



Construction and Validation of Technological, Pedagogical & Content Knowledge (TPACK) Scale

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ABSTRACT

The turn of 21st century marked the beginning of a much common and whispered use of computer technologies in classroom. Technology has played an important role in transforming education to more progressive and interactive ways. The technological, pedagogical, and content knowledge (TPACK) framework has been regarded as potentially effective in guiding teachers to integrate technology into the classroom. This framework helps the teachers to understand the complex relations between different components of the model. There have been numerous studies about the development of TPACK scale in international contexts which were beyond the cultural and language boundaries. A need has been realized by the researcher to develop the TPACK scale in Indian context also. Therefore, in this paper an attempt has been made to construct and validate a tool for measuring Technological, Pedagogical & Content Knowledge (TPACK) of Indian Pre-service Teacher Educators, where in the reliability and validity of the tool have also been established.

KEY WORDS: Technological, pedagogical, and content knowledge (TPACK), Reliability, Validity

INTRODUCTION

The general failure of teacher development programmes was due to the lack of a systematic framework to guide teachers' integration of ICT in teaching and learning. They nominated Shulman's (1986) framework, PCK or Pedagogical Content Knowledge, as a way to tackle this problem. The term Pedagogical Content knowledge (PCK) was put forward by Lee Shulman (1986). Shulman's PCK model has been examined, expanded, and elaborated by many scholars and practitioners since 1986 but the work of Mishra & Koehler (2006) is most significant. They expanded PCK to include another domain – the use of technology to support teaching and learning. The resulting model – Technological, Pedagogical & Content Knowledge or TPACK – adds further complexity to the way we think about teaching, learning, and technology.

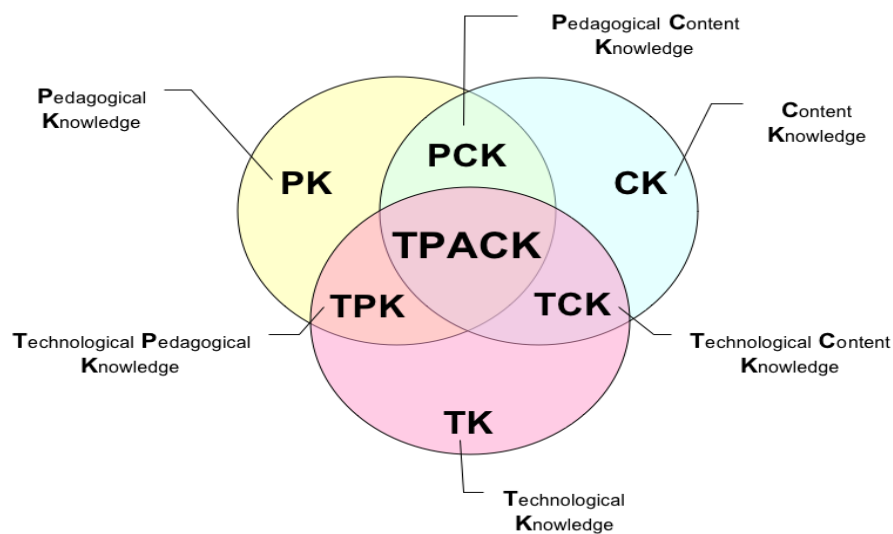


Fig.-1 TPACK Model

TPACK, as represented above in figure-1, is a blooming form of knowledge that goes afar all three core components (Content, Pedagogy and Technology). TPACK is different from knowledge of its individual component concepts and their intersections. It arises from multiple interactions among content, pedagogical, technological, and contextual knowledge. TPACK is a mastery that matures from the interaction among the Content, Pedagogy and Technology Knowledge. This knowledge makes the learning of the subject easier for the student with appropriate pedagogy and technology. It is aimed to go beyond techno-centrism to help teachers in creative thinking.

NEED FOR CONSTRUCTION OF TPACK SCALE IN INDIAN CONTEXT

The notion of TPACK defined as understanding the connections and interactions between and among content knowledge, technological knowledge and pedagogical knowledge to improve student learning. It is quickly becoming popular among researchers and practitioners alike. As a result, various researchers have developed different methodologies which are being able to measure TPACK. In several studies, survey instruments have been developed to measure teachers’ TPACK development (Schmidt et al., 2009). Schmidt et al. (2009) developed the most commonly used scale. Koh, Chai, and Tsai (2010) conducted a validity and reliability study for the TPACK scale developed by Schmidt et al. (2009). Similarly, Dikkartın-Övez and Akyüz (2013) applied the same scale to mathematics teachers and obtained four factors. Sahin (2011) developed a seven dimensional scale, and this scale can be adapted to any subject. Similarly, another seven-dimensional scale was created by Archambault and Crippen (2009). A scale with seven subscales specific to one subject was developed by Akman and Güven (2015). The nature and amount of TPACK is different in India in comparison to other countries and all the existed scale were constructed in foreign perspectives. Therefore, a need to construct a tool for measuring Technological, Pedagogical and Content Knowledge (TPACK) of Indian Pre-service teacher educators was realized. Following steps were taken care of during the construction of TPACK Scale.

