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Effect of the Technology-Supported Learning on the Academic Performance of Secondary School Students

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Abstract *A Posttest only Controlled Group Experiment research was used to explore the effect of teaching through the technology- supported environment on learners' performance. Students of Biology group Grade IX, (n = 177), from public schools of Karachi, participated in the experimental research for 20 weeks in the year 2016-17. The technology-supported learning was intervened in the experiment group whereas, a conventional teaching was intervened in the controlled group. The annual examination's 2017 result was examined and scores of both experimental and controlled participants were compared by the independent sample t-test. The data analysis showed a noteworthy variance in the scores of controlled and experiment batch. The research recommended creating a technology-supported learning environment for Biology students at public secondary schools Sind, Pakistan. Thus the current research recommends a technology-supported learning environment for students.*

Key Words: Technology-Supported Learning, Child as a Digital Explorer, Teacher as a Digital Immigrant, 21st Century Learning Skill

Introduction

The use of technology in teaching is now a global phenomenon with various aspects currently under consideration to make it even better. Scholastic activities such as teaching, learning, and testing are incomplete without the vibrant use of technology and its related advancements. Child of 21st century opens his or her eye in a digital environment, thus today's child acts as a digital explorer who acquires information and investigates phenomena by using digital tools such as internet, mobile phones, iPad, e-book and other forms of digital interaction are features of daily life. Green, Facer, Ditton, and Humphreys (2005) therefore suggest modifications in education system by aligning its components with leaners' strengths, interests, abilities and needs (as cited in Desjardins, 2011). Rideout, Foehr, and Roberts (2010) stated that today's generation of learners, often called digital natives, are different from any generation that has come before them. Today, learners live in a digital environment, as they start getting influenced by digital media even at the time when their brains are still developing. Prensky (2010) found that in 21st century digital environment, learners spend around 5,000 hours of their lives in reading from books only,10,000 hours for playing video games and over 20,000 hours, spend in watching television. When learners enter an education system, they and their teachers face a number of challenges. One of such challenges is teachers' ignorance of digital learners' learning demands (Rikhye, Cook & Berge, 2009). It is thus imperative that teachers understand digital learners' learning demands and acquire sufficient knowledge and skills so that they can create technology enabled learning environment for the students (Rashid & Asghar, 2016).

With the rapid change of the technological environment in the world, a basic need is to prepare students to match the technological environment. The use of technological-supported teaching methodology in secondary school is also gripping the attention of many practitioners including teachers, teacher educators, researchers and philosophers globally. The growing tendency among the practitioners to make technological-supported teaching and learning a part of routine classroom teaching is now taking routes in traditional Pakistani classrooms. This

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encouraged the Government of Pakistan to bring reform in the curriculum which matches the digital native learners. Jamil (2009) argued that after a long period of abandonment and inertia, curriculum reforms have been proceeding since 2001. In Pakistan Curriculum revision was undertaken in 2005-6 of all grades and subjects and technology support was suggested for the provision of a conducive learning environment. Khokhar, Gulab and Javaid (2017) found that classrooms were becoming a hub of pedagogic experiences with the growing use of technology and related instructional designs in Pakistani educational contexts. Khokhar et al. (2017) discovered that out of 120 teachers, 75 percent professionally qualified secondary school teachers demonstrated reluctance in using digital devices as in - classroom learning material in their classroom. Only 21 percent of them considered themselves prepared to teach technology-supported lessons. Information communication technology (ICT) has brought with itself a humongous expansion in classroom pedagogical practices. In the Pakistani scenario, public schools' teachers have minimum opportunities of attending workshops and short courses to enhance their individual teaching skills. Thus teachers from public sectors have less awareness of innovative teaching styles applicable in a technology–supported learning environment. In addition, public sector schools' teachers consider the technological atmosphere a big challenge and a mismatch with their styles of teaching. They consider their conventional teaching sufficient and the technology-supported environment insignificant to enhance students' academic performance and an additional load for both learners and teachers. The current research thus attempted to explore whether or not technology- supported learning environment has a significant effect on students' learning outcomes when, compared to the conventional teaching.

