Cooperative Learning, Group Formation and Performance in Problem-Solving Courses: A Case Study from an HBCU

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Abstract: There are different ways educators use groups to promote learning. This study explored the possibility of improving group performance in problem-solving courses by forming teams based on thinking style preferences of students. This was premised on the assumption that team effectiveness and cohesiveness could be achieved if the thinking preference characteristics of team members were considered in team formation. Four types of groups were formed in several sections of business statistics classes in an Historically Black University. The groups are made up of Detail-Analytical students, Creative-Intuitive students, Homogeneous No Preference students, and Heterogeneous Preference students. The ANOVA test results and subsequent Bonferroni pairwise comparisons revealed that team heterogeneity was not a determinant factor in academic performance. However, the Detail-Analytical thinking students' group performed better than the other groups in problem solving cases.

Keywords: Cooperative learning, Group formation, Problem-Solving, Thinking style preference, Academic performance, Case analysis, HBCU.

The next generation of employees are graduates from tertiary institutions who are ethical, innovative, synthesize information, think holistically, work in groups, communicate effectively, and use creative ways to solve problems (De Boer & Botham, 2003; Scott, 2007). The U.S. Department of Labor (DOL, 2012) identified problem solving and critical thinking as skills needed to pay the bills. The DOL cited the 2010 Critical Skills Survey by the American Management Association in which employers rate problem solving and critical thinking as required skills in the workforce. According to Mandal (2019), problem solving refers to a mental process which produces a solution through the ability to analyze possible alternatives that resolve a problem. According to Loughry et al. (2013), the 2012 Job Outlook Survey that was conducted by the National Association of Colleges and Employers found that the highest rated skill employers identified in new graduates was teamwork.

Szetela and Nicol (1992) noted that problem solving refers to a process of addressing a situation by formulating connections among available facts to explore strategies needed to achieve identified goals. The National Council of Teachers of Mathematics (NCTM) represents a major advocate of making problem solving as a focus of any effective and active curriculum. Garofalo and Lester (1985) suggest that a successful approach to problem solving depends critically on metacognitive processes. In the current educational environment, problem solving complexity is better addressed by teams or groups because the cognitive capacity required is beyond what individuals can handle (Hung, 2013).

There are different ways educators use groups to promote learning. Schmuck and Schmuck (2000), argued that group process in the classroom has become a concern that educators face. According to the authors, the personalized setting in the classroom promotes emotional connections between instructors and students as well as among students. Eitel (2018), argued on the importance of alternative processes of selecting team members to achieve teamwork results. Johnson et al. (2008), and Slavin (2009), identified three general approaches that educators employ to promote group learning. These include cooperative learning, problem-based learning and team-based learning. The cooperative learning approach uses small groups to complete specific activity within an existing course structure. On the other hand, problem-based learning involves a major restructuring of a course in which groups of students are given a problem prior to the exposition of relevant concepts by instructors. Team-based learning is an approach which resides in the middle of the aforementioned approaches. In a team-based learning setting, Fink (2002), and Michaelsen and Sweet (2008), argued that students become motivated to engage in high-quality learning.

Vye et al. (1997) concluded that in order to prepare students for the challenges of the workplace, the education process has shifted away from rote learning. The shift has resulted in the use of several instructional methods, including, problem-based learning as described in Norman and Schmidt (1992) and Tan (2021). Other methods are anchored instruction (Cognition and Technology Group at Vanderbilt, 1990; Günbaş, 2022), project-based learning (Helle et al., 2006; Guo, 2020), and case-based learning (Kolodner et al., 2003; Raza, Qazi & Umer, 2020). Raza et al. (2020) viewed case-based learning as an academic strategy whose importance is derived from being a participative approach when compared with the traditional passive learning method. The authors used the constructivism theory to explore how case-based learning is associated with student engagement as an essential factor in academic achievement. Raza et al. examined the impact of case-based learning on engagement of students, their learning motivation and performance in Pakistan. Student engagement was measured in terms of behavioral, cognitive, emotional and agentic engagement. The results revealed direct and affirmative relationship between case-based learning and the four components of student engagement.

