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RESEARCH PAPER

Enhancing Chemistry Performance and Motivation through Think-Pair-Share Strategy among Higher Secondary School Students

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ABSTRACT

This study aimed at investigating the effect of think-pair-share strategy on motivation and academic performance of higher secondary school students studying chemistry course. The objectives were; to investigate the effect of think-pair-share strategy on students' motivation in Chemistry class, to investigate the effect of think-pair-share strategy on students' academic performance in Chemistry class, and to find the relationship between motivation and academic performance of students in Chemistry class. Quasi-experimental interrupted time series design was used. The instruments for data collection were "Chemistry Motivation Questionnaire", and Chemistry Performance Test. The data obtained were analyzed using paired sample *t*-test. The findings revealed a significant difference in the mean motivation and academic performance scores of the students taught using think-pair-share strategy. It was recommended that workshops and seminars should be organized by school heads to orient chemistry teachers on how to effectively use think-pair-share strategy in the teaching and learning of chemistry.

Introduction

Chemistry is a discipline of science that examines matter, including its composition, characteristics, structure, and chemical changes as well as the rules and laws that control these changes. It is concerned with how different chemicals interact when they are mixed chemically (Usselman & Rocke, 2020). Despite the benefits, students sometimes find it difficult to continue their education in chemistry because of the practical struggle of understanding the course. One of the key issues leading to

students' lack of interest in comprehending chemistry is the employment of ineffective teaching strategies (Jegede, 2007).

Academic performance is the result of education and the mastering of certain learning subjects by students (Pierre, 2010). It represents the degree to which students have finished an academic task satisfactorily. Academic performance is frequently increased when teachers use learner-centered teaching practices that encourage students to take responsibility for their own learning (Furquoun, 2015). Innovative teaching methods not only have the potential to improve achievement but can facilitate proper understanding of concepts learnt (Lom, 2012). One of such innovative teaching methods that hold promises of improving achievement in learning is think-pair-share strategy.

Think-Pair-Share (TPS) is a collaborative learning strategy that encourages students to work together to solve problems or answer questions on an assigned topic (Andrew & Alexandria, 2015). Think-pair- share as the name goes involves the students in thinking about challenging academic tasks given by the teacher individually, pairing with other students to exchange ideas and sharing the idea with the larger class. In the think-pair-share classroom, every student is an active learner. The teacher in this study used think pair share by developing a number of questions related to the objectives of the instruction and challenging the students to provide answers. The teacher will produce a chart of students seating arrangement so that students cannot chose the same person or their friends only by adhering to the chart. Using the chart, students are made to pair with a different student for each question to facilitate greater interaction. During the interaction among pairs, students are expected to bring to the pair learning what they think is the solution to the problem, for which the teacher have given them time to think before pairing. The student pairs are to examine each other's solution to the problem, criticize or add to the solution or learn from it. Students in their pair may choose to solve the problem together with the ideas they have previously thought on their mind. This collaboration to solve a problem must result in a possible or at least tentative solution to the problem, which the students may now share with the entire class. The teacher appoints students at random looking at the chart to ensure that all the students are involved and that the intelligent ones do not dominate the activities. After the sharing, the teacher summarizes the lesson in the order of what students are supposed to learn. Learning through think-pair-share shows that, by the intrinsic nature of the learning strategy, students can learn from their peer. It affords slow pace learners and shy students the opportunity to build self-confidence by learning from their peers (Marvin, 2015). Think-Pair Share also improves students' desire to learn seeing that the task of learning is a collaborative effort where students can improve understanding of chemistry concept by sharing ideas. The thinking part of TPS facilitates students' active cognitive engagement in learning and reduces absent mindedness during instruction.

According to studies conducted by (Gaudet et al., 2010) students' academic performance improves when they are given the opportunity to work together on projects. Academic performance is an essential part of every educational institute (Rono, 2013). It is generally agreed that when students work together, they may each bring their unique set of skills and weaknesses to bear on the greater good of the group's education. There are positive and negative traits present in every learner. Students' decision-making and problem-solving abilities, as well as their academic performance, benefit from participation in collaborative learning activities in small groups (Williamson-Ashe & Ericksen, 2017 as cited in Lewinski, 2021).

