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Man's Approach: A Teaching Innovation Improving Students' Performance in Partial Fraction Decomposition

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Abstract:
Background*: Innovative teaching is one of the highlights of mathematics education in the twenty-first century. In this context, the study examined how Man's approach, an innovative teaching approach, affected the partial fraction decomposition performance (PFD) of engineering students enrolled in the Differential Equations course at the Jose Rizal Memorial State University's Main Campus in Dapitan City, Zamboanga del Norte, during the first semester of the academic year 2022–2023.*
Materials and Methods*: The Pretest - Posttest Nonequivalent Group Design was used in the study as a quasi-experimental method. The traditional PFD approach, which is the method of undetermined coefficients, was presented to the control group, the BSCE-II Block B class of 29 students. The 42 students in the BSCE-I Block A, the experimental group, underwent the procedure using Man's method to solve PFD. The pretest and posttest performance of the student participants in both groups was assessed using a modified questionnaire. The primary statistical methods applied in the study were the arithmetic mean, standard deviation, t-test for independent samples, t-test for correlated samples, and Cohen's d.*
Results*: While the method of undetermined coefficients and Man's approach greatly improved students' PFD performance, Man's approach did so more dramatically than the method of undetermined coefficients.*
Conclusion:*The Man's approach and the undetermined coefficients method substantially improve students' PFD performance, while the latter does it more effectively. Man's approach can thus be used to teach partial fraction decomposition instead of or in addition to the method of undetermined coefficients.*
Key Word*:Innovative Teaching; Teaching Approaches; Partial Fraction Decomposition.*

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I. Introduction

Several methods for improving the conventional problem-solving procedures that the public has long been exposed to and used have emerged as the globe transitions towards a research-centric period. To further simplify the algorithms for performing partial fraction decomposition (PFD) and subsequently provide an alternative to the conventional method of undetermined coefficients, which was observed to be a topic that most students still struggle with, a few research-based PFD methods have been developed recently. Man's approach is one of the PFD techniques that have been created. With this, Man's approach can help students perform better on PFD tests.

In answer to the challenges students were having with differentiation, systems of linear equations, and algebraic manipulation, Man initially proposed his PFD approach in 2007 (Man, 2007; Ling &Vui, 2021). The PFD coefficients of partial fractions with single poles were found using Heaviside's cover-up technique, and partial fractions with multiple poles were determined using fundamental polynomial division (Man, 2007). After this approach's publication, Man (2012) investigated how it might be used in the undergraduate mathematics curriculum. He discovered that it is a good substitute for the method of undetermined coefficients, as shown by the students' better performance.

Compared to the method of undetermined coefficients, other authors have looked at how well Man's approach enhances students' PFD performance. The PFD of proper rational functions with distinct linear factors, repeated linear factors, and irreducible quadratic factors in the denominator can be found using Man's approach. According to the results of Ling and Vui's(2021) study, students who used this method performed better than those who used the method of undetermined coefficients. Similar findings were discovered in another study by Man and Leung (2012), who revealed that students' PFD performance with Man's approach was on par with or even much better than that when using the method of undetermined coefficients.

Contrarily, even if most students responded favorably to Man's PFD technique, many of them felt that it was more challenging than the undetermined coefficients method, which they preferred to study first since they found it simpler and more manageable (Man & Leung, 2012). Unarguably, the method of undetermined coefficients is still the most frequently used PFD approach in institutions of higher learning, notwithstanding the good responses documented by current studies about Man's approach (Bauldry, 2018; Khere et al., 2020; Ling &Vui, 2021). Jose Rizal Memorial State University (JRMSU), notably the College of Engineering, is one of the many educational institutions still adopting the method of undetermined coefficients, as evidenced by their respective course syllabi, learning modules, and reference materials. The mathematics teachers at the college may be viewed as traditional or simply unfamiliar with Man's approach because they used a conventional way of teaching.

