investigating the active lava flows on the Kilauea volcano in Hawaii. The problem case was provided to students in the form of the mission request letter on the Web. The letter asked students to write a report with flight plan recommendations to NASA after exploring factors related to flying the mission. These factors included the purpose of the flight, selection of the best aircraft, characteristics of the remote sensing instrument, airport information, and other conditions that might affect flying the mission. The problem was ill structured because multiple factors related to the flight mission needed to be considered in finding a solution. The tutorial guided the students through five modified learning phases from traditional PBL (Barrows, 1986): specifying the problem (THE PROBLEM), defining the problem (DEFINING THE PROBLEM), investigating the problem with the Web resources (INVESTIGATION CENTER), proposing a group solution (PROPOSE SOLUTION), and presenting a final individual solution (PRESENT SOLUTION).

Treatments

Two different versions of the Web-based tutorials, structured according to the different goal orientations (learning, performance), were developed for this study. Both versions of the tutorial included instructional strategies designed around three contextual factors predicted to influence goal orientation: (a) task design, (b) distribution of authority, and (c) evaluation practices (Ames, 1992; Fuchs et al., 1997; Song, 2004). In an effort to ensure treatment validity, two faculty members from a major northeastern university, with expertise in motivation and learning, reviewed the tutorials. Both agreed that the tutorial incorporated attributes representative of the three contextual factors.

Learning-oriented context. The learning-oriented context included instructional strategies designed to orient students toward a learning-goal orientation. First, for task design, the tutorial included task-instruction messages stressing the importance of challenging work and the intrinsic value of learning. A total of five task-instruction messages were provided, following the five learning phases of the tutorial. For example, the following message was used in THE PROBLEM phase: "Please remember that the most important thing will be for you to try to understand the problem. This is very important because if you try your best to understand the problem, it will help you define the problem and you will be one step closer to finding the best solution." Students were asked to read the task instruction messages at least twice. Classroom observation by the researchers ensured that each student participated in the reading of the messages. Second, for distribution of authority, choices were provided to students. For instance, different navigation buttons were incorporated so that they could choose activities that were interesting to them. In addition, students received prompts that encouraged them to set up a time plan before the investigation. Third, for evaluation practices, peer group performance was evaluated privately to promote a learning-oriented climate. The peer groups submitted two group reports, once after they had finished DEFINING THE PROBLEM and again after they had finished PROPOSE SOLUTION. They received an evaluation of each. The evaluation reports were displayed on a Web bulletin board called "My Papers." Each group's evaluation report was password-protected and inaccessible to other peer groups. The evaluation of the group solutions included suggestions about factors to consider in the future.

Performance-oriented context. The performance-oriented context included instructional strategies designed to orient students toward a performance-goal orientation. For the first factor, task design, the tutorial included task-instruction messages stressing the importance of performance. A total of five task-instruction messages were provided. For example, students were required to read the following message during THE PROBLEM phase: "Remember that the most important thing will be for you to try your best to plan the flying mission correctly. This is very important because if you try your best to develop a mission flight plan without failure or making any mistakes, you will be able to show how well you can do compared to others in your classroom." For the second factor, distribution of authority, the researchers set a sequence with prompts leading to the next learning activity instead of allowing the students to choose which activity to work on next. Also, students received prompts that included recommendations concerning time management so that they could efficiently complete assignments within the class period. For the third factor, the evaluation practice, peer group performance was evaluated publicly to promote a performance-goal oriented climate. Two sample papers were selected and displayed on a Web bulletin board called "Best Papers" after the students had finished DEFINING THE PROBLEM and PROPOSE SOLUTION, respectively. These papers were not password-protected and were accessible to all students. They included evaluation comments based on social-comparative information, such as the following: "We have selected two excellent papers from your class. These papers proposed very feasible solutions for investigating lava flows in Hawaii. Please take some time to look at the best papers and compare them with your group's flight plan."

