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Online Learning on Mathematics Achievement at the Higher Secondary Level

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Abstract:

The study identifies psychological elements that influence students' mathematical performance. A pre-test and post-test nonequivalent control group quasi-experimental research design was used in this study. Using a factorial matrix, the quasi-experimental design was utilized to compare the treatment's (at two levels) scores crossed with gender (at two levels). One intact class was chosen using simple random sampling. The results show a strong positive correlation between mathematics achievement and teacher effectiveness. Students' learning outcomes in mathematics were significantly impacted by teachers who displayed excellent instructional quality, exhibited good pedagogical content understanding, and managed their classes effectively. The study also showed that the use of online learning on mathematics achievement had a favorable impact on students' performance. Online classrooms enabled engaging debates, group problem-solving, and individualized learning experiences, which contributed to improved mathematics performance.

Keywords: *Online Learning, Higher Secondary students, Mathematics and Achievement.*

1. Conceptual Work:

Direct enjoyment of mathematics influenced achievement in mathematics, whereas feelings of difficulty had an indirect influence [1]. Suppose researchers can isolate specific potential predictors of later mathematics achievement, they can explain the reason for those types of knowledge are uniquely predictive, and could devise strategies to improve teaching and learning in those areas [2]. It is more likely that the educational gains would be greater in areas that are considered fundamental for later achievement predictors due to prevailing comprehension gaps among children [3]. The fifth-grade sources of continuity in mathematical knowledge and skills throughout high school [4]. They focused on testing the assumption that prior knowledge of fractions is a strong predictor of later knowledge of algebra and overall mathematics performance [5]. There have been many studies on the connections between attitude towards mathematics and academic achievement. Moreover, there have been no systematic large-scale studies conducted at the national level [6].

The effectiveness of a teacher greatly impacts the decisions concerning his or her training, hiring, paying, professional development, and evaluation strategically [7]. The differences at the level of teaching between

effective and less effective teachers were studied in light of their teaching practices and their student's behaviour in class. Administrators at the school level and district level wished to investigate students' preparedness for learning from the teachers' angle and teacher effectiveness from the learners' viewpoint [8]. Teacher efficacy is something that has been treated extensively from the angle of the.

More overlooked in the literature is the perception of teacher effectiveness by students and the perception of students by teachers in terms of readiness to learn [9]. The online lecture or learning process can be conducted by universities, but online learning has its own challenges, strengths, weaknesses, and barriers [10]. Traditionally, face-to-face learning has been restricted to congesting students in a classroom. The interaction among students is expected to facilitate faster transmission processes [11]. It is expected that the online learning process will assist lecturers and students in performing instructional activities so that the educational process is [12]. Online learning refers to lectures that take place over the Internet, as it enables virtual interaction between lecturers and students [13]. With the growing emphasis on online learning [14], the context of the Internet has enhanced the interaction process of learning as it offers considerable connectivity, accessibility, and flexibility [15]. Therefore, this study investigated the impact of teacher effectiveness, online learning, and mathematics achievement on students at the higher secondary level.

2. Literature:

Glover et al. [16] examined how predicting and providing feedback through data-driven coaching modeling, practice, and "feedback (a) intervention implementation fidelity, (b) utilization of evidence-based teaching strategies, and (c) student achievement at the class level". Also, intervention implementation fidelity was found to mediate the impact of teacher practice opportunities on the strategy used by the teacher in the classroom. Jiang et al. [17] studied the "latent profiles of high school students' expectancy, value, and cost beliefs in mathematics and English through a learner-centered approach". The results of the present study emphasize how critical it is for us to study students' expectancy, value, and cost beliefs in conjunction with the students' motivational constructs to shed light on the motivational complexities within the classroom. Bishara et al. [18] studied the relationship between humour, motivation, and achievement in mathematics in students with learning disabilities. The results exhibit greater achievement and motivation in mathematics when the subject is taught using humour.

Syamsuri et al. [19] explore the correlation between the attitude of secondary school students towards mathematics with their achievement in learning mathematics, it showed a weak but significant positive relationship. Mweni et al. [20] narrate the findings from the study that aimed at identifying the correlation between students' anxiety and achievement in mathematics. Marks et al. [21] assessed two measures of ability and "three of achievement, with composite and multiple SES indicators" and the widely used home observation for measurement of the environment (HOME) for children aged 3 to 15.