According to Agarwal, Buccioni, von Manteuffel, and Tancredi (2021), PFD is important because it offers algorithms for many calculations involving rational functions, including the explicit computation of antiderivatives, Taylor series expansions, inverse Z-transforms, and inverse Laplace transforms. Research has shown that Man's approach is more successful than the method of undetermined coefficients at helping students do better on PFDs (Ling &Vui, 2021). In addition to being one of the respected subjects in engineering licensure examinations, mathematics is an essential component of engineering education (Ignacio, 2016), as it is thought to be the core of the program's primary functions, which include building and designing (Tolbert &Cardella, 2017; Winkelman, 2009). Therefore, any method for raising engineering students' proficiency in mathematics or any related subject would be beneficial in maximizing their potential.

Considering the underlying facts, the researcher intended to investigate if Man's approach could significantly enhance the PFD performance of engineering students at JRMSU. Specifically, the researcher employed the undetermined coefficients method and Man's approach to engineering students at JRMSU to examine how the tools would affect their performance in solving the PFD of proper rational functions. Moreover, in addition to the three cases explored by existing studies, such as the distinct linear factor, repeated linear factor, and irreducible quadratic factor, the researcher also intended to extend its investigation to the fourth case, the repeated irreducible quadratic factor, as the exciting feature of the study. The study expected to holistically determine how the method or approach would fare with the students across all cases.

Theoretical Framework of the Study

The Experiential Learning Theory of Kolb (1984), which holds that "learning is the process whereby knowledge is formed through the transformation of experience," served as the foundation for this study. There are two parts to Kolb's idea. The first is that there is a four-stage cycle to learning. Kolb contends that for successful learning, students must go through all the stages and turn their experiences into knowledge.

The second element focuses on the cognitive processes used to acquire knowledge or the so-called learning styles. Kolb believed that by applying abstract ideas to novel circumstances, people might demonstrate their knowledge or the learning that occurred (Kurt, 2020).

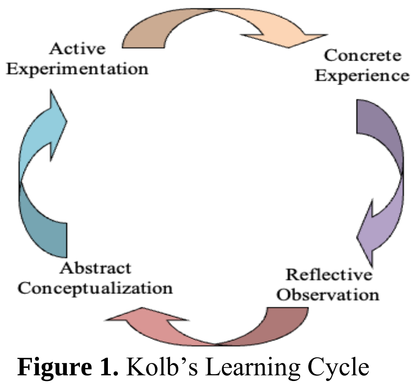

Figure 1. Kolb's Learning Cycle

The four learning stages that Kolb identified in his theory—concrete experience, reflective observation, abstract conceptualization, and active experimentation—are depicted in Figure 1. A completely new experience or a reimagined version of a current event is both concrete experiences. Each student participates in a task or activity the teacher provides during this phase. Kolb asserts that participation is essential to learning, as mentioned in Kurt (2020). Simply reading about it or seeing it in action is insufficient for students. Instead, to learn new information, students must actively engage in the work. The learner steps back after participating in the experience to consider the assignment.

The subsequent stage, known as reflective observation, officially starts with this occurrence. The learner can ask questions and discuss experiences with others throughout this learning process. Abstract conceptualization is the third level. It entails explaining what happened in stage two. The learner attempts to conclude the experience by reflecting on existing knowledge, applying familiar concepts, or debating viable theories with peers. The learner transitions from introspective observation to abstract conceptualization when they start categorizing concepts and making judgments about what transpired. It means examining the incident and making comparisons to their current understanding of the concept. Learners can evaluate new information and modify their results based on previously held beliefs since concepts do not need to be novel.

Active experimentation represents the last level of Kolb's learning process. It is regarded as the cycle's testing phase. Returning to a task, students attempt to apply what they have learned to new circumstances. They can make predictions, analyze assignments, and make future goals based on what they have acquired. Anyone can start at any point in the cycle because Kolb's learning theory is cyclical. The cycle should be followed through to the end to guarantee that real learning has taken place. Each step is connected to the next and needs to be finished to learn anything new (Kurt, 2020).

