# Smart Pathways for Sustainable Education of Teaching and Learning Mathematics at the Elementary Level in Pakistan: The Post-Humanistic Approach

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***Abstract***

*Post-humanism is a critical philosophical theory that suggests how human potential can be increased primarily through technology. There is a need to identify evidence-based recommendations for the development of key competencies in sustainable education, the goal of which is to live sustainably, according to Brundtland (1987). The existing paper investigates the impact of innovative education on student's learning in the subject of mathematics with digitally assisted resources (Symbolab Calculator, Desmos/GeoGebra, GEMT, PhET Sims, Kahoot, Learn Smart Pakistan) for teaching students of grade 8 in district Lahore, Pakistan. The quasi-experimental design was used to explore the effectiveness of technology-mediated math education on students' learning. The pretest, post-test, and control group design compared imaginative pedagogical approaches and traditional teaching methods. The data analysis was done quantitatively. The purpose was to understand the effect of all innovative tools on students' achievement and to engage/motivate them in the learning process. The study involved quantitative analysis with a sample size of 38 (experimental) and 42 (control) participants to study the phenomenon with post-humanistic thought. The data was examined through SPSS ver. 25, and a t-test was calculated for the comparison. The findings showed that intervention of innovative education tools had a noticeable impact on students' mathematics learning.*

**Keywords:** Post-humanism, Imaginative Education Approaches, Sustainable Development, Mathematics, Grade-8.

## Introduction

The humanist view of education operates based on the "hybridity" of human and non-human (Haraway, 1991) and how technology enables humans to enhance capabilities beyond natural limits. Therefore, innovative trends and new teaching modes are needed to make us better human beings. The concept of post-humanism (PH) emerged from this worldview.

Considering the progress of society, sustainable development by adopting innovative, intelligent solutions is crucial as it defines or directs towards educational goals. Creative education is rooted in sustainable development, which received the world's attention in the report by Brundtland in 1987. Moreover, in their relationship with their environment and

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technological advances, humans play distinct roles in achieving sustainable futures, emphasizing their complementary contributions rather than their differences. Smart Education for Sustainable Development (SESD) (Makhdum et al., 2023) is underpinned by innovative education and sustainable development as the inherent purpose of education is to pass on the insight, values, abilities, and competencies to the future generation (Jeronen, 2022), while the specific interpretation is quite challenging in today's scenario. Brundtland's report in 1987 stated the objective of sustainable development and articulated that SD aims to enable sustainable living, as previously mentioned.

Education plays a crucial role in promoting SDG-4, which is the outcome since it explains how learners can be effectively taught within the context of this world around us to accept the obligation to acquire competencies, technology, and resources in a manner that supports as well as facilitate sustainable living and working. Emerging technology has reshaped teaching methodologies and adapted learning practices in classrooms; for example, the effective use of new pedagogies such as Symbolab calculator, Desmos, PHET Sims, Google Earth and Map Tool, GeoGebra, Kahoot, and Learn Smart Pakistan did not prevail in the previous educational framework at the elementary level in Pakistan (Makhdum et al., 2023). Improving education via online platforms is another goal of Pakistan's academic policies. Because of these challenges within our educational system, it is substandard and failed to enhance sustainable education in schools. However, these learning approaches are gravely required in the current Pakistan educational system. The lecture, chalk, and board methods are still used within our education system. Again, the system has fewer resources, and our teachers are less informed about the innovative pedagogical tools.

Regarding teaching mathematics, a collaborative effort involving students, teachers, and schools is indispensable to improve the competencies and capabilities needed to shape how students will learn in the future. Such education links a PH perspective in which the unit of analysis is sustainable educational practices. Hence, this paper investigates the impact of SE tools on students' mathematics outcomes at the elementary stage in Pakistan.

**Objectives of the Study**

- The objective was to determine the effect of using smart education approaches at the elementary level in Pakistani schools on students' learning outcomes.

**Research Questions**

- How does using an innovative educational environment at the elementary level in Pakistani schools affect students' learning?
- The bright educational environment constitutes imaginative approaches such as Desmos, Symbolab Calculator, GeoGebra, Google Earth, Learn Smart Pakistan (LSP), and PhET simulations, and the infrastructure for math education was used at the elementary learning stage in Pakistani schools on students' performance.

**Hypotheses of the Study**

Ho**:** There is no change in student's learning after intervening with an innovative education environment.

H1: There is a change in students' learning after intervening with innovative education pedagogies and tools.

