CHAPTER 4

ANALYSIS, INTERPRETATION AND DISCUSSION

In this chapter, the researcher analyzed two types of collected data - quantitative and qualitative. The analysis of quantitative data was carried out by the researcher with the help of SPSS 21.0 software. The quantitative data analysis basically explains the demographic profile of the college teachers, technology availability in colleges or personally they possess, technology usage, techno-integrated teaching knowledge and the comparison of teachers techno-integrated teaching knowledge in relation to their gender, locale, teaching experience, teaching subject, teaching position, academic qualifications and between the two divisions i.e. Jammu and Kashmir division. The analysis of qualitative data explored the implementation of techno-integrated teaching knowledge in the context of planning and execution in classroom. The statistical methods/tests used by the researcher for quantitative data analysis procedure are the following.

1) Tabular representation of demographic profile of teachers.

2) Tabular representation of availability and usage of technology among college teachers.

3) t-Test for variation between male and female, rural and urban, and Jammu and Kashmir college teachers.

4) ANNOVA for comparing the techno-integrated teaching knowledge of teachers in terms of their teaching experience, teaching position, teaching subject/s and teachers' educational qualification.

As, grounded theory research design was followed by the researcher in the qualitative study of the research problem, the qualitative data analysis was carried out through the process of open coding of the transcripts. Every single sentence and statement of transcripts was coded by the researcher and it gave rise to a large number of codes. The researcher reduced down this large number of codes through axial coding i.e. merging the codes with similarities. After that, the researcher developed sub-themes from these axial codes, and finally from sub themes, prominent themes were developed by the researcher through constant comparative method of coding. The themes explained along with the actual response statements made by the respondents and in the context of teachers' techno-integrated teaching. Finally, the researcher interrelated the themes in order to develop the proposed theory and model, which the researcher assumes will work where the research was carried out or may work in similar other situations. However, requires some further refinement by extending the study to other dimensions like perspectives from administrators and learners.

Demographic profile of college teachers

The sample of the study was 320. The researcher selected this sample of respondents randomly from 10 randomly selected colleges. The demographic profile of selected sample college teachers were analyzed by the researcher in the tabulated form in the table number 5.

Table 5: Demographic profile of college teachers

Total teacher respondents	**320**		
Demographic characteristic	Group	Frequency	Percentage
Gender	Male	160	50.0
	Female	160	50.0
Locale	Rural	169	52.8
	Urban	151	47.2
Teaching experience	0 to 5 years	143	44.7
	6 to 10 years	66	21.3
	11 to 15 years	68	20.6
	Above 15 years	43	13.4
Teaching position	Professors	32	10.6
	Associate professors	92	28.8
	Assistant professors	96	30.0
	Temporary teachers	98	30.6
Teaching subject	Social science	135	42.2
	Science	113	35.3
	Technical/ professional	72	22.5
Teacher qualification	Masters	195	60.9
	M.Phil	79	24.7
	Ph.D	46	14.4

The demographic profile of college teachers were based on gender, locale, teaching experience, teaching position, teaching subject/s and qualification. The sample were comprised of 150 (50%) male and 150(50%) female teachers, 169 (52.8%) rural teachers and 131 (47.2%) urban teachers, 143 (43.7) teachers with 0 to 5 years of teaching experience, 66 (21.3%) possessing 6 to 10, 68 (20.6) with 11 to 15 years of teaching experience, 43(13.4%) with above 15 years of teaching experience and 32(10.6%) teachers were professors, 92(28.8%) teachers were associate professors, 96(30.0%) teachers were assistant professors and 98 (30.6%) were temporary teachers and 135(42.2%) were teachers with social science teaching subjects, 113(35.3%) were teachers with science teaching

subjects and 72 (22.5%) were teachers with technical/professional teaching subjects and 46(14.4%) teachers were with masters degree, 79(24.7%) teachers were with M.Phil degree and 195 (60.9%) teachers were with PhD degree.

Research question 1: What kind of infrastructure support is available for college teachers?

The researcher was interested to check the infrastructure support available to college teachers necessary for techno-integrated teaching. The researcher studied this research question under two sub domains i.e. 1) technology availability for college teachers 2) technology usage by college teachers. The researcher made two checklists of required technologies necessary for techno-integrated teaching. From the checklist, researcher enquired about available technology for teachers in institutions or personally. The following is the checklist which shows the availability/non-availability of technologies in the govt. colleges.

Table 6: Technology availability for teachers personally or in colleges

Technology	**GD C1**	**GD C2**	**GD C3**	**GD C4**	**GD C5**	**GD C6**	**GD C7**	**GD C8**	**GD C9**	**GDC 10**	**Total**
Computer /Laptop/Desktop	32	32	30	31	29	32	32	32	31	32	313 **(97%)**
Smartphone	32	32	31	30	32	32	32	31	32	32	316 **(98%)**
Scanner	14	10	9	13	15	6	9	13	11	10	110 **(34%)**
VCD, DVD	12	10	3	3	0	10	11	7	7	4	67 **(21%)**
Interactive DVD,CD	3	6	4	6	2	8	3	3	6	10	49 **(15%)**
Laser disc	7	12	10	7	9	6	8	7	6	8	80 **(25%)**
Speakers	16	14	12	16	15	14	12	12	14	5	130 **(41%)**
Digital Camera	6	6	5	12	11	8	15	10	12	5	90 **(28%)**
Microphone	12	22	11	10	12	16	11	12	12	11	129 **(40%)**
Projectors	32	32	32	32	32	32	32	32	32	32	320 **(100%)**
Smart boards	32	32	32	32	32	32	32	32	32	32	320 **(100%)**
Internet/Wi-Fi	32	32	32	32	32	32	32	32	32	32	320 **(100%)**
LAN	6	5	3	6	7	6	5	6	2	6	52 **(16%)**
Web technology	4	4	6	12	7	4	9	2	1	6	55 **(17%)**
Discussion boards	2	1	0	3	6	2	2	4	1	4	23 **(8%)**
Google cardboard	4	4	2	6	1	3	5	6	4	4	39 **(12%)**

Interpretation and discussion

The purpose of this aspect of research question was to study the availability of technological facilities for the teachers in person or in their colleges. The table shows that the technological facilities like computers, laptops, desktops, smart phones, projectors, smart boards and Wi-Fi facilities are possessed by all the teachers. Technology tools like scanners, laser discs, speakers, microphones and digital cameras are possessed by 50-80% of teachers and the latest technological facilities like LAN, Google cardboards, web technologies are possessed by a small portion of 20-30% of teachers. The percentage results show teachers possess sufficient basic ICT infrastructure facilities but are lacking in the latest and advanced technological facilities both in person and in their colleges **(Bingimeals, 2009 & Ayegie, 2013).** Teachers when got interviewed by the researcher made a strong responses about the scarcity of technological facilities. According to **Lee & Lee (2014)** limited technological resources within educational institutions is a great impediment for technology integration in classrooms. One of the teacher said that '*we (teachers) do not have enough technology resources in our colleges; we are still relying on old audio-visual aids'.* The other teacher replied that '*the number of computers, projectors and smart classrooms in our colleges is very limited'.* For teachers to teach through techno-integrated teaching approach, availability of technological tools especially the modern digital technologies are essential requirements.

