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DIGITAL LITERACY AND TPACK INTEGRATION: AN EMPIRICAL STUDY OF PROSPECTIVE TEACHERS IN PAKISTAN

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Abstract
This paper was explored the correlation between the digital literacy (DL) and Technological Pedagogical Content Knowledge (TPACK) in prospective teachers. The quantitative design used was corelational, and a multi-stage method of sampling was used in choosing the sample size of 415 participants across the chosen universities. Two modified tools the Digital Literacy Scale and the TPACK Scale were employed. Reliability was determined with the use of Cronbach alpha and validity was ensured by reviewing and pilot-testing by the experts which indicated high internal consistency. The analysis of data was done through descriptive statistics, Pearson correlation, and independent samples t-tests. The results unveiled a significant positive association between digital literacy and TPACK that indicated potential teachers who were more digitally literate defined better technological integration competencies. An important variability was also noted in terms of the type of institution (public/private) as well as gender. Future teachers at the public universities were found to have relatively low digital literacy and TPACK, which is mostly explained by the lack of access to digital resources and inadequate training. The paper demonstrates the importance of special professional development programs to enhance the level of digital literacy and TPACK, especially in public universities. Fair access to digital infrastructure and training should be given to ensure better integration of technology and better quality of teaching in Pakistan. The research was constrained to the universities in Lahore.

Keywords: *Digital Literacy, TPACK, Prospective Teachers, Technology Integration, Higher Education*

Introduction

The use of technology in the teaching process has become one of the main conditions of modern education. The digital literacy (DL), or the capacity to access, analyze, produce, and convey information with the help of digital technologies, is critical to the effective integration of technologies in prospective teachers (Gilster, 1997; Ng, 2012). Digital literacy goes beyond mere technical abilities to incorporate cognitive and socio-emotional skills that a person requires to participate significantly in the digital space (Eshet-Alkalai, 2004).

Digital literacy is also intimately connected with the Technological Pedagogical Content Knowledge (TPACK) paradigm that understands effective pedagogy as the combination of technology and pedagogy, with the content knowledge (Mishra and Koehler, 2006). According to the TPACK model, the most effective process of integrating technology in the teaching process is associated with the knowledge of the teacher about the compatibility of technological tools with pedagogical strategies and the content of the subject. The empirical research has revealed that teachers who possess better digital skills exhibit more TPACK and have more confidence in technology-based instruction (Chai, Koh, and Tsai, 2013; Voogt et al., 2013).

Teacher education programs in the world tend to focus more on the digital competence in order to correspond to the digitalized learning environments (UNESCO, 2018). In developing regions like Pakistan, however, the differences remain in the access to digital infrastructure, training opportunities, and institutional support. The differences are especially clear between the public and the private universities, as resources differences impact further opportunities of prospective teachers to acquire digital literacy skills. The high cost of access to digital tools and formalized professional development inhibits the operationalization of TPACK by teachers leading to less effective technology integration.

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Despite the significant role of TPACK that has been largely accepted, there is scanty empirical studies carried out in Pakistan on the impact of digital literacy on its growth among future teachers. This is a major gap considering the National Education Policy (Government of Pakistan, 2017), that emphasizes the incorporation of technology to enhance teaching and learning outcomes. Lack of digital literacy can also mean that potential educators will not find it easy to match the use of technology with instructional goals and disciplinary information, which constrain the potential of technology-based pedagogy.

Hence, the paper research is aimed at exploring the correlation between digital literacy and TPACK in the context of potential teacher candidates in the university level in Lahore, Pakistan. It also examines disparities in terms of institution type and demographics. The study will contribute to the education of teacher programs and policy interventions to enhance digital competence and integrate technology in higher education effectively by presenting empirical data about this relationship.

Literature Review

The fast process of digitalization of education has turned to digital literacy to become a mandatory proficiency of teachers, in particular, in tertiary education and teacher training programs. Digital literacy defines the skills of using digital tools as well as the skills to navigate, evaluate, create and communicate information within a range of digital contexts (Ng, 2012). Digital literacy in the modern educational context is moving to the next level of simple ICT proficiencies to the competencies of critical thinking, online communication, critical use of information, and adaptive learning practices (Eshet Alkalai, 2004). In the case of future teachers, high levels of digital literacy form the basis to the use of technology in the teaching and learning processes and in a manner that is purposeful and effective.