Although the stages function as a whole to create a learning process, specific individuals could favor some stages over others. For instance, some people spend more time in active and tangible stages than abstract ones. The learning styles, the second element of Kolb's experiential learning theory, were born out of this condition. Kolb distinguishes four different learning methods, including accommodating, diverging, assimilating, and converging, based on his four-stage learning cycle. According to Kolb's learning cycle stages, Figure 2 illustrates how each learning style supports and functions.

Diverging learning styles dominate the regions of concrete experience and reflective observation. People with this learning style are particularly adept at grasping the broad picture and connecting seemingly unrelated pieces of knowledge to make a logical whole. Divergers are expressive and imaginative, and they love to generate new ideas. Converging learning style, on the other hand, is prevalent in the opposite fields - abstract conceptualization and active experimentation. The ability to put concepts into practice is a strong suit of convergers. The assimilating learning style dominates reflective observation and abstract conceptualization. Assimilators' capacity for understanding and developing theoretical models is one of their most valuable traits. They are less interested in how theories are put into practice but more in abstract ideas than in actual individuals.

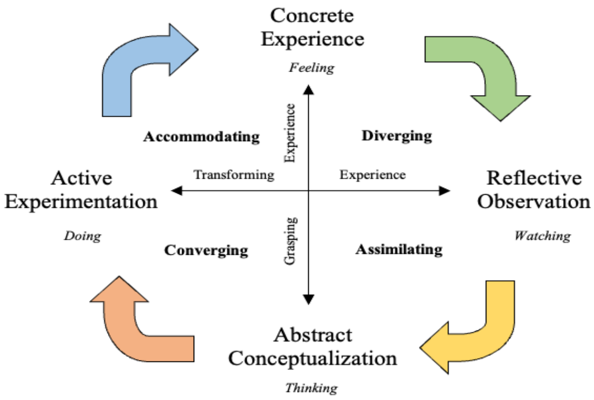

Figure 2. Kolb's Learning Styles

II. Material and Methods

This study used a quasi-experimental research design with the pretest-posttest nonequivalent groups design to achieve the study's objectives. Following the procedure, the study used two intact groups as experimental and control groups. A treatment (experimental) group was given a pretest, a treatment (Man's approach), and a posttest. Similarly, a control group was also given a pretest and a posttest. However, in between the conduct of the said tests, the control group received the treatmentbut was instead exposed to the traditional approach (Method of Undetermined Coefficients). The quasi-experimental research design was appropriate for this study since the researcher wanted to investigate if Man's approach can significantly improve engineering students' PFD performance more than the traditional approach.

The subjects of the study were the second-year engineering students enrolled in the Math 211 (Differential Equations) course for the First Semester of the Academic Year 2022-2023. Using the lottery method, the researcher chose two sections of the course at random to constitute the control and experimental groups of the study. He also considered the entry competency shown in each subject's report card to determine the degree of similarity in features between individuals from each group. Another lottery method was employed to determine the group exposed to traditional teaching and Man's approach.

Table 1. The Subjects of the Study

Group	Number of Students Enrolled	Percentage
Second Year BS Civil Engineering Block A (Experimental)	42	59.15%
Second Year BS Civil Engineering Block B (Control)	29	40.85%
Total	**71**	**100%**

The corresponding author facilitated the control and experimental groups of the study based on their class schedules.Figure 3 shows the process that was employed in this study. As illustrated, the control and experimental groups took the pretest (X1 and Y1) prior to the treatment. After conducting the pretest, the students in the control group were taught about partial fraction decomposition using the traditional teaching method. In contrast, the experimental group was taught about partial fraction decomposition using Man's approach. After the treatment, both groups were given a posttest (X2 and Y2).