Assessment Instruments

Five instruments were used to measure (a) self-efficacy, (b) perceived goal atmosphere, (c) goal orientation, (d) intrinsic motivation, and (e) problem-solving skills.

Self-efficacy. Fouad, Smith, and Enochs's (1997) assessment of math and science self-efficacy was used for the pretest because it was developed for middle-school students. The questionnaire included 12 items scored on a 5-point Likert-type scale: 5 items referred to math self-efficacy (e.g., "I can earn an A in math"; "I could determine the amount of sales tax on clothes I wanted to buy"); 7 items referred to science self-efficacy (e.g., "I can earn an A in science"; "I could develop a method to figure out why kids watch particular TV shows"). The total scores on this instrument could range from 12 to 60. Students' actual self-efficacy scores in this study ranged from 30 to 56. Students who scored at or above the median of 46 were categorized as having high self-efficacy (n = 44, M = 49.98, SD = 3.20), and those who scored below the median (45 or below) were categorized as having low self-efficacy (n = 46, M = 39.17, SD = 4.38). Cronbach's alpha was used to calculate the internal consistency of the test items and was found be .81 in this study, indicating high reliability; this evidence supports the supposition that these items are measuring the same underlying construct.

Perceived goal atmosphere of peer group environment. Perception of classroom goal structure, one of the subscales in the *Manual for the Patterns of Adaptive Learning Scale* (PALS) was adapted for this study (Midgley et al., 2000). The PALS measured student perceptions of the learning and performance goals in the classroom environment. The word *classroom* in the PALS items was changed to *group* to measure students' perceptions of their peer-group environments. The modified PALS included 14 items and used a 5-point Likert-type scale ranging from 1 (*not at all true*) to 5 (*very true*). Six items pertained to a learning-goal atmosphere (e.g., "In my group, trying hard is very important"); 8 items pertained to a performance-goal atmosphere (e.g., "In my group, getting good grades is the main goal"). Cronbach's alphas for the perceived learning- and performance-goal atmosphere in this study were .81 and .77, respectively.

Goal orientation. Goal-orientation items from the PALS were used (Midgley et al., 2000). Each learning- and performance-goal orientation was assessed with a 5-point Likert-type scale ranging from 1 (*not at all true*) to 5 (*very true*). The questionnaire included 14 items: 5 items pertained to a learning-goal orientation (e.g., "One of my goals in group work is to learn as much as I can"); 9

items pertained to a performance-goal orientation (e.g., "One of my goals is to show others that I'm good at my group work"). Cronbach's alphas for the learning- and performance-goal orientation in this study were .78 and .86, respectively.

Intrinsic motivation. The measure of intrinsic motivation was adapted from the children's academic intrinsic motivation inventory (CAIMI; Gottfried, 1985). For measuring intrinsic motivation in science, 24 items (e.g., "I enjoy learning new things when I solve science problems in KaAMS"; "I enjoy understanding my work when I solve science problems in KaAMS") were used, with a 5-point Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Cronbach's alpha for intrinsic motivation in this study was .89.

Problem-solving skills. Problem-solving skills were measured with a scoring rubric adapted from Ge and Land's (2003) rubric for solving ill-structured problems. Performance was measured as interval data according to degree of quality on the three major constructs of problem-solving skill: (a) problem representation, (b) solution development, and (c) monitoring and evaluation of solutions. Problem representation was worth 10 points; solution development, 8 points; and monitoring and evaluation of solutions, 3 points. Thus, each case was worth a total of 21 points. Three raters, a researcher in this study and two doctoral students majoring in instructional technology, were trained to use the rubric. Each rater scored the individual problem-solution reports against the scoring rubric. The scores from all three raters were collected and final scores were determined according to the following rules:

(a) If all raters agreed, the researcher used the agreed-upon score.

(b) If two raters agreed, the researcher used the score that had the higher level of agreement.

(c) If all three raters disagreed, all raters reviewed the reports again and developed a new score.