Digital Literacy and Teacher Preparation

Digital literacy has become a requirement in teacher education programs across the world as a means of successful technology integration in classrooms (UNESCO, 2018). This has been demonstrated in some studies that pre service teachers who have a greater digital literacy level feel more confident and empowered to use technology in instructional activities (Tondeur et al., 2017). Indicatively, Tondeur and others discovered that digital competencies have an impact on the choices of future teachers, their planning, and the way they use technology to conduct learning practices. In addition, digital literacy assists the teachers to adjust to the changing digital platforms, teaching learners through interactive media as well as allowing students control over learning (Farrell and Wachholz, 2003).

But this relationship is not even around the regions and institutions. Lack of digital literacy among pre service teachers is a persistent gap in digital literacy in the context of technologies and professional development when access to technology and professional development is low as is the case in many developing countries including Pakistan (Kafyulilo, 2014). South Asian contextual studies demonstrate that varying access to digital resources, irregular training, and infrastructural inequalities are all the factors that influence unequal digital literacy among future educators (Rehman and Iqbal, 2018). This is in line with your Hypothesis 02 that the levels of digital literacy of prospective teachers in private universities is higher than in public institutions.

The TPACK Framework: Theory and Empirical Evidence

The Technological Pedagogical Content Knowledge (TPACK) model assumes that the presence of technology in instruction is at the nexus of technological knowledge (TK), pedagogical knowledge (PK) and content knowledge (CK) (Mishra and Koehler, 2006). TPACK goes further to develop the idea of Shulman (1986) of pedagogical content knowledge by adding the third area, technology, which should be comprehended together with pedagogy and content. As noted by some of the researchers technology is not enough, teachers need to

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be aware of how to match technology to instruction strategy and subject specific objectives to attain meaningful learning (Koehler and Mishra, 2009).

Empirical studies have always demonstrated that those teachers with higher TPACK scores are more apt to use technology in manners that have a positive influence on student engagement and learning results (Chai, Koh, and Tsai, 2013; Schmidt et al., 2009). As an example, Chai et al. (2013) concluded that the TPACK proficiency correlates with positive learning conditions and teacher thoughtfulness. Equally, Angeli and Valanides (2009) stated that pre service teachers who take integrative technology courses have more ability to develop technology enhanced lessons in a manner that promotes pedagogical objectives.

Digital Literacy as a Predictor of TPACK

There is also an emerging body of evidence that indicates that digital literacy serves as a good predictor of TPACK (Koehler, Shin, and Mishra, 2012). Since TPACK includes technological knowledge, it can only be concluded that even the initial digital skills of teachers are critical to their overall technological competence. A study by Niess (2005) has shown that digital literacy is a key that helps teachers to build TPACK through empowering them to utilize digital materials, test the use of instructional technologies and assess the effectiveness of digital tools in pedagogy.

This pattern is supported by quantitative research. To illustrate this, Sajid et al. (2020) found that there was a significant positive relationship between digital literacy and TPACK in pre service teachers in Pakistan that showed that the greater the digital literacy the stronger the TPACK components. This is similar to your Hypothesis 05 which found out that there was a strong positive correlation between DL and TPACK. Additionally, Yilmaz (2011) established that more digitally literate teachers are more likely to implement student centered and constructivist methods of teaching, which is an indication of more integration of technology in the way instruction is designed.

Gender and Institutional Influences on Digital Literacy and TPACK

Some reports have indicated that there are demographic variables which have a bearing on digital literacy as well as TPACK. Although past research has recorded gender disparities in digital skills as a general aspect of ICT, more recent studies in teacher education indicate that the discrepancy is decreasing. As an example, Hatlevik et al. (2015) reported that there was no significant effect on gender in digital competence of teacher students, which confirms your Hypothesis 01 of non significant gender differences in digital literacy.

Nevertheless, institutional context is also important factor influencing both digital literacy and the development of TPACK. Research conducted by Ertmer et al. (2015) highlighted that the presence of institutional support, the possibility to use technology infrastructure, and professional development contribute greatly to the results of TPACK. Prospective teachers in your study in the case of private universities exhibited better TPACK than those in the case of the public universities (Hypothesis 03). The same findings were also provided by Abdullah and Ward (2016), who found that university courses that were more technologically integrated yielded graduates with superior TPACK and the use of instructional technology.