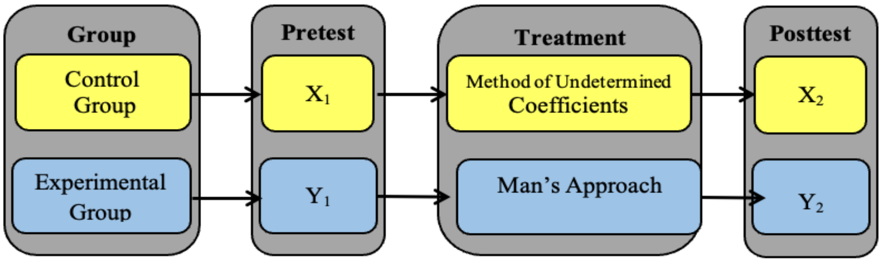

Figure 3. The Research Process

This study was conducted during the middle term of the First Semester of the Academic Year 2022-2023. The corresponding author, the class instructor, facilitated the control and experimental groups of the study based on their class schedules.

Table 2. Matrix of Activities for the Control and Experimental Groups

Class Session	Topic	Objectives	Time Allotted	Strategy: Experimental Group	Strategy: Control Group
1 October 17, 2022		Pretest (Experimental and Control)	1 ½ hours		
2 October 19, 2022	Partial Fraction Decomposition: Distinct Linear Factor and Repeated Linear Factor	1. Solve the PFD of proper rational functions with distinct linear factor in the denominator	½ hour	Man's Approach	Traditional Approach
		2. Solve the PFD of proper rational functions with repeated linear factor in the denominator	½ hour		

3 October 24, 2022	Partial Fraction Decomposition: Irreducible Quadratic Factor and Repeated Irreducible Quadratic Factor	1. Solve the PFD of proper rational functions with irreducible quadratic factor in the denominator	½ hour	Man's Approach	Traditional Approach
		2. Solve the PFD of proper rational functions with repeated irreducible quadratic factor in the denominator	½ hour		
4 October 26, 2022		Posttest (Experimental and Control)	1 ½ hours	Man's Approach	Traditional Approach

The research instrument utilized in the study was the pretest/posttest questionnaire extracted from the study of Ling and Vui (2021) titled "Exploring Two Methods of Partial Fraction Decomposition on Students' Performance." This adapted instrument was made up of questions on proper rational function, specifically under the categories of distinct linear factors in the denominator, repeated linear factors in the denominator, and irreducible quadratic factors in the denominator. However, the researcher provided an additional item to the test covering the fourth case, repeated irreducible quadratic factors, since the questionnaire was limited solely to the three PFD cases.

The questionnaire was composed of three questions, one from each of the first three cases of PFD: distinct linear factor, repeated linear factor, and linear quadratic factor. The questions were adopted from UniversitiTeknologi MARA's Item Bank System (IBS), a computerized collection of test items designed using an assessment specification table compliant with the requirements of the Ministry of Education and the guidelines of their university. To further ensure the questionnaire's quality, validity, reliability, fairness, and consistency, the instrument was further reviewed by an experienced Resource Person (RP). It was revised according to his feedback (Ling &Vui, 2021). As for the additional item for the repeated irreducible quadratic factor, the question was referred to the researcher's adviser and mathematics instructors of the College of Engineering. To further extend the validity and reliability of the instrument to the chosen research environment, the questionnaire was also pilot-tested to other engineering students in JRMSU Dapitan Campus.

Students' PFD performance in the pretest and posttest of the control and experimental groups was based on their obtained scores. Each item in the test was marked using the modified scoring rubric for PFD, adapted from Man and Leung's (2012) study.

Table 3. Scoring Rubric

	4	**3**	**2**	**1**	**0**
Accuracy in calculations		High (90-100% of the calculations are correct.)	Average (75-90% of the calculations are correct.)	Low (Less than 75% of the calculations are correct.)	No answer (No attempt at solving the problem.)
Number of correct PFD coefficients		No mistake (All PFD coefficients are correct.)	1 mistake (One PFD coefficient is incorrect.)	2-3 mistakes (Two or three PFD coefficients are incorrect.)	No answer (No attempt at solving the problem.)
Mastery of the method concerned	Excellent (90-100% of the steps are correct.)	Very Satisfactory (85-89% of the steps are correct.)	Satisfactory (75-84% of the steps are correct.)	Unsatisfactory (75% of the steps are correct.)	No answer (No attempt at solving the problem.)