**Significance of the Study**

Innovative education can help both teachers and students, as it can develop lifelong learning and problem-solving skills. Some examples include MCQs for students, holding quizzes, allocating assignments with deadlines, and planning lessons. Thus, teachers can improve their

teaching style for mathematics at all levels. Adopting innovative educational strategies enhances the teaching-learning process of math, as they also need a dynamic and adaptable flexible environment to learn from each other independently. Heidegger (1977) averted that technology can do a lot without direct human involvement, and human survival depends upon technology-facilitated education that elicits brilliant teaching approaches to post-humanism, which is the logical move of the educational implication of post-humanism.

**Smart Approaches**

All these approaches are easy to learn, simple to operate, and user-friendly without prior experience. Some are economical tools, and some are free. These were designed to augment teaching practices and math content knowledge through technology-enriched environments. All these approaches offer instructional materials, promote effective learning, help preserve students' interests, and minimize cognitive overload (Makhdum et al., 2023). All these approaches have simple and attractive interfaces. The current paper aims to bridge the gap between what we are doing and what is to be done.

## Research Methodology

This paper was a quantitative inquiry that depicts post-humanism towards SE and assesses its effect on the performance of grade-8 learners in mathematics in Lahore, Punjab, Pakistan, for a bright learning environment. This paper aimed to reveal the impact of innovative pedagogies for teaching mathematics on learners' performance at the elementary level. It defines Smart Education as an effective tool to get the most out of it and was conducted under the positivistic paradigm (Alharahsheh & Pius, 2020). The pretest post-test control group design was applied within the quasi-experimental research (Cuttler et al., 2019) design. The paper's main aim was to explore the impact of new pedagogical strategies compared to conventional instructional approaches for teaching Math to grade 8. It was performed in the private sector in district Lahore. The intervention of innovative education was conducted in the experimental group, whereas the teacher assigned by the school taught the control group.

The experimental study involved one treatment group (sample size = 38) and one control group (sample size = 42). Respondents were randomly assigned to both groups. Before starting the intervention, a pretest was conducted on the participants to test the homogeneity through an independent sample t-test. The conventional teaching methods, including chalkboard and sometimes multimedia presentations by the schoolteacher, carried on for the control group while the other group experienced an innovative approach. Later, post-tests were conducted for both groups, and a paired sample *t-test* was calculated for pre-post-test scores to explore the improvement in the students' learning outcomes for each group. Eventually, an independent sample *t-test* for post-tests was administered to determine substantial differences between the improvements of control and experiment groups (Cuttler et al., 2019).

The academic period of the experiment was one term, i.e., quarterly; a total of 50 lessons were constructed to explore the effect of smart teaching approaches on students' learning acquisition in teaching math to grade 8 students.

**Population and Sample of the Study**

The target population was all the private schools in the Lahore district with grade 8 students aged 13 to 15, who were all girls because it was a girls' school. The intervention was undergone in the private school of Lahore, which was taken as the accessible population. An intact section of the eighth-class Math’s subject was taken from a private school.

**Achievement Test**

The self-designed achievement test using multiple-choice questions was used to gather data from the intact group's school before and after the experiment. Participants were initially selected through random assignment. The MCQ-based conceptual test comprised 100 items for measuring students' concepts in math in conformity with complex analytical and reasoning skills according to Bloom's taxonomy framework. The content included mathematics topics derived from the Cambridge O-level books of the Math's syllabus and was aligned with the course plan provided by the school. The time allocated for the achievement test was one hour to obtain both groups' pre and post-intervention marks.

**Validity of the Instrument**

The validity of the achievement test was assessed through expert opinions that specialized in the respective fields, and pilot testing was performed to determine face, content, and construct validity. They authenticated the content's appearance, appropriateness, language, and logic. The reliability of the paper was calculated and determined by Cronbach Alpha using SPSS, version 25.0. After this, a pilot test was carried out on other sections of the eighth grade of the private school to determine the degree of the achievement test's validity for eighth-grade students. For this purpose, 50 students were chosen for the pilot study apart from the treatment groups, and consequently, the test was refined. Later, item analysis was carried out underpinned by the pilot testing to assess the item quality. Reliability was calculated through Cronbach Alpha through SPSS, which was .895.

**Intervention Orientation**

The tools to be used in the intervention were introduced before commencing each topic in the class. The teachers taught the treatment group, and the control group had the equivalent qualifications and experience, and students were given lessons in a well-equipped computer lab.