Interrater reliability, the percent agreement between raters for all items, was 80.8%. This measure consists of the ratio of the number of times that the raters agreed divided by the total number of subjects tested.

Procedure

Two weeks before the experiment, the self-efficacy test was administered to all participants in the target classrooms. The researchers formed each peer group from the intact class. To randomly assign students, the researchers used paper cards with student identification numbers and self-efficacy scores. Students in the high self-efficacy group were randomly drawn to be assigned to either a heterogeneous or a homogeneous peer group. Students in the low self-efficacy peer group were also randomly drawn and assigned to either a heterogeneous peer group or a homogeneous peer group. To establish heterogeneity, the researcher paired the student who scored highest on the self-efficacy test with the one who scored just below the median; the second highest student was paired with the student who scored second below the median, and so on, so that the students just above the median were paired with the students who had the lowest scores (Singhanayok & Hooper, 1998). To establish homogeneity, the researcher composed high self-efficacy peer groups consisting of two participants with high levels of self-efficacy, and low self-efficacy peer groups consisting of two participants with low levels of self-efficacy. Given that each classroom had 23–25 students, each class contained either 11 or 12 peer groups. Finally, the heterogeneous and homogeneous peer groups were randomly assigned to either the learning-oriented context or performance-oriented context treatment groups.

The study was administered in three separate 45-min sessions. Students completed the ill-structured problem-solving tutorial depending on the different goal-oriented context assigned to them. After completing the treatment materials, each student wrote an individual problem-solving report on blank paper. The students then completed survey questionnaires that measured their perceived goal atmosphere of their peer group environment, goal orientation, and intrinsic motivation.

RESULTS

The results are described for intrinsic motivation, components of problem-solving skills, and correlations among variables related to learning-goal orientations.

Intrinsic Motivation

Students who participated in the learning-oriented context were predicted to have significantly higher intrinsic-motivation scores than students who participated in the performance-oriented context. To identify the effects of goal-oriented context and peer group composition on intrinsic motivation, a 2×2 factorial analysis of variance (ANOVA; Goal-Oriented Contexts, Peer Group Composition) was run. Table 1 shows the mean scores and standard deviations for intrinsic motivation.

The factorial ANOVA results showed a significant main effect for type of goal-oriented context. The students in the learning-oriented context had significantly higher intrinsic-motivation scores ($M = 3.49$, $SD = .69$) than the students in the performance-oriented context ($M = 3.16$, $SD = .66$), $F(1, 85) = 5.36$, $p = .02$, $\eta^2 = .06$. However, the ANOVA showed no main effect for type of peer group composition, $F(1, 85) = .52$, $p = .47$, $\eta^2 = .01$. Nor was the interaction between type of goal-oriented context and type of peer group composition significant, $F(1, 85) = .01$, $p = .93$, $\eta^2 = .00$.

Components of Problem-Solving Skill

Table 2 shows the descriptive statistics for the three components of problem-solving skills. To identify the effects of the goal-oriented context and peer-group composition on problem-solving skills, a 2 × 2 multivariate analysis of variance (MANOVA) was initially conducted. The MANOVA did not yield any significant main effects for the type of goal-oriented context, Wilks's Lambda = .99, $F(3, 84) = .22$, $p = .88$, $\eta^2 = .01$, or for the type of peer group composition, Wilks's Lambda = .07, $F(3, 84) = 1.92$, $p = .13$, $\eta^2 = .06$. Nor was the interaction significant, Wilks's Lambda = .98, $F(3, 84) = .45$, $p = .72$, $\eta^2 = .02$. However, as shown by Table 2, the mean score for the heterogeneous peer group condition is directionally higher than that of the homogeneous peer group condition, especially in *monitoring and evaluation.* Although research on problem solving suggests that problem-solving skills mainly consists of three main components (Ge & Land, 2003), it is risky to assume that middle school students possess all three components, because of the limitations of their cognitive developmental stage. Thus, the three components might not be

Table 1 ☐ Means and standard deviations for intrinsic motivation.