The following scores and their corresponding verbal description were used to describe the students' overall pretest and posttest performance in the control and experimental groups.

Range of Score (40 points)	Description
32.01 – 40.00	Excellent
24.01 – 32.00	Very Good
16.01 – 24.00	Good
8.01 – 16.00	Fair
0.00 – 8.00	Poor

To describe the pretest and posttest performance of the students in the control and experimental groups along the PFD topics: distinct linear factor, repeated linear factor, irreducible quadratic factor, and repeated irreducible quadratic factor having ten (10) items, the following range of scores and its corresponding verbal description was used.

Range of Scores (10 points)	Description
8.01 – 10.00	Excellent
6.01 – 8.00	Very Good
4.01 – 6.00	Good
2.01 – 4.00	Fair
0.00 – 2.00	Poor

The arithmetic mean, standard deviation, t-test for independent samples, t-test for correlated samples, and Cohen's d were the main statistical techniques used in the study.

II. Results and Discussion

Table 4. Pretest performance of the students in the control and experimental groups

Groups	PFD Topic	Total Points	Min	Max	Mean	Standard Deviation	Interpretation
Control	Distinct Linear	10	0	10	2.897	2.335	Fair
	Repeated Linear	10	0	10	2.655	2.567	Fair
	Irreducible Quadratic	10	0	6	1.655	1.717	Poor
	Repeated Irreducible Quadratic	10	0	3	1.138	1.481	Poor
	Total	40	0	26	8.345	5.360	Fair
Experimental	Distinct Linear	10	0	10	3.095	1.185	Fair
	Repeated Linear	10	0	3	2.429	1.192	Fair
	Irreducible Quadratic	10	0	3	1.714	1.503	Poor
	Repeated Irreducible Quadratic	10	0	3	1.071	1.455	Poor
	Total	40	0	13	8.310	3.460	Fair

Table 4 presents the pretest performance in partial fraction decomposition of the engineering students in the control and experimental groups. The table reveals that, out of 40 points, students obtained scores ranging from 0 to 26, with the greatest range coming from the case of distinct linear factor and repeated linear factor and the least range obtained from the case of repeated irreducible quadratic factor. Based on the individual scores across each PFD case, the table shows that the student's performance was fair in distinct linear factor and repeated linear factor and poor in irreducible quadratic factor and repeated irreducible quadratic factor. Overall, the mean scores in both control and experimental groups were indicative of fair performances. In addition, as stipulated in the table, the standard deviations for the two groups were more than 3.0, signifying a higher degree of heterogeneity of the student's scores. The results imply that students generally have less or no knowledge of partial fraction decomposition and thus need intervention to improve their performance.

In their study, Ling and Vui (2021) emphasized that students struggle academically in PFD due to their inadequate conceptual knowledge of Algebra, as seen in their failure to handle fractions and solve systems of linear equations. Mathematical fraction operations are typically difficult for students, especially regarding fraction equivalence, common denominators, the technique and notion of division, whole number bias, and improperly employing fraction operations (Bentley &Bossé, 2018).

Table 5. Test of difference in the pretest performance of the students between the control and experimental groups

Groups	N	Mean	Standard Deviation	t-value	p-value @ .05	Decision
Control	29	8.345	5.360	0.03	0.975	Not Significant
Experimental	42	8.310	3.460			

Table 5 presents the t-test of significant differences in the engineering students' pretest performance in partial fraction decomposition between the control and experimental groups. The control group's mean (X1 = 8.354) was slightly higher than that of the experimental group (Y1 = 8.310). At a 0.05 level of significance, the result showed no significant difference in the pretest performance of the students between the control and experimental groups [$t = 0.03$; $p > 0.05$]. The students' pretest scores in the two groups were quite close, suggesting that their knowledge and proficiency in the topic were comparable. The current finding is similar to Ocampo (2014) and Turtogo (2021). The independent sample t-test result showed no discernible difference in math ability between the experimental and control groups involved in their studies.

