

# Evaluating the Impact of Instructional Strategies on Students' Performance: Statistical Evidence from ANOVA and Tukey's HSD Post Hoc Test



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## Abstract

*This study aimed to evaluate the most effective in-class instructional strategies that enhance the academic performance of pre and post-graduate students in Karachi, Pakistan. It reviewed the three instructional strategies, including the Lecture-Based Instructional Strategy, Activity-Based Instructional Strategy, and Constructivist Instructional Strategy. The targeted population of the study was comprised of the pre and post-graduate students currently enrolled in various public-sector universities in Karachi. The achieved scores for writing and reading English text from the students were measured along with the implemented instructional strategies in their classes. The findings reveal that the academic performance of pre and post-graduate students, in terms of writing and reading English text, differs based on the various in-class instructional strategies (teacher-centred, activity-based and constructivist). Since the constructive method was found to be producing the highest writing and reading scores, significantly outperforming both traditional lecturer-based and activity-based methods, the study recommends that teachers and curriculum developers consider the constructive instructional method.*

## Keywords

*Activity-Based Instructional Strategy*

*ANOVA and Post Hoc Tests*

*Constructivist Instructional Strategy*

*Lecture-Based Instructional Strategy*

*Students' Performance*

## INTRODUCTION

Educational outcome reflects the quality of instructional strategies used in a classroom setting. In the last several decades, the educational standards have been considerably changed, as the traditional models of teacher-centred instructional approaches have been substituted by the student-centred interactive and inquiry-based approaches (Alam, 2023; Helmke, et al., 1986). This change has been influenced by the increased appreciation of active student learning, critical thinking and collaborative learning as essential in enhancing academic performance. Nevertheless, with all these developments, the success of various teaching methodologies still differs among the teaching environments, especially in developing nations where the contextual factors can affect the learning results (Warsah, et al., 2021). Ahmad et al. (2022) define the instructional strategy as a systematic and organized way that teachers use to put together content delivery, classroom teaching, assessment, and learning activities.

The traditional lecture-based instructional strategy, also known as teacher-centred approach, is mostly focused on the transfer of knowledge between the teacher and the student, which leads to passive learning (Kay, et al., 2019). The activity-based learning, on the other hand, promotes student engagement, achieved by involving students in practical activities, discussions, and problem-solving activities, promoting a deeper comprehension (Naik et al., 2024). The constructivist instructional strategy goes further to reinforce this idea by stating the active role of learners to build knowledge based on previous experiences, social interaction, and reflection (Mishra, 2023). According to Kozanitis and Nenciovici (2023), the instructional strategies can be a significant limitation to the students' performance in academics. In the context of Pakistan, where all the instructional strategies (including the traditional lecture-based, the activity-based, and the constructivist instructional strategies) are being implemented, it is of utmost importance to understand the most effective instructional strategy.

## Objectives of the Study

- To test the impact of various instructional strategies in classroom (teacher-centred, activity-based and constructivist) on the academic performance of pre and post graduate students.
- To determine the most effective instructional strategies that enhance the academic performance of pre and post graduate students.

## Research Questions

- What is the impact of different in-class instructional strategies on the academic performance of pre

and post graduate students?

- Which in-class instructional strategy (among teacher-centred, activity-based and constructivist) is most effective in enhancing the academic performance of pre and post graduate students?

### **Research Gap and Motivation for the Present Study**

Although there has been a lot of research studies conducted on the methods of teaching, the results are not consistent because of the contextual differences which include the size of classes, the subject being taught, competence of the teacher and the resources provided by the institution. In addition, a very few numbers of research studies have compared the traditional teaching methods, activity-based teaching methods and constructivist teaching methods in one study through the application of powerful statistical methods like ANOVA and post-hoc methods (Sezuo, 2022; Merrill, 2008). Hence empirical studies that are controlled should be conducted in order to establish the comparative efficacy of these pedagogical approaches. Because of these different results, researchers are calling out to more systematic and controlled studies. Properly constructed research with the proper statistical tools like ANOVA can be used to determine the actual effect of the teaching methods and minimize the effect of other factors.