	Peer-Group Composition								
	Heterogeneous			*Homogeneous*			*Total*		
	M	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*
Goal-Oriented Context									
Learning	3.54	(.61)	23	3.45	(.77)	23	3.49	(.69)	46
Performance	3.22	(.65)	23	3.10	(.69)	21	3.16	(.66)	44
Total	3.38	(.65)	46	3.28	(.75)	44	3.33	(.70)	90

Note: The range of intrinsic motivation using a 5-point Likert-type scale is from 1 (*strongly disagree*) to 5 (*strongly* agree).

regarded as correlated dependent measures accounting for problem-solving skills in these students. The fact that the only significant positive correlation found was between problem representation and solution development ($r = .82$, $p < .01$, $n = 90$) added to the uncertainty of the problem-solving construct in middle school students. Thus, to further explore this assumption, univariate analyses were run for each of the three components. Tests of homogeneity of variance (Shapiro-Wilks's tests and Levene's test) showed that the assumption of equal variance was met at the .05 alpha level.

For the *problem representation,* the factorial ANOVA results did not reveal any significant main effects for the type of goal-oriented context, $F(1, 86) = .47$, $p = .50.\eta^2 = .01$, or for the type of peer group composition, $F(1, 86) = .00$, $p = .95$, $\eta^2 = .00$. The interaction effect between type of goal-oriented context and type of peer group composition was not significant, $F(1, 86) = .35$, $p = .56$, $\eta^2 = .00$. For the *solution development,* the factorial ANOVA results did not reveal any significant main effects for the type of goal-oriented context, $F(1, 86) = .10$, $p = .75, \eta^2 = .00$, or for the type of peer group composition, $F(1, 86) = .09$, $p = .77$, $\eta^2 = .00$. The interaction effect between type of goal-oriented context and type of

Table 2 ☐ Means and standard deviations for the three components of problem-solving skill.

	Peer-Group Composition								
	Heterogeneous			*Homogeneous*			*Total*		
	M	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*
Problem Representation									
Learning-Oriented	5.60	(1.90)	23	5.30	(2.30)	23	5.46	(2.09)	46
Performance-Oriented	5.65	(2.84)	23	5.91	(1.67)	21	5.77	(2.33)	44
Total	5.63	(2.39)	46	5.59	(2.03)	44	5.61	(2.21)	90
Solution Development									
Learning-Oriented	4.13	(1.77)	23	3.65	(1.67)	23	3.89	(1.72)	46
Performance-Oriented	3.91	(2.52)	23	4.14	(2.05)	21	4.02	(2.29)	44
Total	4.02	(2.16)	46	3.89	(1.86)	44	3.96	(2.00)	90
Monitoring/Evaluation									
Learning-Oriented	.48	(.95)	23	.22	(.60)	23	.35	(.80)	46
Performance-Oriented	.65	(.98)	23	.14	(.36)	21	.41	(.79)	44
Total	.57	(.96)	46	.18	(.50)	44	.38	(.79)	90

Note: The possible range of scores for problem representation, solution development, and monitoring and evaluation of solutions is 0–10, 0–8, and 0–3, respectively.

peer group composition was not significant, $F(1, 86) = .68$, $p = .41$, $\eta^2 = .01$. However, for the *monitoring and evaluation,* the factorial ANOVA results did show a significant main effect for the type of peer group composition, $F(1, 86) = 5.57$, $p = .02$, $\eta^2 = .06$. The students working in the heterogeneous peer groups had an overall average of .57 ($SD = .96$) for monitoring and evaluation of solutions, while the students working in the homogeneous peer groups had a significantly lower overall average of .18 ($SD = .50$). The results of the ANOVA did not reveal a significant main effect for the type of goal-oriented context, $F(1, 86) = .09$, $p = .76$, $\eta^2 = .00$, or any interaction effect between type of goal-oriented context and type of peer group composition, $F(1, 86) = .58$, $p = .45$, $\eta^2 = .01$.