Table 6. Posttest performance of the students in the control and experimental groups

Groups	PFD Topic	Total Points	Min	Max	Mean	Standard Deviation	Interpretation
Control	Distinct Linear	10	0	10	4.827	2.778	Good
	Repeated Linear	10	0	10	5.414	3.030	Good
	Irreducible Quadratic	10	0	10	4.931	3.463	Good
	Repeated Irreducible Quadratic	10	0	10	3.483	3.269	Fair
	Total	**40**	**3**	**38**	**18.655**	**10.080**	**Good**
Experimental	Distinct Linear	10	3	10	7.905	2.335	Very Good
	Repeated Linear	10	3	10	6.905	1.859	Very Good
	Irreducible Quadratic	10	0	10	7.310	2.494	Very Good
	Repeated Irreducible Quadratic	10	0	10	5.024	3.353	Good
	Total	**40**	**14**	**40**	**27.144**	**7.340**	**Very Good**

Table 6 shows the posttest performance in partial fraction decomposition of the engineering students in the control and experimental groups. It can be gleaned from the table that, out of 40 points, students exposed to Man's approach obtained scores ranging from 14 to 40, while those exposed to the traditional method of undetermined coefficients got scores ranging from 3 to 38. Students exposed to Man's approach showed good-to-very-good performances across each PFD case and good PFD performance in general. On the other hand, students exposed to the method of undetermined coefficients exhibited fair-to-good performances and good PFD performance overall. Despite the improved performances, the standard deviations for the two groups were still greater than 3.0, suggesting a higher degree of heterogeneity of the student's scores.

The study's finding supports Ling and Vui's (2021) results in terms of improved mean scores. After exposing students from control and experimental groups to the undetermined coefficients method and Man's approach, both groups showed improvement in their performance, as manifested in their increased mean scores. However, in terms of standard deviation, Ling and Vui (2021) obtained partially different results. While the posttest standard deviation of those exposed to the undetermined coefficients method increased, the posttest standard deviation of those exposed to Man's approach decreased as opposed to the increase disclosed in this study.

Other studies have explored the undetermined coefficients method and Man's approach to solving PFD coefficients. Both methods are similar but differ in terms of the algebraic concepts involved in their implementation. Students who utilize Man's approach assess PFD coefficients by performing substitution in specific polynomial division functions. Students who apply the undetermined coefficients method solve the system linear equations via an algebraic approach to find PFD coefficients. If students underperform in this topic, it may be attributed to their inability to apply the techniques and their difficulties in dealing with four partial fractions due to lengthy, complex, and inconvenient computations (Ling &Vui, 2021; Man, 2012).

Table 7. Test of difference in the posttest performance of the students between the control and experimental groups

Groups	N	Mean	Standard Deviation	t-value	p-value @ .05	Decision
Control	29	18.655	10.080	-3.88	0.000	Significant
Experimental	42	27.144	7.340			

The t-test of significant difference in the posttest performance in partial fraction decomposition of the engineering students between the control and experimental groups is reflected in Table 7. The table reveals that the experimental group (Y2 = 27.144) obtained a higher mean score than the control group (X2 = 18.655). Students who utilized Man's approach in the posttest performed better than those who employed the undetermined coefficients method. Furthermore, the table reveals that, at a 0.05 level of significance, there existed a significant difference in the means of the scores of the two groups [$t = -3.88$; $p < 0.05$] after the intervention. It implies a significant variation between the student's performance using Man's approach and the traditional undetermined coefficients method.

The present finding supports Ling and Vui (2021) and Man and Leung (2012). Their studies also discovered that students employing Man's approach tended to fare better in PFD than those using the traditional approach.

