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Exploring the connectivity of mathematics to real life applications for meaningful student engagement and training

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Abstract

Mathematics is often perceived as an abstract and challenging subject by many students. However, its principles and concepts are deeply rooted in real-life applications that span across various fields such as engineering, medicine, finance and everyday problem-solving. This paper explores the significance of connecting mathematical concepts to real-life applications to enhance student engagement and training. A sample of 20 students were selected and their performance evaluated when mathematics is taught with/without real-world application. The study reveals an average improvement score of 31.8%. A paired t-test (30.42) was conducted to further validate that there is a statistical significance between pre-test scores and post-test scores. While the Cochran Q test was employed to test if there is a statistical difference among four identified teaching methods; real-world application, pictorial illustration, local content application and visual illustration. By illustrating the practical relevance of mathematics, educators can foster a deeper understanding and appreciation of the subject, thereby improving learning outcomes and preparing students for future challenges.

Keywords: Research design, target population, sample size, pre-test, post-test, improvement score, paired t-test, correlation analysis, real-world application, pictorial illustration, local content, visual illustration, Cochran Q test

1. Introduction

Mathematics is a fundamental discipline that underpins much of the modern world. Despite its importance, many students struggle to see its relevance to their lives and future careers. This disconnect can lead to disengagement and poor performance in mathematics.

To address this issue, educators need to highlight the practical applications of mathematical concepts and demonstrate how these concepts are used to solve real-world problem.

21st century, educational administrators and teachers have been focusing on how mathematics can be applied in the real-world. According to Vassiliou (2011) ^[1], since 2007, most European countries have focused on improving the mathematical skills of students in solving real-world problems, rather than theoretical and abstract mathematical concepts. Most students prefer to solve mathematics problems when they can see how their learning can be applied in real life, so considering appropriate practical problems for use in the classroom plays an important role in increasing student's interest (Vos, 2018) ^[10].

Historically, mathematics has been a subject that many students struggle with. How often have you heard a younger learner utter the words, "I'm never going to use this stuff" as they are struggling to solve some algebra or calculus problems? For many parents and teachers, the utterances of this phrase (or ones like it) is too often a common occurrence in the classroom (Wanamaker C., 2022) ^[11].

According to Van T (2018) ^[8]. The exasperated sighs of students who insist that they will never need the information they learn in maths classes are so common that many teachers and parents have stock answers for the ways maths function in everyday life. But math is also relevant to a wide variety of academic subjects, which means that a student who does poorly in math could end up struggling in other subjects. Many classes in college and trade school

involve measuring, weighing, drafting, understanding chemical formulas, calculating statistics and analyzing marketing data, for instance, students career options will be limited if they do not have a solid foundation in math.

Most often, student's carrier choice(s) is directly tied to their mathematical strength. While those enrolling into mathematics program yearly is low the number and types of problems in our everyday life and communities (e.g. data mining, traffic control system, data

Interpretation, programmers, business and weather forecasting, etc) requiring mathematical know-how to solve is growing geometrically. Thus, it is paramount to build a more mathematics inclined student community.

A mathematics inclined student community does not imply that every student is a mathematics student. It only indicates that members of the community under discuss can clearly identify, appreciate and understand the problem at hand as a problem identified, they say, is half-solved. If a problem is properly identified and understood, then the procurement officer can accurately and easily itemize what will go into solving a problem, the marketing department can correctly bill customers, the programmer will know the correct units of measurements to use for an app.

According to Arianz A. (2023) ^[12], when real-world connection is incorporated into lessons, students have the opportunity to see how math fits into their daily lives. In turn, math becomes a visible phenomenon in their routines instead of a set of abstract rules and concepts confined to the classroom.

Integration of real world applications into mathematics education is supported by various educational theories, including constructivism and experiential learning. Constructivist theories suggest that learners builds knowledge more effectively when can relate new information to their existing experiences (Piaget, 1973) ^[7]. Similarly experiential learning emphasizes the importance of engaging students in hands-on activities that allow them to apply theoretical knowledge to practical situations (Kolb, 1984) ^[5]. These frameworks provides a solid foundation for developing teaching strategies that connects mathematics to real life scenarios, thereby enhancing student engagement and comprehension.

A study by Boaler (2016) ^[2] demonstrated that student who engaged in real world mathematics projects showed significant improvement in both their problem solving skills and their attitudes towards mathematics. The project based approach allowed students to explore mathematical concepts through task that mirrored real life challenges, such as budgeting for a community event or analyzing data trends in sports statistics.