Review of Related Literature

A number of researches identified the positive significant outcome of using technology as teaching tool on the learning outcomes scores of pupils. Laurillard (2013), Tidd and Bessant (2018), Healey (2018), Tondeur, Baruch, Prestridge, Albion, and Edirisinghe (2016), Genlott and Grönlund (2016), Hwang, Lai and Wang (2015), Casey, Goodyear and Armour (2017), Blanchard, Prevost, Tolin, and Gutierrez (2016) and Uluyol and Şahin (2016) have provided empirical proves for a significant effect of technology integration as teaching tool in schools and classrooms. Haas (2005) reported a significant effect of technology-supported environment on students' learning. Similarly, Salvara (2016) reported a substantial correlation betwixt student learning outcomes and the use of digital devices as a tool for in-class learning material (as cited in Moreno, 2016). Salvara further explained that learners come to schools from different backgrounds, socio-economic status or having varying learning styles and interest, be that as it may, it is a major task for a teacher to satisfy students' needs. In relation to technology use, the literature emphasizes the necessity for educators to modify their teaching in order for the potentials of technology to be realized. The paradigm of technology could be a source of bringing a drastic variation in the educational system of Pakistan, especially in public sector schooling system. Such a paradigm shift can enhance the educational standards in the schools of public sector. Ganyaupfu (2013) conducted a quantitative research (n = 109) and found that there is a disparity effect of teaching styles on learners' performance scores when teaching with three teaching styles. The teacher-student interactive method followed by learners–centered approach was found to be the most effective one on comparison with teacher-centered. Previous researches such as Hakkinen, Jarvela, Makitalo, Ahonen, Naykki and Valtoen (2017), Blaschke and Hase (2016), Stronge (2018) and Cronjé (2018) statistically proved and concluded that 21st century needs a change in teaching style that match with 21st-century learner's learning style. Bashir, Mahmood, and Shafique (2016) found that when undergraduate and alumni students from the University- campus of Punjab used the technology both at the campus Library's Digital Lab Unit and at home, their academic performance was improved. Thus Bashir el at. (2016) recommended that educational institutions must have ICT-based courses for students if the focus is their academic performance. Additionally, Mahmood, Khattak, Haq, and Umair (2018) argued that for 21st-century digital learners, a comprehensive reform with a great focus on technology is to be required. Young (2008) found a positive attitude among students after using technology tools in the public school classroom. Young further elaborated that schools must play a dynamic role to prepare learners for the 21st-century technology-dependent world. It is thus important that teachers incorporate ICT tools in their pedagogical practices.

The Technology Acceptance Model (TAM) guided the current research study; it is one of the widely used models in education. For example, Teo, Lee, and Chai (2008) used the TAM framework in Singapore and examined the pre-service teachers' attitudes (n= 239) towards using technology. Findings indicated that a positive perception of the usage of technology does not only make the work easy but it also plays a great role in increasing user's efficiency. Azawei, Parslow, and Lundqvist (2017) suggested that TAM is a strong and perfect model to understand the role of individual factors and their relationship with willingness to use and practice technology. Ahuja and Thatcher (2005) and Teng (2015) stated that the TAM model referred to information system theory which explains how a user accepts technology and make it habitual (as cited in Durodolu, 2016). Teng argued that behaviour determines the intention to use a system, and intention to use a technology is determined by the attitude of a person towards using the system. Liaw (2008), Shin and Kang (2015) claim that TAM has attracted significant attention of practicing teachers and researchers in e-learning. The TAM model predicts the technology related human behaviour which includes whether to accept or reject the use of technology. Many of the previous researches like Azawei, Parslow and Lundquist (2017), Shin and Kang (2015), Sun, Tsai, Finger, Chen and Yeh (2008), Wixom and Todd (2005) encouraged using the TAM for the current research.

Integrative literature review reported a number of studies that signify the increase in performance and satisfaction of learners when they used technology tools in their teaching-learning process. Using a survey (n = 212), Tennyson (2010) found that technology-enabled environment had a noteworthy learning outcome on the learners' performance. In addition, Wilkins (2012) found that learners were largely satisfied in using technology in their learning process. Findings of Aishereef (2013) showed that the online networking plays a vital part in students' gratification with the online courses.