Technology usage

The researcher was interested to assess the usage of technology by teachers in their teaching profession. For this purpose, the researcher used the checklist and administered to the selected respondents to make their responses. The responses against each technology name were created by the researcher as once a day, once a week, once a month and don't use. Responses made by the teachers were analyzed by using frequency and percentage methods as shown in the table 7.

Table 7: Checklist of technology usage by teachers

Technology	**Once a day**	**Once a week**	**Once a month**	**Don't use at all**
Computer /laptop/desktop	**231**	59	30	0
Scanner	26	**175**	86	33
VCD, DVD	4	16	76	**224**
Interactive DVD,CD	4	16	76	**224**
Laser disc	2	6	56	**256**
Speakers	23	**121**	112	64
Digital Camera	16	87	**123**	94
Microphone	23	**121**	96	80
Projectors	37	**156**	115	12
Smart boards	2	73	**190**	55
PPT	3	57	**212**	28
Word processor	2	35	**143**	**140**
E-mail	37	**173**	95	15
Spreadsheets/excel	2	21	77	**220**
SPSS/Minitab	0	0	6	**214**
Wi-Fi	256	62	2	0
LAN	2	12	**156**	**150**
Web technology	51	79	82	**108**
Discussion boards	3	86	71	**160**
Graphical tools	2	31	57	**230**
Simulation	2	12	33	**273**
Hypermedia/multimedia	2	16	32	**270**
Online demo	2	2	7	**309**

Interpretation and discussion

The purpose of checklist was to assess the usage of digital technologies by the teachers. The table shows that 90-100 % of teachers are using the technologies like computers, laptops, smart phones, Wi-Fi/internet facilities at least once every day. The technological facilities like projectors, micro phones, speakers, smart classrooms are used by 50-60% of teachers at least once every week, 20-30 % of teachers use at least once every month and10-20 % of teachers do not use at all. The technological facilities like online demo, Google classrooms, and online discussion forums like blogs, LAN are used by 0 % of teachers on daily basis, 10-20 % of teachers use them once a week, 30-40 % of teachers use at least once a week and 40-50 % of teachers do not use at all. The researcher when interviewed the teachers about the usage of technology, the data revealed that teachers are mostly using the computers, laptops, smart phones and Wi-Fi/internet facilities for their personal use rather than for their teaching purposes. However, teachers are using technology but to a little extent. One teacher replied that '*I am using sometimes my laptop (Microsoft word) for the writing of notes material of my teaching subject and distribute it among my student's'*. The data revealed that teachers are mostly using the internet/Wi-Fi facilities for social networking and for their other personal uses. One teacher replied that '*sometimes we (teachers) are using it in our classes also to show online videos and documentaries related to the topic to our students'*. One teacher replied that '*I am using the college Wi-Fi for learning the content of my teaching subject (Economics), as there is the latest information, surveys and reports available'*. The technological facilities like projectors, Google classrooms, blogs, smart classrooms, simulations, and latest teaching apps like Geogebra are not regularly used by the teachers. However, it is used once in a

week/month. The researcher during the classroom observations focused that teachers were specifically using projectors for teaching PPTs. However teachers were also using Google classrooms for distribution of assignments and grading. Online discussion were also carried out among teachers and students and students and students through WhatsApp groups, blogs and Google websites regarding the taught content and important topics.

Objective 1.1: To study the TPACK knowledge of college teachers.

Hypothesis 1.1: There is no difference in TPACK knowledge of college teachers.

Table 8: TPACK knowledge of college teachers

TPACK Level	Z score	% of teachers
Extremely high	**+2.01 & above**	**0**
High	**+1.26 to +2.00**	**3**
Above average	**+0.51 to +1.25**	**6**
Average	**-0.50 to + 0.50**	**77**
Below average	**-1.25 to -0.51**	**12**
Low	**-2.00 to -1.26**	**2**
Extremely low	**-2.01 & below**	**0**

The table 8 depicts comparison of level of TPACK among college teachers. The results demonstrate that college teachers showed a variation in their level of TPACK knowledge.

77 % of teachers were on average level of TPACK scale, 14 % below average and only 9 % of teachers above average. The results showed that a very few teachers of colleges had high knowledge of TPACK. Thus, the hypothesis gets rejected.

Objective 1.2: To study the component wise TPACK knowledge of college teachers.

Hypothesis 1.2: There is no difference in components of TPACK knowledge of college teachers.

Table 9: component wise level of TPACK knowledge of college teachers

Sr. No	TPACK Dimension	Z-Score	Level
1	TK	+1.21	Above Average
2	PK	+1.17	Above Average
3	CK	+1.76	High
4	TPK	+0.32	Average
5	TCK	+0.41	Average
6	PCK	+0.23	Average
7	TPACK	+0.33	Average
8	TTPACKS	+0.34	Average

Interpretation and discussion

Table 9 depicts components of TTPACK and level of teachers' knowledge. The researcher converted the raw scores obtained by teachers in this scale in to standardized scores and compared them with the z scores of TTPACKS scale. This comparison depicted

the TPACK knowledge and the knowledge of seven components i.e. TK, PK, CK, TPK, TCK, PCK and TPCK of teachers. The table 9 shows that teachers self assessed technological knowledge and pedagogical knowledge were on above average level, content knowledge was on high level and PCK, TPK, TCK, TPCK and TPACK knowledge were on average level.

Objective 2.1: To compare the TPACK knowledge of college teachers in relation to gender.

Hypothesis 2.1: There is no significant difference in TPACK knowledge of college teachers in relation to gender.

Table 10: Comparison of TPACK between male and female college teachers

Gender	N	Mean	SD	df	T	Significance	Result
M ale	160	218.63	11.71	318	.066	.948	Not significant
Female	160	218.55	12.08				

The values in the table 10 clearly show that there exists no significant difference in techno-integrated teaching knowledge of college teachers with respect to their gender. Hence, hypothesis can't be rejected **(Naaz & Khan, 2018, Ozdemier, 2016 and Shehu, 2010).**

Objective 2.2: To compare the TPACK knowledge of college teachers in relation to locale.

Hypothesis 2.2: There is no significant difference in TPACK knowledge of college teachers in relation to locale.

Table 11 : Comparison of TPACK between between rural and urban college teachers

Locale	N	Mean	SD	Df	T	Significance	Result
Rural	201	219.39	12.10	318	1.280	.202	Not significant
Urban	119	217.69	11.60				

The table 11 shows the t value (t= 1.280, P= 0.202) of rural and urban college teachers is not significant at 0.05 & 0.01 confidence level. So, the hypothesis can't be rejected. The results showed no significant difference in the TPACK knowledge of rural and urban teachers **(Selvam & Anabazhagam, 2013 and Rana, 2012).**

Objective 2.3: To compare the TPACK knowledge of college teachers in relation to teaching experience.

Hypothesis 2.3: There is no significant difference in TPACK knowledge of college teachers in relation to gender.