Bamidele (2005) ^[3] in his study mathematics not dreadful subject stated that in Nigerian schools, student's general impression is that mathematics is dreadful subject but ironically, this subject is the basis for scientific and technological advancement of any country. This was corroborated by Prof Samuel Ale, that the subject is rather an interesting one hence, the establishment of the National Mathematical Centre (NMC) in Abuja, Nigeria. The main objectives of the NMC was to improve on the teaching and learning of mathematics; to develop interest in the mathematical sciences; to enable researchers in the mathematical sciences to come together for more advanced work by organizing workshops not only for Nigeria, but also for West Africa and the world at large.

Mathematics is a subject that everyone will use at one point or the other, whether we like it or not. It has become the companion of man since the beginning of human existence on earth. When man first wanted to answer questions such as 'How many?' man invented math. The laws of mathematics governs everything around us and without a good understanding of them, one will definitely encounter significant problems in life.

Mathematics is not only about complicated formulas. Many international bodies' universities and communities dedicate good chunk of their resources to educate, illustrate and maintain the importance of mathematics in our everyday life. Maths is useful in everyday life. Maths can help us do many things that are important in our everyday lives. Here are some of the tasks for which Maths is important:

- Managing money
- Balancing the checkbook
- Shopping for the best price
- Preparing food
- Figuring out distance, time, and cost of travel
- Understanding loans for cars, trucks, homes, schooling or other purposes etc. (NIU Brochure on Math Matters)

According to Emma L. (2018) ^[4]. Even those suffering from math-related anxieties or phobias cannot escape its everyday presence in their lives. From home to school, to work and places in between, math is everywhere. Whether using measurements in a recipe or deciding if half a tank of gas will make the destination, we all use maths. It is a good idea, therefore for teachers and parents of reluctant math learners to use real world examples to ignite a spark of practical interest.

A mathematical aware society is solution oriented and more productive. This paper examines various strategies for connecting mathematics to real-life applications and discusses their impact on student engagement and training.

2. Research Design

This study employs a quasi-experiment design with a pre-test and post-test approach. The study examines how incorporating real-life applications in mathematics impacts student engagement and understanding using a survey-based descriptive research design.

2.1 Population and Sample

2.1.1 Target Population

The target population for this study comprises undergraduate students of Delta State Polytechnic Ogwashi-Uku.

2.1.2 Sample Size

A total of 20 students were purposively selected to participate in the study.

2.1.3 Sampling method

A Non-Probability sampling technique was employed to select the participants. The 20 students were drawn across four distinct academic schools within the Polytechnic.

- School of Business
- School of Engineering
- School of Applied Sciences
- School of Information and Communication Technology (ICT)

2.2 Data Collection Methods

2.2.1 Questionnaire

Students responded to a structured questionnaire designed with closed-ended items on a 5-point Likert scale. The Questionnaire assessed their engagement levels and understanding of mathematical concepts, both with and without real-word applications.

2.2.2 Classroom Observations

A subset of the sampled students was observed during mathematics instructions that incorporated real-world problem-solving tasks. The observation focused on student's participation, engagement and comprehension during these

practical sessions.

2.2.3 Teacher Interviews

Semi-structured interviews were conducted with mathematics educators to explore their instructional strategies, specifically their methods for integrating real-life applications into mathematics teaching. The interviews also captured the teachers' perceptions of the impact of these strategies on students learning and engagement.

3. Data Analysis

3.1 Descriptive Statistics

Table 1: Pre-test and Post-test Scores

Student	Pre-test score (100)	Post-test score (100)	Improvement Score (%)	d_i	$(d_i - \bar{d}_i)^2$
1	50	67	+34.0	17	1.8225
2	55	70	+27.3	15	0.4225
3	43	60	+39.5	17	1.8225
4	45	65	+44.4	20	18.9225
5	53	68	+28.3	15	0.4225
6	57	73	+28.1	16	0.1225
7	40	57	+42.5	17	1.8225
8	62	75	+21.0	13	7.0225
9	47	63	+34.0	16	0.1225
10	54	69	+27.8	15	0.4225
11	56	71	+26.8	15	0.4225
12	49	65	+32.7	16	0.1225
13	44	62	+40.9	18	5.5225
14	52	67	+28.8	15	0.4225
15	46	54	+17.4	8	58.5225
16	51	66	+29.4	15	0.4225
17	58	47	+27.6	16	0.1225
18	42	59	+40.5	17	1.8225
19	48	64	+33.3	16	0.1225
20	50	66	+32.0	16	0.1225
Total	1002	1,315	636.3	313	100.55

