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THE MEDIATING ROLE OF TECHNOLOGY BETWEEN STUDENTS' ATTITUDES AND ENGAGEMENT TOWARDS SCIENCE: A QUANTITATIVE STUDY OF STUDENTS' PERCEPTION

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ABSTRACT

The attitude of students towards science is an important issue around the world. This study is an effort to enhance student's engagement by increasing their interest in science through technology. This study aimed to find the mediating role of technology between students' academic engagement and their attitude towards science. We conducted a mediation analysis on 400 completed questionnaires filled by science students of wah Cantt, Pakistan. The surveys were distributed among the science students of matriculation, including the 9th and 10th class of 15 randomly selected secondary schools. This study explored the mediating role of technology attitude for learning as a mediating variable between students' academic engagement and students' attitudes towards science. The results showed that a technology attitude for learning is a partial mediator between students' academic engagement and students' attitudes towards science. Further, the study also showed the levels of students' academic engagement, students' attitude, and technology attitude for learning is prominent in male students as well as 10th class students as compared to females and students of 9th class.

Disciplinary: Science Education, Education Management.

1. INTRODUCTION

Education is a process that develops all individuals' capabilities to fulfill one's responsibilities in society. Investment in school leads to higher economic growth (Bridsall, 1999) through increasing innovation and technological changes in life. The quality of human resources plays a critical role in nations' progress (Khalid & Khan, 2006), which is strengthened by the standards of its educational system. Governments, schools, and teachers set these standards. For higher quality education,

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everyone must be highly skilled and professional. Teachers need educational expertise and skills. It can also help teachers to face the challenge of new technologies in teaching as different subjects of science need different skills for effective teaching and learning process.

Secondary school education connects primary education and working life. Secondary school shapes the future education and job by classifying into two significant categories called Science and Arts. Secondary school education develops attitudes, values, and skills required for socio-economic development. Technology is changing rapidly and transforming society as well. The role of science in the scientific and technological development of the nation needs not to overemphasize. That is why science is a compulsory subject at the primary and middle level.

In Pakistan, science is taught as a compulsory subject from grade one to grade eight, after that students may choose their field between sciences and arts. If they choose science, they further study the subjects physics, chemistry, and biology. At the high school level (SSCI and SSII), the proportion choosing the science option is only about 35 percent, which is lower than the estimated target decided by the government.

Secondary school, as a crucial stage of the education system, is traditionally academic and evaluated by an exam (Olssen & O'Neil, 2004). Education is an activity of learning and teaching, so teachers and students need to be involved equally. However, Students' education not only depends on the environment, curriculum, and teacher, but it is also very much dependent on their academic engagement, feeling, and perception about the subject they study. Student engagement is one of the most crucial elements of classroom learning. The issue of student disengagement with the subject of science is a matter of concern for educators both internationally and nationally (Fensham, 2004). The Relevance of Science Education Project (ROSE) identified key affective dimensions related to student engagement includes students' attitudes towards science.

Student's attitudes toward science and their teachers both work side by side in a given learning environment. If students' perspective is negative, they may perform poorly. Thus, Students need to develop a positive attitude toward science subjects and their teachers need to enhance the development of a strong foundation of science. Donavan (1967) stated that it is the attitude developed by the students who are likely to stimulate or stop further study of science.

The attitude of students towards science has been a center of interest in the field of science education for over the last four decades. Declining interest in science has been causing a problem in learning science because it affects the focus of a student in learning (Bae, 2002). A lot of research have been done on students' attitude towards science (Barmby et al., 2008; Simon, 2019) and have shown a continuous decline of school students in science (Anderhag et al., 2016; Dawson, 2000; Osborne et al., 2003; Potvin & Hasni, 2014). According to students after primary school, they feel more detached with science and find it more challenging to relate to practical life (Tytler et al., 2008). This declining attitude has been found in the starting of the elementary level of schooling (Kerr & Murphy, 2012; Pell & Jarvis, 2001) or secondary schools (Anderhag et al., 2016; Barmby et al., 2008; Häussler & Hoffmann, 2002; Osborne et al., 2003).

According to Haladyna & Shaughnessy (1982), students' attitudes toward science is determined by the teacher, student, and learning environment. Self-related factors like feelings and habits (Haste, 2004; Lemke, 2001; Roberts, 2002), teachers related factors such as teaching practices, teacher support, feedback, innovative teaching and learning strategies (Anderhag et al., 2016; Breakwell & Beardsell, 1992; Myers III & Fouts, 1992) and teachers' confidence in teaching science (Tytler et al.,

2008) significantly affect the students' attitude for science learning. Learning environment factors including School, classroom activities, the science curricula, or lab, students' relations with each other determine students' attitude towards science (Myers III & Fouts, 1992; Osborne et al., 2003).