Table 12: Comparison of college teachers TPACK in relation to teaching experience

Source of Variance	Sum of squares	df	Average score	F	Significance	Result
Between groups	810.30	3	270.10	1.930	.0125	Not significant
Within groups	44218.88	316	139.93			
Total	45029.18	319				

For the analysis of data, groups were formed on the basis of teaching experience. The results of table 12 results clearly depict that there exists no significant difference in techno-integrated teaching knowledge of college teachers in relation to

their teaching experiences. So, the hypothesis can't be rejected **(Dedun, 2013, Selvam & Anabazhagam, 2013, Devananthan, 2008).**

Objective 2.4: To compare the TPACK knowledge of college teachers in relation to teaching position.

Hypothesis 2.4: There is no significant difference in TPACK knowledge of college teachers in relation to teaching position.

Table 13. Comparison of teachers TPACK in relation to teaching position

Source of Variance	**Sum of Squares**	**Df**	**Mean score**	**F**	**Significance**	**Result**
Between groups	499.006	3	166.335	1.180	.317	Not significant
Within groups	44530.182	316	140.918			
Total		319				

The table 13 clearly depicts the calculated values of teachers in relation to their teaching positions. The calculated values were not significant at 0.05 and 0.01 confidence level. The hypothesis can't be rejected. The results clearly reveal that no difference exists in the TPACK knowledge of teachers who were divided by the researchers in four groups on the basis of teaching positions they hold i.e. professors, associate professors assistant professors and temporary teachers **(Devananthan, 2008).**

Objective 2.5: To compare the TPACK knowledge of college teachers in relation to teaching subject.

Hypothesis 2.5: There is no significant difference in TPACK knowledge of college teachers in relation to teaching subject.

Table 14. Comparison of teachers TPACK in relation to teaching subject

Source of Variance	Sum of Squares	Df	Mean score	F	Significance	Result
Between groups	36.534	2	18.267	.129	.879	Not significant
Within groups	44992.654	317	141.933			
Total	45029.188	319				

The calculated values in table 14 clearly reveal that techno-integrated teaching knowledge was not significant at 0.05 confidence interval. The hypothesis that no variation exists in teachers TPACK knowledge in relation to their teaching subjects can't be rejected. Thus, there is no difference in the teachers TPACK knowledge that were distributed by the researcher in the science, social science and professional/technical teaching subjects **(Dedun, 2013, Teo, 2008).**

Objective 2.6: To compare the TPACK knowledge of college teachers in relation to educational qualification.

Hypothesis 2.6: There is no significant difference in TPACK knowledge of college teachers in relation to educational qualification.

Table 15: Comparison of teachers TPACK in relation to educational qualifications

Source of Variance	Sum of Squares	Df	Mean score	F	Significance	Result
Between groups	264.020	2	132.010	.935	.394	Not significant
Within groups	44765.168	317	141.215			
Total	45029.187	319				

The table 15 shows that the calculated values of teachers are not significant at 0.05 difference levels. The hypothesis can't be rejected. The results clearly revealed that there exists no variation in the teachers TPACK knowledge when compared on the basis of educational qualifications they possessed i.e. masters, M.Phil, Ph.D. and teacher education degrees **(Onsanya et al, and Devanathan, 2008).**

Objective 2.7: To compare the TPACK knowledge of college teachers in relation to region.

Hypothesis 2.7: There is no significant difference in TPACK knowledge of college teachers in relation to region.

Table 16: Comparison of college teachers TPACK in relation to Jammu & Kashmir division

Division	**N**	**Mean**	**SD**	**df**	**T**	**Significance**	**Result**
Jammu	160	275.63	11.71	318	.121	.763	Not significant
Kashmir	160	275.55	12.08				

The values in the table clearly show that there exists no significant difference in techno-integrated teaching knowledge of college teachers in relation to Jammu & Kashmir division. Hence, hypothesis was accepted.

Objective 3.1: To compare the components of TPACK knowledge of college teachers in relation to gender.

Hypothesis 3.1: There is no significant difference in components of TPACK knowledge of college teachers in relation to gender.

Table 17: Comparison of TPACK components between male and female teachers

Independent variable	Gender	N	Mean	SD	t	Significance	Result
TK	M F	160 160	20.36 20.59	2.365 2.176	.910	.363	Not significant
PK	M F	160 160	25.68 26.16	9.976 9.954	.432	.666	Not significant
CK	M F	160 160	35.22 35.40	3.543 3.461	.463	.643	Not significant
TPK	M F	160 160	44.86 45.33	3.691 3.880	1.122	.263	Not significant
TCK	M F	160 160	24.26 24.36	2.112 1.957	.439	.100	Not significant
PCK	M F	160 160	28.23 28.11	1.799 1.865	.605	.546	Not significant
TPACK	M F	160 160	39.35 39.30	3.696 3.667	.121	.903	Not significant

Interpretation and discussion

The table shows that no difference was found in the techno-integrated teaching knowledge of college teachers in relation to their gender variable. Thus, the hypothesis was accepted at 5 % level of significance for all the aspects of techno-integrated teaching of

college teachers in relation to their gender (**Naaz & Khan, 2018, Ozdemier,2016 and Shehu, 2010).**

Objective: To compare the components of TPACK knowledge of college teachers in relation to locale.

Hypothesis: There is no significant difference in components of TPACK of college teachers in relation to locale.

Table 18: Comparison of TPACK components among rural and urban teachers

Independent variable	**Locale**	**N**	**Mean**	**SD**	**T**	**Significance**	**Result**
TK	Rural Urban	169 151	20.43 20.53	2.2432. 309	.384	.701	Not significant
PK	Rural Urban	169 151	25.70 26.17	9.7111 0.242	.425	.671	Not significant
CK	Rural Urban	169 151	35.20 35.43	3.451 3.556	.585	.560	Not significant
TPK	Rural Urban	169 151	44.99 45.21	3.911 3.656	.527	.597	Not significant
TCK	Rural Urban	169 151	24.46 24.15	2.124 1.921	1.334	.183	Not significant
PCK	Rural Urban	169 151	28.20 28.13	1.834 1.864	.332	.741	Not significant
TPACK	Rural Urban	169 151	39.41 39.23	3.768 3.580	.459	.646	Not significant

Interpretation and discussion

The table shows that no difference was found in all components of TPACK of teachers in relation to their locality. The hypothesis can't be rejected at 5 % level of significance for all aspects of techno-integrated teaching knowledge. However, during interview the teachers who were from urban areas showed positive attitude towards technology component than their counterparts. One teacher who was from urban area and also working in a college of urban area replied *….yes, I am using the technologies in my teaching to keep up to date myself and students also.* The other teacher replied that *I got motivated by my daughter who is studying in a DPS Srinagar when she tell us about her teachers ,….they teach us through projectors, smart classrooms and also she is discussing her studies with her classmates on a online group developed by her female teacher*. The teachers from rural areas and also working in colleges established in rural areas or far flung areas were in a state of denial. One rural teacher working in a rural college replied that *…..yes technology is important but students misuse most of time on their smart phones, so we do not allow them to use in classrooms, we mostly teach them through lecture method.* The researcher also observed that the colleges established in rural and far flung areas have their technology availability less than their counterparts. Colleges in urban areas were having good computer labs, projectors and smart classrooms and stable Wi-Fi facilities where as in rural/far flung areas, available technological tools were old , outdated and not properly maintained, frequent power cuts and unstable or no Wi-Fi facilities .