Correlations Among Variables Related to the Learning-Goal Orientation

Correlation analyses were conducted for students who participated in treatment groups designed to increase the same types of goal orientations: (a) the learning-oriented, heterogeneous peer groups, (b) the performance-oriented, homogeneous peer groups. The analyses were not conducted in the other two treatment groups (the learning-oriented, homogeneous peer groups and the performance-oriented, heterogeneous peer groups), because they included treatments designed to increase different types of goal orientations in each treatment.

To determine the correlation between learning-goal orientation and other variables, Pearson's r was calculated for the students participating in a treatment designed to enhance their learning-goal orientation: the learning-oriented, heterogeneous peer group treatment group ($n = 23$). Table 3 shows the results of the correlations among the variables related to the learning-goal orientation.

Significant positive correlations were found (a) between a perceived learning-goal atmosphere and a learning-goal orientation ($r = .83$, $p < .01$, $n = 23$) and (b) between a learning-goal orientation and solution development ($r = .50$, $p < .05$, $n = 23$), but *not* between learning-goal atmosphere and solution development ($r =.25$, $p > .05$, $n = 23$). Based on these findings, it is assumed that when the students perceived the learning-goal atmosphere in the learning-oriented, heterogeneous peer groups, they tended to develop a stronger learning-goal orientation. Students with stronger learning-goal orientations also tended to have better solution development skills. A first examination of the results might lead one to conclude that there was a direct linear relationship flowing from a perceived learning-goal atmosphere to a learning-goal orientation and then solution development. However, because there was no significant relationship between the first factor, the perceived learning-goal atmosphere, and the third, solution development, one might then conclude that it was the students' learning-goal orientation influencing both how they perceived the treatment and how they developed a problem solution. Since these results are correlational, the second explanation is more plausible, lending importance to the learning-goal orientation regardless of how it is developed.

Next, to test correlations between performance-goal orientation and other variables, Pearson's *r* was calculated for the students participating in a treatment designed to enhance their performance-goal orientation: the performance-oriented, homogeneous peer group treatment group ($n = 21$). Table 4 presents the results.

A significant positive correlation was found between a perceived performance-goal atmosphere and a performance-goal orientation ($r = .45$, $p < .05$, $n = 21$). The relationship between perceiving a performance-goal atmosphere and developing a performance-goal orientation was predicted and desirable. Although these predictable patterns were not tested in the other treatment groups, the results indicate that a perceived performance-goal atmosphere does not relate to the development of either intrinsic motivation or problem-solving skills. In sum, the results confirm the hypothesis that significant positive correlations between goal orientation and problem solving would be found only among variables related to learning-goal orientation

Table 3 ☐ Results of correlations (Pearson's *r*) among variables-related learning-goal orientation in learning-oriented context—heterogeneous peer group ($n = 23$).

	Learning-Goal Orientation	*Intrinsic Motivation*	*Problem Representation*	*Solution Development*	*Monitoring/ Evaluation*
Perceived Learning-Goal Atmosphere	.83 *	.13	.15	.25	–.11
Learning-Goal Orientation		.30	.38	.49*	–.00
Intrinsic motivation			–.06	.26	.06
Problem Representation				.79*	.34
Solution Development					.26

Note. * $p = .05$ (2 tailed)

DISCUSSION

The higher intrinsic motivation score under the learning-oriented context is consistent with the results of previous studies that the learning-goal support can better prompt intrinsic motivation than can the performance-goal support (Butler, 1987; Rawsthorne & Elliot, 1999). Goal orientations were created by incorporating contextual factors designed to increase student goal orientation into treatment materials in this study. The findings extend the limitations of past studies that have not looked at the effects of the combinations of the contextual factors, but investigated those of individual contextual factors (Elliot & Dweck, 1998; Gabriele & Montectinos, 2001; McNeil & Alibali, 2000).