In the study "Assessment of the Academic Achievement in Mathematics of Grade Eight Students of Victorino Mapa High School," Perez et al. [22] evaluated the effect of pre-recorded video lessons on the mathematics achievement of Year 8 students at Victorino Mapa High School in 2021-2022. The questionnaire results were also positive in that students found the materials utilized during the lessons helpful to their learning.

Theoritical Aspects of the Study:

A strong grounding in mathematics gives pupils more job alternatives and aids in the development of nuanced viewpoints. Genuine inventiveness, increased production, and an improvement in citizens' social well-being are all sparked by mathematical abilities. Any country's population must demonstrate a high level of scientific and mathematical literacy as a solid foundation for technical capability for it to be

internationally competitive. Numerous nations continue to be poor as a result of weak mathematical and scientific literacy. Even though these nations use mathematics as a qualification for professions in science, technology, engineering, and mathematics at the university level, student proficiency in mathematics is low when compared to high-achieving nations. As a result, the study determined which factors would determine whether a study was included or excluded when conceptualizing and quantifying instructional efficacy and the effects of online learning on student accomplishment.

3. Method:

By leveraging the Internet and various online learning platforms, learners can access the online learning environment from any location and study at their own pace. The learning environment can be more flexible with this form of learning. For a very long time, officials and academics have been deeply concerned about the mathematical abilities of secondary school students. Many academics think that the best indicator of a nation's long term economic potential is the mathematical proficiency of its secondary school students. By categorizing how researchers have conceptualized, operationalized, and assessed teaching effectiveness and online learning processes for students' academic achievement in mathematics at the higher secondary level, this research seeks to better understand these mechanisms. The major goal of the suggested activity is to raise students' math proficiency in higher secondary school. Calculate the psychological elements that cause children to do poorly in mathematics for this purpose. To examine how the learning environment affects students' academic progress in mathematics, this study used both an experimental and a descriptive survey approach. It sought to gather information from a sizable number of students about the elements of the learning environment to ascertain their opinions, attitudes, and perceptions of interest using a simple, structured questionnaire. A sample size of 354 students was selected, which corresponds to 30% of the total population. A sample is useless unless it accurately represents the complete population from which a generation is derived. To make analysis easier, the researcher samples all of the pupils, regardless of their gender or age. To obtain a fair representation of the population, the researcher utilized a random selection technique.

3.1 Data Collection:

An achievement exam and a structured questionnaire served as data collection tools. Four questions were asked about each element of the learning environment that was the subject of the 16-item questionnaire. On the other hand, the research was taught to the sampled students for two weeks, while the control group was taught by the experiment. The researcher ensured that the experimental groups received high-quality instruction, while the control groups were taught in a neutral environment.

Table 1: Demographic Details of Respondents

Demographic	Characteristics	No. of Respondents	Percentage
Gender	Male	147	41.5%
	Female	207	58.5%
Age	17-18	127	35.8%
	16-17	93	26.2%
	15-16	71	20%

	14-15	63	18%
Standard	11	193	54.5%
	12	161	45.5%
Type of e-books	Non-interactive mathematics e book	189	53.3%
	Interactive mathematics e book	165	46.7%
Platform	Zoom Meeting	195	55%
	Google Classroom	159	45%

Schools were approached for the data collection either by calling the head teacher or dean of studies or by visiting them personally. Table 1 displays the information that was gathered from higher secondary school students using Google Classroom and Zoom meetings. These made the researcher and the department head of mathematics connect. The student survey and the Mathematics test were given out at the start of the academic year. With the assistance of one or more math teachers, the researcher and/or his assistants gave the tests and questionnaires to the students during math class. First, for this survey, two different geographical and educational categories are chosen. In this study, they gathered 147 male and 207 female students from government and private schools, ranging in age from 19 to 20, 17 to 18, 15 to 16, and 13 to 14. With the aid of Zoom meetings and Google Classroom, they gathered information on 131 non-interactive and 189 interactive mathematics e-books for online learning. The confidentiality of the study's data collection and its exclusive usage for research purposes were guaranteed to the students.

3.2 Pre-Test and Post-Test:

The population of the study was made up of all eighth-graders attending elementary schools in public and private elementary, middle, and high schools. The study's sample consisted of 354 students from Higher Secondary Schools in the eighth grade. Using a random selection technique, students were split into Experimental and Control groups, based on results from a pre-test. A total of 354 students made up the experimental and control groups. Two equally qualified and experienced maths teachers taught both groups to protect the integrity of the subject for the experimental group received problem-solving instruction on the other hand the control group received standard instruction.