Günbaş (2022) employed anchor learning as one of the application models of constructivist theory, which prescribes that all learning activities should be organized around an anchor such as a story, problem, or case. The author focused on the three design principles of anchor instruction theory, namely; video-based/animation principle, narrative principle and embedded data design principle. The study tested anchor-based instruction using a sample of pre-service mathematics teachers. The results from the design approaches of the sampled subjects were consistent with the predicted benefits of anchor learning. Guo et al. (2020) noted that higher education is expected to help students to acquire soft and hard skills. Unfortunately, the traditional learning process only creates a situation in which the teacher transmits knowledge and students receive information. In this case, higher education seems to develop students' research skill rather than professional skill. They noted that project-based learning is geared to help students prepare for the labor market with competitive skills that create benefits for the society at large.

Guo et al. (2020) conducted a review of empirical studies to evaluate the different approaches used to measure project-based learning outcomes. They advocated for an improvement in measurement instruments and data analysis.

The unifying thread in all these instructional methods is the use of real problems as the primary drivers of instruction. Problems reflect complex interactions and generally require complex cognitive processing in search of solutions. Bierhals et al. (2007), and Kearney et al. (2009), argued that effective solutions to real-life complex problems require a team since the necessary cognitive capacity is beyond what an individual possesses. Smith et al. (2009), concluded that team-based learning enhances problem-solving skills, creates energy in the classroom, nurtures the development of group cohesion and ensures that students prepare for class. The nucleus of team-based learning is teamwork which produces individual and group accountability (McInerney & Fink, 2003). Gencer (2019) reported that group formation is critical in the development of members' attitudes and behavior. Mosher (2013) noted that team-based learning has drawbacks which include the management of conflicts and reconciliation of differing levels of efforts by individual team members. Thus, team formation is a critical ingredient in achieving the benefits of team-based learning. Alberola et al. (2016) observed the absence of many studies on the key issue of team formation. Hansen (2006), Michaelsen et al. (2004), and Shimazoe and Aldrich (2010), argued that instructors should be guided in the formation and management of teams. They should be purposeful in reducing any barriers to team effectiveness and cohesiveness.

The objective of this study is to explore the possibility of improving group performance in problem-solving courses by forming teams based on student-reported preferences for problem solving. This is premised on the assumption that team effectiveness and cohesiveness can be achieved if cognitive and thinking processing characteristics of team members are considered in team formation. In this new era of international competition, industrial organizations place much significance on team-oriented work environments. It is argued that cohesion and synergy are achieved when heterogeneous work teams value and manage conflict. Since higher education is relied upon to produce the future industry captains, efforts should be placed on developing teamwork skills in college students (Alberola et al., 2016). The importance of this study is hinged on the effectiveness of thinking preference diversity and its role in teaching and learning. Moreover, it is salient to identify if team formation is a significant factor driving the success of a team. More importantly, Haq et al. (2021), argued that personality traits influence academic success and thus significantly predict academic performance. The literature also reveals a superiority of heterogeneous over homogenous groups (Zamani, 2016).

Herrmann Whole Brain Model, Thinking Style, and Learning

The brain is divided into four quadrants: left cerebral mode, left limbic mode, right limbic mode, and right cerebral mode (Herrmann, 1996; Burgess, 2018). Each quadrant respectively represents a thinking structure: analytical thinking, sequential thinking, interpersonal thinking, and imaginative thinking. The left cerebral mode favors analytical thinking which is consistent with factual, logical, technical, and quantitative ways of thinking. On the other hand, the left limbic mode favors sequential thinking which involves structure, safekeeping, organized, detailed, and planned activities. The right limbic favors preference for information that is interpersonal, feeling-based and packed with emotion. Finally, the right cerebral quadrant is characterized by conceptual and holistic approaches to thinking.