### **Significance of the Study**

The findings of the present study would be evidence for teachers in Pakistani context on the effectiveness of various instructional strategies. The findings would assist them to adopt the most effective strategy for their teaching practices. The findings would also assist the curriculum designers to come up with modern and effective curriculum in line with effective instructional strategies.

## **LITERATURE REVIEW**

The methods of teaching are considered very crucial in learning and academic achievement of students (Diseth, 2007). The manner in which, a teacher conveys the materials, engages the students and controls the classroom activities, has a significant influence on the ability of the students to comprehend the concepts as well as their knowledge application (Harvey & Goudvis, 2007). In the course of time, the issue of whether the traditional teaching methods could be applied to the learners of the present-day generation has become the concern of educators and researchers, particularly, as the modern education is associated with critical thinking, creativity, and participation (Fishman, et al., 2016). From this perspective, Andreucci-Annunziata (2023) discuss

### **Traditional Lecture-Based Instructional Strategy and Its Limitations**

The conventional way of teaching by lecturing is long applied in schools and universities. In this approach, the instructor tends to do most of the speaking during the lesson, and the students listen and make notes (Abdel Meguid & Collins, 2017). Despite the fact that this method may be used to address a huge syllabus within a limited period of time, most researchers are of the view that it fails to engage students in the learning process (O'Brien, et al., 2009). Students who are passive might not be able to think critically and pose questions or to relate new information to their prior knowledge (Peled, et al., 2020). This has the effect of making learning a simple memorization as opposed to understanding. The other significant weakness of teaching through lectures is that it is not effective in meeting the needs of various learning styles. Learners have varied ways of learning, some people prefer to see images, others to hear and others to be involved in practical tasks (Pashler, et al., 2008). The traditional lectures are primarily based on listening, and this might not be appropriate to all learners. This has the effect of making many students not grasp the concepts well and they might not take the subject seriously (Miller, et al., 2013). Researchers claim that this type of superficial learning may have adverse impacts on the retention and academic achievements in the long-term perspective (Farr, 2012).

### **Students-Centred Teaching Approaches: Activity-Based and Constructivist Models**

To eliminate the constraints, learner-centred models of teaching like constructivist and activity-

based models have become a focus. The approaches are founded on the fact that students learn more when they are actively involved in the process (Keengwe, et al., 2009). Students do not passively receive information, but rather, they build knowledge by means of discussions, group work, problem-solving activities, projects, and practical activities. The role of the teacher in such classrooms is more of a guide or a facilitator and not a source of knowledge. Learner-centred teaching methods have proven to bring about positive results in the case of many studies (Darsih, 2018). Studies show that students who are taught activities and the interactive method usually perform better in school than those who are taught using the traditional lectures. Such students are also more likely to acquire more skills in solving problems and have greater motivation in learning (Miller, et al., 2013). Students feel more in control, interested and in charge of their own learning and thus perform better when they are actively engaged.

## Comparative Studies

A number of studies have indicated significant differences in achievement scores of students with preference on interactive and activity-based teaching. From this perspective, the results of the study conducted by Thomas (1997) indicate that the learning outcomes of students can be influenced by the teaching strategies in a measurable way, but not all the studies can show the same. According to some researcher, the teaching method could be effective in one context of learning, and not in another. The success of a teaching method may be affected by factors like the size of the classroom, the subject, the experience of the teacher and the resources at his disposal. In other words, activity-based learning can be more efficient in smaller classes where teachers can easily control the group activities and offer attention. When the classes are large, one might not be able to engage every student (Exeter et al., 2010). The topic under instruction is also significant, although learner-centred approaches have been effective in certain courses such as science and social studies, they might not be effective when dealing with courses where a lot of theoretical description is involved. The second important factor is teacher knowledge because the application of the activity-based methods involves appropriate training, planning, and managing the classroom (Nageen, et al., 2023). Such methods might fail to give the intended results without proper preparation.