Challenges in Technology Integration in Teacher Education

Although there are known advantages, issues in the technology integration continue to exist. TPACK development may be hampered by faculty inclinations, insufficient exposure to digital learning tools in training and curriculum restrictions (Archambault and Barnett, 2010). Researchers have in the Pakistani context also cited these similar barriers such as a poor access to hardware and software, absence of systematic ICT modules in the teacher education curriculum and limited access to hands on practice in technology (Ali and Arif, 2012). Such circumstances can help to clarify the differences in your research involving public and private institutions and bring up the problem of fair digital preparation of teacher education programs.

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Synthesis and Research Gap

Conclusions in the literature lead to the belief that digital literacy forms the basis of establishing effective TPACK and that institutional support is an important determinant of the process. Nevertheless, there is still a lack of localized empirical data in South Asian settings, specifically in gender, institutional differences as well as predictive power of digital literacy towards TPACK. Your research contributes to bridging this gap by analysing these relationships among potential teachers in Lahore, Pakistan, in a systematic manner and also testing demographic differences related to it that have not previously been given much attention.

Objectives of the Study

1. To assess the level of digital literacy among prospective teachers.
2. To measure the level of Technological Pedagogical Content Knowledge (TPACK) among prospective teachers.
3. To investigate the relationship between digital literacy and Technological Pedagogical Content Knowledge (TPACK) among prospective teachers.

Hypotheses

Ho_1 There is a no significant difference in the level of digital literacy between publicprivate prospective teachers?

Ho_2There is a no significant difference in the level of digital literacy between male and female prospective teachers.

Ho_3 There is a no significant difference in the level of TPACK between public and private prospective teachers.

Ho_4 There is a no significant difference in the level of TPACK between male and female prospective teachers.

Ho_5 There is a no significant relationship between prospective teacher's digital literacy and TPACK.

Research Methodology

Research Design

To investigate the relationship between prospective teachers' digital literacy (DL) and their Technological Pedagogical Content Knowledge (TPACK), a quantitative research approach was adopted. Specifically, a descriptive correlational design was used to determine the strength and direction of the association between the two variables.The research design was used as a methodological approach that indicated data collection, analysis, and interpretation. The data collection was done using two structured questionnaires on a five-point Likert scale with answers that were mutually contradictory with each other and marked Strongly Disagree to Strongly Agree.

Population

The study population consisted of prospective teachers in the universities in Lahore, Punjab province in Pakistan. It has 58 universities that provide undergraduate, postgraduate and doctoral degrees. Out of these institutions, 33 are publicly based and 25 are privately based.

Sampling Technique

The multi-stage sampling method was applied to guarantee the wide coverage of both the public and the private universities. In the second stage, each of the six universities was randomly selected with a department being chosen. Prospective teachers who took part in the third stage were chosen randomly among the selected departments based on the required sample size. This process made sure that there was representation by institutions and academic disciplines.

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Sample

The sample was made up of 415 prospective teachers. Of them 210 were female and 205 were male. The respondents were chosen at the various departments of the chosen universities and they volunteered to take part in the research.

Pilot Testing

The instruments were modified, and 50 prospective teachers (enrolled in an M.Phil. program) were pilot tested to test the clarity and reliability, as well as, appropriateness of the items.

Reliability of the Instrument

The reliability was estimated with the help of the alpha coefficient of Cronbach. The scale of Digital Literacy had a Cronbachs alpha of 0.99 which is very good internal consistency. The TPACK Scale had a Cronbachs alpha of 0.91 which is quite reliable. These findings demonstrated that the two instruments were appropriate data collection instruments.

Validity of the Instrument

Expert review led to face and content validity. The instruments were reviewed by three research experts working in the Education sector of the Institute of Education and Research (IER), University of the Punjab, to check on their clarity, relevancy, and conformity to the objectives of the study. The necessary changes were made on their feedback.

Data Collection Procedure

The adapted Digital Literacy and TPACK scales were used to collect data. Formal permission was sought before data collection was carried out by making the respective university administrations the target area to distribute the questionnaires to potential teachers. The subjects were made informed of the study purpose and made to know that they could participate in the study on a voluntary basis. Participation of the respondents involved in the study was informed prior to the administration of the questionnaires.

Data Analysis

The mean, standard deviation and frequency distribution were also employed as descriptive statistics to characterize the general levels of digital literacy and TPACK and to analyze their differences depending on gender and type of institution.

