Influence of Learning Style Heterogeneity on Cooperative Learning

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Abstract

Achievement and satisfaction with a cooperative learning project was assessed in a six-year experimental study in an introductory biology course. Comparisons were made between assigned groups composed of students with all the same Gregorc learning styles (homogeneous) versus groups composed of three or four Gregorc learning styles (heterogeneous). Project grades were not significantly different for homogeneous and heterogeneous groups. Nearly all answers given on a 15-question satisfaction survey also were not significantly different between groups, with the single exception of one question which indicated that heterogeneous groups felt that the workload for the project was more equitably distributed among the group. Significant correlations were found between grades, satisfaction, and perceived learning. Students with the highest course grades were the most satisfied with their own personal work and the least satisfied with the overall benefits of the cooperative learning project. Group project grades were received prior to completion of the satisfaction surveys and were found to be significantly correlated to many answers on the survey. Student perceptions of learning were correlated to nearly all other questions on the survey and may be the driving factor to explain both achievement (grades) and satisfaction with cooperative learning.

Introduction

Cooperative learning may have numerous academic, social, and psychological benefits. Higher academic achievement has been reported in many studies at the primary, secondary, and higher education levels (for reviews, see, Slavin, 1995; Springer et al., 1999). Cooperatively working on tasks in a group can also improve interpersonal skills and social acceptance, as well as increase self-esteem and improve attitudes toward learning (McManus and Gettinger, 1996; Slavin, 1995). However, research also indicates a great variability in the realized benefits of cooperative learning, and some studies have not shown significant academic benefits over traditional, individual or competitive learning (Burron et al., 1993; Sherman, 1988; Slavin, 1983).

Many factors may affect the success of cooperative learning. One important factor that has been advocated is the use of heterogeneous groups. Theory and research suggest that the most effective cooperative work groups include a mixture of students in terms of ability, gender, and ethnic background (Mandel, 2003; Webb, 1991). However, few researchers have investigated the effects of learning style heterogeneity in cooperative work groups.

Many learning style models have been proposed to explain differences in how students perceive, process, interpret, and retain information. One of the most widely cited and well established models is that of Gregorc (1979), which uses two types of learning orientations (concrete and abstract) and two types of ordering orientations (sequential and random). These orientations are then combined to form four learning styles: Concrete Sequential (CS), Abstract Sequential (AS), Abstract Random (AR), and Concrete Random (CR) (Table 1). Most people show a preference for one or two of the learning styles and the Gregorc Style Delineator can be used as a self-administered test to determine learning style preferences (Gregorc, 1982a).

Table 1. Brief description of the four Gregorc learning styles (adapted from Gregorc, 1979).

Learning Style	Description of Learner
Concrete Sequential (CS)	• Like hands-on, concrete learning materials • Prefer step-by-step directions • Appreciate order and logical sequence
Abstract Sequential (AS)	• Skilled use of written, verbal, and image translation • Prefer presentations with order and substance • Favor abstractions and simulated experiences
Abstract Random (AR)	• Attuned to atmosphere and mood • Favor abstract, subjective experiences • Prefer unstructured information and busy environments
Concrete Random (CR)	• Trial-and-error acquisition of information • Prefer concrete examples and practice • Intuitively successful in unstructured problem-solving experiences

Learning styles of students can have a profound effect on how they approach learning tasks. Thus, the dynamics of a cooperative work group may be affected by the mixture of learning styles represented in a group. Having a diversity of learning styles could

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result in higher performance and satisfaction if student strengths are complimentary. On the other hand, a diversity of learning styles might result in less agreement on how to approach and complete a task, which in turn could decrease student satisfaction with the cooperative learning experience and result in decreased efficiency and performance quality. This study uses the Gregorc (1979) system of learning style classifications to test the effects of learning style heterogeneity in a cooperative work group. No published studies could be found that experimentally compared heterogeneous and homogeneous groups with this widely-used system of learning style classification.