Mean Pre-test Score: 50.1

Mean Post-test Score: 65.8

Mean (Average Improvement) = 31.8%

Table 2: Student Engagement and Improvement Scores

Student	Engagement Score (X)	Improvement Score (Y)	$X - \bar{X}$	$Y - \bar{Y}$	$(X - \bar{X})^2$	$(Y - \bar{Y})^2$	$(X - \bar{X})(Y - \bar{Y})$
1	4.5	34.0	0.1	2.2	0.01	4.84	0.22
2	4.2	27.3	-0.2	-4.5	0.04	20.25	0.9
3	4.6	39.5	0.2	7.7	0.04	59.29	1.54
4	4.8	44.4	0.4	12.6	0.16	158.76	5.04
5	4.3	28.3	-0.1	-3.5	0.01	12.25	0.35
6	4.4	28.1	0	-3.7	0	13.69	0
7	4.7	42.5	0.3	10.7	0.09	114.49	3.21
8	4.1	21.0	-0.3	-10.8	0.09	116.64	3.24
9	4.3	34.0	-0.1	2.2	0.01	4.84	0.22
10	4.2	27.8	-0.2	-0.4	0.04	16.0	0.8
11	4.5	26.8	0.1	-5.0	0.01	25.0	-0.5
12	4.6	32.7	0.2	0.9	0.04	0.81	0.18
13	4.8	40.9	0.4	9.1	0.16	82.81	3.64
14	4.4	28.8	0	-3.0	0	0	0
15	4.1	17.4	-0.3	-14.4	0.09	207.36	4.32
16	4.3	29.4	-0.1	-2.4	0.01	5.76	0.24
17	4.5	27.6	0.1	-4.2	0.01	17.64	-0.42
18	4.7	40.5	0.3	8.7	0.09	75.69	2.61
19	4.2	33.3	-0.2	1.5	0.04	2.25	-0.3
20	4.4	32.0	0	0.2	0	0.04	0
Total	88.6	636.3			0.94	938.41	25.29

3.2 Statistical Inference

3.2.1 Paired t-test

The proposed hypothesis is to test if there is any significant difference between the two groups in table 1.

$$H_0: \mu_1 - \mu_2 = 0$$

$$H_1: \mu_1 - \mu_2 \neq 0$$

$$\alpha = 0.05.$$

The test statistic is given as;

$$t = \frac{\bar{d}}{S.E(\bar{d})}$$

where $\bar{d} = 15.65$ and $S.E(\bar{d}) = 0.5144$

$$t = \frac{15.65}{0.5144} = 30.42$$

Decision Rule

Reject H_0 , if $t > t_{\alpha/2}$, v. Otherwise accept H_0 .

Since $t_{30.42} > t_{2.093}$. We conclude by saying we don't have sufficient evidence to accept H_0 . Hence we accept H_1 .

3.2.2 Correlation Analysis

Correlation analysis between Engagement Score (X) and Improvement score (Y), given the following summary values from table 2

$$\sum X = 88.6 \quad \sum Y = 636.3 \quad \sum (X - \bar{X})^2 = 0.94 \quad \sum (Y - \bar{Y})^2 = 938.41$$

$$\sum (X - \bar{X})(Y - \bar{Y}) = 25.29$$

Pearson product moment correlation coefficient is given as

$$r = \frac{\sum (X - \bar{X})(Y - \bar{Y})}{\sqrt{\sum (X - \bar{X})^2 \sum (Y - \bar{Y})^2}} = \frac{25.29}{\sqrt{(0.94)(938.41)}} = \frac{25.29}{\sqrt{882.1054}} = \frac{25.29}{29.7003}$$

$$r = 0.85.$$

3.2.3 Measurement of Students Output across Four Teaching methods

The following teaching methods were selected based on the responses gotten from the teacher's interview and are selected based on modal strength.

1. Real world data application (R)
2. Pictorial illustration (P)
3. Local Content application (L)
4. Visual illustration (V)

The 4 methods were tested across the 20 students. The basic aim was to test the effectiveness of the 4 teaching methods on the sampled students.