Objective 3.2: To compare the components of TPACK knowledge of college teachers in relation to teaching experience.

Hypothesis 3.2: There is no significant difference in components of TPACK knowledge of college teachers in relation to teaching experience.

Table 19: Comparison of teachers TPACK components in relation to teaching experience

Independent variable		Sum of Squares	DF	Mean Square	F	Significance	Results
TK	Between Groups	13.293	3	4.431	2.858	.001	Significant
	Within Groups	1632.554	316	1.166			
	Total	1645.847	319				
PK	Between Groups	159.851	3	99.284	2.536	.014	Significant
	Within Groups	31437.196	316	51.485			
	Total	31597.047	319				
CK	Between Groups	82.266	3	11.422	4.268	.081	Not Significant
	Within Groups	3820.106	316	12.089			
	Total	3902.372	319				
TPK	Between Groups	11.940	3	14.980	4.275	.012	Significant
	Within Groups	4565.248	316	3.447			
	Total	4577.188	319				
TCK	Between Groups	7.712	3	4.571	3.620	.002	Significant
	Within Groups	1311.038	316	2.149			
	Total	1318.750	319				
PCK	Between Groups	30.597	3	10.199	3.051	.029	Significant
	Within Groups	1056.291	316	3.343			
	Total	1086.888	319				
TPCK	Between Groups	26.510	3	13.837	4.652	.007	Significant
	Within Groups	4283.690	316	4.556			
	Total	4310.200	319				

Interpretation and discussion

The hypothesis was rejected at 5% level of significance for content knowledge (CK) only, and not rejected for rest of the components of TPACK scale. The table shows that no

significant differences were found in the content knowledge of teachers who were divided by the researcher in four groups on the basis of their teaching experiences. However in the other six components of TPACK, significant differences were found. The data collected through interview of teachers and their classroom observations also support the above findings. The data revealed that teachers with higher teaching experience possess a sound basis of information and understanding, and the knowledge of incorporation of all the aspects of the model. Experienced teachers revealed that we are using different pedagogies like lecture method, discussion method, demonstration method, buzz sessions, brainstorming, and different technologies like projectors, Google cardboards, simulation, Google classrooms, blogs, WhatsApp groups, email in our classroom teaching. One teacher replied that I have attended different workshops, training programs and seminars during my service where I learned about the use and integration of different pedagogies and technological tools in our classrooms. One experienced teacher of subject mathematics having 12 years of experience said that "*I am using Geogebra app in the teaching of our students. He said this app is useful in the teaching of geometry, algebra, statistics, trigonometry and calculus from primary to university level"*. Experienced teachers also have developed the e-content of their teaching subjects which they provide to their students in PDF formats. One teacher replied that "*I am using the Google classroom from the beginning of every session where I add my students to this classroom and distribute the assignments, grade their assigned work and also carry out online discussions about the content taught and important topics in general"*. Teachers with less experience are mostly using the lecture methods in their classrooms and are not much aware about the latest pedagogies and technological facilities.

Objective 3.3: To compare the components of TPACK knowledge of college teachers in relation to educational qualification.

Hypothesis 3.3: There is no significant difference in components of TPACK knowledge of college teachers in relation to educational qualification.

Table 20: Comparison of TPACK components in relation to educational qualification/s

Independent variable		Sum of squares	Df	Average Square	F	Sig.	Results
TK	Between groups	.135	2	.068	.013	.987	Not significant
	Within Groups	1645.712	317	5.192			
	Total	1645.847	319				
PK	Between Groups	780.703	2	390.352	.015	.109	Not significant
	Within Groups	30816.343	317	97.212			
	Total	31597.047	319				
CK	Between Groups	15.046	2	7.523	.613	.542	Not significant
	Within Groups	3887.326	317	12.263			
	Total	3902.372	319				
TPK	Between Groups	26.714	2	13.357	.931	.395	Not significant
	Within Groups	4550.473	317	14.355			
	Total	4577.188	319				
TCK	Between Groups	6.217	2	3.109	.751	.473	Not significant
	Within Groups	1312.533	317	4.140			
	Total	1318.750	319				
PCK	Between Groups	.674	2	.337	.098	.906	Not significant
	Within Groups	1086.214	317	3.427			
	Total	1086.888	319				
TPCK	Between Groups	6.692	2	3.346	.246	.782	Not significant
	Within Groups	4303.508	317	13.576			
	Total	4310.200	319				

Interpretation and discussion

The table 20 shows that no significant difference exists in the components of TPACK among teachers who were divided by the researcher in three groups on the basis of their academic qualifications i.e. Masters, M.Phil and Ph.D. The hypothesis can't be rejected at 0.05 & 0.01 level of significance for all aspects of techno-integrated teaching knowledge (TPACK) of college teachers in relation to their educational qualification. However the qualitative data revealed that the teachers techno-integrated teaching knowledge varies. Teachers holding research degreres were interested in adoption of new pedagogies and technologies ion their teaching where as teachers with masters degree rely mostly on lecture methods. One teacher holding research degree replied *that online technology tools provide good amount of latest information and access to recent developments of my teaching subject, so I am using the internet mostly for that purpose.* Teachers who hold online certificate courses responded positively. As one teacher replied *that I have done various online courses and they helped me very much in my understanding of teaching subject .....i am also working for developing the same or even better on my teaching subject for the learners*. Teachers holding some teacher education degrees like B.Ed, M.Ed, Diploma or Certificate courses were having sound techno-integrated teaching knowledge.

Objective 3.4: To compare the components of TPACK knowledge of college teachers in relation to teaching subject**.**

Hypothesis 3.4: There is no significant difference in components of TPACK knowledge of college teachers in relation to teaching subject**.**

Table 21: Comparison of teachers TPACK components in relation to teaching subject.

Independent variable		Sum of squares	df	Mean Square	F	Significance	Results
TK	Between groups	14.321	2	7.161	2.391	.031	Significant
	Within Groups	1631.525	317	5.147			
	Total	1645.847	319				
PK	Between Groups	354.808	2	177.404	2.800	.021	Significant
	Within Groups	31242.239	317	98.556			
	Total	31597.047	319				
CK	Between Groups	28.586	2	14.293	1.170	.312	Not significant
	Within Groups	3873.786	317	12.220			
	Total	3902.372	319				
TPK	Between Groups	7.858	2	3.929	.273	.762	Not significant
	Within Groups	4569.330	317	14.414			
	Total	4577.188	319				
TCK	Between Groups	7.646	2	3.823	.924	.398	Not significant
	Within Groups	1311.104	317	4.136			
	Total	1318.750	319				
PCK	Between Groups	4.514	2	2.257	.661	.517	Not significant
	Within Groups	1082.374	317	3.414			
	Total	1086.888	319				
TPCK	Between Groups	3.981	2	1.991	.147	.864	Not significant
	Within Groups	4306.219	317	13.584			
	Total	4310.200	319				