Gilakjani and Sabouri (2017) stated that the use of technology in education unlocks a new epoch of information and supports as a catalyst tool to enhance teaching styles. Other researchers (as cited in Gilakjani, 2017) agreed that technology assists teachers to enhance their teaching styles. Rodriguez, Peterson, and Ajjan (2015) argue that some of the on line networking namely, Facebook, YouTube blogs, and educational websites can be used in the teaching-learning process to enhance performance. Greenhow and Lewin (2016) stated that using social media promotes a student-centered learning approach among secondary school students, the tools which are used let learners interrelate and cooperate with each other.

Aishereef (2013) suggested that educational institutions should be ensuring understanding and use of social network technology within the classrooms. However, there has been an inconsistency between the widely accepted promise of technology to transform teaching and learning and actual results and experiences in the field. Secondary schools in Pakistan are in particular need to realize that the world today is evolving and social networking and collaboration is the demand of today's technological world. This two-group post-test controlled group experimental research explored the effect of teaching instruction on the learning outcomes of secondary school learners in a technology-supported environment in mainstream public school, Karachi, Pakistan.

Considering TAM as a base model, the current experimental research provided a technology-supported learning environment for randomly assigned participants to an experimental group (n = 88) and a conventional teaching experience for randomly assigned participants to a control group (n = 89) for 20 weeks and evaluated whether or not a technology-supported environment has a significant effect on learning outcomes of participated learners in Biology subject. (See conceptual framework in Figure 1).

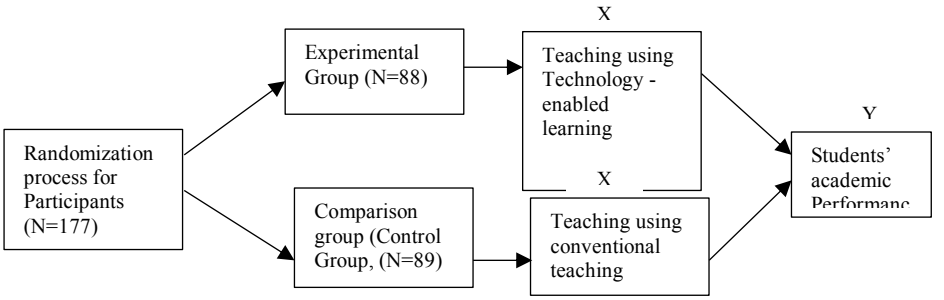

Figure 1: *Conceptual Framework*

The investigation attempted to answer, how *well technology-supported learning classroom environment predict the academic performance of the mainstream secondary school students?* The following hypotheses guided data analysis for the current research.

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

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

Where μ1= mean scores for posttest of the controlled group, μ2= mean scores for the posttest of the treatment group. Figure 1 illustrates the conceptual framework of the study.

Methodology

The current research was guided by the randomized posttest-only control group experimental group research design (Cox, 2019). The study employed two groups of participants: one that received a technology-supported learning environment and the other controlled group that continued experiencing the conventional teaching method. Mackinnon (2015) discussed that designing an intervening variable which is known as an independent variable or dominant variable in experimental research provides a dynamic role in connecting the link between the manipulated variable and the responding variable and also explaining the effect of the independent variable on the dependent variable. The target population of the current research was students from three high schools, enrolled in Grade IX, Karachi region, of Pakistan. Out of 177 public school students who participated in the study 60 (33.898%) were male and 117 (66.101 %) were female, the age of all students ranged between 14 and 17 years, out of which 36 (20.33 %) were between 14 and 15 years, 139 (78.53 %) were between 15 and 16 years and 12 (6.77 %) were between 16 and 17 years old. Among the teachers who participated in the study, 25 percent were holding Bachelor degrees of science and Education, 37.5 percent were holding Master degree in Science and Bachelor in Education, and 37.5 percent were holding Bachelor degree of Science and Master degree of Education. From the participants, 12.5 percent teachers had less than ten years of experience of teaching Biology, 37.5 percent had 11-15 years and 50 percent had 16-20 years of experience of teaching Biology.