3.2.1 Problem-Based Learning Task:

Six groups of six students in four groups and two groups of seven kids were formed in the experimental group before the therapy; each group had a different learning style and academic performance. After that, teachers and students received training in problem-based learning. The therapy involved the kids working in small groups to solve illogical challenges. Everyone in the group was accountable for something. The discussion in the class was expected to have active participation from the students. While looking for a solution, they had to exchange knowledge, ideas, and experience with one another. They all have to be considerate of the wants and sentiments of the other group members. Each student had to do an independent study in addition to the group projects, and they had to be able to describe, explain, and assess their learning both individually and in groups. The instructor set up the problem-based learning sessions' groups and established a focused, collaborative environment. The teacher made sure that the topic was in the students' hands. When direction was required, the teacher posed open-ended, very general questions and gave the class

plenty of time to concentrate on the objective. Critical thinking was encouraged by the teacher. Students rated one another for participation, preparedness, interpersonal skills, and contribution to group success after the problem-based learning implementation. In this way, it was anticipated that students would understand their position and what was expected of them on an individual and group level. It was anticipated that the four-week duration of the trial would be enough. The exact post-test was given following a four-week treatment period.

3.2.2 Research Tool

Teachers received a self-administered questionnaire. Within-teacher variables included teacher efficacy and three predictors: course track, course grade, and match with the teacher's area of teaching specialisation. Developed a special instrument for this study where the teacher efficacy measures from prior studies did not fulfill the requirements of situational specificity. Reasons for focusing on subjects rather than courses include that subjects are more general and less specific as compared to courses, and subjects have previously been shown to be able to predict within-teacher variation in teacher efficacy. Four courses that teachers would be teaching in the autumn were identified. The sixth item was eliminated owing to the lower level of consensus surrounding it and its adverse impact on the scale's dependability. For each of the four courses, the final five prompts were used to derive the average teacher efficacy score.

Z-scores were used to translate the raw scores since they tended to be bimodal and negatively skewed.

4. Discussion:

4.1. Regression Analysis

Multiple linear regression analysis was done to determine the relationship between students' thinking capacity and their problem-solving competence after the components' validity and reliability were validated.

Table 2: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.216[a]	.046	.019	5.893
a. Predictors: (Constant), AS, MPD, MA, LTE, LH, SLA, PI, TE, OLSR, SC				
b. Dependent Variable: SAA				

The model summary of the study is shown in Table 2, which includes the data for the regression, regression square, standard error of the estimate, and Durbin Watson. For AS, MPD, MA, LTE, LH, SLA, PI, TE, OLSR, and SC, this was expected. The dependent variables, however, are SAA. Here, the standard error is 5.893 and the R square value is 0.046.

Table 3: Regression Analysis

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	580.501	10	58.050	1.672	.086[b]
	Residual	11911.140	343	34.726		
	Total	12491.641	353			
a. Dependent Variable: SAA						
b. Predictors: (Constant), AS, MPD, MA, LTE, LH, SLA, PI, TE, OLSR, SC						

The most popular statistical technique currently in use for evaluating hypotheses is ANOVA. This approach is flexible enough to accommodate more experimental designs and spans a wide range of topics. Table 3 shows the results of the ANOVA regression analysis, which includes 580.501 Sum of Squares values and an F value of 1.672. The dependent variable is SAA, and the predictors are TM, GE, and ME.

Table 4: Coefficient Analysis

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	Std. Error	Beta		
1	(Constant)	16.536	3.000		5.513	.000
	LTE	-.018	.058	-.017	-.313	.754
	TE	.081	.055	.081	1.485	.138
	MPD	-.065	.055	-.064	-1.178	.240
	OLSR	-.001	.054	-.001	-.012	.990
	SLA	.033	.053	.034	.624	.533
	PI	-.039	.058	-.037	-.683	.495
	MA	.059	.052	.060	1.117	.265
	LH	-.096	.052	-.099	-1.838	.067
	SC	.077	.055	.077	1.394	.164
	AS	.116	.053	.120	2.190	.029
a. Dependent Variable: SAA						

Table 4 shows the regression test coefficient values, which can be used to predict variables and determine whether they affect the statistically significant model (by looking at the "Sig." column). Additionally, the

values in the "B" column under "Unstandardized Coefficients" can be used because the constant value is 16.536, and the t value is 5.513. The relevance of the work is 0.000, respectively.