When students work together and learn to accept responsibility for one other's work, they not only gain confidence in their abilities but also in their ability to succeed in their classes (Jacobs, 2016). Strong teams in well-taught collaboration rely on mutual support and improvement. As an example of productive, autonomous, goal-oriented cooperation, Jacobs (2016) provided many case studies. Not only do participants have an opportunity to motivate one another's abilities, but they also receive a comprehensive breakdown of their assignments and when they are expected to be completed. Appreciation for one another's ideas and constructive criticism of individual team members. In addition, everyone in the team is responsible for creating their own presentation. Because of this presentation, they are to put in more struggle to be successful individually for the sake of the team if one of its members is underperforming (Jacobs, 2016). While working in groups, conventional students may be more motivated to learn and grow, as suggested by research from Trespalacios et al. (2011) and Sears and Reagin (2013).

The issues of instructional method often appear as one of the contributing factor to chemistry students' academic performance because most methods adopted by chemistry teachers are teacher-centred. Many secondary schools lack the facilities as well as the infrastructure needed for effective teaching and learning to ensure optimal learning of chemistry concepts (Sulaiman & Shahrill, 2015). In some cases, the chemistry teacher may not be conversant with innovative pedagogical approaches to teaching that can make the learning of chemistry more meaningful to the students. Consequently, students' academic performance in chemistry has remained low.

Pakistan's educational system rarely addresses the issues of students' motivation and instructor's feedback during the course of instruction at the college level (Din & Saeed, 2018). There can be no successful learning or teaching without the involvement of all parties involved. Therefore, it is important to analyze the roles of instructors and students in giving and receiving feedback in a classroom setting to boost students' motivation in terms of learning goal orientation (Javed, 2017).

Literature Review

Think-pair-share (TPS) is a technique of group study in which learners discuss and work out solutions or answers to questions about, issues posed to the group as a

whole. Students are given individual time to reflect on a topic or answer a question before contributing to a group discussion. Having a classmate to talk about what they're reading with boosts students' engagement, helps them focus, and improves their comprehension. Figure 2.2 from Bullock (2021) shows that this method works well to get the whole class involved in finding out new things and learning them.

TPS is a method of group instruction which was developed by Frank Lyman in 1982. Even if students do not have a strong interest in the material, they are urged to participate (Lyman, 1982; Marzano & Pickering, 2005). Students practice not just digesting the content but also communicating and solving problems. According to Robertson (2006), the Think-Pair-Share process was developed so that students might generate their own ideas and then discuss them with their peers. Instead of the usual presentation format in which the teacher asks questions and the students answer them, the Think-Pair-Share method can get more students involved and keep them focused on the material at hand. A TPS might take as little as 5 minutes or as long as 30 minutes. Researchers have shown that students are more engaged in classroom conversations when they require more time to think of something to say before speaking (Sampsel, 2013). When students work together to improve and expand on ideas, they are more likely to take ownership of their work.

Following the procedures outlined by Sumarsih and Sanjaya (2013), the "Think-Pair-Share" method may be implemented.

- Teachers put students in groups of four and give each group a number.
- A well-reasoned question or topic for debate is introduced (what qualities define an effective manager, for instance).
- During "Think" time, students are encouraged to express themselves and think about the topic at hand in their own words. In fact, if the "thinking" time is distributed fairly, pupils will provide higher-quality answers.
- Teachers put students in groups based on the numbers they were given, and then use the numbers to lead discussions.
- It is often necessary for students to put their efforts in groups to resolve a problem or gain knowledge about a topic, and teachers recognize this necessity. A variety of pupils offer to speak up and contribute their thoughts to the discussion.

Think-Pair-Share is a useful activity due to its many benefits. The students should take the time allowed for silence to meditate on the prompt. As a result, it reduces the possibility that the majority of students will rely on an enthusiastic or attention-seeking classmate to save the day whenever the teacher poses a question in class. Time made aside for quiet contemplation also allows students who need a moment to gather their thoughts (or courage) to join in the discussion. As well as

encouraging students to think critically, the Think-Pair-Share method ensures that every student has a chance to speak. In this way, students learn the value of discussing ideas with a classmate and reflecting on and defending their thinking in an academic setting. When asked a question one-on-one, students often report feeling far more comfortable than if the same subject had been posed to the class and a single volunteer response had been gotten.

TPS afford students the opportunity to take active role in their own learning through cognitive engagement, peer learning and sharing. Students synthesize and evaluate their ideas, or purported solutions to problems, apply them in understanding the solution better or in teaching their pair and further sharing their ideas with the whole class. These features of TPS bear good and positive prospect for the students' achievement in chemistry. Thus, the researcher is poised to investigate whether T-P-S would improve achievement in chemistry when compared to the conventional method of teaching. The conventional method of teaching is what the teacher does in the classroom (Millis, 2012).