An instrument for the performance of students comprised the set of standardized assessment papers prepared by the Board of Secondary School Education Karachi. After the treatment, the findings obtained through the test administration on the experimental group were analyzed by using the independent t-test and compared with that of the control group. Sedgwick (2012) stated that independent samples t-test is used when researchers are interested to compare means of the two dependent groups in a study to find the effect of the explanatory variable. In the current research, the means of both the treatment and control groups were compared after the intervention of 20 weeks of intervention. A pilot study was conducted to assess reliability of the research tool and improve upon the tool prior to the performance of a full-scale research study. The study was consisting of three phases, the first phase consisted of the teacher professional learning and development (CPLD) activities and enhancing teaching integrating technology in classrooms for the treatment group. The second phase was the provision of a technology-supported environment through the integration of technology in classroom. The intervention started on August 1, 2016 and ended on November 30, 2016. The third phase was the assessment of experimental group who had been taught with technology- supported learning and control group who had been taught conventionally. For teachers' CPLD, the Apricot Education System was involved and conducted Digital Learning Fundamental Course for 08 Biology teachers. A 6–day digital learning IT CPLD was scheduled for teachers from March 21 to March, 26 2016. Before starting the actual study, a parent-teacher meeting was called to deliberate the research objectives and procedure and to request them to allow smart cell phones or laptops to their children at school to fulfil the research requirements. Only eight (08) students were granted permission to bring smart cell phones and two (02) were permitted to bring lab tops in the intervention class. To enable students, use online sources, the school administrator agreed to arrange an internet device. After the teachers' CPLD, randomized grouping and pilot study, the main study was started which included 10 periods per week that is, two (02) consecutive periods of 35 minutes' duration each. The Biology textbook for grade IX, published by Sindh Text Book Board, Jamshoro, was taught in both groups. After 20 weeks of the intervention,

a post-test was conducted and performance scores of students in both the experiment and controlled groups were analyzed using the Independent Sample t-test through SPSS V-22.

Data Analysis

Before applying the Independent Sample t-test to test the H-null, all assumptions such as random sampling, dependent variables measured on an interval, reasonable large sample, homogeneity and normal distribution of data were satisfied. The data is considered normally distributed if its values remain between – 1.96 and + 1.96 after dividing the skewness values by its standard error. Similarly, the data is said to be free from outliers if the values of kurtosis remain between – 1.96 and + 1.96 after dividing the kurtosis values by its standard error (Thode, 2002). Table 1 presents the normality test for the current research. The values of skewness, after dividing by its standard error, remain between the threshold values (Skewness = .063/.183 = -0.334). Similarly, the values of kurtosis, after dividing by its standard error, remain between the threshold values (Kurtosis = -.684/.363 = -1.88). Therefore, the data for the current research was considered normally distributed and fit for the Independent Sample t-test.

Table 1. Normality Test

		Statistic	Std. Error
	Std. Deviation	11.552	
	Skewness	-.063	.183
	Kurtosis	-.684	.363

Table 2. Descriptive Statistics

	Group	N	Mean	SD	SE
Scores	Controlled Group	89	50.43	7.006	.743
	Experiment Group	88	69.17	6.555	.699

The Table 2 provides 'descriptive statistics' of the scores in Biology subject across control and experiment groups. As per the results portrayed in the table, the students in the control group gained 50.43 mean scores and experiment group gained 69.17 mean scores. This implies that the performance of the students was improved in Biology subject due to the intervention. The descriptive statistics showed the value of Std. Deviation (SD) for controlled group is 7.006 and for treatment group it is 6.555. The coefficient of variation (CV = SD/Mean) for both the control group (.139) and the experiment group (.095) are less than one (1) thus it can be concluded that the CV for both the groups is low and the SD is spread out around the mean.

