THE SOCIOGRAPH: FRIENDSHIP-BASED GROUP LEARNING IN THE MATHEMATICS CLASS

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Article Info	ABSTRACT
	Mathematics class can cause many problems if students do not organize diversity and habits correctly. Using a sociograph to form a mathematics study group is one way to organize assortment in the mathematics class. Sociograph is a friendship pathway that appears in a math class. In this sense, this study aims to determine the impact of forming study groups based on friendship in a mathematics class on problem-solving abilities. A quasi-experimental research design with 30 students was used. A friendship questionnaire and a problem-solving test were used as instruments. In addition, an independent t-test was used to analyze the data. The study results indicate that study groups formed through friendship pathways (sociograph) have a more significant effect than those formed through other means. As a result, the formation of heterogeneous groups based on friendship can be used as an alternative to the formation of study groups.

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1. INTRODUCTION

Character is defined as the psychological traits of morality or manner that set one individual apart from another (Ganellen, 2007; Kosinski et al., 2014). Character is an identity that describes a person's qualifications (Asch, 2005; Fejes & Köpsén, 2014). It does not necessitate quantitative evaluation tools, so its formation does not necessarily entail a separate subject (Entwistle & Ramsden, 2015; Orne, 2006). Various student characters from outside the classroom provide color-to-student interaction in the mathematics class. This character difference is one reason why learning in mathematics class will cause many problems (Cheema & Kitsantas, 2014; Pekrun, 2014). Students' personalities are very diverse or heterogeneous, and their habits differ. The impact of learning mathematics is that

it can organize students' diversity and habits so that learning goals can be achieved while remaining unlikely to be affected (Kereluik et al., 2013; Killpack & Melón, 2016; Kövecses-Gősi, 2018; Widodo & Purnami, 2018).

Social interaction is a pattern that teaches students how to analyze a phenomenon related to their life problems and experiences (Russell & Martin, 2014). Social interaction is a relationship between two or more people or between one person and another (Cacioppo & Cacioppo, 2014). A reciprocal relationship develops between the two parties during that interaction (Lewis et al., 2014; Sprecher et al., 2013). Students who engage in social contact are more likely to have an attitude of collaboration, to connect with others on an individual or group level, to communicate with one another, and to offer solutions to problems (Cowie et al., 1994; Cullen-Lester & Yammarino, 2016; Ratts et al., 2016; Tseng & Kuo, 2014).

By focusing on students' emotional and social needs, teachers can play a crucial part in fostering positive interactions in the classroom (Bambaeeroo & Shokrpour, 2017; Glass et al., 2015). Students can feel at ease and enjoy studying at school through these interactions, which will help them meet their learning goals (Biesta, 2015). The students' situation and psychosocial state must be considered by the teacher before teaching, especially in math class (Roeser et al., 2013). This seeks to help students effectively absorb the knowledge the teacher is trying to deliver (Hattie, 2015; Rasmitadila et al., 2020). This leads to patterns of social interaction between students and their environment, which can assist teachers and students in creating effective learning environments since teachers can recognize the diversity and habits of students. This notion is consistent with constructivism, which identifies the importance of social and interpersonal interactions, as well as an individual's ties with their social environment, as the starting point for knowledge (Bozkurt, 2017; Endres & Weibler, 2017; Galbin, 2014). Instead of only remembering formulae or theorems, students are considered to grasp mathematical concepts if they can create cognitive links between new experiences and their prior comprehension of mathematics (Bujak et al., 2013; Esteban-Guitart & Moll, 2014; Haylock & Manning, 2018). Students engage with other students and their groups, and as a result, the learning process involves social relationships (Amineh & Asl, 2015; Argyle, 2017).

One technique for organizing very diverse students is to divide them into study groups, as in cooperative learning in mathematics (Capar & Tarim, 2015; Chan & Idris, 2017; Slavin, 1988; Zakaria et al., 2013). Some of the learning goals achieved through group work include allowing students to discover their unique talents and skills, making the material simpler to understand, giving students more roles and responsibilities for learning and understanding the materials, and raising students' awareness of cooperation, mutual tolerance, and respect (Islamov et al., 2016; Kauffman, 2015; Nenotaek et al., 2019; Zakaria et al., 2013).

As of now, the process of creating study groups, such as in cooperative learning models for mathematics, is heterogeneous and uses several ways, such as counting techniques and random, peer-to-peer, or lottery processes (Van Ryzin et al., 2020). In reality, some earlier researchers who studied cooperative learning noted that the creation of groups in collaborative learning occurs randomly based on peers (Ji et al., 2016; Stigmar, 2016). The issue arises when some students encounter mathematical difficulties and are hesitant to approach the teacher or other group members who are not on the same "frequency" as them. This is true even when the research results indicated that students' cognitive abilities had improved. Even though math class can be integrated into society, friendship groups are rarely formed in class (Esmonde et al., 2013; Esmonde & Langer-Osuna, 2013; Fields & Enyedy, 2013). In mathematics class, study groups built on friendships between students will reduce problems with students who are unwilling to ask the teacher questions or do not participate in group activities consistently (Wang & Tahir, 2020).