## Contextual Modifying Factors of the Teaching Methods Effectiveness

The success of teaching methods is also influenced by institutional resources. Activity based learning usually demands such teaching materials, technology, and accommodating classroom conditions. Teachers in institutions that lack resources might encounter difficulties in the implementation of these methods (Caleb, 2024). This is possibly the reason why other researchers have depicted mixed or weak results on innovative teaching methods.

## Theoretical Framework

The constructivist learning theory (Von Glasersfeld, 2012), student-centred learning theory (Trester, 2019), and theory of active learning (Hanneke, 2014) are the theoretical bases of this study. As discussed by Von Glasersfeld (2012), the constructivist theory focuses on the experience of learners as active builders of knowledge by means of interaction with the environment, past experiences, and social cooperation instead of being passive receivers of information. In this respect, it is more probable that the teaching methods which foster exploration, discussion and reflection can support meaningful learning and academic progress. The learning theory centred on the students also justifies this perception since it reverses the direction of teaching away the teacher and towards the student. A student-centred classroom has learners who actively engage in the learning process and responsible of their understanding as they take part in inquiry based and collaborative learning. These strategies are linked to the high motivation, interest, and enhanced thinking, which have a positive effect on academic achievement. The current research is also supported by the active learning theory which emphasizes the significance of involving the learner by use of activities like problem solving, group work and real-life applications. It is proposed that active learning strategies enhance better academic performance and development of higher order thinking skills as opposed to the lecture delivered teaching approach. These theoretical views combined

constitute a solid basis of the analysis of the impact of various teaching methodologies on the academic performance of the students.

## Conceptual Framework

The conceptual structure of this study shows the connection between instructional practices and academic achievement of students. The independent variable is the instructional strategies including the traditional lecture-based instructional strategy, the activity-based learning, and the constructivist instructional strategy. The dependent variable, on the other hand, is the academic performance of pre and post graduate students.

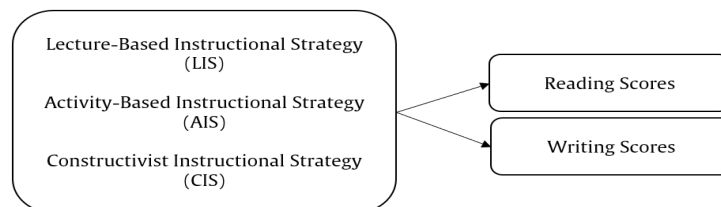


Fig. 1. Conceptual Framework

H<sub>1</sub>: The academic performance in terms of writing English text of pre and post graduate students is different on the basis of various instructional strategies in the classroom (teacher-centred, activity-based and constructivist)

H<sub>1.1</sub>: Teacher-centred instructional strategy is better than the other strategies for teaching writing English text

H<sub>1.2</sub>: Activity-based instructional strategy is better than the other strategies for teaching writing English text

H<sub>1.3</sub>: Constructivist instructional strategy is better than the other strategies for teaching writing English text

H<sub>2</sub>: The academic performance in terms of reading English text of pre and post graduate students differs based on the various instructional strategies (teacher-centred, activity-based and constructivist)

H<sub>2.1</sub>: Teacher-centred instructional strategy is better than the other strategies for teaching reading English text

H<sub>2.2</sub>: Activity-based instructional strategy is better than the other strategies for teaching reading English text

H<sub>2.3</sub>: Constructivist instructional strategy is better than the other strategies for teaching reading English text

## METHODOLOGY

The research strategy adopted for the present research study was exploratory in nature using quantitative approach, a cross-sectional survey design was used to conduct the research. The study was conducted using descriptive strategy following a quantitative approach. The researcher adopted survey design to gather the data from the pre and post graduate students currently enrolled in various public-sector universities in Karachi. In other words, the targeted population of the study was comprised of the pre and post graduate students currently enrolled in various public-sector universities in Karachi. A simple random sampling technique was adopted to select the participants; however, the sample size was 1000. According to Noor et al. (2022), the simple random sampling is a foundational probability method where every member of a population has an equal, independent chance of being selected for a study. This technique eliminates researcher bias by using random selection processes, such as lottery draws

or random number generators, ensuring a highly representative sample. The only inclusion criterion for the sample selection was to be a pre and post graduate students currently enrolled in any public-sector university in Karachi.