Unfortunately, the quality of education is falling in emerging nations like Pakistan. According to Bhatti and Qazi (2017), Pakistani students have a lot of difficulties finishing annual test papers, which has a detrimental impact on how well they perform on science exams (Akram et al., 2017). Additionally, it is discovered that they fear chemistry and find it to be a challenging subject. They also show reduced motivation for chemistry (Chishti & Rana, 2021; Din & Saeed, 2018). Also, the distinctive qualities of their students are not taken into account by teachers while developing their teaching methods and strategies. The most popular kind of instruction, which involves using chalk and talking, is lecturing, according to Najmonnisa, Amin ul Haq, and Saad (2019). Sultana and Zaki (2015) stated that the present environment of classrooms in our educational system does not permit the use of interactive teaching methods, which forces students to learn through rote memory rather than the development of critical thinking skills. Because traditional or standard classroom learning activities have not been successful in developing thoughtful and reflective learners, the existing teaching approaches need to be altered. To address these issues, Pakistan's educational system needs to be modernized by incorporating new teaching methods (Raza, Qazi, Umer, et al., 2020).

Hypotheses

In this experimental research, the following null hypotheses were tested:

$\boldsymbol{H_{o1}}$: There is no significant effect of think-pair-share strategy on students' motivation in chemistry class.

$\boldsymbol{H_{o2}}$: There is no significant effect of think-pair-share strategy on students' academic performance in chemistry class.

H_{o3}: There is no significant relationship between students' motivation and academic performance in Chemistry class.

Material and Methods

The positivist research paradigm was followed in this quantitative and experimental study. Following the positivist research paradigm, the deductive technique was used in this study to measure the effect of think-pair-share strategy on the academic performance of chemistry students in district, Lahore.

Research Design

This study was experimental in nature, and quasi-experimental interrupted time series design was implemented to collect students' data. Think-pair-share learning strategy was the independent variable while student's motivation and academic performance were the dependent variables.

Population

The population of this study was all the male students studying Chemistry subject in public colleges at intermediate level in district, Lahore.

Sample

For present study, an intact group of 25 students (boys) studying Chemistry class at the intermediate level in a semi-autonomous higher secondary school in district Lahore was selected through convenience sampling. The age range of the sample was between 17 to 20 years old. As the students in this research study were already intact and could not be separated nor adjusted, therefore, the entire group was used to represent the large population of students studying in this subject.

Research Instruments

For this study purpose, two instruments were used; the first instrument was the "Chemistry Motivation Questionnaire" (CMQ), the adapted form of the Science Motivation Questionnaire (SMQ) developed by Glynn & Koballa (2006) to measure students' motivation to learn Chemistry, and the second instrument was the "Chemistry Performance Test" (CPT) to determine the effect of the intervention strategy on students.

Instrument-1: Chemistry Motivation Questionnaire (CMQ)

The 30-item Science Motivation Questionnaire (SMQ) is a 5-point Likert type scale ranging from 1 (never) to 5 (always). For this study, the Science Motivation Questionnaire (SMQ) was substituted with the word "Chemistry," making it a Chemistry Motivation Questionnaire (CMQ). It was administered before and after the intervention of this experiment to measure the motivation of students for Chemistry

learning and keeping in view the lack of proficiency in English language of Pakistani public college students, this questionnaire was translated into Urdu language which is the native language of this country.

Instrument-2: Chemistry Performance Test (CPT)

The Chemistry Performance Tests (CPT) was designed by the researcher herself to measure the academic performance of students. The pre-test consisted of 20 multiple-choice objective questions, with four options and one correct option from the units taught. Likewise, the posttest consisted of 20 multiple-choice objective questions, each with four options and one correct option. All of these tests (pretests & posttests) were constructed using table of specification and unit wise SLOs covering the six levels of Bloom's taxonomy of educational objectives.

Pilot Study

Pilot study was done on a sample of 70 students from a semi-autonomous girls' college in district Lahore to ensure the validity and reliability of these instruments and seeking expert opinions from the expert teachers and researchers. The researcher also conducted item analysis, item discrimination, difficulty levels and uniformity before conducting these tests in the experimental settings. The construct validity of the motivation questionnaire was measured through factor analysis.