The only related research is that of Miller and Polito (1999), Huxham and Land (2000), and Miller et al. (1993), with Miller and Polito (1999) being the only other experimental study that used a traditional learning style system. No differences were found in grades and satisfaction of heterogeneous and homogeneous groups based on a field-dependence/ independence classification system (Miller and Polito, 1999). Huxham and Land (2000) used Honey and Mumford learning styles and found no difference in the performance of heterogeneous groups as compared to randomly assigned groups. Miller et al. (1993) found that there were differences in the performance and satisfaction of students based on the cognitive style mixes in groups. The students in that study were categorized as "integrators," "problem finders," "problem solvers," or "implementers" based on Gordon's cognitive style typology (Miller et al., 1993).

Additional experimental research is needed to assess this potentially important aspect of group heterogeneity that may contribute to the variability in the successful use of cooperative learning in higher education. Furthermore, there is a need for more research about cooperative learning in general within higher education, as most of the research in this area has focused on the benefits in primary and secondary education.

Methods

This study was conducted at Longwood University (Farmville, VA) in a second-semester freshman introductory biology course during the spring semesters of 1999-2004. Nearly all students enrolled in the course were biology majors. Each year 9 to 12 students in the class were participants in the university's Honors Program and had a separate extended laboratory period, though all students attended the same lecture periods for the course. A total of 205 students (62 males and 143 females) were included in this six-year study.

At the beginning of the semester, the Gregorc Style Delineator (Gregorc, 1982a) was used to determine the dominant learning style of each student. Gregorc (1982b) reports validity and reliability ranges for this instrument as 0.85-0.88 and 0.89-0.93, respectively. Students were assigned to groups of three or four students, creating approximately one-half "mixed learning style groups" (heterogeneous) and one-half "same learning style groups" (homogeneous). The total number of groups and students throughout the six years of the study were 25 heterogeneous groups (97 students) and 29 homogeneous groups (108 students). The heterogeneous learning style groups had one person from each of the three or four Gregorc learning styles. On the rare occasion (N=14) when a student's highest learning style score was a tie between two categories, the student was placed in the category that would best facilitate the desired group formations. To minimize drastic differences in the overall academic ability levels between groups, honors students were distributed among the groups so that each group had at least one honors student, but no groups consisted entirely of honors students. No other factors, such as race or gender proportion, were used to determine group assignments. Each group was then randomly assigned a research topic of one of the following invertebrate taxa: Porifera, Cnidaria, Platyhelminthes, Nematoda, Annelida, Mollusca, Myriapoda, Arachnida, or Echinodermata.

The cooperative learning project consisted of three parts: (1) an oral presentation, (2) a written report, and (3) a lab station construction. The 12 to15 minute oral presentations focused on providing their classmates with information about the classification, distinguishing characteristics, and importance of the organisms in the assigned taxon. The written report included more comprehensive and detailed information from the group's library research. The lab station construction involved creating a hands-on teaching tool for their classmates to observe during the designated laboratory period. Students were encouraged to be creative, but all lab stations had to include some written information as well as some available live or preserved specimens. The lab stations were set up by the students prior to the laboratory periods. During lab, all students in the class rotated around the room to observe each group's lab station. Each of the three components of the project was graded by the instructor, with all students in the group receiving the same grades. Also, the students were told that the information presented by all groups in the oral reports and lab stations were considered potential test questions.

When the projects were assigned, students were encouraged to work together as a group to conduct the library research. Each group could then decide how to divide up the work for the various parts of the project. The following example was provided to illustrate how a group might decide to distribute the workload: one group member could be the person primarily in charge of the lab station construction, another could compile all group member's information and type the written report, and the remaining one or two person(s) could construct the PowerPoint

presentation and be the main speaker(s) for the oral presentation. Care was taken to remain as consistent as possible in the format, instructions, and grading of the projects from one year to the next.

After the completion of the projects and the return of the grade sheets to the students, each student completed a 15-question survey to assess student satisfaction with the group project. The survey consisted of statements to be assessed on a five-point Likert-type scale as follows: 1=strongly agree, 2=agree, 3=neutral, 4=disagree, and 5=strongly disagree.

Data were analyzed using JMP, Version 3 and SPSS, Version 14, with a p-value <0.05 indicating statistical significance. One-way analysis of variance (ANOVA) was used to test for differences in grades and survey responses of students in heterogeneous vs. homogeneous learning style groups. Further explorations of the data used ANOVA and correlation analyses to assess differences based on grades, gender, and individual learning styles.