In this regard, this study aimed to determine the impact of forming study groups based on friendship in mathematics class on students' cognitive abilities. This study defines the student's cognitive ability as solving mathematical problems. This ability allows students to use mathematical activities to solve problems in mathematics, other sciences, and everyday life (Widodo, 2017; Widodo et al., 2017; Widodo et al., 2019b). In addition, a sociograph can be used to illustrate the dynamics of friendship in math class. The sociograph pathway can identify the math study group depending on how closely the students are interconnected. It is hoped that students will be able to ask their peers to understand complex content rather than coming to their supporting teacher.

2.   METHOD

2.1.   Research Design

Because external factors that affect research results cannot be controlled entirely, this quasi-experimental study was chosen. A nonequivalent post-test control-group design was adopted for the investigation. In general, the experimental and control groups' student groups engage in the same type of learning, known as problem-based learning. The same teacher observed the learning process, the control and experimental groups attended the same class, and the subject matter was the same to prevent teaching-related bias from affecting the research findings.

This questionnaire aims to discover if students will likely seek assistance when presented with mathematical problems. Following that, four groups with four students each were chosen. The researcher verified that establishing two groups was based on friendships among students in the mathematics class using the four selected groups. The experimental group was later used to refer to these two groups. Finally, students from the control and experimental groups took a post-test to gauge their cognitive capacities after learning the math material at the end of the lesson.

2.2.   Participant

Purposive sampling was used to select participants for this study. Purposive sampling is a technique with defined goals and characteristics (Etikan et al., 2016). The study aimed to see how group learning using a sociograph affected the ability to solve mathematical problems. As a result, the students used in this study were 16 students divided into four study groups. Two of the four study groups were formed based on student friendship pathways, so they were assigned to the experimental group. The other two groups, in contrast, joined the control group because group formation was not based on student friendship pathways.

A friendship questionnaire is required to determine who the closest friend is in order to determine the friendship network. This friendship questionnaire only has one question: "When faced with a mathematical problem, whom do you turn to for assistance? Mention no more than two students! ". Figure 1 depicts creating a friendship path or sociograph based on the questionnaire results. Following all these, two study groups were formed based on the friendship pathway: group A, which consisted of 1, 2, 18, and 19, and group B, which consisted of 5, 6, 16, and 22.

One group was compared to sociograph groups to determine whether study groups formed on sociographs have a positive effect; namely, study groups formed heterogeneously and not based on friendship pathways. Group C consists of 18, 15, 23, and 24 students, while Group D consists of 9, 15, 20, and 26 students.
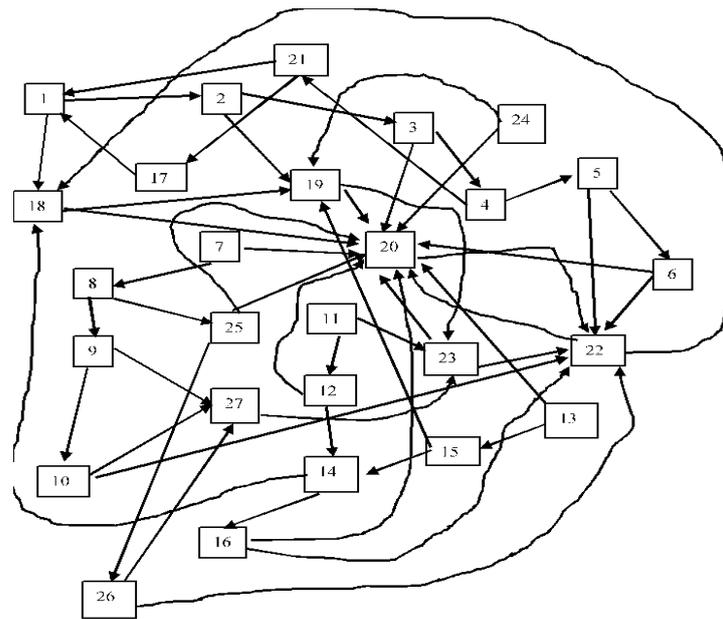
Figure 1. Sociograph in the mathematics class

2.3.   Research Instruments

A research instrument is a tool used to measure an object and gather data from a variable (Taherdoost, 2016). A mathematical problem-solving test provided after each learning session served as the research instrument for this study. Because of this, each learning session's test for research participants only consists of a one-word problem with a mathematical solution. The format of this test is based on the material quadrilateral aspects. This content contains squares, rectangles, parallelograms, rhombuses, kites, and trapeziums. The score criteria for the test of mathematical problem-solving are shown in Table 1 (Widodo, 2017; Widodo et al., 2017; Widodo et al., 2019b).