Surprisingly, no significant difference was found between different types of goal-oriented contexts on the three components of problem-solving skills. The findings conflict with the results of previous studies that report positive effects of learning-oriented contexts on achievements (Ames, 1992). One possible explanation is that having a choice of learning activities given to the learning-oriented context group may have caused students to skip essential information required for solving the ill-structured problem due to the time limit

Table 4 ☐ Results of correlations (Pearson's *r*) among variables-related performance-goal orientation in performance-oriented context—homogeneous peer group ($n = 21$).

	Performance-Goal Orientation	*Intrinsic Motivation*	*Problem Representation*	*Solution Development*	*Monitoring/ Evaluation*
Perceived Performance-Goal Atmosphere	.45*	−.11	−.34	−.10	.09
Performance-Goal Orientation		−.25	−.43	−.31	.07
Intrinsic motivation			.39	.26	−.11
Problem Representation				.67*	.02
Solution Development					.11

Note * $p = .05$ (2 tailed)

imposed for the study. Researchers on goal orientation suggest that restricting time works against the development of learning goals (Epstein, 1989). Another possible explanation comes from the level of tasks performed. Students in this study were asked to find solutions to an ill-structured problem. Most research on goal orientation has investigated the effects of contextual factors in terms of lower-level memory-related cognitive tasks (Dweck & Leggett, 1988). Although some researchers suggest that manipulating contextual factors may be equally effective in increasing student performance on higher-level cognitive tasks (Pintrich & Schunk, 2002), that was not the case in this study. Ill-structured problem-solving tasks are more challenging to students than are other tasks. The students participating in the current study may have needed additional cognitive or motivational support to develop their problem-solving skills, as determined by other variables, such as emotion or self-efficacy (Ford, 1992).

Despite the mixed effects for the learning-oriented context on dependent measures, this study has implications for the design of motivation-supported problem-solving environments. If, as the results of the study imply, a learning-oriented context is more motivating than a performance-oriented context, then instructional designers or instructors should provide middle school students with contextual factors appropriate to the learning-oriented context in order to prompt motivation toward problem-solving tasks. These strategies may include: (a) messages that stress the intrinsic value of learning ill-structured tasks, (b) the chance to explore learning resources in order to find solutions, and (c) self-referenced evaluations.

The higher student performance on monitoring and evaluation skill under heterogeneous peer grouping supports the hypothesis that heterogeneous peer groups are more effective in creating an atmosphere in which both high and low levels of self-efficacy students share their experience and viewpoints during problem solving than are homogeneous peer groups. A flexible atmosphere created by heterogeneous peer grouping based on self-efficacy might help students to actively participate in the evaluation process. The findings also add empirical support to Hooper et al.'s (1993) argument that heterogeneous peer grouping according to factors other than ability level should be considered as a grouping strategy to increase problem-solving skill. However, given the positive effect on only one of the problem-solving skills, the results should be interpreted in the context of limited findings and warrant further research. The partial effects of heterogeneous peer grouping on problem-solving skills could be explained by students perhaps needing more time to fully engage in the problem-solving process. As a result, they might not work effectively in the peer groups at the beginning of the problem-solving process, for example, during problem definition and solution development. According to

Nath and Ross (2001), successful peer group learning requires training in which students build positive interdependence. The ambiguity and complexity of ill-structured tasks might hinder students with different levels of self-efficacy from fully engaging in the process of identifying the problem and developing solutions. In addition, the students who were in heterogeneous peer groups did not score significantly higher intrinsic motivation than those in homogeneous peer groups. One possible explanation is that the self-efficacy scores suffered from low sensitivity in assessing student self-efficacy because of the use of a self-reporting questionnaire. Another explanation could be that students with medium levels of self-efficacy were not dropped in composing the peer groups. The heterogeneity in heterogeneous peer groups might be reduced with the addition of students who scored around the median and thus, students might not get the hypothesized benefits of heterogeneous peer grouping (Lou et al., 1996). Finally, other factors might have been involved in the development of the weaker effects on intrinsic motivation, such as gender partnering in the formation of peer groups.