Results and Discussion

Learning Style Profile and Main Effects

Using combined data from all years, the distribution of Gregorc learning styles (Gregorc, 1979) in the course was as follows: 43% Concrete Sequential (CS), 14% Abstract Sequential (AS), 23% Abstract Random (AR), and 20% Concrete Random (CR). The learning style percentages of a given class varied somewhat between years, but CS was consistently the most common and AS was the least common learning style in five out of the six years. Consequently, most of the homogeneous learning style groups in this study (16 out of 29) consisted of students with the dominant learning style of CS.

When analyzed by gender, CS was the most common and AS was the least common learning style among both males and females (Figure 1). However, CR was the second most common learning style among males and AR was the second most common learning style among females (Figure 1). This is largely consistent with gender differences seen in a previous study where Gregorc scores were analyzed (O'Brien, 1991).

The final grade received in the course was not significantly different for the four learning styles, or for gender. Tests for main effects of individual learning styles also showed no significant differences in satisfaction as assessed by answers to survey questions.

Homogeneous vs. Heterogeneous Learning Style Groups

There was no significant difference in the work quality, as measured by grades, of homogeneous and heterogeneous learning style groups. This contrasts with the findings of Miller et al. (1993) where diverse groups outperformed homogeneous cognitive style groups. However, Miller et al. (1993) used a different style classification system (Gordon's cognitive style typology), rather than a traditional learning style classification, such as the Gregorc learning styles used in the present study.

Survey answers given by students in homogeneous learning style groups were not significantly different from those in heterogeneous groups for nearly all questions on the survey. The only exception to this was for question #3 (Table 2). This question states "The workload for the project was distributed equitably among the members of my group." Students in heterogeneous learning style groups indicated significantly higher agreement with this statement than students in homogeneous learning style groups. Only 18% of students in heterogeneous groups disagreed with the statement (score of 4 or 5 on the Likert-type scale), whereas 36% of students in homogeneous learning style groups disagreed. This difference in perceived workload distribution may be a reflection of actual differences that existed in the ability of groups to work together effectively and to divide tasks based on individual preferences. In heterogeneous learning style groups it

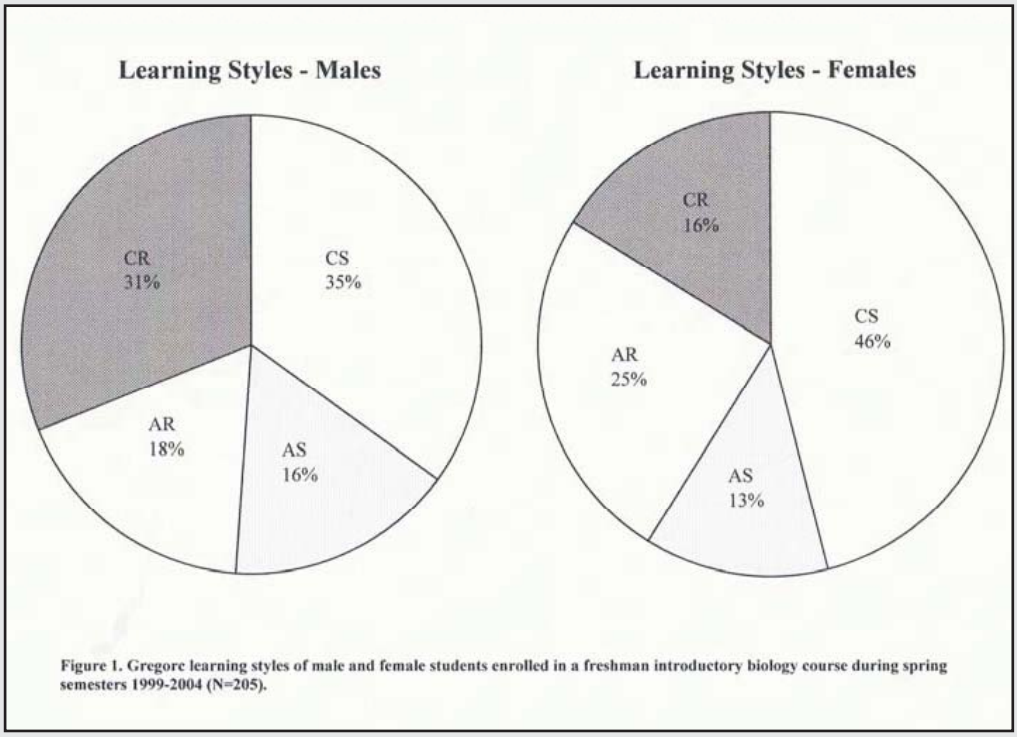

Figure 1. Gregorc learning styles of male and female students enrolled in a freshman introductory biology course during spring semesters 1999-2004 (N=205).