Intervention

The instructor in this study was the researcher herself. The students were oriented on the concept of think-pair-share. The teacher modeled for the students how to select their pair partner according to the serial numbering of the students in the classroom seated arrangement. For the entire treatment period, the serial arrangements were prepared on a chart and placed in the classroom so that students may know who their pairs are for the whole of the treatment exercise. After the brief orientation, the teacher introduced the students to the topic of the first week and challenged them with questions on the objectives of the instruction. The teacher then gave the students a general overview of what they are expected to bring back for their class presentation. To make the lesson organized, the students were given the topic of the lesson a week before the lesson. During each challenge, the students selected a different pair partner. The students would share their answer to the questions with their pairs and formulate answer for each questions. Students presented their answers in an organized manner and prepared to answer the questions in the general class after their presentation. To ensure active participation from all the students, the teacher chose at random, the students to answer the questions for each given lesson. At the end of the lesson, the teacher summarized the correct points of the lessons while correcting students on wrong answers given for the questions posed as a challenging task for the students.

Data Collection

Students' prior knowledge was assessed in the form of pretest. After implementing the activities of this technique, posttest was administered with different multiple choice questions to see the performance of students in the units taught. The whole exercise lasted for six weeks involving one week for pretest and orientation on think-pair-share, four weeks of treatment and one week of revision and posttest. To measure the motivation of students in chemistry course, Chemistry Motivation Questionnaire (CMQ) was conducted once in the initial phase before conducting the intervention and then again after conducting the intervention.

Data Analysis

The instruments were administered as pretest and posttest. The data generated from the tests were organized and analyzed. To find the effect of think-pair-share strategy on students' motivation and academic performance, paired sample t-test was used. Moreover, to find the strength and direction of association that existed between the two variables; motivation and academic performance of students, Pearson product-moment correlation coefficient was used.

Ethical Considerations

Before the intervention, proper permission was taken from the administration of the higher secondary school to conduct the intervention for a specific period of time. The research participants were free to choose to participate without any pressure or coercion. They were allowed to withdraw from or leave the study at any point without feeling an obligation to continue. The participants were provided with relevant information about the study, its duration, and the risks and benefits of taking part in it. The students' personal data was protected as long as for the purpose of this study. The results of this research study were also communicated transparently and honestly to avoid misconduct wherever possible.

Results and Discussion

Table 1
Paired Sample T-test for mean difference of the students' motivation scores

		Paired Differences					*t*	*df*	Sig. (2-tailed)	Cohen's *d*
		M	*SD*	Std. Error Mean	95% Confidence Interval of the Difference					
					Lower	Upper				
Pair 1	Motivation Before - Motivation After	-11.88000	6.11910	1.22382	-14.40584	-9.35416	-9.707	24	$p < .001$	1.86

The effect of think-pair-share strategy on students' motivation was calculated with a paired sample t-test. Based on the data, students' levels of motivation increased significantly from before (M = 116.80, SD = 6.17) to after (M = 128.68, SD = 6.60), t (24) =-9.70. The mean improvement in motivation levels was 11.88, with a 95% confidence range of -14.00 to -9.35. The variations in the means have a p-value of $p < .001$ (2-tailed),

which is significantly less than .05. Hence, the effect size was large with *Cohen's d* = 1.86 (>.80). Because there was seen a statistically significant improvement in students' motivation levels before and after the treatment, the researcher concluded that the null hypothesis could be rejected.

Table 2
Paired Sample T-test for mean difference of the students' academic performance

		Paired Differences					*t*	*df*	Sig. (2-tailed)	Cohen's *d*
		M	*SD*	Std. Error Mean	95% Confidence Interval of the Difference					
					Lower	Upper				
Pair 1	TPS Pretest - TPS Posttest	-9.96000	1.83666	.36733	-10.71814	-9.20186	-27.114	24	$p < .001$	7.36

The Tables 2 showed that the academic performance of students who were taught using the think-pair-share method was analyzed using a paired sample t-test. Students' performance improved significantly from before (M = 7.64, SD = 1.18) to after (M = 17.60, SD = 1.41) as shown by t (24) =-27.11. The mean increase in the performance scores was 9.96 with a 95 % confidence interval ranging from -10.71 to -9.20. The p- value of the mean differences was p < .001 (2-tailed) smaller than p < .05. The value of Cohen's d was 7.36 (> .80) which indicated a large effect size. Thus, the null hypothesis was rejected because the Think-Pair-Share strategy did have an effect on how well students performed in Chemistry class.