At first, students observed their teacher and cleared their math concepts using SE approaches to acquire knowledge. They needed to be attentive and focused for qualitative learning and to retain the topic. The students of grade 8 were involved in learning through drill and practice, and they could reproduce their math concepts/knowledge and use them proficiently. At this stage, the teacher facilitated the students' learning, motivating them to complete the task and apply it in the real-world context utilizing the software. Furthermore, all tasks consolidated the theory (SCT) idea that emphasizes mental processes and social aspects of phenomena.

## Results

In the beginning, the treatment was conducted to analyze the pre and post-test marks of the students, and for this purpose, independent sample *t-tests* and paired sample *t-tests* were designed to evaluate the groups. The *t-tests* were applied to administer quantitative data analysis and appraisal to assess whether the innovative methodology was more beneficial than the conventional approach for instruction. To determine the impact of treatment, a paired samples *t-test* was run to see the students' learning, which was significantly distinct in statistical terms on the pre and post-test returns. After the term ended, all the participants underwent a post-test or post-assessment. The differences in the marks were computed for both the groups before and after the intervention to compare gains in scores. Finally, the independent sample *t-test* was utilized to see which group showed more academic achievement.

**Statistical Analysis**

Scores based on the Statistical description provided the compiled data of both the groups between their pre and post-test, presented in the tables below.

Where, Total participants N = 80, *M* = Means, *SD* = standard deviation and the Significance Level = .05.

**Table 1: Participant Count in each Group**

| Groups | Number of Participants | Percentage (%) | Ages (years) |
|---|---|---|---|
| Control | 42 | 52.50 | 13-15 |
| Experimental | 38 | 47.50 | 13-15 |
| Total | 80 | 100.00 | |

Above table indicated that forty two (52.50%) participants were in the control group whereas, thirty eight (47.50%) were for the intervention and their ages had a range of thirteen to fifteen years according to their grade level.

**Normality Check**

According to Ghasemi and Zahediasl (2012), it was necessary to follow a normal distribution to use parametric inferential statistics such as *t-test*. In view of this, Kolmogorov Smirnov test has been applied to verify the data normality.

**Table 2: Normality of Data**

| | Kolmogorov-Smirnov | |
|---|---|---|
| | **Df** | **Sig.** |
| Control_preTest | 42 | .200 |
| Experiment_preTest | 38 | .200 |
| Control post-test | 42 | .200 |
| Experiment_posttest | 38 | .113 |

In view of the table above, Kolmogorov Smirnov test was applied, and the impacts were analyzed. For this, the tests reported in the table above based on the results compared the sample scores to a normal distributed data; the $H_0$, assumes that the "sample distribution is normal." However, if the test yields significance, the distribution shows a deviation from normality (Nahar et al., 2022). Both the tests reported in the table no. 3 confirmed the normality of the data ($p > .05$).

**Homogeneity of the Groups**

During the onset phase of the term, an initial pre-test was applied administering the achievement test to evaluate both the groups to attain scores before intervention of the new teaching style. For this, independent sample *t-test* was administered, and the results are reported in the table below.

**Table 3: Independent Sample t-test for pre- test scores of the Groups**

| | | Levene's Test for Equality of $\sigma^2$ | | t-test for Equality of *M* | | | | |
|---|---|---|---|---|---|---|---|---|
| | | F | Sig | t | Df | Sig. (2-tailed) | *M* Difference | S. Error Difference |
| Pre | Equal Variances Assumed | .005 | .945 | .040 | 78 | .968 | .096 | 2.409 |
| | Equal Variances not Assumed | | | .040 | 77.337 | .968 | .096 | 2.408 |

As indicated in the table by Levene's test *t = .040 (78)*, ($p > .05$), it was evident that the groups are the similar in terms of their *M score*s and thus, no significant difference was seen between groups ($p > .05$). After this, post-test was carried out to all respondents in the groups to evaluate the impact of experiment. A paired sample t-test was applied to explore the potential improvements in knowledge, skills, and performance resulting from the new teaching approach. The comparison group also underwent for any potential development to ensure that all the groups underwent the same procedures for a fair comparison of results.