The data collection method in this research was primary through a predesigned questionnaire with close-ended items. The questionnaire had two segments including a) the demographic information of the participants and b) their achievement scores and the implemented in-class instructional strategy by their teachers. The second segment of the questionnaire was based on the study variables including the in-class instructional strategy, Lecture-Based Instructional Strategy (LIS), Activity-Based Instructional Strategy (AIS), and Constructivist Instructional Strategy (CIS), and the students' performance (their achieved scores) in reading and writing of English text. The collected data was using a statistical package well-known as Statistical Package for the Social Sciences (SPSS) by applying descriptive statistics and inferential analysis (Sun, 2019; Marshall & Jonker, 2011; Ramdani, 2025). The test of significant differences in average scores of students' academic achievements based on the groups associated with the instructional strategies was performed with ANOVA. Before running ANOVA, it was checked whether the assumptions of normality and homogeneity of variance were satisfied. In the cases where the ANOVA results were significant, Tukey's post-hoc multiple comparison tests were used to identify group differences.

## RESULTS & FINDINGS

### Descriptive Statistics

The demographic information of the participating students includes their gender, their age group, their enrolled academic discipline, their enrolled academic programme, and their employment status. From this perspective, the number (frequency) of the male participants was 475 that made 47.5 per cent. The number (frequency) of the female participants was 525 that made 52.5 per cent. The number (frequency) of participants from the age group of 26-30 was 316 that made 31.6 per cent, from the age group of 31-35 was 422 that made 42.2 per cent, from the age group of 35-40 was 124 that made 12.4 per cent, and the participants aged 40 or more were 138 that made 13.8 per cent. The number (frequency) of the participants enrolled in the academic discipline of Sociology was 166 that made 16.6 per cent, enrolled in the academic discipline of Arts & Humanities was 229 that made 22.9 per cent, enrolled in the academic discipline of Political Science & International Relations was 204 that made 20.4 per cent, enrolled in the academic discipline of Economics was 161 that made 16.1 per cent, and enrolled in the academic discipline of Psychology was 240 that made 24.0 per cent. The number (frequency) of participants enrolled for Associate Degree was 472 that made 47.2 per cent, enrolled for Bachelor's Degree was 256 that made 25.6 per cent, enrolled for Master's Degree was 143 that made 14.3 per cent, enrolled for MS/M.Phil. Degree was 126 that made 12.6 per cent, and enrolled for Ph.D. Degree was 3 that made 0.3 per cent. The number (frequency) of employed participants was 522 that made 52.2 per cent and unemployed participants was 478 that made 47.8 per cent (Table 1).

**Table 1**  
Demographic Information of Participating Students

	Variables	Frequency	Percent
<b>Gender</b>	Male	475	47.5
	Female	525	52.5
<b>Age Group</b>	26-30	316	31.6
	31-35	422	42.2
	35-40	124	12.4
	40+	138	13.8
<b>Academic Discipline</b>	Sociology	166	16.6
	Arts & Humanities	229	22.9
	Political Science & International Relations	204	20.4
	Economics	161	16.1
	Psychology	240	24.0
<b>Academic Programme</b>	Associate Degree	472	47.2
	Bachelor's Degree	256	25.6
	Master's Degree	143	14.3
	MS/M.Phil.	126	12.6
	Ph.D.	3	0.3
<b>Employment Status</b>	Employed	522	52.2
	Unemployed	478	47.8
<b>Total</b>		1000	100.0

**Inferential Analysis**

A one-way Analysis of Variance (ANOVA) was conducted to examine if there were a statistically significant differences in the achieved scores of writing and reading English text within the three differently in-class implemented instructional strategies. From this perspective, the ANOVA results show a statistically significant difference in writing scores by implementing the three different instructional strategies,

$$F(2, 997) = 223.77, p < .001.$$

This confirms that the mean score of writing English for at least one group score is significantly different from the others.