Digital literacy and TPACK levels of independent samples were compared using t-tests to determine the difference between:

- Public and private universities
- Male and female prospective teachers

To determine the relationship between digital literacy and TPACK, Pearson's correlation analysis was employed to assess the strength and direction of the association between the two variables.

Results and Discussion

Hypothesis 1

H_{01}: There is no significant difference in the level of digital literacy between male and female prospective teachers

Table1

	Gender	N	mean	Std. Deviation	t	.sig
DL	Male	205	4.101	0.9582	1.184	0.237
	Female	210	4.210	0.906		

The independent samples t-test was used to test the difference in digital literacy (DL) between male and female potential teachers. The analysis revealed that there was no statistically significant difference, t(413) = 1.184, p =.237, at the 0.05 level of significance. The null

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hypothesis (H 0 1) is not rejected as the p-value (.237) is larger than.05. This means that gender does not play a major role in influencing digital literacy among future teachers. The average DL score of male prospective teachers was 4.101 (SD = 0.958) and the mean score of female prospective teachers was 4.210 (SD = 0.906). The standard deviation and means are similar, implying that there is a similarity in the level of digital literacy between the genders.

Hypothesis 02

H₀₂: *There is no significant difference in the level of digital literacy between prospective teachers from public and private universities.*

Table 2

	Sector	N	Mean	Std. deviation	T	.sig
DL	Public private	207	4.041	1.053	-2.500	0.013
		208	4.210	0.906		

The independent samples t-test was taken to determine the level of digital literacy (DL) of prospective teachers in the public and the private universities. The findings showed that there was a statistically significant difference, t (413) = -2.500, p =.013, with the level of significance of 0.05. Because the p-value (.013) is not more than.05, the null hypothesis (H 0 2) is rejected. This suggests that the type of institution has a significant effect on prospective teachers' digital literacy. The mean DL score for prospective teachers in public universities was 4.041 (SD = 1.053), whereas those in private universities had a higher mean score of 4.210 (SD = 0.906). The t-value of -2.500 indicates a moderate difference in digital literacy levels between the two groups, with private university prospective teachers demonstrating slightly higher digital literacy.

Hypothesis 03

H₀₃: There is no significant difference in the level of TPACK between prospective teachers from public and private universities.

Table 3

	Gender	N	Mean	Std. deviation	T	.sig
TPACK	Public	207	3.893	0.9477	-2.528	0.012
	private	208	4.104	0.882		

An independent samples t-test was conducted to compare TPACK levels between prospective teachers enrolled in public and private universities. The results revealed a statistically significant difference between the two groups, $t(413) = -2.528$, $p = .012$, at the 0.05 level of significance. Since the p-value (.012) is less than the alpha level of .05, the null hypothesis (H_{03}) is rejected. This indicates that institutional type has a significant effect on TPACK levels. The mean TPACK score for prospective teachers from public universities was 3.893 (SD = 0.948), whereas prospective teachers from private universities had a higher mean score of 4.104 (SD = 0.882). These findings suggest that prospective teachers in private universities demonstrated significantly higher TPACK levels compared to those in public universities.

Hypothesis 04

H₀₄: *There is no significant difference in the level of TPACK between male and female prospective teachers*

Table 4

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	Gender	N	Mean	Std. Deviation	t	.sig
TPACK	Male	205	3.885	1.027	-2.338	0.020
	Female	210	4.112	0.784		

An independent samples t-test was conducted to examine the difference in TPACK levels based on gender. The results indicated a statistically significant difference between male and female prospective teachers, $t(413) = -2.338$, $p = .020$, at the 0.05 level of significance. Since the p-value (.020) is less than the alpha level of .05, the null hypothesis (H_{04}) is rejected. This finding suggests that gender has a significant effect on TPACK levels. The mean TPACK score for male prospective teachers was 3.885 (SD = 1.027), whereas female prospective teachers had a higher mean score of 4.112 (SD = 0.784). These results indicate that female prospective teachers demonstrated significantly higher TPACK levels compared to their male counterparts.