Table 3
Relationship between Motivation and Academic Performance of Students

		Motivation	**Academic Performance**
Motivation	Pearson Correlation	1	.589**
	Sig. (2-tailed)		.002
	N	25	25
Academic Performance	Pearson Correlation	.589**	1
	Sig. (2-tailed)	.002	
	N	25	25

**. Correlation is significant at the .01 level (2-tailed).

To measure the linear relationship between students' motivation and performance in Chemistry class, a Pearson product-moment correlation coefficient was calculated as shown in

Table 3. The data showed that the students' academic performance was positively related to their motivation in chemistry subject, as indicated by a statistically significant relationship (r =.59, n = 25, p .01). Thus, the hypothesis was rejected because there was a significant relationship between students' motivation and academic performance in Chemistry class.

Findings

The findings of this study showed that the mean scores of the motivation of students taught through think-pair-share strategy were significantly higher (Mean Difference = 11.88, $p < .05$) than the mean scores of students before the start of the experiment and the mean scores of the academic performance of students taught through think-pair-share strategy were significantly higher (Mean Difference = 9.96, $p < .05$) than the mean scores of students before the start of the activity. Moreover, the results from Pearson correlation revealed a strong, positive and significant relationship between the two variables ($r = .59$, $n = 25$, $p < .01$) indicting that the students' academic performance was associated with their motivation in Chemistry subject.

Discussion

The finding of the study showed that there was significant difference in the mean performance of students taught using think-pair-share strategy. The observed result is because think-pair-share strategy afforded the students opportunity to interact extensively over the learning material. Thus, students who could not understand some aspect of the material on their own, asked and inquired from their peers during the pairing. Also, students shared with the larger class in the likeness of a teacher thereby concretizing what they have learnt. Students' ability to understand the material during the thinking time also helped them to develop skills of scientific thought and may have increased their scientific literacy. Have read, understood and sought assistance, students developed a study pattern that proved effective and therefore had the motivation to further study other materials even on their own and with their pairs. The extra studies facilitated meaningful and deeper learning of the materials and its contents resulting in increased academic performance. This study's use of think-pair-share as a collaborative learning strategy was validated by research indicating that this method of evaluation considerably outperforms the more traditional lecture format in improving students' academic performance in higher education. According to research conducted by Rehman, Nadeem, and Rafiq (2021), entitled "Effect of Think-Pair-Share Teaching Strategy on Understanding the Concept of Science in Students at Elementary Level," this method was found to improve students' ability to learn and retain information, as well as their motivation, reading comprehension, and writing skills, as well as their ability to work together to find solutions to classroom problems. As an added bonus, it encourages more active learning among the pupils.

The findings of the study are in line with that of Furquon (2015) that there was a significant difference in reading comprehension achievement between the students who were taught by using think-pair-share model and those who were taught by using teacher-centered method. The findings of the study also support that of Marvin (2015) that there was significant difference in the posttest academic performance mean scores between the experimental groups (Co Op-Co Op), (Think-Pair-Share) and control group (traditional method). The findings of the study are also in line with that

of Andrew and Alexandria (2015) that students' learning outcomes improved significantly from this strategy of think-pair-share. The findings also support that of Adekunle (2015) that students taught with guided discovery and think-pair-share strategies obtained significantly higher posttest mean scores than those in the lecture strategy. The think-pair-share method was also linked to students and teachers having more chances to practice understanding other people's points of view and to do formative evaluation (Ariana, 2013). The finding of the study also revealed that there was a significant relationship between the mean performance scores and motivation of students in chemistry. Hence, there haven't been many studies on this topic in Pakistan. Such studies are essential to educating educators and students about the importance of motivating factors in teaching and learning. According to prior studies, student motivation is crucial to the teaching and learning of the topic of chemistry. As a result, it would seem that chemistry education needs to be enhanced if a nation is to advance in science and technology.

Conclusion

The conclusion drawn from the findings is that think-pair-share strategy is an effective strategy for the teaching and learning of chemistry concept. The strategy also makes the learning of chemistry more engaging for students. It can also be concluded that when chemistry teachers adopted think-pair-share teaching strategy, the students' academic performance improves enhancing their social and communication skills. Both high achievers and low achievers are proven to benefit think-pair-share strategies used in classrooms increasing their motivation and interest in the subject.

Recommendations

In line with the findings of this study, the following recommendations are made:

- Chemistry teachers should adopt the use of think-pair-share strategy in the teaching and learning of chemistry in order to ensure meaningful learning.
- Workshops and seminars should be organized by school heads to orient chemistry teachers on how to effectively use think-pair-share strategy in the teaching and learning of chemistry.

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