Table 8. Test of difference between the pretest and posttest performance of the students in the control group

Control Group	N	Mean	Mean Difference	Standard Deviation	Computed t	p-value	Cohen’s d
Pretest	29	8.345	10.310	5.360	-4.76	0.000	1.23
Posttest	29	18.655		10.080			

Table 8 summarizes the test result of the difference between the pretest and posttest performance of the students in the control group. The t-test for correlated samples revealed that the means in the pretest and the posttest scores of the students who attended the undetermined coefficients method differed significantly [$t = -4.76$; $p < 0.05$]. The posttest mean (X2 = 18.655) was greater than the pretest mean (X1 = 8.345), suggesting that the undetermined coefficients method statistically improved students' PFD performance. The effect size ($d = 1.23$), calculated based on the test result, indicated that the difference was quite big (Cohen,1988; Refugio et al., 2019; Kraft, 2020). It means that the PFD method used considerably impacted how well students learned to solve partial fraction decomposition problems. The result implies that learning still took place even when students were exposed to the conventional approach of solving PFD.

In support, traditional methods, which are tried and true, are still crucial for education. Although they may not be the most exciting way to learn, they have historically been effective, especially in retaining mathematical concepts and standard algorithms (Tall, 2004, as cited in Turtogo, 2021).

Table 9. Test of difference between the pretest and posttest performance of the students in the experimental group

Experimental Group	N	Mean	Mean Difference	Standard Deviation	Computed t	p-value	Cohen’s d
Pretest	42	8.310	18.834	3.460	-14.10	0.000	3.28
Posttest	42	27.14		7.340			

Table 9 presents the test of the difference between the pretest and posttest performance of the students in the experimental group. The t-test for correlated samples showed a significant difference between the means in the pretest and the posttest scores of the students exposed to Man's approach [t = -14.10; $p < 0.05$]. The posttest mean (Y2 = 27.144) was greater than the pretest mean (Y1 = 8.310), signifying that Man's approach improved students' PFD performance. The effect size (d = 3.28) was relatively large (Cohen, 1988; Refugio et al., 2019; Kraft, 2020). It means that the PFD method used significantly impacted the students' performance in partial fraction decomposition problems.

The present finding corroborated the study of Ling and Vui (2021). Results of their study revealed that Man's approach significantly improved students' scores in PFD, with effect sizes ranging from moderate to large. They concluded that a well-designed Man's approach would increase students' ability to find partial fraction decomposition of a proper rational function, thus improving their performance on the topic.

Table 10. Test of difference in the mean gain scores of the students between the control and experimental groups

Groups	N	Mean	Standard Deviation	t-value	p-value @ .05	Decision
Control	29	10.310	11.674	-3.35	0.002	Significant
Experimental	42	18.834	8.656			

The t-test of significant difference on the pretest and posttest mean gain scores of the students between the control and experimental groups is reflected in Table 10. The t-test for independent samples showed that the mean of gained scores in the control and experimental groups significantly differed after exposing them to their respective interventions [t = -3.35; $p < 0.05$]. Additionally, the mean of gained scores of the experimental group (Y2 – Y1 = 18.834) was greater than that of the control group (X2 – X1 = 10.310). It means that the experimental group outperformed the control group. The finding implies that Man's approach statistically and significantly improved the performance of the engineering students more than the traditional method of undetermined coefficients.

The current finding confirms Ling and Vui (2017). They concluded that when performing the PFD of appropriate rational functions, students who utilized Man's approach significantly outperformed those who employed the method of indeterminate coefficients. Similarly, Man and Leung (2012) discovered in their study that the PFD performance of students adopting Man's approach was on par with or even statistically and significantly superior to those employing undetermined coefficients.

III. Conclusionand Recommendation

Before the intervention, the students' performance in the control and experimental groups on partial fraction decomposition was statistically comparable. The Man's approach and the undetermined coefficients method dramatically improve students' PFD performance, while the latter does it more effectively. Man's approach can thus be used to teach partial fraction decomposition instead of or in addition to the method of undetermined coefficients. As a result, math educators should investigate and apply Man's method for instructing and mastering partial fraction decomposition. The curricula for mathematics courses involving partial fraction decomposition should cover both Man's and conventional procedures to give students options for which method they will use in problem-solving.

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