Table 1. Indicators of the problem-solving from Polya

Polya's Step	Score	Indicators
Understanding the Problems	3	Students can explain in written form what they know and need from the clearly-stated problem.
	2	Students only write (express) what they know or what is asked of them.
	1	Students note down (disclose) data/concepts/knowledge that is unrelated to the nature of the problem, causing students to misunderstand the problem at hand.
	0	Students do not write anything, so they do not comprehend the nature of the problem.
Devise a plan (Translate)	2	Students write down/tell the sufficient and necessary conditions (formula) of the problem posed and use all the collected information.
	1	Students tell/write the steps to resolve the problem but must do it more coherently.
	0	Students do not tell/write the steps to solve the problem.

Polya's Step	Score	Indicators
Carry out the plan (solve)	4	Students carry out their plans and follow the steps to solve the problem correctly. There are no procedural errors, nor are there any algorithm/calculation errors.
	3	Students carry out their plans correctly, following the steps to solve the problem, and there are no procedural errors, but there are algorithm/calculation errors.
	2	Students carry out their plans, but errors in procedure occur.
	1	Students carry out their plans, but procedural, and algorithm/calculation errors exist.
	0	Students need help to carry out the plans that they have made.
Look back (check and interpretation)	1	Students re-check their answers.
	0	Students do not re-check answers.

2.4. Data Collection and Analysis

Examples of questions that are posed to subjects at the end of a learning session include:

A square photo frame is rotated at 45°, with the axis of rotation at the point where the diagonals intersect. If the square's side length is 1 cm, determine the area of the slice between the photo frame before and after rotating it!

The learning model used in both groups (control and experimental groups) in this study was problem-based learning. Furthermore, the mathematics material given to both groups was the same, the teacher who provided the mathematics material to the two groups was also the same, and the treatment time (including learning time) assigned to the two groups was also the same. This was carried out to avoid biased research results. Therefore, researchers make every effort to prevent non-observational variables that could tamper with the findings of this study.

2.5. Data Analysis

The post-test provided to students at the end of the learning session is given 15 times since the math teacher conducts learning for around one month with 15 meetings. Moreover, the post-test results on problem-solving were used to calculate the average level of problem-solving for each treatment group. In addition, the Statistical Package employed the average findings from each session of the Social Sciences (SPSS Version 21) program to determine the data distribution, the overall average for each group, and the standard deviation in demographic data. Finally, the average of each treatment group's data was examined in a paired t-test to determine the answer to this study question.

Using the independent t-test, it is feasible to conclude that study groups based on friendship paths (sociograph) influence problem-solving skills. T-value is obtained if the significance coefficient is less than 0.05.

3.   RESULT AND DISCUSSION

3.1.   Result

Geometry is the mathematical material used in this study to determine the area and perimeter of a rectangle. The teacher conducts learning 15 times to complete this material, and Table 2 shows the average problem-solving ability for each session and group.

Table 2. The score of problem-solving skill

Session	A score of problem-solving skill	
	Control group	**Experiment group**
1	7.250	8.000
2	7.250	8.375
3	8.375	7.125
4	7.250	7.875
5	7.625	7.750
6	7.375	8.000
7	7.625	7.625
8	7.625	7.875
9	7.500	7.125
10	7.000	8.625
11	7.500	7.250
12	7.500	8.125
13	7.000	8.375
14	7.750	8.125
15	7.250	8.625
average	7.458	7.925

The data in Table 2 is used to calculate a t-test using IBM SPSS Statistics Version 25 software. An assumption test, namely the population normality test and variance homogeneity, is performed before calculating this paired t-test. The population normality test employs the chi-square test, assuming that if a significance coefficient (asymp. Sig.) greater than 0.05 is obtained, the sample is drawn from a normally distributed population. The Levene test is used in the population variance homogeneity test, which assumes that if a significant coefficient (Sig.) of more than 0.05 is obtained, the two samples used have the same variance.

Table 3. The result of the normality test with chi-square

	Exsperiment	**control**
Chi-Square	1.200	4.133
Df	8	6
Asymp. Sig.	0.997	0.659

Table 3 shows that the chi-square calculation results for the experimental and control groups were 1.200 with an Asymp. Sig of 0.997, respectively, and 4,133 with Asymp.Sig.

of 0.659. These results indicate that the samples in the experimental and control groups come from normally distributed populations.

The results of Levene's test calculations using IBM SPSS Statistics Version 25 software showed that Levene's test statistic was 2.042, df1 was 1, df2 was 28, and a significance coefficient was 0.164. These results indicate that the two sample groups used have the same variance.