The lack of significant difference on dependent measures between the treatment group designed to increase learning-goal orientation (learning-oriented, heterogeneous peer groups) and the other three treatment groups might be because the heterogeneous peer grouping did not provoke the development of learning-goal orientation that had been hypothesized. Given that the learning-oriented context included three key contextual factors, the goal encouragement of the heterogeneous peer grouping might be not as strong as that of the learning-oriented contexts, resulting in nonsignificant differences between this group condition and the other types of group conditions. Another explanation might be that heterogeneous peer grouping by self-efficacy levels was not as strong a determining factor in facilitating learning goals as heterogeneous peer grouping by ability levels. Future research on heterogeneous peer grouping by ability levels might detect if there is a meaningful difference.

Correlational results between the learning-goal orientation and solution development support the hypothesis that a positive correlation would be found between learning-goal orientation and the outcome variables when students participate in a treatment group designed to increase the learning-goal orientation. These findings are consistent with the results of previous studies that indicated positive associations between learning-goal orientation and adaptive learning outcomes (Dweck & Leggett, 1988; Linnenbrink & Pintrich, 2002). In addition, our results did not reveal relationships between the learning-goal orientation and intrinsic motivation, or between intrinsic motivation and problem-solving skills. The findings are, therefore, inconsistent with the hypothesis that students in learning-oriented, heterogeneous peer groups would receive more encouragement to develop a learning-goal orientation, and, as a result, positive correlations would be found between learning-goal orientation, intrinsic motivation, and problem-solving skills. The nonsignificant correlation between the learning-goal orientation and intrinsic motivation might be explained by the sample size ($n = 23$) in the learning-oriented, heterogeneous peer group treatment being too small to represent a true correlation. It might also be that a self-reported measure used for intrinsic motivation was not sensitive enough to produce the hypothesized correlation between the variables. With regard to the nonsignificant relation between intrinsic motivation and problem-solving skills, some researchers have reported a weaker connection between intrinsic motivation and achievement. For example, Harackiewicz et al. (1998) found that interest in learning tasks does not predict learning outcomes. This may have been the case with problem-solving skills as well.

The results of this study suggest several areas for future study. In this study, the learning-oriented context increased students' intrinsic motivation scores but failed to produce significantly higher problem-solving scores. Recent studies on goal orientation report that learning goals are related to intrinsic motivation whereas some aspects of performance goals, such as the desire to demonstrate high ability, are related to performance (Barron et al., 2003). Therefore, future research should examine the distinctive effects of different types of goal-oriented contexts on specific learning outcomes.

Additional research on peer group composition is also needed. First, given the theoretical concept of problem solving, future studies justified by MANOVA, including all three components of problem-solving skills, should provide more reliable findings. Second, the fact that the peer groups were formed from intact classes might present a threat to the internal validity of the selection (e.g., biased assignment of subjects to experimental groups). The researchers in this study tried to address this issue by randomly assigning the students within each class. Although this is an inherent problem for school-based experimental research using intact classes, it remains to be studied in the future. Third, the potential links between self-efficacy scores and other achievement scores were not clarified in this study because of the timing of the tests. Some research suggests that self-efficacy is related to achievement and, thus, may act as a proxy measure of achievement. Future studies should test the relationship between self-efficacy and achievement. Finally, given the high mean scores in the low self-efficacy group ($M = 3.97$ out of 5), the low self-efficacy group might be more accurately described as being a medium self-efficacy group. Future studies should drop the middle third of the students, those who scored around the median in the formation of heterogeneous and homogeneous groups, in order to thoroughly examine the effect of peer group composition. □

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