Table 3. *Independent Samples t-test, Main Study*

	Levene's Test for Equality of Variance							95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Score Equal Variances assumed	.416	.52	-18.374	175	.000	-18.743	1.020	-20.76	-16.73
Equal variances not assumed			-18.38	174.470	.000	-18.743	1.020	-20.756	-16.73

Table 3, Independent Samples t-test, spectacles the outcomes extreme significant to the Independent Samples t-test. Table 3 shows two measures that deliver altered units of evidence: (A) Levene's Test for Equality of Variances and (B) t-test for Equality of Means. In Table 3, F is the indicator of Levene's test that was used to measure the equality of variances for the control and experiment groups. As the p-value for the Levene's test is greater than .05 (Sig. = .520), it can be determined that there is an alteration between the variances of the sample. It is also established in Table 3 that the sig. values for the t-test are less than .05 ($t_{175} = 18.743$, $p < .001$). Thus the H-null (Ho: $\mu_1 - \mu_2 = 0$) is rejected and the alternate hypothesis (H_a: $\mu_1 - \mu_2 \neq 0$) is accepted. The finding from the hypothesis testing determines significant difference in the performance of secondary school students who were taught Biology in a technology-enabled environment and in those who were taught in a conformist / traditional teaching-learning environment.

Table 2 indicates that the mean performance scores of the treatment on the posttest are higher than the control group (Control Group = 50.43, n = 89; Experiment Group = 69.17, n = 88). It can therefore be concluded that students who were taught in a technology-supported environment performed better in the examination administrated by the Board of Secondary School Education Karachi than those who were taught in a conventional teaching environment. Lakens (2013) suggests calculating Cohen's *d* to determine the effect size of the intervention provided to the experiment group. For the t-test, Cohen's *d* can be determined by mean difference between the experiment and the control and dividing the finding by the pooled standard deviation. For the current research, the effect size is calculated below:

$$SD_{pooled} = \sqrt{((SD_1^2 + SD_2^2)/2)} \quad \text{..... (Eq. 1)}$$
$$= \sqrt{((7.006^2 + 6.555^2)/2}$$
$$= 6.784$$
$$\text{Cohen's } d = (M_2 - M_1) / SD_{pooled} \quad \text{..... (Eq. 2)}$$
$$= (69.17 - 50.43)/6.784$$
$$= 2.76$$

Cohen (1988) explained that the effect size could be interpreted as small, medium and large if their obtained values lies respectively as 0.2, 0.5 and 0.8. Since the effect size calculated for the current research is large ($d = 2.76$), it can be concluded that the technology-supported environment has a large effect on the performance of secondary school Biology students in the examinations conducted by the Board of Examination, Karachi.

Result

The outcomes of the data analysis recommended that strong validity existed among the independent variable and dependent variables. It also shows that there is a significant association between teaching styles in classroom practices with performance of learners. Such significant relationship has also been found in various other research studies. Aloraina (2012) determined that there was statistical significance variance between the experiment group and controlled group at a significance level of 0.05 when using computer and multimedia technology in treatment class while other controlled class was treated with traditional discourse techniques. Sung, Chang and Liu (2015) analyzed the empirical research and they found that there is a positive effect on achievement scores while teaching -learning take place in technology-supported environment.

Finding of statistics analysis exhibited a significant difference in the means of two group, and it was concluded that teaching using technology –supported learning was effective teaching strategy when compared with teaching using conventional in control group. The analysis revealed that teaching biology using technology as teaching tool at secondary school level had a significant effect on performance of students. Kremer, Brannen and Glennerster (2013) suggest matching teaching pedagogy with learners' learning style at secondary school level, Glennerster et al. (2013) further explained that technology would potentially improve teachers' pedagogy and students learning. The current research provided an empirical evidence for the positive effect of technology-supported environment, thus such environment can be considered as a quality /standard teaching and learning technique for public school classroom.

Conclusion

The result of present research study has contributed both in theoretical as well as practical implication for academic practice. Research recommended that at secondary school level, Department of Education, Government of Sindh, provides not only a comprehensive technology-based training for all teachers but also allocate handsome budget for improvement of technology-supported learning environment in all public sectors schools to ensure that each student is getting quality education. Digital learning fundamental course provided support to integrate ICT in teaching Biology. This research suggested that digital learning fundamental course would develop ICT skills among teachers and students both nationally and internationally. Government should recommend this course to all secondary teachers from public sector secondary level. This research presented lesson plans with web links to understand the different concept of Biology, in this regard distance learning would be benefited for irregular and e- learners. The present research is proposed as a starting point for filling the gap in the local context and paves the way for future comprehensive research in all subject taught at secondary and primary level, so that a better understanding of the 21st century learner, teacher classroom could be expected for teaching different subjects for different Grades.

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