According to Steinberg (1993), the four distinct parts of the brain are medulla oblongata, pons varolii, cerebellum and cerebral cortex. The cerebral cortex has right, and left hemispheres and these

hemispheres are connected by corpus callosum tissue. Holtgraves (2013) reported that hemispheric preference is associated with how variable the size of the corpus callosum is. The corpus callosum of a right brain dominant person is relatively larger than that of a left-brain dominant person. According to de Boer (2001), it is possible for an individual to prefer cognitive activities associated with a particular quadrant. Burgess (2018) noted that both sides of the brain are connected by several nerve fibers and makes communication possible between the two sides. Both sides (hemispheres) of the brain contribute to everything we do but in different proportions.

Table 1

Herrmann's Brain Dominance Model

Mode	Type of Thinking	Thinking Characteristics	Preferred Activities
A: Left Cerebral	Analytical	Logical, Critical, Auditive, Technical, Quantitative	Collecting data, Analysis, Judging ideas based on facts, Criteria and logical reasoning
B: Left Limbic	Sequential	Structured, Safekeeping, Organized, Detailed, Complexity, Planned	Following directions, Detail-oriented work, Step-by-step problem solving, Organization and implementation
C: Right Limbic	Interpersonal	Emotional, Spiritual, Sensory, Feeling, Kinesthetic	Listening to and expressing ideas, Looking for personal meaning, Sensory input, and Group interaction
D: Right Cerebral	Imaginative	Visual, Holistic, Intuitive, Innovative, Conceptual	Looking at the big picture, Taking initiative, Challenging assumptions, Metaphoric thinking, Long-term thinking and Creative problem solving

Source: iacet.org

As summarized in Table 1 the left hemisphere consisting of left cerebral and left limbic operates linearly in a sequential fashion. Some researchers had claimed that individuals who are left brain dominant tend to be logical, analytical, detail-oriented, fact-oriented, and numerical [Detail-Analytical] (Bawaneh et al., 2011; Duman, 2010; Hall, 2005; Jensen, 2008; Soyoof et al., 2014; Yazgan & Sahin, 2018, and Yapar Sogut & Yazgan, 2019). The right hemisphere consisting of the right limbic and right cerebral is non-linear, simultaneous in operation and is predisposed to non-verbal information. The researchers concluded that individuals who are right brain dominant are highly global, visual, emotional, creative, and intuitive [Creative-Intuitive]. Individuals who use both hemispheres are whole-brain classified [Homogeneous No Preference]. In view of this model, it is logical to expect that left brain dominant individuals would achieve a better academic performance in problem solving.

Weiss (2000) viewed brain-based learning as an exploration of the human brain and how it processes emotion, motivation, attention, memory to help review and revise theories of learning. De Boer and Bothma (2003), argued that effective learning is associated with the whole brain model because effective teaching activities are expected to account for cognitive functions. The cognitive functions are activated when the brain quadrants are awoken in teaching and learning activities. In an exploratory study, De Boer et al. (2015), created diverse groups of students in a course module christened Innovation

101 using students' Herrmann Brain Dominance Instrument (HBDI) results. The group assignment involved creative problem solving. The group membership represented a whole brain thinking in which all four quadrants are present in each group. The authors tried to employ what they referred to as "activating multiple intelligence." They concluded that the whole brain thinking makes a fertile ground of cultivating and nourishing higher education intelligence.

In the neuroscience and psychology fields, the idea of "brain-based" learning strategy is considered unscientific and should be approached with caution (Dekker, et al., 2012). The two brain hemispheres are connected by massive corpus collosum which makes it possible for communication to exist between the hemispheres. Therefore, cognitive functioning involves both hemispheres in a complex manner. It is argued that if neurons are activated in one location within one hemisphere, it will lead to activity in many regions within both hemispheres (Allen and van der Zwan, 2019). According to Nielsen et al. (2013) some individuals can be stronger analytically in thinking while others can be stronger in thinking creatively. Other people who are stronger across multiple domains also exist. The authors argued that it is a myth to associate the traits with the predominance of one hemisphere over the other. However, Doron et al. (2012) linked the source of the brain-based myth to the originating source of specific processes in the brain to hemispheric dominance. They argued that a huge amount of information is being exchanged between the two hemispheres at any point in time and that the cognitive processes rely on the coordination of inter-hemispheric processing that is considered very complex.