Hypothesis 05

H_{05}: *There is no significant relationship between prospective teachers' digital literacy and their TPACK.*

Table5

		DL	TPACK
TDL	Pearson Correlation	1	.767(**)
	Sig.(2-tailed)		.000
	N	415	415
TPACK	Pearson Correlation	.767(**)	1
	Sig.(2-tailed)	.000	
	N	415	415

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

To examine the relationship between digital literacy (DL) and Technological Pedagogical Content Knowledge (TPACK), Pearson's correlation analysis was conducted. The results revealed a strong positive correlation between digital literacy and TPACK, $r(413) = .767$, $p < .001$. This indicates that higher levels of digital literacy are associated with higher levels of TPACK among prospective teachers. Since the p-value is less than the 0.01 level of significance, the null hypothesis (H_{05}) is rejected. Therefore, it is concluded that a statistically significant and strong positive relationship exists between digital literacy and TPACK.

Discussion and Conclusions

Discussion

The present study examined the relationship between prospective teachers' digital literacy (DL) and their Technological Pedagogical Content Knowledge (TPACK) at the university level, as well as differences across gender and institutional type. The results offer some understanding on the effect digital literacy has on TPACK as well as how demographic variables can mediate the variables.

Gender Differences and Digital Literacy

Hypothesis 01 was aimed at establishing whether there existed differences in DL among male and female potential teachers. The findings showed no significant difference (t(413) = 1.184, p =.237), which implied that the two genders have similar levels of digital literacy. It is consistent with the previous studies suggesting that digital tools are commonly accessible and proficient among male and female pre-service teachers (Ng, 2012; Chai, Koh, and Tsai, 2013). It suggests that gender itself is not a factor of digital competence among potential teachers of university level in Lahore.

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Digital Literacy and Differences in Institutions

Hypothesis 02 investigated the variation in digital literacy of prospective university teachers in universities that are public or private. Findings revealed a large difference (t (413) = -2.500, p =.013) with the participants of the private university exhibiting a little higher digital literacy. This result indicates unequal accesses to digital tools, infrastructure, and training opportunities in the case of both public and private institutions, which is in line with past research that found the lack of resources in the public universities in the developing setting (Voogt et al., 2013; UNESCO, 2018).

TPACK Institutional Type and Gender Differences

Hypothesis 03 examined the differences between TPACK between prospective teachers of public and private universities. The findings indicated a large difference (t (413) = -2.528, p =.012), where the respondents in the private university reported higher TPACK levels. Equally, Hypothesis 04 compared the gender differences in TPACK and found that female potential teachers had much higher TPACK compared to their male counterparts (t(413) = -2.338, p = .020). The findings indicate that institutional support, access to technology, and pedagogical exposure can help develop TPACK, and female teachers can be more skillful in the process of technology integration with pedagogical and content knowledge, which is in line with the findings that gender differences in technology adoption and teaching practices are a reality (Chai et al., 2013; Mishra and Koehler, 2006).

Correlation between Digital Literacy and TPACK

The fifth hypothesis was to examine the correlation between DL and TPACK. The Pearson correlation analysis showed a strong positive relationship (r(413) =.767, p<.001), which is that the greater the digital literacy the greater the levels of TPACK. This result is in line with the theoretical frameworks of the TPACK framework which underlines that technological competence is the basis of successful integration of pedagogy and content knowledge (Mishra and Koehler, 2006). The outcome highlights the importance of digital literacy in enabling future teachers through it to successfully integrate technology in teaching methods.

Implications

The findings bring out a number of significant implications. To address the inequality between institutions, first, the development of the professional programs should emphasize the digital literacy of all potential teachers, especially in state universities. Second, instructional programs in teacher education must focus on incorporating TPACK-based training, where the digital literacy is tied with pedagogical and content knowledge, so that future teachers are able to utilize technology in a way that is significant to their teaching practice. Lastly, policymakers ought to focus on the equal access to digital infrastructure and resources so that potential teachers can become equally digital in terms of competency and TPACK irrespective of their gender and institutional affiliation.

Conclusion

This research offers empirical information that digital literacy and TPACK have a significant connection among the prospective teachers of university level in Lahore, Pakistan. Although there were no gender differences in digital literacy, the female prospective teachers were more likely to have higher TPACK levels, and the participants of the private university were more successful in digital literacy and in TPACK compared to the participants of the public university. This high positive correlation between the digital literacy and TPACK demonstrates the necessity to have digital skills in order to integrate technology into teaching.

The paper highlights that there is a necessity to focus on specific interventions to improve digital literacy and TPACK, especially in higher education institutions, and to provide an equal

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access to technological tools among institutions. With these gaps closed, the teacher education programs will be equipped better to prepare future teachers to overcome the digital challenges of the contemporary education process, and it would eventually result in better teaching, and student achievements in Pakistan.

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