may be more likely to have students who each prefer to work on different parts of the project. For example, CS learners may have found the hands-on lab station more appealing than the written or oral reports. Abstract Sequential learners may have preferred the written report. Possibly, in homogeneous learning style groups everyone had the same preferences and someone always had to be forced into a less preferred and seemingly more difficult task. Future studies could assess this possibility by asking for information about what parts of the project each student worked on most.

Previous studies suggest benefits of heterogeneous groups in cooperative learning (e.g., Slavin, 1995; Webb, 1991). This study specifically focused on the effect of learning style heterogeneity within groups, an aspect which has not been experimentally tested with the Gregorc (1979) style classification. Overall, the learning style composition of groups had a minimal effect on achievement and satisfaction in this cooperative learning study. In a smaller experimental study using field-dependence/independence classification, Miller and Polito (1999) also found no significant differences in achievement and satisfaction when comparing homogeneous and heterogeneous cooperative learning teams. The largest part of the Miller and Polito (1999) study involved numerous short-term assignments. This contrasts with the single, (though multi-faceted) long-term assignment from the present study. Taken together, this study and that of Miller and Polito (1999) suggest that for both short-term and long-term cooperative learning, the learning style composition of groups has a minimal effect on achievement and satisfaction.

Table 2. Survey response comparisons for students in cooperative learning groups with others of the same learning style (homogeneous) versus those in groups with three or four of the Gregorc learning styles (heterogeneous).

Survey Question[z]	Homogeneous	Heterogeneous	p-value[y]
(1) I was satisfied with the overall **quality** of work performed by other members in my group.	2.11 ± 0.11[x]	2.03 ± 0.11	0.61
(2) I was satisfied with the overall **quality** of the work that I personally performed.	2.05 ± 0.11	1.93 ± 0.10	0.45
(3) The workload for the project was distributed equitably among the members of my group.	2.72 ± 0.13	2.31 ± 0.11	0.02*
(4) I was dissatisfied with the attitude of one or more members in my group.	3.72 ± 0.14	3.86 ± 0.15	0.52
(5) I was dissatisfied with the lack of or minimal participation of one or more members in my group.	3.58 ± 0.15	3.67 ± 0.15	0.67
(6) I enjoyed interacting with my group members to complete this project.	2.16 ± 0.10	2.25 ± 0.11	0.53
(7) The members of my group worked alone on individual parts of the project without much interaction.	2.90 ± 0.12	2.77 ± 0.12	0.46
(8) I enjoyed learning the information about my group's topic.	2.29 ± 0.11	2.12 ± 0.09	0.28
(9) I enjoyed the process of creating the oral presentation, written report, and/or the lab set-up.	2.43 ± 0.11	2.43 ± 0.11	0.98
(10) I probably would have enjoyed this project more if my group had a different topic (i.e., one of the other possible taxa).	3.45 ± 0.13	3.44 ± 0.11	0.94
(11) I probably would have enjoyed this project more if I had been assigned to work with different people.	3.37 ± 0.12	3.48 ± 0.12	0.48
(12) I learned a lot about my group's topic.	2.05 ± 0.11	1.84 ± 0.09	0.16
(13) I learned a lot from the oral presentations of other groups.	2.46 ± 0.10	2.42 ± 0.10	0.76
(14) I learned a lot from the lab set-ups of other groups.	2.41 ± 0.10	2.30 ± 0.11	0.43
(15) Overall, I probably would have learned more if we would have skipped the group projects and just left the instructor deliver the lectures and set up the lab.	2.90 ± 0.12	3.08 ± 0.13	0.32

[z]Scale: 1=strongly agree, 2=agree, 3=neutral, 4=disagree, 5=strongly disagree
[y]One-way ANOVA: *=significant at $p<0.05$
[x]Mean ± standard error

In the present study, individual learning styles also did not correlate to the differences seen in work quality or satisfaction. Thus, factors other than learning styles must be considered to understand the observed variability in this study.