The effect size (Eta Squared,  $\eta^2$ ) was:

$$\eta^2 = \frac{16038.431}{51767.975} = 0.310$$

This is also a large effect size, indicating that approximately 31.0% of the variance in writing scores is attributable to group differences (Table 2). The result supports the  $H_1$  i.e. the academic performance in terms of writing English text of pre and post graduate students differs based on the various in-class instructional strategies (teacher-centred, activity-based and constructivist).

The ANOVA results, on the other hand, indicate a statistically significant difference in the reading scores by implementing the three different instructional strategies,

$$F(2, 997) = 229.78, p < .001.$$

This confirms that the mean score of reading English for at least one group score is significantly different from the others.

The effect size (Eta Squared,  $\eta^2$ ) was calculated as:

$$\eta^2 = \frac{SS_{between}}{SS_{total}} = \frac{16918.481}{53622.844} = 0.316$$

This is also a large effect size, indicating that approximately 31.6% of the variance in reading scores is attributable to group differences (Table 2). The result supports the  $H_2$  i.e. the academic performance in terms of reading English text of pre and post graduate students differs based on the various in-class instructional strategies (teacher-centred, activity-based and constructivist).

**Table 2**  
One-Way ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Writing Score	Between Groups	16038.431	2	8019.216	223.77	.001
	Within Groups	35729.544	997	35.837		
	Total	51767.975	999			
Reading Score	Between Groups	16918.481	2	8459.240	229.778	.001
	Within Groups	36704.363	997	36.815		
	Total	53622.844	999			

This represents a large effect size, indicating that about 31.6% of the variance in reading scores is explained by group differences (Table 2). The results of One Way ANOVA demonstrate that the three different instructional strategies have a substantial impact on both reading and writing performance of the pre and post graduate students. However, ANOVA does not indicate which specific groups differ. Therefore, post hoc test (Tukey HSD) was conducted to identify pairwise group differences (Table 3). In other words, a Tukey HSD post hoc test was conducted following the one-way ANOVA to determine which instructional strategies significantly was different in writing and reading scores. The results show three distinct homogeneous subsets; for instance, the mean writing and reading scores for the traditional lecture-based teaching were 69.35 and 69.95, the mean writing and reading scores for the activity-based teaching were 74.41 and 75.60, and the mean writing and reading scores for the constructive teaching were 79.17 and 79.99. Each instructional strategies appears in a separate subset, indicating that traditional lecturer-based produced significantly lower writing and reading scores than both activity-based and constructive methods. Activity-Based method produced significantly higher writing and reading scores than traditional lecturer-based but significantly lower scores than the constructive method. The Constructive method produced the highest writing and reading scores, significantly outperforming both traditional lecturer-based and activity-based methods. Since none of the strategy shares the same subset, all pairwise differences were statistically significant at  $p < .05$ .

**Table 3**  
Post Hoc (Tukey HSD)

Instructional Strategies	N	Subset for alpha = 0.05		
		1	2	3
Writing Score	Traditional	354	69.35	
	Activity Based	334		74.41
	Constructive	312		79.17
	Sig.		1.000	1.000
Reading Score	Traditional	354	69.95	
	Activity Based	334		75.60
	Constructive	312		79.99
	Sig.		1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 332.447.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

The results of Post Hoc (Tukey HSD) support  $H_{1,3}$  (i.e. Constructivist in-class instructional strategy is better than the other strategies for teaching writing English text) and  $H_{2,3}$  (i.e. Constructivist in-class instructional strategy is better than the other strategies for teaching reading English text). The rest of the hypotheses including  $H_{1,1}$ ,  $H_{1,2}$ ,  $H_{2,1}$ , and  $H_{2,2}$  were not supported respectively.