**Table 4: Paired Samples t-test to Compare the Pre Test and Post Test Marks of the Control Group**

| | Paired Sample *t test* | | | | | | |
|---|---|---|---|---|---|---|---|
| | | *M* | Std. Dev. | S. Error Mean | t | Df | Sig (2-tailed) |
| Pair 1 | Pretest (Cont.) / Posttest (Cont.) | -2.333 | 8.847 | 1.365 | -1.709 | 41 | .095 |

As indicated from the results in the table above that there was no notable improvement in *M* achievement score for the base line group by the close of the academic session, who were receiving instruction through conventional means *t = -1.709 (41)*, ($p > .05$).

**Table 5: Paired samples t-test to Examine the Difference between pre and Post Test of the Experimental group**

| | Paired Sample *t test* | | | | | | |
|---|---|---|---|---|---|---|---|
| | | *M* | S. Dev. | S. Error Mean | t | df | Sig (2-tailed) |
| Pair 1 | Pretest (Exp.) / Posttest (Exp.) | -32.211 | 10.583 | 1.717 | -18.761 | 37 | .000 |

The results reported from a paired sample t-test to explore in case there were statistical variations in the students' performances on the post-test of the treatment group. The *M* scores were compared to test the significant difference with the implementation of the new teaching strategies being applied and therefore, according to the statistical perspective there is substantial difference in the *M* of the treatment group, *t = -18.761 (37)*, ($\boldsymbol{p < .05}$). To conclude, the experimental group which experienced the new teaching style, exhibited improvement. Therefore, the null hypothesis was refused.

**Table 6: Independent Samples t-test for both the Groups' Post Tests**

| | | Levene's Test for Equality of $\sigma^2$ | | t-test for Equality of *M* | | | | |
|---|---|---|---|---|---|---|---|---|
| | | F | Sig | t | D f | Sig (2-tailed) | *M* Difference | S. E. Difference |
| **Post** | Equal $\sigma^2$ Assumed | .537 | .046 | 11.075 | 78 | .000 | -29.781 | 2.689 |
| | Equal $\sigma^2$ not Assumed | | | 10.984 | 72.981 | .000 | -29.781 | 2.711 |

Results in the table above showed that the groups were shown to differ markedly in their *M* scores *t = 11.075 (72.981),* ($\boldsymbol{p < .05}$) and for this independent sample *t-test* was applied. To conclude, treatment had a noticeable impact on the students' performance.

**Table 7: Descriptive Statistics Before and after Intervention**

| Group Statistics | N | Min | Max | Mean (*M*) | Std. Dev. (*SD*) |
|---|---|---|---|---|---|
| Experiment_preTest | 38 | 22 | 67 | 41.74 | 10.709 |
| Control_preTest | 42 | 21 | 65 | 41.83 | 10.804 |
| Experiment post | 38 | 45 | 96 | 73.95 | 13.003 |
| Control post | 42 | 19 | 69 | 44.17 | 11.039 |
| Total | 38 | | | | |

Above table reported the analysis of pre-tests *M* and *SD* scores in the study groups. It indicated that the initial outcomes (*M* scores) achieved by the experimental group was 41.74 and that of the other group was 41.83 on the pretest whereas, of the experiment group prior to intervention was marginally reduced. Also, *SD* of the experimental group, indicated a somewhat reduced than that of the control group. Thus, the descriptive statistics of post-tests scores demonstrated that there was a significant rise in the *M* score. Hence, there was a clear improvement in the *M* after the treatment was applied.

## Conclusion

Statistical analysis and findings revealed that there were no substantial variations between the groups, and initially they were approximately equal regarding achievement in math ability. More so, the comparison between *M* pretest scores of both the groups was not significant at .05 level which means that the level of performance in mathematics before treatment was insignificantly different. However, the disparity in mean post-test scores between both the groups was considerably different at .05 level. As a result, the variance in math proficiency of both the study groups was attributable to SE. The results underscore the need for appropriate intervention strategies; however, as pointed out by Makhdum et al. (2023), these strategies can also be linked to their development.

The existing paper explored the relationships and connections among post humanism, sustainability and inner transformation in education, and provides profound understanding of the process of implementing thoughtful interventions for smart education. Furthermore, it offers a thorough comprehension about how to apply thoughtful interventions effectively to achieve desired learning outcomes for the students of grade 8.

The current paper has established the effectiveness of smart education supported by smart learning environments through post-humanistic lens at elementary level in Pakistani schools on students' learning. It leads towards the importance of sustainable education of teaching and learning mathematics (Zwolinska et al., 2022) and they have a strong theoretical foundation exhibit that education has an important role to achieve sustainable development. Finally, it can be deduced that smart education for sustainability works, and this is because, it is the smart tools that develop sustainable competencies among students.

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