After performing the t-test assumption test, and then conducting the paired t-test using the IBM SPSS Statistics Version 25 software, it was discovered that the t-test is 3.039, the df is 38, and the sign coefficient is 0.005. If the t table for a df of 28 is 1.699, then the tob obtained exceeds the t table. Furthermore, based on the obtained significance coefficient of less than 0.05, the formation of study groups based on the friendship path (sociograph) affects the ability to solve mathematical problems differently.

Table 4. The result of descriptive statistics

Group	N	Mean	Standard deviation
Experiment	15	7.925	0.488
Control	15	7.458	0.340

According to Table 4, the average control group was 7.927, while the average experimental group was 7.458. Based on these averages, study groups formed through friendship pathways (sociograph) have a more significant effect than those formed through other means.

3.2.   Discussion

The findings revealed that study groups formed based on friendship paths (sociograph) had a more significant impact than those formed based on other criteria. This demonstrates that the process of social interaction during learning will produce a rule or agreement that must be followed. These agreements are called norms. There are two norms in learning mathematics: social and socio-mathematic. Social norms are rules or patterns of social interaction that are not tied to topics or learning materials, such as tolerance of the surrounding environment in daily interactions, how to adequately express opinions, and respect for the views of others. Socio-mathematical norms are explicitly linked to mathematical argumentation, namely how students engage in the process of interaction and negotiation with their surroundings in order to understand mathematical concepts so that the arguments expressed can be mathematically accepted by others (Bonotto, 2010, 2011, 2013; Cobb et al., 1989; Lopez & Allal, 2007; Partanen & Kaasila, 2015; Yackel & Cobb, 1996; Yackel et al., 1991; Yackel & Rasmussen, 2002). When the explanations and justifications made in the mathematics learning class are acceptable to the environment, socio-mathematical norms can be formed (Mueller et al., 2014).

Unknowingly, teachers and students have used socio-mathematical norms during the learning process, such as encouraging students to ask questions and argue during the learning process, creating a creative and innovative learning environment, and employing learning methods that enable students to become more active. The problem is that learning mathematics places less emphasis on friendship in mathematics class. Friendship is one factor contributing to the development of socio-mathematical norms and the acquisition of problem-solving abilities (Lopez & Allal, 2007; Widodo et al., 2020; Widodo et al., 2019a). Along with the communication that develops between people, friendships play a role in how strong a student community is at school. If handled effectively, these communities can help teachers carry out the learning process in the classroom.

A social network or networking is a collection of interactions influenced by friendship and communication. For example, the relationship that develops between companies in the industrial world is based on the existence of formalized social networks. This type of relationship is referred to as social network analysis (Freeman, 2004; Serrat, 2017). In social media, an image of a network or networking formed from interaction and communication between individuals is called a sociograph (Barkley, 2012; Liberatore et al., 2018). However, several studies state that the sociograph picture is called a sociogram (Corbisiero, 2022; Saqr et al., 2018). For example, a graph known as a sociograph represents the social network shown in Figure 1 (Al-Fayoumi et al., 2009).

The general goal of sociographs in social media is to discover networks in regular communication or interaction (Campbell et al., 2013; De Jaegher et al., 2010; Liberatore et al., 2018). By adopting the sociograph's function on social media, the sociograph is portrayed in the social interactions in the mathematics classroom setting to describe or be familiar with social networks in mathematics learning. Teachers can forecast the critical sources for solving mathematical issues by studying the sources of social networks in mathematics learning. The learning process in the mathematics class can aid the teacher's mathematics learning if the communities built based on social interaction networks can be handled by the teacher effectively. This explains why instructors must establish networks or friendship networks in math classes.

As shown in Figure 1, separating subjects 20, 22, 19, 23, and 27 allows for creating math study groups. This is because anytime a question relating to mathematics is posed, they serve as the go-to resource or command center for students to find solutions. The ability of students in subjects 11, 13, 21, and 24 to solve mathematical problems is precarious. This is evident because no students in one class attempted to approach him for assistance when he was given a mathematics problem requiring that subjects 11, 13, 21, and 24 be placed separately. As a result, subjects 20, 22, 19, 23, and 27 focus on mathematical learning activities, and weak subjects are separated.

Teachers can effectively control mathematics study by creating learning communities based on social interaction networks. By adopting the sociograph pathway, teachers can reduce social disputes during arithmetic lessons, resulting in efficient learning. Because of this, study groups formed based on friendship, or sociographic lines benefit students' problem-solving abilities.

4.   CONCLUSION

Sosiograph is a friendship channel that can be used instead of forming study groups in math class. Students in the mathematics class with the learning center category must be separated so that they can replace the teacher's role in conveying material to friends in the group.

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