## Discussion

The results of this study demonstrate that the three different instructional strategies have a significant and substantial impact on both reading and writing performance. The findings are aligned with the reviewed literature. For instance, Miller, et al., (2013) found that students who are taught using activities and the interactive method usually perform better in school than those who are taught using the traditional lectures. Such students are also more likely to acquire more skills in solving problems and have greater motivation in learning. Pashler, et al., (2008) found the significant weakness of teaching through lectures that it is not effective in meeting the needs of various learning styles. Learners have varied ways of learning, some people prefer to see images, others to hear and others to be involved in practical tasks. The findings of the present study are also supported by its theoretical framework i.e. the constructivist learning theory, as discussed by Von Glasersfeld (2012), which focuses on the experience of learners as active builders of knowledge by means of interaction with the environment, past experiences, and social cooperation instead of being passive receivers of information. Therefore, it is more probable that the teaching methods which foster exploration, discussion and reflection can support meaningful learning and academic progress (Von Glasersfeld, 2012).

## CONCLUSION

The research contains a strong empirical data on the relative efficacy of various teaching approaches in affecting the academic performance of students. The study used Analysis of Variance (ANOVA) and Tukey post-hoc test to include a large population of students and thus concluded that the teaching methodology is a decisive factor in determining the learning outcome of students. It was found that statistically significant differences existed between Traditional, Activity-Based, and Constructivist teaching approaches. The results indicated that the constructivist instructional approach had the highest academic performance, then the Activity-Based method and the lowest level of performance was recorded with the Traditional lecture-based method. Such differences were not merely observed in the average scores of achievements but also justified statistically and all the null hypotheses were rejected. The findings are very much based on the theoretical frameworks of constructivist, active learning and student-centred learning theories, which highlight the importance of learner activity, interaction and knowledge construction in the process of effective learning. One of the strengths of this research is the fact that it has provided a qualitative comparison of three major teaching methodologies under one analytical framework. In contrast to previous studies which tended to concentrate on narrow comparisons of instruction, this research offers clear and statistically sound facts in support of the learner-centred pedagogies. The results share implications on the classroom practice, curriculum development, and educational policy, especially facilitating instruction approaches that lead to greater understanding and increased student academic performance.

### *Recommendations*

According to the findings, it is suggested that teachers should embrace the use of Constructivist and Activity-Based instructional model to improve student engagement, critical thinking, and academic achievement. The educators ought to incorporate the cooperative learning, inquiry learning, problem-solving activities, and real-life application in their teaching practices as opposed to employing only lecture teaching methods. Revision of the curriculum structures should incorporate the learner centred exercises, interactive work and project-based learning elements to the curriculum structure. The schools and education administrators should promote professional development initiatives that equip teachers with skills on how to effectively apply the constructivist and activity-based instructional method. Also, these methodologies should be matched with the assessment systems; particular performance-based evaluations that involve projects, presentations and reflective assessment are required.

### *Limitations*

This study is not without limitations. The sample was selected in the formal learning institutions in a

given context and this can reduce the applicability of the results to other parts or educational systems. In addition to this, academic performance was assessed in terms of achievement scores which might not capture all other learning outcomes like creativity, problem solving ability or long-term knowledge acquisition. The research also failed to consider moderating variables subject area, teacher experience, class size, or access to instructional resources, which can affect the efficacy of the instructional practices. Moreover, the research has a limitation of studying the long-term effects of the teaching methods on student achievement because of the cross-sectional nature of the research.

### Future Directions

The effectiveness of teaching methodologies should be investigated in the future in various subjects, levels of education, and learning settings so that the research findings can be more generalized. It is suggested that longitudinal studies are required to examine the effect of constructivist and activity-based teaching methods on academic performance and skill development in the long term. Additional research could also investigate the relationship between teaching practices and other aspects like student motivation, learning styles, teacher competency and institutional resources. The use of mixed-method research designs that would integrate quantitative analysis with qualitative classroom observations and interviews may be able to shed more light on the systems under which learner-centred teaching practices might enhance the learning outcomes of learners.

### Competing Interest

The authors declared no conflict of interest.

### Authors' Biography

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