Moore et al. (2012), argued that thinking style and emotional intelligence are intertwined and that outside the field of neuroscience, people embrace the idea that thinking styles are conceptualized in terms of Herrmann right-brain, left-brain, or whole-brain classifications. Margret and Lavanya (2017) reported a positive correlation between hemispheric dominance and emotional intelligence in graduate students. They also found a significant positive relationship between emotional intelligence and thinking style preferences. McAdam (2006), Sharpling (2002), Singh, (2015), Morris (2007) and Moore et al. (2012), agreed on the benefits of group diversity. Haq et al. (2021), and Lambic et al. (2018), reported superior academic performance of heterogeneous groups over homogeneous groups. However, Wyman and Watson (2020), reported no significant difference between the scores of homogeneous and heterogeneous groups in a study based on fifth-grade students drawn from an elementary school in Georgia.

The existing research shows that instructors can achieve better academic outcome by employing team-based instructional strategies (Brame & Biel, 2015; De Vita, 2001; Dillenbourg, 1999; Felder, 1996; Hong & Page, 2004). Hassaskhah and Mozaffri (2015), compared the performance of student-selected and teacher-selected groups in an English literature class. The results indicated that the teacher-selected group recorded a better academic outcome. They concluded that group formation method has merits in terms of academic outcome. Hong and Page (2004), and Farland et al. (2019), concluded that the method of team formation has an effect on team performance. In view of these findings, it is logical to employ a team formation process that is driven by the thinking preferences of team members and its relationship with team performance, especially in an Historically Black University.

Grouping Strategies and Instructional Learning

In a detailed analysis of the Association to Advance Collegiate Schools of Business (AACSB) key standards introduced in 2013 relating to teamwork, Loughry et al. (2013), noted that Standard 9 required accredited business programs to expose students to interpersonal relations and teamwork. This means that business

graduates possess good team skills such as interpersonal skills, the ability to work within a diverse environment, and the ability to understand oneself within a diverse group.Standard 10 required students to have opportunities to work together and learn from each other on some tasks without prejudice to the teaching and learning model employed. Classroom activities involve interpersonal intricacies and subjective depth which go beyond the imagination of the instructor (Schmuck & Schmuck, 2000). There is no single teaching and/or learning theory that can explain all the complexities and dynamics of the classroom environment. According to Schmuck and Schmuck (2000), there are several reasons why educators pay attention to group processes in the classroom environment. These include the increasingly complex nature of social conditions associated with large concentrations of people resulting in the need to learn how to operate in a group setting. Moreover, the modern life that exists today, especially in the cities, requires an ability to relate with other people which could bring about interpersonal frictions. Group life is critical in the development of self-concept because self-esteem is affected by the way people in an environment respond to us. By nature, people feel worthwhile and esteemed through interactive gratification from other people in their environment.

According to Nhan and Nhan (2019), any teaching strategy which engages students to maximize their practice time and gives room for socialization is bound to yield positive results in learning. The authors referred to cooperative learning as an active pedagogy which promotes student learning by encouraging the adoption of cognitive strategies at a level that promotes critical thinking and positive disposition. Mahenthiran and Rouse (2000), reported that the Accounting Education Change Commission has favored cooperative learning which allows students to maximize their interpersonal skills. Grimm (2004) defined cooperative learning as any framework of collaboration among students which gives room for maximum learning in the face of group interdependence but with individual accountability. Ward (1987), and Greenlee and Karanxha (2010), argued that an effective cooperative group is one that is diverse in ability and other characteristics. Such a heterogenous group has the potential for all members to learn, increases student engagement, facilitates social interaction, motivates members, and improves students' self-concepts and attitudes toward self. Ward (1987) concluded that a dominant thread in research on instructional methods is that the use of groups in the classroom results in positive academic outcomes for students.

Several researchers such as Yu et al. (2023), Rudman and Kruger (2014), Gevers and Lubbe (2012), and Ballantine and Larres (2007), supported the promotion of cooperative learning in the classroom because it is a way to encourage the involvement of students in the learning process. It allows the instructor to enhance the ability of students to acquire additional skills beyond team building. Ballantine and Larres (2007), reported that several benefits accrue to group assessment including the development of generic skills and promotion of deeper learning. Gevers and Lubbe (2012), identified students' exposure to important intellectual as well as social skills needed in the workplace.