In some studies, boys have positive attitude than girls and vice versa (Abbas et al., 2011; Weinburgh, 1995, Beauchamp & Parkinson, 2008; Dawson, 2000; Hill et al., 2010; Jones et al., 2000; Osborne & Simon, 2009; Schibeci, 2008; Weinburgh, 1995). Teachers should be confident in teaching science to improve the way of teaching science (Tytler et al., 2008). Further cultural, ethnicity, parental, religious have been found to be critical influences on attitudes toward science (Anderhag et al., 2016; Breakwell & Beardsell, 1992; Christidou, 2006; Dawson, 2000; Khishfe & BouJaoude, 2016; Kidman, 2010; Logan & Skamp, 2008; Lyons, 2006; Osborne et al., 2003). Few studies have also reported that students' knowledge about science at the primary level and Parental involvement also plays a crucial role in the development of scientific attitudes of students in later years of schooling for science (Tytler et al., 2008, Abbas et al., 2011; George & Kaplan, 1998; Wang & Wildman, 1995).

Therefore, the problem of negative attitudes toward science may originate from the primary level, and the solution should be started as early as possible with science when students are more receptive to new impulses(Anderhag et al., 2016). For this purpose, science subjects' curriculum is needed to be more appealing to students, through adding engaging, practical experiences (Barmby et al., 2008; Christidou, 2006). Besides, a considerable amount of international attention has been giving to the ICT for contributing immensely to economic, social, and educational change (R.B., 2008; Willinsky, 2014).

The usage of ICT in students' learning environment is considered as an essential factor for students' engagement. In the 21st century, the world is developing in various directions and introducing complex demands in careers, which is no longer attainable through old learning environments and learning paradigms (Avgerinou, 2015). ICT as a fundamental component of general education provides opportunities to students to develop valued skills and abilities including the ability of problem-solving, creative thinking, collaborating and innovating, as these competencies are vital for working 21st-century workplace (Cisco, 2011) through re-energized educational spaces, new curriculum as well as delivery methods. Thus the application of innovative information and communication (ICT) technologies facilitate educators in teaching and learning (Wilson & Boldeman, 2012).

2. LITERATURE REVIEW

Studies have shown that ICT is making significant transformations in students'learning, and Students using ICT facilities have higher learning gains. The learners in the 21st-century are called 'digital natives' because they are more accustomed to the recent technologies than the previous generation. The use of ICT at a young age is frequent as a source of information, entertainment, and social communication like blogs, wikis, podcasting, and social networking, etc. Information and communication technologies (ICT) have the power to engage disengaged students through the Internet, mobile phones and devices, games, digital photography, music, etc. (Wilson & Boldeman, 2012). However, there is very little use of ICT in classroom learning.

Hassan & Sajid (2012) confirmed the existence of barriers at various levels of teaching and

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learning to the integration of Information and Communication Technologies (ICTs) at the secondary level learning in Punjab, Pakistan. The participants showed positive perceptions about the integration of ICT into their teaching and learning, and Administration and ICT coordinators highlighted many barriers. The study emphasized the infrastructure, curriculum up-gradation, and teachers' training for better ICT integration in education at the secondary level.

On the other hand, (R. Abbas, Ashraf, Bowra, & Ahmad, 2011; Shah, Mahmood, & Harrison, 2013) explored the Pakistani students' attitude towards science learning through the scale of attitude towards science learning (AtSL). The results showed an increase in students' attitudes towards science learning with the change in grade, and girls were more inclined towards science learning than boys. Paternal education, occupation, and students' locality may affect students' attitudes for learning science; however, maternal education and occupation cause significant differences in attitudes towards learning science. (Anwar & Bhutta, 2014) concluded that student engagement is compulsory in science learning in order to keep their attitudes positive.

There are several studies relevant to ICT, students' attitudes towards science, and student engagement, but none of the studies has explained ICT as a mediator between students' attitudes towards science, and students' academic engagement. This study is motivated by the fact that a strong foundation in essential Science content and skills can enhance the students' interest in science learning through ICT integration (Jonathan Osborne et al., 2003). This paper tried to fill an identified gap in the research field by providing a mediating role of ICT in science learning for engaging diverse young students in science class at the secondary level.

3. CONCEPTUAL BACKGROUND

There is not a significant method to measure the impact of ICT on students' engagement. However, a bunch of literature has identified the substantial effect of ICT integration on the students, teachers, learning environments, policies, procedures, as well as pedagogies according to (Newhouse, 2002). There are several dimensions through which ICT can improve student learning. It includes students' ICT competence, engagement, learning outcomes. Learning Environment Attributes Teacher Professional ICT Attributes and School ICT Capacity. However; the impact of ICT integration on student engagement is still ambiguous. There are contradictory views regarding the use of ICT in education. The integration of ICT is still weak because of the rapid evolvement of technology. Currently, Pakistan is not only facing difficulties in the implementation of effective learning management systems in schools but also students do not have proper access to technology.