MAJOR STEPS FOR CONSTRUCTION OF TPACK SCALE

a) Pre-requisites for TPACK Scale Construction

The first and foremost step for any test construction involves the permission from the developer. Before starting any work, the permission from Dr. Denise Schmidt via e-mail was taken to develop the Technological, Pedagogical & Content Knowledge (TPACK) scale into Indian version. The second step involves determining the Construct Focused for Measurement. In TPACK Scale development,

this phase includes a comprehensive literature review on PCK and TPACK. As noted earlier, Shulman's (1986) conceptualization of PCK and Mishra and Koehler's (2006) TPACK model were adapted as a theoretical framework. After the extensive literature review definitions of the construct were developed based on the selected frameworks. The next step involves the selection of a response format, which is another critical step of the scale development. A 5-point Likert Scale was used because it is generally accepted format for evaluating Technological, Pedagogical & Content Knowledge (TPACK) of pre-service teacher educators. The last step of this section belongs to the development of the item pool. 61 items were framed based on seven dimensions i.e., Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Pedagogical Knowledge (TPK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK) and Technological, Pedagogical & Content Knowledge (TPACK). The items in the initial TPACK pool were assessed for content validity by experts. Based on expert's comments and feedback, revisions were made in the second draft of TPACK Scale.

Table 1: components of TPACK and No. of items in each component

Sr. No.	Dimensions	Nature of Items	Item No.	Total
1	Technological Knowledge	positive	1 to 10	10
2	Pedagogical Knowledge	positive	11 to 18	8
3	Content Knowledge	positive	19 to 26	8
4	Technological Pedagogical Knowledge	positive	27 to 37	11
5	Technological Content Knowledge	positive	38 to 44	7
6	Pedagogical Content Knowledge	positive	45 to 51	7
7	Technological Pedagogical and Content Knowledge	positive	52 to 61	10
	Total			61

b) Item Analysis of TPACK Scale

Before the development process of the scale was completed, the scale was administered to 110 pre-service teachers. As per Kelley (1939), the upper and lower criterion groups contain 30 pre-service teacher educators in each group. So, in order to find out the Discriminatory Power of each item, t-test was used to check the significance of the difference between upper and lower criterion group for each item. All the items (except item no. 4, 7 and 41) have sig. Value less than 0.05. So, these three items (4, 7 and 41) were rejected after Item Analysis as shown in table 2. The draft now contained 58 items (statements). **These 58 items were arranged in serial order again.**

Table 2: t-Value and Significant Value for each Item in Upper (U) & Lower (L) Criterion Group

Item No.	Mean	Std. Deviation	t-value	p-value (Sig. Value)	Item No.	Mean	Std. Deviation	t-value	p-value (Sig. Value)
1	2.733	.980	15.272	.000	31	2.900	.662	24.002	.000
2	2.267	.740	16.784	.000	32	.467	1.106	2.311	.028
3	2.667	.844	17.302	.000	33	2.767	1.006	15.059	.000
4	0.033	1.033	0.177	.861	34	1.967	.890	12.104	.000
5	2.800	.805	19.048	.000	35	3.033	.718	23.127	.000
6	2.900	.960	16.554	.000	36	2.500	.974	14.062	.000
7	0.067	1.258	.290	.774	37	2.767	.898	16.882	.000
8	2.867	.860	18.250	.000	38	2.433	1.040	12.815	.000
9	2.767	.858	17.654	.000	39	2.767	1.073	14.127	.000
10	2.700	.915	16.155	.000	40	2.600	.894	15.922	.000
11	3.000	.871	18.866	.000	41	.133	1.074	0.680	.502
12	2.867	.819	19.164	.000	42	2.033	1.299	8.571	.000