4.2. Chi-Square Test Analysis

Table 5: Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	480.824[a]	506	.783
Likelihood Ratio	418.256	506	.998
Linear-by-Linear Association	.034	1	.853
N of Valid Cases	354		
a. 552 cells (100.0%) have an expected count of less than 5. The minimum The expected count is.01.			

From Table 5, it is important to note that all 552 cells (100.0%) had an expected count less than 5, with the minimum expected count being.01, which violates the assumption of the Chi-Square test regarding expected frequencies. This violation may affect the validity of the test results.

4.3 Reliability Analysis

Assessing the validity and factor structure of the Collective Efficacy Short Form as particularly applied to the higher secondary students in this study, was the first step in the data analysis process. Utilizing confirmatory factor analysis, data were examined. In a rotating varimax solution, there were two components. Each of the six measures showed a significant connection with group competence, and the six items for group competence were precisely loaded.

Table 6: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.794	.192	11

The reliability study as shown in Table 6 indicated a strong Cronbach alpha degree of dependability for group competency at (.794). On the other hand, just three of the items in the second component showed significant connections. For task analysis, reliability analyses were

Unacceptably poor (.149). The task analysis factor of higher secondary school pupils is not supported by these results, but the group competence factor is. Thus, a single-factor instrument evaluating just the faculty group competency component of teacher effectiveness with six items was produced by the factor analysis for use with higher secondary school students.

Table 7: Item Statistics Analysis

	Mean	Std. Deviation	N
LTE	18.96	5.519	354
TE	19.25	5.923	354
MPD	19.59	5.889	354
OLSR	19.11	5.942	354
SLA	19.19	6.019	354
PI	18.56	5.568	354
MA	18.88	6.041	354
LH	19.51	6.130	354
SC	18.90	5.898	354
AS	19.61	6.178	354
SAA	19.34	5.949	354

Table 7 displays the summary item data from the reliability test. It shows that summary statistics, a subset of descriptive statistics, provides a general overview of the sample data. Statisticians typically try to describe and characterize the observations by determining their minimum, maximum, range, and variance. In this instance, the range is 18.56, and the values for the six items' standard deviations are 5.519 and 5.949. For SAA, the average values are 19.34.

Table 8: Intraclass Correlation Coefficient

	Intra-class Correlation b	95% Confidence Interval		F Test with True Value			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.021	.006	.040	1.241	353	3530	.002
Average Measures	.194	.064	.313	1.241	353	3530	.002

Table 8 shows that the average measure's lowest and upper bounds are 0.064 and 0.313, respectively, while the ICC's value is 0.194 with a significance level of 0.002.

5. Conclusion:

New teaching-learning paradigms and instructional tools have been made possible by technological advancements in the twenty-first century. Online learning is one of the ideas created by such advances. Mean, standard deviation, and the chi-square test were the data analysis techniques used for quantitative

data, and they were all processed by SPSS. This study emphasizes the considerable influence of online learning and teacher effectiveness on higher secondary students' mathematics proficiency. The results show that the crucial effective teaching methods and the use of online learning can raise students' mathematics performance. Students' learning achievements in mathematics are greatly influenced by teachers who exhibit excellent instructional quality, have solid pedagogical content understanding, and successfully manage their classes. Performance improvements are a result of their knowledge, their capacity to hold students' attention, and their capacity to explain complex concepts in simple terms and provide encouraging feedback. Additionally, incorporating online learning into math instruction is advantageous. Interactive learning platforms, online resources, and virtual classrooms offer chances for group conversations, cooperative problem-solving, and individualized learning. Despite the benefits of online learning, obstacles like technological difficulties and the lack of widespread access to dependable internet connectivity must be resolved. For successful implementation, it is also important to promote digital literacy among teachers and students and to provide proper training in online teaching approaches. The conclusions of this study indicate that it is crucial to fund programs for the professional development of teachers to advance their instructional abilities, content knowledge, and classroom management techniques. Additionally, educational institutions ought to place a high priority on the creation of digital infrastructure, guarantee fair access to online materials, and aid teachers and students in successfully navigating online learning environments. Addressing these issues will enable educators, policymakers, and curriculum creators to support effective teaching methods and fully use the advantages of online learning to improve mathematical achievement among students in higher secondary-level students.

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