There is a growing body of research related to student attitudes and how they relate to student engagement. ICT is considered as a major factor affecting Student engagement. The intricacy of interrelationships between student engagement and student attitudes has forced to investigate other factors like the usage of technology for learning science. The use of computers and the internet makes students more motivated and attentive in class(Balanskat, 2006). Personal use of technology at home helps students to use in school in a better way more recurrently and with more confidence as compared to those students who don't use a computer or internet at home (Underwood, 2009).

4. METHODOLOGY

The present study employed the quantitative method. The questionnaires for the present study were adopted from different studies to assess the mediating role of technology between students'

attitudes towards science and academic engagement at its best. We used simple random sampling for selecting schools and students.

5. A SAMPLE OF THE STUDY

The city of Wah Cantt was selected from the province of Punjab. An equal number of girls and boys' schools were chosen from the city Wah cant. The population of the study is science students (SSC) from secondary school, specifically of 9^{th} and 10^{th} classes SSCI and SSCII, also known as part I and part II students. We used simple random sampling for selecting schools among 44 schools with 1300 faculty members and over 40000 students registered with the Federal board in Pakistan (FBISE). We distributed 450 questionnaires among secondary school science students of 15 randomly selected schools. A total of 400 completed questionnaires were used in the analysis.

5.1 DEMOGRAPHIC CHARACTERISTICS OF PARTICIPANTS

The survey method was used to collect the data. The researcher administered the questionnaire, and the said data was collected personally. Most of the respondents returned the questionnaires on the same day, but a few asked to return the day next. Students were asked to fill the survey for the given close-ended questions. Demographic factors included gender and level of education at SSC (SSCI/ SSCII). All the students were science students.

5.2 INSTRUMENTS

In this study, we used students' attitudes towards science as independent, student engagement as a dependent, and students' attitude towards technology as mediators. The mediating analysis in the Spss21 extension of Preacher and Hayes was done to examine the potential of technology or ICT as a mediator.

5.3 STUDENTS' ATTITUDE SCALE TOWARDS SCIENCE

The data for students' attitudes towards science was measured through Simpson – Troost Attitude Questionnaire (STAQ) (Liaghatdar et al., 2011). This questionnaire consists of 44 items on 5-point Likert-type scales as Always, Frequently, Usually, Rarely, and Never corresponding to the factors determining the attitude of science students at the secondary level.

5.4 STUDENTS' ACADEMIC ENGAGEMENT SCALE

Students' academic engagement scale was taken as outcome variable based on Utrecht Work Engagement Scale-Student (Schaufeli, Martínez, Pinto, Salanova, & Bakker, 2002). The UWES-S is a 14 items scale that covers passion, dedication, and concentration. The 5-point Likert-type scales as Always, Frequently, Usually, Rarely, and, Never were used.

5.5 TECHNOLOGY ATTITUDE SCALE FOR LEARNING

Technology attitude scale for learning as a mediator of this study measured the access, perceptions, and learning with technology. The Items 1-11 of the survey are related to the students' access to technology for indicating their level of access to different types of technologies. The access for technology was measured through a 3-point Likert scale as 1=no access, 2=limited access, and 3=full access. Items 12-19 of the survey helped to measure the students' perceptions of learning with Information and Communication Technology. 5-point Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree) was employed for each item in order to indicate the degree to which they feel towards technology-based learning. Attitudes towards the use of technology for

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learning Items 20-28 measured students' attitudes towards the use of technology for learning; for each item, a 5-point Likert scale was used (Chenoby, 2014).

6. MEDIATION ANALYSIS

The mediating analysis was conducted with the help of the Spss21 extension of Preacher and Hayes to capture the mediating part of technology attitude for learning between students' academic engagement and students' attitudes towards science where students' academic engagement and students' attitude towards science were treated as dependent and independent respectively.

7. RESULTS

7.1 PARTICIPANT CHARACTERISTICS

The data showed an almost equal number of female and male students in science class with a little number of boys greater than girls. As out of the total number of science students participants, 204 boys and 196 are girls. Participants' characteristics were observed not only for all participants but also at gender and SSCI level as SSCI and SSCII.

7.2 CORRELATION ANALYSIS

Descriptive statistics and correlations are given below. Pearson's correlation coefficients were used to examine correlations. Table 1 showed the results of descriptive statistics and the correlation between students' academic engagement, students' attitude, and technology attitude for learning. The correlation analysis showed that students' academic engagement, students' attitude, and technology attitude for learning are significantly and positively correlated with each other.