Greenlee and Karanxha (2010), reported criticisms levied against leadership preparation programs and the response in the form of using cohorts to motivate the learning process. According to the authors, cohorts create opportunities for group interactions and collective learning. In their review of the literature, Greenlee and Karanxha (2010) reported that group experience provided a sense of community to members, promoted professional collaboration and increased members' social capital. Michaelson and Sweet (2008), argued that a properly designed team-learning model would increase attendance and performance due to peer pressure. They reported that cooperative learning results in high performance in academics. They concluded that the power of team learning is due to the level of

cohesiveness that is developed in a group setting. They identified the essential ingredients of team learning to include:

(1) Proper formation and management of groups
(2) Members' accountability for individual and group work
(3) Promotion of learning and team development through assignments
(4) Frequent and timely feedback

Bryant and Albring (2006) reported that several professional organizations have required educators to instill team building skills in their accounting students. The logical avenue for achieving the goal of promoting team building competency by accounting educators is through group projects. To support this assertion, Scott (2007), argued that individuals with similar abilities can still tend to approach problems differently and that this approach tends to have a direct effect on team performance. Grimm (2004) noted that group learning conditions tend to yield a better academic performance than in individual learning conditions. In Grimm's study of elementary school students, the spread in performance was a mean score of approximately fifteen percentage points. Frigotto and Rossi (2012), applied the concept of group diversity in a communication problem solving environment. They reported that communication becomes effective when group members approach problem solving from relatively richer representations. They argued that the approach creates a basis for integrating diverse opinions of group members. According to Mieschbuehler and Dexter (2010), group work involves challenges, ranging from group formation process, interpersonal factors, the free-rider problem, group report presentation anxiety, and the grading process. Forsyth (2014) who focused on the required dynamics in an effective team identified characteristics such as interaction, team goals, interdependence, team structure, and team cohesion.

Method

Given the value of team and group work, this study explored the use of group dynamics to achieve superior performance in a problem-solving case scenario. The key research question is whether a heterogeneous group of students can achieve a better academic performance compared to a homogeneous group of students in a problem-based case analysis. According to Hughes et al. (2017), case-based teaching has the potential to develop a rich insight into students' knowledge base. It can stimulate students' knowledge structure, skills, and experience of resolution of real-life problems. The authors note that students taught using a cooperative learning method show higher level reasoning and critical thinking skills. Hughes et al. (2017), report that the use of cases with different perspectives can bring out the different cognitive skills of team members. Mushtaq et al. (2012), argue that the group formation method is critical in academic performance within a cooperative learning environment. In this study, the thinking preference disposition of students was employed in group formation with the expectation that the best group dynamics would yield superior academic performance in a problem-solving case.

Participants

A total of 132 students who enrolled in one of the Business Statistics courses in a southwestern Historically Black University in the 2018-2019 academic year participated in the current study for extra credits. This research was exempt from Institutional Review Committee of the University because it was employed as a teaching-enhancement tool. Forty-four teams of three students were formed. Furthermore, 68 of the students were males and 64 females (see Table 2). There were 23 Accounting

majors, 20 in Finance, 60 in Management, 8 in Management Information Systems and 21 in Marketing. Classification by class revealed that 90 were juniors and forty-two seniors. It should be noted that participation in this project was completely voluntary.