Interpretation and discussion

The table 21 results in that there exists no variation in all the knowledge components of TPACK except the technological knowledge component between the teachers categorized in three groups on the basis of their teaching subjects i.e. social science, general science and professional/technical subjects. The hypothesis can't be

rejected on all components of TPACK except the technological knowledge component at 0.05 & 0.01 level of significance. The data collected through interviews depicted the different picture. Teachers of the subjects like computer science and information technology hold deep technological knowledge but lacking in pedagogical knowledge and techno-integrated teaching knowledge. While interview with a computer science teacher, it was revealed that technology is used in classrooms. As the teacher said *'we are using computer labs, projectors, smart classrooms…we don't have any kind of problems…you should go to other departments ,…they are not using them…go and tell them, there is a need for them to learn about the technologies* . However, in context of pedagogical knowledge, only teachers from Education and Psychology were found equipped. *As one teacher of EVS replied that I heard about Pedagogy after two years of working in a college*. Subject/s of teaching matters a lot in techno-integrated teaching. The researchers observed that teachers from technical/professional subjects, Computer sciences and information technology and other similar subjects hold sound technological knowledge and competent in their operation, but unaware about how to use technology for teaching purpose effectively i.e. lacking pedagogical knowledge. 'Teachers teaching the subjects like education and psychology were well aware about different teaching methods and use of technologies in their classrooms. However, such teachers are not competent enough in the blending of TK, PK & CK. All the teachers of other science and social science subjects were good in their subject knowledge, but lacking in TK & PK, and finally in the incorporation of these three domains.

Objective 3.5: To compare the components of TPACK knowledge of college teachers in relation to teaching position.

Hypothesis 3.5: There is no significant difference in components TPACK knowledge of college teachers in relation to teaching position.

Table 22: Comparison of Teachers TPACK components in relation to teaching position

Independent variable		Sum of squares	Df	Mean Square	F	Significance	Results
TK	Between groups	7.134	3	2.378	.459	.711	Not significant
	Within Groups	1638.713	316	5.186			
	Total	1645.847	319				
PK	Between Groups	96.628	3	32.209	.323	.809	Not significant
	Within Groups	31500.418	316	99.685			
	Total	31597.047	319				
CK	Between Groups	34.139	3	11.380	.930	.427	Not significant
	Within Groups	3868.232	316	12.241			
	Total	3902.372	319				
TPK	Between Groups	54.492	3	18.164	1.269	.285	Not significant
	Within Groups	4522.696	316	14.312			
	Total	4577.188	319				
TCK6	Between Groups	12.194	3	4.065	.983	.401	Not significant
	Within Groups	1306.556	316	4.135			
	Total	1318.750	319				
PCK	Between Groups	14.707	3	4.902	1.445	.230	Not significant
	Within Groups	1072.181	316	3.393			
	Total	1086.888	319				
TPCK	Between Groups	21.751	3	7.250	.534	.659	Not significant
	Within Groups	4288.449	316	13.571			
	Total	4310.200	319				

Interpretation and discussion

The table 22 shows that there exists no variation in all aspects of TPACK among teachers who were divided by the researcher in four sub groups i.e. professors, associate professors, assistant professors and temporary/contractual teachers. The hypothesis can't be rejected at 0.05 & 0.01 level of significance for all aspects of techno-integrated teaching knowledge (TPACK) of college teachers in relation to their teaching position. The qualitative data revealed that the teachers who hold permanent positions, no matter of which group they belong, showed positive attitude towards the integration of technology in their classrooms. These teachers have created Google classrooms, blogs and e-content for their teaching subjects, and hold good experience in using the smart classrooms and other digital technologies in their teaching. These teachers got the opportunities of attending the conferences, workshops and other training programs required for the technological up gradation. However, teachers holding temporary/contractual positions presented the different figure. One contractual teacher replied …*we have to teach 4-5 classes every day, how can we use technology tools in all these classes…we have also the administrative workload …sometimes we get in the merit list sometimes not…these things weaken our dedication towards teaching.*

Objective 3.6: To compare the components of TPACK knowledge of college teachers in relation to region.

Hypothesis 3.6: There is no significant difference in components of TPACK knowledge of college teachers in relation to region.

Table 23: Comparison of TPACK components in relation to Jammu and Kashmir divisions

Independent variable	Group	N	Mean	SD	T	Significance	Result
TK	J K	141 179	30.36 00.59	3.365 3.176	.810	.263	Not significant
PK	J K	141 179	35.68 36.16	7.976 7.954	.532	.566	Not significant
CK	J K	141 179	39.22 39.40	2.543 2.461	.263	.443	Not significant
TPK	J K	141 179	44.86 45.33	4.691 4.880	.122	.363	Not significant
TCK	J K	141 179	27.26 27.36	2.112 1.957	.239	.200	Not significant
PCK	J K	141 179	21.23 21.11	1.799 1.865	.305	.446	Not significant
TPACK	J K	141 179	36.35 36.30	2.696 2.667	.221	.503	Not significant

Interpretation and discussion

The hypothesis can't be rejected at 0.05 and 0.01 level of significance for all components of techno-integrated teaching knowledge (TPACK) of college teachers in Jammu and Kashmir. The table 23 shows that no significant difference was found in all knowledge aspects of TPACK among teachers of Jammu division and Kashmir division. During qualitative interview, 5 teachers from Jammu and 5 from Kashmir were interviewed. The data revealed that teachers in both divisions hold sound techno-integrated teaching knowledge and showed progressive behavior towards the incorporation of technology in actual classrooms. But teachers in Kashmir division responded the internet blockade as a

barrier in their techno-integrated teaching due to various demographic reasons. One teacher replied that *…there is ban on internet for days to months…so we rely mostly on lecture methods*.

Qualitative analysis

Qualitative research work here focused to explore the issues teachers faced by teachers during integration of technology in their planning and execution of content knowledge, and to propose the suggestive theory and model that will enhance the techno-integrated teaching of teachers in the context studied i.e. at higher level of teaching and in the state of J & K. The researcher employed grounded theory research design for this purpose. The basic purpose of grounded research design is to develop theory or to modify the existing one. Here, main objective was to explore whether the existing theory of TPACK is applicable in the specific context where research conducted or need a refinement. For this purpose a sample of 10 teachers who showed high level of TPACK knowledge, according to the results of quantitative data analysis where a standardized questionnaire was used to assess the level of knowledge of teachers about TPACK, was selected through purposive sampling. In-depth interviews and classroom observations were employed for data collection procedure. From the transcripts and field notes, open coding was done. Open coding of the data leaded to the large number of codes followed by axial coding to reduce them in smaller number. In axial coding, similar codes are merged to a single code. On the basis of axial coding, categories/themes through constant comparative method of coding was emerged. The prominent themes emerged along with their frequencies were highlighted in the table no. 26.

The important themes emerged through coding process are discussed by the researcher as following.