Table 1: Descriptive statistics and correlations for Students Academic Engagement, Students Attitude, and Technology Attitude for Learning (N=400)

Scales	Mean ± SD	1	2	3
Students' Academic Engagement	37.033±2.79	1	-	-
Students' Attitude towards science	131.258±9.29	.588**	1	-
Technology Attitude for Learning	69.163±6.46	.603**	.166**	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

8. MEDIATION ANALYSIS

The mediating analysis was conducted to capture the mediating part of technology towards learning. In mediation analysis, students' academic engagement as an outcome, students' attitude towards science as an independent variable while technology attitude for learning was taken as mediator.

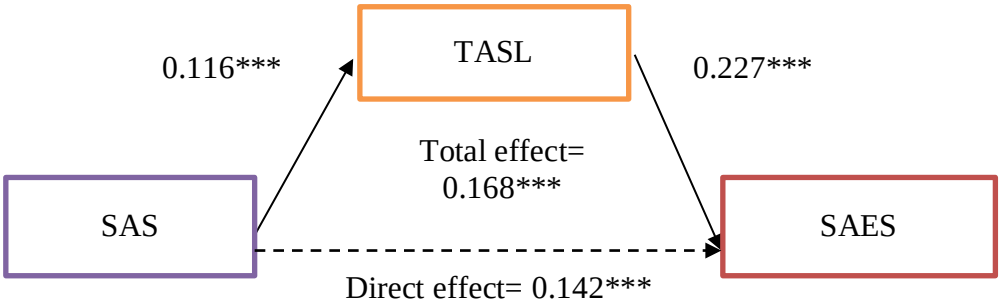

Figure 1: Mediating analysis, Students' Academic Engagement as an outcome, Students Attitude as Independent variable and Technology Attitude for Learning as Mediator

Figure 1 showed that technology attitude for learning partially mediate the relationship between students' attitude and students' academic engagement where

TASL = Technology attitude scale for learning

SAS = Students' attitude for science

SAES = Students' academic engagement scale

8.1 INDEPENDENT SAMPLES T-TEST

The independent samples t-test tests were used to compare the differences among Students' Academic Engagement, Students' Attitude towards science and Technology Attitude for Learning at gender as well as class level.

Table 2: Gender-Based Differences among Students' Academic Engagement, Students' Attitude and Technology Attitude for Learning

	Male		Female			
	(n=204)		(n=196)			
Variables	M	SD	M	SD	T	P
Students' Academic Engagement	37.348	2.80	36.704	2.75	2.318	.021*
Students' Attitude	132.907	7.99	129.541	10.21	3.681	.000***
Technology Attitude for Learning	70.162	7.15	68.122	5.48	3.193	.002**

Table 3: Class-Based Differences among Students' Academic Engagement, Students' Attitude, and Technology Attitude for Learning

	1st Year		2nd Year			
	(n=227)		(n=173)			
Variables	M	SD	M	SD	T	P
Students' Academic Engagement	36.621	2.89	37.572	2.57	-3.420	0.001**
Students' Attitude	130.397	9.40	132.387	9.04	-2.134	0.033*
Technology Attitude for Learning	68.282	6.50	70.318	6.24	-3.159	0.002**

Tables 2 and 3 depicted the results of independent samples t-test tests to compare the differences in the levels of students' academic engagement, students' attitude and technology attitude for learning between gender as well as SSC level. The results showed higher levels of students' academic engagement, students' attitude, and technology attitude toward learning in male students as compared to female students. Similarly the levels of students' academic engagement, students' attitude, and technology attitude for learning higher in the students of 2nd-year class that that of 1st-year class.

9. CONCLUSION AND RECOMMENDATION

This study was an effort to increase the level of engagement in science subjects by making it more entertaining through using technology. The best way to engage students can be found by asking students about it. Therefore in this study, the students were asked about their attitudes and level of engagement for science subjects. The questionnaire for showing their attitudes for science included several factors that can probably determine their attitude towards it, like the perception of students about science teacher, teaching method, the environment of science class, study habits for science subjects, likeness or dislikes for science, the attitude of family and friends for science, dedication, and anxiety towards science. Similarly, students can tell accurately how much engagement they feel during studying science. The finding revealed that technology might work as a partial mediator for

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science students and thus can enhance their engagement in science by making science more entertaining and enjoyable.

Pakistan is a developing country, and continuously struggling with ups and downs condition so as its education system. In this current situation, the government can't integrate ICT in every school because of the limited budget. However, students do have access to different technology devices outside of school, and they are learning a lot from it. But there is a still need for technology integration in schools like other countries in the world. According to studies, In Pakistan, luckily students have positive for science as compared to the world's declining trend in science. There is just a need to be aligned with the world ICT integration policy set by Millilium development goals so that students can enjoy science and their positive attitude towards it can be maintained. However, this study is just limited to science learning, but it can be applied to any other subjects of secondary education as well as for other specific science subjects at different levels of education.

10. AVAILABILITY OF DATA AND MATERIAL

Information used and generated from this work is available by contacting the corresponding author.

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