Influence of Factors Other Than Learning Style

Further statistical explorations of the data indicated that grades were significantly correlated to student satisfaction. The overall course grade of individual students (a possible indicator of a student's ability level) was significantly correlated to their response to survey question number 15 (Table 3), with a trend for students with higher grades agreeing

Table 3. Correlations between survey answers, grades in the course, and grades on the cooperative learning projects.

Survey Question[z]	Course Grade r[y]	Project Grade r
Question 1	-.003	-.177*
Question 2	-.186**	-.239***
Question 3	.024	-.083
Question 4	-.024	-.025
Question 5	-.001	-.005
Question 6	.010	-.162*
Question 7	-.135	.048
Question 8	-.060	-.196**
Question 9	-.022	-.272***
Question 10	.118	.093
Question 11	.033	.040
Question 12	-.109	-.255***
Question 13	.074	.020
Question 14	.009	-.138
Question 15	-.232***	.004

[z] See Table 2 for list of survey questions

[y] r =Pearson product moment correlation coefficient;
*, **, or *** = significant at p≤ 0.05, 0.01, or 0.001, respectively

more strongly with this statement: "overall, I probably would have learned more if we would have skipped the group projects and just let the instructor deliver the lectures and set up the lab." This result is consistent with informal written and verbal feedback from students which often indicated that the highest achievers tended to dislike group projects, fearing that their grades might be compromised by the work of others. Further research is currently in progress to evaluate this possible relationship between high achievement and dissatisfaction with group projects. The answer to survey question number 2 was also correlated to the overall course grade (Table 3), indicating that high-achievers tended to be more satisfied with the quality of their work. This result is not surprising and is similar to findings in other research (O'Quin, 1996).

The most striking relationships between grades and student satisfaction were seen when the group project grades were compared to survey responses. There was a significant correlation between group project grades and the responses to survey question numbers 1, 2, 6, 8, 9, and 12 (Table 3). Students received their grades prior to completing the surveys and this may have greatly influenced their perceived learning and their satisfaction with the project. Alternatively, student learning influenced both the grade received and the response to other questions on the survey. This alternative explanation seems quite plausible since perceived learning about the group topic (survey question 12) was correlated to answers given for every other question on the satisfaction survey, with the single exception of question number 7. Additionally, this interpretation (that learning influenced grades) would be in agreement with modeling results of other research (Bean and Bradley, 1986; Pike, 1991) which indicated satisfaction had a greater influence on college student grades than grades had on satisfaction. Further research would be necessary to distinguish between these two possible explanations.

Additional statistical analyses indicated that gender was not significantly related to any responses on the satisfaction survey. Data about age, race, and other possible influencing factors were not collected in this study. Informal written and verbal information from students indicated that in some cases various problems such as conflicting schedules and interfering employment commitments lead to dissatisfaction within groups, but this was only anecdotal and could not be statistically evaluated. Additional possibilities exist for the influence of other factors not specifically measured in this study. For example, the ability of a group to work harmoniously may have been influenced by previous experience and training in effective cooperative learning interactions (Cohen, 1994; Gillies, 2002). Student satisfaction may likewise have been influenced by many other factors such as student age, prior group grade experience, and outside employment commitments (Barfield, 2003).

Summary

Though the theoretical benefits of heterogeneous learning style groups has often been assumed, very few empirical studies have investigated the realized effects of learning style composition in cooperative learning groups. This six-year experimental study found no difference in the academic achievement and only minimal differences in the satisfaction of homogeneous versus heterogeneous learning style groups. This suggests that the learning style composition of groups is not a critical consideration for the successful use of cooperative learning techniques. Although not the initial focus of the study, several equally important findings also linked grades and satisfaction in this cooperative learning experiment. The highest achieving students were the most satisfied with their own personal work and the least satisfied with the overall benefits of the cooperative learning project. Significant correlations were found between a student's perceived level of learning, satisfaction with the project, and the project grade, though further research would be necessary to definitively determine cause and effect relationships.

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