Table 24: Coding of transcripts

Codes	F	Sub-Themes	Prominent themes
Insufficient resources, outdated, maintenance of resources, instable internet, frequent power cuts	33	Infrastructure resource availability	PLANNING
Access to online resources, latest subject advancements, teaching by colleagues and administrative support, extra time and effort, incentives and rewards, external disruptions	31	Teachers motivation	
Planning of content(what to teach), planning in mind, no written plans or templates, pedagogical planning lacking, unawareness, lack of integration	52	Improper lesson planning	
Losing the importance, incentives and rewards, student technology misuse, welcoming of innovations and resistance to change, personal use of technology, lack of confidence, Conventional methods, strong belief on traditional methods, myth about losing importance, resist to change, welcoming innovative ways	24	Attitude of teachers	
Smart phone/computer use, illiteracy, ICT courses, communication capability in collaboration, learning in connection	6	Students digital literacy	
Syllabus coverage, little class time duration, time in operating the technological tools and time in completing the online assignments	23	Time	EXECUTION
Training of teachers, administrators & students, provisions for incentives and rewards, managing sufficient and updated resources, encouraging teachers	14	Administrative support	

Theme 1: Planning

The first prominent theme emerged from the coding of qualitative data was 'Planning'. This theme includes the issues teachers face while planning for the integration of technology in teaching. This theme was developed on the basis of merging down the sub-themes which were 1) lesson planning 2) infrastructure support 3) teachers motivation 4) Attitude of teachers 5) students digital literacy. All these sub themes are explained separately in the present study.

Lesson planning

Planning the lesson before teaching to students is one of the essential requirement/pre-condition for the effective teaching. The analysis of transcripts were lacking in the framing of proper lesson plans, which in turn paves a negative effect on their classroom teaching. Mostly teachers not prepared the detailed description of topics rather have a imaginary thought about what to teach. Thus, in this process 'How to teach' i.e. pedagogical component was absent in the teachers lesson planning as it was imagined only. As one teacher said…. *I am not planning the lessons in any written format but …I go through the in-depth study of my lesson at my home or sometimes in my college and write down important points on the paper…take this paper in my class and then deliver the lecture ….explain it thoroughly to my students and they understand it very well*. Teachers were also unaware about the pedagogies and integration with content knowledge, so about the lesson planning. One EVS teacher said *…after two years of teaching in a college, I heard about the word 'Pedagogy' as there was some training program on it and after that I*

realized how much I am lacking. As there was unawareness of pedagogical knowledge, teachers were not able to integrate technological facilities in their classroom teaching wsa focused during classroom observation. Most of teachers were using projector for techno integration in classrooms.

Motivation of teachers

Motivational factors are basically the reasons or factors for acting or behaving in a particular way. In this study, the data revealed that there were many motivational reasons which either encourage or discourage the teachers towards the techno-integrated teaching. Teachers responded that latest technologies provided us a greater access to the available online resources and the latest developments happening around the world. So, they were frequently using the internet and Wi-Fi resources. As one of the teachers said that *"I am using the internet… Wi-Fi for so many reasons mentioned social networking, for my own updating of knowledge and for teaching the content/topics to my students". One teacher of subject Economics replied that I use the latest survey reports or any other latest information related to teaching subject available online and relate it with the content I am teaching to my students*. Viewing the other teachers' online lectures also motivated the teachers to incorporate ICT in teaching profession. *As one teacher said that I viewed many videos on my Facebook page that my colleagues are using smart classrooms in their colleges.* Teachers also replied that the support or outlook of our administrative officials especially the heads of departments also play a great role in this context. Principlas and other administrators with positive outlook towards the latest technologies support their teachers innovations and latest pedagogical use in their teaching. Competency simply is "the ability to do

something successfully or efficiently. The competency of teachers in the technology integration is the core dimension of TPACK model of teaching. The data revealed that absence of digital skills in teachers were prominent. Teachers were mostly teaching through conventional methods of teaching especially lecture method was dominating the scene. Teachers were unaware about the latest digital technology tools and consequently integration in teaching was a far reaching dimension for them. During observation, it was found that mostly teachers were using projectors and sometimes PPT in their classes. The digital technologies already available in the colleges, teachers do not know how to operate them successfully. However, some teachers were using the online teaching-learning resources for their classroom teaching purpose like Google classrooms, subject specific teaching apps and different software SPSS, Minitab etc

Teacher attitude towards techno-integration

Attitude basically is a way of thinking or feeling about something. Techno-integration was perceived differently by different teachers. Some teachers hold a misconception of losing their importance if technological tools are integrated in their teaching profession. As one teacher responded*…when everything, students will learn online/on the internet, what is the purpose of coming to classes and teaching them…we have been taught by lectures and understand well, why not the present generation which is more intelligent.* Some teachers were having a fear of losing their importance in institution or before students, if they use modern digital technologies in teaching. However, some other teachers look that their perceived role of techno integration as a challenge. The role of teacher has shifted from an instructor to facilitator and constructor of knowledge. One teacher responded*…yes, it is important to use latest technologies in our classroom teaching, as it will keep us up to*

date….develop technical skills among teachers and students ….make our classroom attractive and interesting. Some teachers hold a misconception that technologies like internet/wifi waste the time of students. Instead of using them for learning purposes, they spent most of their time on WhatsApp, Face book, PUBG, TikTok and other things. So they were not in much support of the techno-integrated teaching.

The role of teachers is dynamic in nature. The rapid advancements and developments of information and communication technology around the world laid down a great affect on the role and responsibility of teachers. In the 21st century, it is quite surprising to see that teachers are still dominated by old conventional methods of teaching. In the traditional/conventional teaching and learning process, teacher normally dominated the classroom instruction-delivering a sounded lecture, while students passively receive the knowledge from the teacher. Some teachers have myth- the myth of losing their importance. As some teachers responded…. *if everything is available online/internet, students learn on their own, why they come to colleges….yes sometimes we can use it but not on regular basis….* Teachers are not mere information providers or to dominate the entire teaching-learning process, but facilitators. Teachers hold strong belief on conventional methods of teaching, so they don't think of or take interest in new innovative methods. One teacher replied….*it gives me a kind of internal satisfaction to deliver a good lecture on my topic, as I think that I have done something and students understood it very well.* But there is a lack of students 'active participation in old/conventional teaching methodologies (**Boud and Feletti, 1991)**.

Teacher willingness/interest to integrate technology in teaching is an important factor for successful techno-integrated teaching. Teachers having good techno-integrated teaching

competency and good technological resource availability in colleges was a good condition for teachers' interest in techno-integrated teaching. Teachers who like to adapt new ways, welcome the innovations. Some teachers have a fear to adopt new innovative methods, they resist to change. This pinpoints that the introduction of technology in education aggravate an array of feedbacks from teachers that express passion and skepticism to fear and indecision. They believe in their conventional methods. One teacher said *"it gives me a satisfaction to teach our students through lecture method instead of applying other pedagogy, as I believe they will understand properly only through lecture method".*

Infrastructure facilities

Almost all the teachers who got interviewed responded that there was a lack of infrastructure and technology resources in their institutions, which restrict teachers technology incorporation in classroom teaching. However, the quantitative data showed that basic infrastructure/technological facilities were available in all govt. colleges, sufficiency of technological resources were different. As one teachers said …..*one projector, one smart classroom and a few computers, and limited other technological resources are not enough in the colleges where there are thousands of students enrolled*. The researcher also observed that the available technological resources in the said colleges were less in number, outdated and not properly maintained. *One of the teacher replied that there is not a stable Wi-Fi connection in our campus which restrict me to use online resources properly. The other teacher mentioned that there is also a lack of technology resources from students' side also. Every student is not having a Smartphone and those possess do not have good internet connection, as most of the students are from far flung areas, where there is not enough power supply and internet connectivity. This restricts me to use online resources like whatsapp group, Google websites and blogs properly*. The data

revealed that institutions do not have sufficient modern technological facilities. Teachers revealed that we do not have enough computers, projectors, smart classrooms, interactive white boards and other resources. According to **Lee & Lee (2014)** limited technological resources within educational institutions is a great impediment for technology integration in classrooms. Example, when there is absence of digital technological tools, it can restrict the incorporation. Teaching with technology requires sufficiency in technological resources.