Table 2

Students' Classification by Major and Gender

Major	Count	Male	Female
Accounting	23	12	11
Finance	20	10	10
Management	60	31	29
Mgmt Info System	8	4	4
Marketing	21	11	10
Total	**132**	**68**	**64**

Study Design and Procedures

The participating students were directed to the online Hemispheric Dominance Inventory platform of the Middle Tennessee State University, which was available at: (www.capone.mtsu.edu/studskl/hemispheric_dominance.html) to complete an online questionnaire. The students were instructed to submit their printed results to their instructors. Three-student teams were formed based on students' classification results from the Hemispheric Dominance Inventory test which were interpreted as thinking style preferences in line with results reported by Margret and Lavanya (2017). Group 1 was made up of Detail-Analytical students while Group 2 consisted of the Creative-Intuitive students. Group 3 had the Homogeneous No Preference students, and Group 4 had the Heterogeneous Preference students which is a mix of students from Groups 1, 2 and 3. Thus, Groups 1, 2, and 3 were homogeneous groups while Group 4 was a heterogeneous group. A case analysis assignment including an Excel data file and 12 case questions worth 44 points were given to each team toward the end of each semester. The case assignment captured most of the concepts in a typical undergraduate statistics course. Team members were required to hold face-to-face meetings with an agenda. Detailed team meeting minutes were required to monitor the contributions of team members. The students were required to submit their team case reports within one week. Once submitted, each of the three instructors (who are coauthors of this research) did a review and graded the team submissions based on agreed rubric to remove any bias in the scores. The data were aggregated for analysis. Thereafter, the responses were coded into SPSS for statistical analysis. The summary statistics of the group scores are reported in Table 3. The mean score for Group 1 was the highest at 26.62 while Group 2 average score of 9.86 was the lowest. The mean score for Group 3 and Group 4 were very close at 21.78 versus 20.18 respectively. The other statistics such as standard deviation and minimum scores are captured in Table 3.

Table 3

Summary Statistics of Group Scores

Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum
					Lower Bound	Upper Bound	
1	22	26.62091	11.385321	2.427359	21.57294	31.66888	8.000
2	7	9.85714	4.879500	1.844278	5.34436	14.36993	4.000
3	9	21.77778	11.987262	3.995754	12.56355	30.99200	8.000
4	6	20.17500	13.124858	5.358201	6.40131	33.94869	7.000
Total	44	22.08432	12.197863	1.838897	18.37583	25.79281	4.000

Results

A one-way ANOVA (analysis of variance) was conducted to identify whether the average team project scores of the four teams differ from one another. The equality of error variances across the treatment groups on the dependent variable was first examined using the Brown-Forsythe test which was not statistically significant (p = 0.280). Since this test applies the medians in the analysis, it was found to be more robust than the Levene test which is based on means (Wang et al., 2017). Although the standard deviation of Group 2 was smaller than the standard deviations of each of the other groups, the Brown-Forsythe test reported in Table 4, clearly demonstrated the lack of statistical significance among the four population variances.

Table 4

Brown-Forsythe Test (Equality of Variances Test)

ANOVA

	Sum of Squares	df	Mean Square	F-Statistic	Probability
Between Groups	187.783	3	62.594	1.325	.280
Within Groups	1889.104	40	47.228		
Total	2076.887	43			

The ANOVA results reported in Table 5 indicate that there is a significant difference among the four groups' average scores. The test statistic (F-calculated) was 4.162 with a p-value of 0.012 which is significant at the $p < 0.05$ level. In addition, pairwise multiple comparisons were performed based on the Bonferroni test. A summary of the results revealed that the average scores of Group 1 [the Detail-Analytical group] (n = 22), Group 2 [the Creative-Intuitive group] (n = 7), Group 3 [the Homogeneous No Preference group] (n=9), and Group 4 [the Heterogeneous Preference group] (n=6) were 26.621, 9.857, 21.778, and 20.174, respectively. The average scores of the Detail-Analytical group were significantly different from the average scores of the Creative-Intuitive group (p=0.007). However, there were no significant differences between the Detail-Analytical group and the Homogeneous No Preference group,

the Detail-Analytical group, and the Heterogeneous Preference group. In this study, the number of teams in Group 1 was almost equal to the sum of the number of teams in the other three groups which is consistent with prior empirical work of Saleh (2001) whose research report implied that students who belong to the Detail-Analytical group usually picked a college academic major in business.

Since the mean of the Creative-Intuitive Group 2 was 9.857, one would be tempted to infer that the score would be significantly different from the other group scores. However, the multiple comparison technique revealed that it was not statistically significant.