Table 3: Measured Output across Teaching Methods

Student	R	P	L	V	R_i
1	1	1	0	0	2
2	1	0	0	0	1
3	0	0	0	0	0
4	0	1	0	1	2
5	0	1	1	1	3
6	1	1	1	1	4
7	1	0	1	1	3
8	0	1	0	1	2
9	1	0	0	0	1
10	1	1	1	1	4
11	1	0	0	1	2
12	1	1	1	0	3
13	1	0	0	1	2
15	1	1	1	1	4
16	0	1	0	1	2
17	1	0	0	1	2
18	0	0	1	1	2
19	1	1	0	1	3
20	1	1	1	1	4
R_j	14	12	9	15	50

Success = 1

Failure = 0

The proposed hypothesis is to test if there is any significant difference among the teaching methods.

$$H_0: \mu_i = 0$$

$$H_1: \mu_i \neq 0; \text{ for } \forall i's \text{ with } i = 1, 2, 3, 4$$

$$\alpha = 0.05.$$

Using Cochran method, we have the following;

$$Q = (k-1) \left\{ \frac{\sum R_j^2 - \frac{(\sum R_j)^2}{K}}{\sum R_i - \frac{\sum R_i^2}{K}} \right\}$$

$$\text{Where } \sum R_j^2 = 14^2 + 12^2 + 9^2 + 15^2 = 646$$

$$(\sum R_j)^2 = (14 + 12 + 9 + 15)^2 = 50^2 = 2500$$

$$\sum R_i = 2 + 1 + \dots + 4 = 50$$

$$\sum R_i^2 = 2^2 + 1^2 + \dots + 4^2 = 150$$

K = 4 (No of methods)

$$Q = (4 - 1) \left\{ \frac{646 - \frac{2500}{4}}{50 - \frac{150}{4}} \right\} = 3 \frac{(646 - 625)}{(50 - 37.5)} = 3 \frac{(21)}{12.5} = 5.04$$

$$\therefore Q = 5.04$$

$$\text{At } \alpha = 5\%, \text{ we have ; } \chi^2_{k-1, 1-\alpha} = \chi^2_{4, 0.95} = 7.51$$

Decision Rule

Reject H_0 , if $Q_{calc} > Q_{tab}$. Otherwise accept H_0 .
Since $Q_{5.04} < Q_{7.51}$, we say, we don't have sufficient evidence to reject H_0 . Hence we accept it.

4. Results and Discussion

The data of table 1 and the paired t-test (1) provides a clear comparison between student's baseline knowledge and their understanding after an intervention-likely the application of real real-life mathematical teaching methods. All students showed improvement score ranging from +17.4% to +44.4%. Which reflects a substantial increase in knowledge or problem-solving ability after the intervention. Further investigation into the outliers (like Student No 15) could offer insights for tailoring support.

The paired t-test result equally confirmed that there is a statistical significance between the students' performance before and after intervention.

The Pearson correlation coefficient ($r = 0.85$) demonstrated a strong positive relationship between engagement and performance improvements.

This implies that higher engagement in mathematics, particularly when connected to real-life applications, is associated with greater performance improvements. By moving beyond the traditional topics like algebra, calculus, etc and demonstrating the practical utility of mathematics in various fields, educators can enhance student engagement and motivation.

The result of the Cochran's Q test suggest no significant difference(s) in effectiveness among the teaching methods (RPLV) evaluated. While this test did not reveal significant difference among the four teaching methods, the integration of real-life application in mathematics education has shown to promote student engagement and cognitive development.

5. Conclusion

This research confirms that real-life applications enhances mathematical understanding and engagement. This not only builds a more mathematically inclined student community but also prepares students to apply mathematical concepts to diverse real-world problems.

By employing diverse teaching strategies like; real-world data application, pictorial illustration, local content application and visual illustration, education planners in Nigeria can create a mathematics curriculum that resonates with students and reflects the relevance of mathematics in their lives.

Moreover, the integration of real-world application into mathematics education represents a promising pathway towards creating a more engaging, effective and relevant learning experience for students. As educators continue to explore innovative approaches to teaching mathematics, the focus on real word connections will undoubtedly play a crucial role in shaping the future of mathematics education.

Future studies should explore scaling this approach across diverse demographics and integrating digital tools.

Declaration of interests:

The authors declare that they do not have any competing interests.

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