Level of learners

A teacher is considered successful when he/she has information about the characteristics of his students, their interests, capabilities, background, and level of understanding. These things are important for every teacher to know his students very well. While using the latest digital technologies in our classrooms or teaching through TPACK, these things are quite important. The data from field notes revealed that techno-integrated teaching depends on the level of students to whom teachers teach. *One of the teacher said that all students are not digitally literate….some are good in running their smart phones, computers, some do not know how to create our own account, Microsoft word, excel…….* There should be a provision of training for students for using Smartphone, computers and other technological resources for their academic learning purposes. Using of online technological resources like Google classroom, it requires the interest and dedication from student side also. Teachers who were using these online discussion forums responded "*….students must have technological recourses especially the internet not only in their colleges but also in their homes also, so that the online discussion forums can work properly…..students sometimes claim for internet instability* (in Kashmir division), *error in smart phone, computer, and some do their assignments and some don't, even some don't have these smart phones… students are not serious".*

Theme 2: Execution

The 2nd prominent theme emerged from the coding process of qualitative data was 'Execution'- execution of what teachers planned. The sub-themes merged in this theme were 1) time 2) teacher as a facilitator 3) administrative support. All these sub-themes are discussed one by one.

Time

During interview most of the teachers said that "*we don't have enough time to use projectors, smart classrooms and other digital technologies regularly*". Thus, lack of time as barrier was found in this study. The data revealed that the teachers must have to complete the syllabus within the specific period of time, conduct unit tests and their evaluation and a huge administrative workload. These things restrict them in thinking about the successful techno-integrated teaching in classrooms, as small amount of time was left after performing all duties. Moreover, some teachers mentioned that "*the average class duration time is about 40-45 minutes; it takes a time to start, adjust and operate these digital technologies in a successful manner".* One of the teacher said "*our institution offers a very little amount of time almost negligible for ICT training*. Thus qualitative analysis clearly depicts that that planning and focus for techno-integrated instruction was a time intense activity.

Administrative support

Administrative support, support from the heads of institutions is an essential requirement for techno-integrated teaching. The support from principles, head of departments and other administrators encourage the teachers to teach their students according to the 21st century skills. During interview, some teachers said *"we were not*

encouraged or supported by our administrators towards technology integration in classroom. They just focus on regular class work, no matter how we teach, coverage of syllabus on time and other administrative workloads". Some teachers said *"they were well supported by their heads in innovative things".* The other replied that there should be incentives or rewards for those who teach their students the best. The other teacher said "*there was a lack of knowledge in the administrators about 21st century teaching skills. They are old in their ages, they have done their degrees which are very old, and training should also be provided to them, so that they will encourage their teaching faculties.* Administrative support is basically a very much wider dimension. This dimension in techno-integrated teaching should focus on providing the all kind of support and opportunity for teachers to teach accordingly. Managing sufficient ICT material resources, training programs, workshops, seminars for both students and teachers to make them digitally literate and sound, incentives and rewards for excellent teachers, and finally help in developing the constructive environment in the educational institutions. During interview and observation it was found that the teachers hold good academic qualifications in teaching subjects who developed a good subject specific content knowledge among them. But pedagogical knowledge and technological knowledge among teachers was found at a very minimal. Moreover, the recruitment and selection of teachers in higher education do not require any kind of teacher education course as eligibility, so most of the teachers were without teacher education courses. One of the teacher said *"that after 2 years of teaching, I heard about the word pedagogy"*. Teachers responded that there should be a proper and systematic training for them especially meant for the purpose of developing techno-integrated teaching skill among them. Most teachers just only know the names or heard about the names of

technologies but do not aware about how to operate them for their classroom purposes. Teachers made strong arguments about their continuous professional development through training programs, workshops, seminars and refresher and orientation courses. *One of the teachers responded that every year or every semester, one week training workshops should be arranged for teachers by the concerned authorities.* Researches **(Lee & Lee, 2014, Yousuf & Balogan, 2014 and Qasem & Vishwananthapa, 2018)** showed that ICT intervention programmes had improved the teachers' techno – integrated teaching competency.

TPACK lesson plan sample

The researcher proposed a sample of TPACK lesson planning as a format/template while teaching through TPACK model. It should be remembered that this is not applicable to different types of contents or subjects, teachers teach at different levels. Neither there is a specific recipe available for teaching through TPACK. However, as a format or lesson planning template, it may work.

TABLE 25: TPACK lesson plan sample

Title/topic: Coordinate Geometry
Subject :Mathematics
Class : B.A/B.SC Mathematics
Semester : 1st
Time duration: 50 minutes
Objectives: After reading this topic, learner should explain 1. *To find the distance between two pair of points on a plane* 2. *To plot points, lines and curves on x and y axis* 3. *To study algebraic equations graphically.*
Learning Material *Lines, surfaces and curves*
Learning processes: Discussions among learners & online distribution of assignment.

Learning Activities: 1. Before the actual classroom teaching, the teacher may inform the students what he/she is going to teach tomorrow. So, learners can do small reading about the topic. 1. Initially, the learners discuss in groups whatever they learn about the content/topic before the classroom teaching by the teacher. 2. After that, one learner from each group discusses the main findings of their learning and discussion with the whole class. 3. In this whole discussion, learners with the help of teacher, compare and contradict the findings emerged from their discussions in context of the topic to be covered. 4. The teacher introduces the terms cardinal and ordinal numbers and explains as well as gives examples on how to write and use them in simple sentences. 5. Students are then asked to perform various practice exercises through GeoGebra app and also take help of other app i.e. Photomath. (Note: depends on the availability of the personal computers as well as the Internet connection, the teacher can assign different pairs to different PCs and play the games as teams). The teacher will walk around to observe and assist any team having difficulty with the games. 6. Results and whatever the assignment work is to be done is uploaded by the teacher and students jointly on the Google classroom and whatever the doubts, are cleared in a collaborative way. 7. The teacher reviews what the students have learned through the GeoGebra and helps them wrap-up their learning experience by asking them to take turns to individually do an online quiz about coordinate geometry. 8. While doing so, the teacher distribute the assignments to the students who have not yet got the turn to do the online quiz to and submit them to the teacher as soon as they finish.
Resources and Tools: 1. GeoGebra online teaching-learning app (www.geobegra.org) 2. Google classroom website 3. Photomath online application (www.photomath.org)
Assessment: Online discussion forums like blogs and Google classroom can be used by the teacher in order to conduct evaluation of students. Online tests, quizzes and assignment can be used for evaluating the learners performance.