Table 5

Test for Equality of Group Means

ANOVA

Factor	Sum of Squares	df	Mean Square	F-Statistic	Prob.
Between Groups	1522.020	3	507.340	4.162	0.012
Within Groups	4875.858	40	121.896		
Total	6397.878	43			

Multiple Comparisons

Dependent Variable: Score

Bonferroni

GROUP (I)	GROUP (J)	Mean Difference (I-J)	Std. Error	Prob.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	16.763766*	4.791088	0.007	3.46434	30.06319
	3	4.843131	4.368615	1.000	-7.28356	16.96982
	4	6.445909	5.084961	1.000	-7.66926	20.56108
2	3	-11.920635	5.563976	0.230	-27.36549	3.52422
	4	-10.317857	6.142463	0.605	-27.36852	6.73280
3	4	1.602778	5.818946	1.000	-14.54984	17.75539

* The mean difference is significant at the 0.05 level.

Discussion and Conclusion

To meet the challenges of the day, educators embrace the use of teams in the classroom. The ability of students to work with others is described as an efficient and effective way to prepare college graduates for the business world. A thorny issue in this endeavor is the group formation method. This study is an exploratory one geared to group formation based on the preferred thinking style of students. The rationale is that group heterogeneity driven by thinking style preferences can serve as a catalyst to accelerate the benefits of collaboration with the utmost improvement in academic performance in problem solving courses.

Four types of groups were formed in several sections of Business Statistics classes in an Historically Black University in the southwestern part of the U.S. The first homogeneous group was made up of Detail-Analytical thinking students while the second homogeneous group included students who identified as

Creative-Intuitive in thinking. The Homogeneous No Preference thinking style students form the third homogeneous group. And the last group, which was a heterogeneous group, was made up of a mix of the students from the three groups (Heterogeneous Group). This group is the Heterogeneous Preference thinking group. The ANOVA results revealed that average group scores for the four groups are unequal. Further analysis using the Bonferroni pairwise comparison indicated that the average performance score of Detail-Analytical thinking students' group was higher than the Creative-Intuitive thinking group's score. However, there was no difference in the average scores when the Detail-Analytical Group was compared with the Homogeneous No Preference Group. Moreover, there was no statistical difference in the scores of the Detail-Analytical Group and the Heterogeneous Group. The study results revealed that the Detail-Analytical Group did better than Creative-Intuitive thinking group in a problem-solving case. In summary, the study results revealed that team heterogeneity may not a be a determinant factor in academic performance because the average score for Group 4 was not the highest score in this study. However, the average score for Group 1 exceeded the average scores for the other three groups suggesting that the Detail-Analytical thinking students performed better in problem solving cases.

The results reported in this study are subject to some limitations. The research design allowed students to self-report their hemispheric preferences. This approach could only measure an individual's preference for certain types of activities over others. The analysis could have been affected by the fact that the four groups utilized had unequal sizes. The research also rested on the use of business statistics students from one academic year as participants. Moreover, the case analysis project only lasted one week. There was not enough time for the teams to maximize the benefits of team cohesion. As Greenlee and Karanxha (2010) noted, an effective team is one that is diverse in ability and other characteristics with potential for members to learn, increase members' engagement and facilitate social interaction. Rock and Gerkovich (2021) espoused the concept of a diverse team in terms of cognitive elaboration which allows the exposition and correction of faulty thinking while generating fresh and novel ideas. This process takes time to gain ground. However, the overall results reported in this study are nevertheless consistent with Farland et al. (2019), and Briggs (2020), who found a weak impact of team formation method on group performance. The results are at variance with Haq et al. (2021) and Lambic et al. (2018) who reported superior academic performance by heterogeneous teams relative to homogeneous teams.

The authors agree with Rusticus and Justus (2019), who identified other factors that influence group dynamics and consequently, group performance. These include, communication, workload distribution, differences in goals and motivations, and group socialization. Munro and Laiken (2003) identified other team success factors including facilitative leadership, information sharing, conflict management and clear role and performance expectations. Further research should be focused on separating these factors from the impact of thinking style preferences on group formation to achieve the desired results of collaborative learning.

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