The above suggested TPACK lesson plan clearly shows the teachers plans to teach through TPACK model keeping in view the seven components of TPACK knowledge. Content knowledge in the plan is the teachers knowledge about coordinate geometry i.e. planes, lines, curves, surfaces etc, pedagogical knowledge is the plan of teacher to teach in the form of group discussions and individual self study and the technological knowledge of teacher

plans to integrate the internet and online application of GeoGebra and PhotoMath, and finally the Google classroom. The *Pedagogical Content Knowledge* (PCK) element of the lesson is when the teacher assigns the students to work collaboratively, be it in pairs or in groups. Collaborative work is believed to be able to promote interaction between students with different abilities and skills and help every student to accomplish the tasks in hand within a short time. As a result, every student experiences success and enjoys the hand-on learning. The *Technological Content Knowledge* (TCK) of the teacher reflects on how he uses assignments and quizzes that are really built for students learning about coordinate geometry. The online math learning applications, assignments and quizzes provide direct results for the students and, therefore, offer them immediate feedback that is supposed to encourage them to evaluate their learning and go over the learning materials so that they can better their achievement scores and deepen their understanding of coordinate geometry. The teacher demonstrates his *Technological Pedagogical Knowledge* (TPK) by using GeoGebra and PhotoMath and having the students play the games with their pair independently. This way, the content covered in the applications will be mastered without unnecessary explanation from the teacher. By working collaboratively with peers, each student will have an opportunity to be successful without the interference in individual's ability and skills. In all, the *Technological Pedagogical Content Knowledge* (TPACK) that the teacher possesses is shown when he uses online applications, assignments and quizzes as his aids and when he has students work together in groups and pairs. This way, the materials essential to learn about coordinate geometry will be mastered in no time. Moreover, every student will be able to enjoy hand-on coordinate geometry activities and experience success in achieving the goals of the learning.

Proposed techno-integrated teaching model

The model of TPACK was studied by the researcher in a specific context i.e. among higher education teachers in the state of Jammu & Kashmir. Certain dimensions emerged in this research study, which are significant in effective and successful techno-integrated teaching. The researcher inter-related these important dimensions and proposed a suggestive TPACK model in this specific context. The researcher found that beyond teachers' good TPACK knowledge, there are important issues which had a great effect on teachers techno-integrated teaching. As the researcher explored the infrastructure support or technological facilities available for teachers either personally or in their colleges, the results showed that technological facilities in the institutions are inadequate, insufficient, outdated and not properly maintained. A teacher, who is good enough in three knowledge domains i.e. TK, PK & CK but lacking the material resources necessary for execution, will not be successful in techno integrated teaching. So, this is the important dimension in teaching through TPACK. The researcher propounded that in the Technological knowledge (TK) dimension of TPACK, the sub dimension of sufficient technological resource availability and their proper maintenance should be included. In this regard, administrative support is required for teachers. Administrators have to manage the required material resources necessary for techno-integrated teaching. Moreover, when a teacher holds a sound TPACK knowledge and resources are sufficient and updated, the other important dimension in teaching through TPACK is the interest of teachers. The interest of teacher in using innovative/new ways is important, only then the techno-integrated teaching will be effective and successful. Otherwise, disinterest of teachers will not make TPACK teaching effective and complete. Some teachers welcome the new innovative things/changes

whereas some fear of new things and resist to change. Basically, the interest/willingness of teachers in using new teaching strategies is very much dependent on his knowledge and confidence in new strategies. Teachers who are taught by conventional ways and now teach their students in similar ways, show a very minimal interest in innovative ways. The researcher propounded that teachers should be provided the special trainings which will completely focus on teachers' improvement in latest pedagogies which are based on Constructivism and Connectivism learning theories. Dimension of administrative support, as per researcher, calls for managing sufficient material resources, training programs for professional development of teachers, provisions for incentives and rewards for effective teachers and encouragement by the heads of institutions. One other important dimension in techno-integrated teaching is the from the students side. If all the above mentioned conditions i.e. teachers sound knowledge, sufficient resources, enough training, good interest and enough administrative support or whatever other conditions are required, are fulfilled. But the learners or students are not digitally literate and sound, TPACK will not work effectively. Students' knowledge about how to operate different digital technologies, how to incorporate them in our learning and more importantly how to communicate or respond to others in collaboration, are essential for successful techno-integrated teaching. The researcher propounded those students digital literacy is essential component in TPACK teaching-learning process. The researcher has developed a suggestive LTPACK model on the basis of findings of this research work. The researcher assumes that this proposed model will work in Indian conditions. The basic LTPACK model is based on the idea of PCK given by Shulman. Shulman emphasized on the two important knowledge domains i.e. knowledge about the different teaching strategies, the subject/s of teaching and finally the knowledge of incorporating these two. Shulman propounded that prospective teachers

should hold intensive knowledge and understanding of the different teaching strategies and how to use them while teaching the content, and the incorporation of these two knowledge domains. This integration will make our teaching-learning process more effective and fruitful. Shulman's PCK model was further extended to TPACK model as the technological knowledge component included in it by Kohler and Mishra. The technology especially the latest digital material resources dramatically channelized the way we learn and teach today. TPACK model developed by Kohler and Mishra, (2008) is based on the three knowledge domains i.e. Technological, pedagogical and content knowledge. TPACK model recommends prospective teachers hold sound understanding and information in these three knowledge domains, and finally the knowledge about the integration of these three knowledge domains. The integration of these three knowledge domains gives rise to four other components i.e. TPK, TCK, PCK and TPACK. Finally, TPACK model is comprised of seven components of knowledge. TPACK model recommends that teachers should be very well versed in these seven dimensions of knowledge for teaching according to the latest theories of learning i.e. Constructivism and Connectivism. The researcher has made a further extension of TPACK model through the incorporation one other important component in it i.e. learner knowledge (LK). Learner knowledge (LK) refers to the knowledge/awareness about the students/learners you teach i.e. their characteristics, tastes and preferences, level of understanding, and more importantly the learners level of digital literacy and communication capability in case of the constructivist and connectivist learning strategies. Unless our learners are digitally literate and sound in their communication, integration of technology, the online discussions will not be effective'. Successful techno-integrated teaching knowledge is possible only if the teachers hold these four knowledge domains very well. This proposed TPLACK model, as it incorporated the

fourth basic dimension in TPACK model, gave rise to six more integrated knowledge aspects i.e. TLK, PLK, CLK, TPLK, PCLK, TCLK and finally the LTPACK. Here, T refers to technology, P To pedagogy, C to content and L to learners knowledge aspects of the proposed model. Basically, the entire integrated dimensions in TPACK and proposed LTPACK model are based on these knowledge aspects. So, the researchers proposed LTPACK model propounds that prospective teachers should hold strong understanding and information about these aspects and the incorporation of these four aspects in order to teach effectively.

Figure 3: Proposed LTPACK model