13	2.667	1.061	13.762	.000	43	2.500	.974	14.062	.000
14	2.867	.860	18.250	.000	44	2.867	.819	19.164	.000
15	2.733	.740	20.240	.000	45	2.500	1.196	11.447	.000
16	2.967	.850	19.110	.000	46	2.867	.776	20.232	.000
17	2.867	.776	20.232	.000	47	2.800	.961	15.953	.000
18	2.900	.845	18.801	.000	48	3.033	.765	21.721	.000
19	2.933	.944	17.012	.000	49	2.667	.661	22.100	.000
20	3.000	.695	23.649	.000	50	2.200	1.324	9.104	.000
21	2.867	.681	23.041	.000	51	2.600	.855	16.656	.000
22	2.633	.850	16.963	.000	52	2.767	.817	18.543	.000
23	3.000	.910	18.062	.000	53	2.967	.718	22.619	.000
24	2.667	.711	20.538	.000	54	2.967	.928	17.512	.000
25	2.633	.809	17.835	.000	55	2.300	1.442	8.736	.000
26	3.000	.910	18.062	.000	56	2.400	1.276	10.304	.000
27	2.967	1.033	15.725	.000	57	2.700	1.149	12.868	.000
28	2.400	.968	13.573	.000	58	2.733	.907	16.503	.000
29	2.700	.651	22.708	.000	59	2.500	1.306	10.481	.000
30	3.100	.607	27.953	.000	60	2.767	1.165	13.006	.000
					61	2.700	.915	16.155	.000

c) Standardization of TPACK Scale

(i) Item – Total Correlation

For standardization of test, it was administered on 400 pre-service teacher educators (both male and female). Participants were chosen from different teacher training institutions. They were chosen randomly. After collecting the data from 400 pre-service teacher educators, Item-Total Correlation was calculated. Item no. 1, 2 and 8 were excluded from the scale at this stage because of low item-total correlation as shown in table 3.

Table 3: Item-Total Correlations for the Items in Scale

Item No.	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Item No.	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
1	175.63	1948.373	.453	.976	30	175.96	1914.758	.722	.976
2	175.80	1945.237	.469	.976	31	175.85	1919.050	.709	.976
3	175.94	1932.515	.595	.976	32	175.94	1917.194	.742	.976
4	176.03	1930.613	.535	.976	33	175.83	1921.112	.694	.976
5	176.11	1931.799	.607	.976	34	175.88	1924.179	.691	.976
6	175.83	1934.534	.607	.976	35	175.88	1917.874	.720	.976
7	176.22	1937.083	.547	.976	36	175.89	1929.052	.641	.976
8	175.86	1943.317	.474	.976	37	175.72	1926.122	.622	.976

9	176.00	1936.386	.604	.976	38	175.92	1920.825	.680	.976
10	176.23	1917.454	.718	.976	39	175.97	1915.490	.712	.976
11	176.28	1919.652	.665	.976	40	175.92	1925.918	.632	.976
12	176.16	1920.412	.657	.976	41	175.89	1926.575	.647	.976
13	176.13	1923.630	.649	.976	42	175.70	1940.034	.552	.976
14	176.19	1927.366	.614	.976	43	175.81	1929.892	.601	.976
15	176.24	1920.103	.677	.976	44	175.89	1916.166	.649	.976
16	176.15	1927.246	.622	.976	45	176.01	1918.902	.632	.976
17	176.09	1922.268	.670	.976	46	175.77	1914.614	.648	.976
18	176.07	1923.111	.653	.976	47	175.94	1912.758	.659	.976
19	176.19	1919.244	.663	.976	48	175.94	1916.084	.672	.976
20	176.26	1919.752	.688	.976	49	175.91	1928.027	.590	.976
21	176.22	1917.180	.710	.976	50	176.10	1926.443	.568	.976
22	176.27	1912.061	.719	.976	51	175.87	1923.106	.599	.976
23	176.20	1917.395	.678	.976	52	175.89	1929.443	.536	.976
24	176.19	1918.838	.684	.976	53	176.03	1922.049	.547	.976
25	175.62	1926.296	.659	.976	54	176.02	1918.722	.576	.976
26	175.84	1918.593	.746	.976	55	175.98	1919.228	.568	.976
27	175.91	1913.182	.756	.975	56	176.07	1913.311	.638	.976
28	175.93	1914.968	.732	.976	57	175.79	1923.595	.579	.976
29	176.11	1910.704	.727	.976	58	175.95	1924.133	.578	.976

(ii) Reliability of TPACK Scale

Reliability of the scale has been measured by Split-half and Test-Retest method. Furthermore, Cronbach’s alpha, the coefficient of internal consistency has also been calculated. Results given below in table 4 indicating that the scale is highly reliable.

Table-4

Sr. No.	Method of Testing Reliability		Coefficient of Reliability
1.	Split-half	Spearman-Brown	.904
		Guttman Coefficient	.904
2.	Test-Retest		.992
3.	Cronbach’s Alpha		.986

(iii) Validity of Scale

• **Content Validity**

All the 55 items of TPACK Scale has been evaluated by the various experts. Content validity has been established while preparing the initial draft of TPACK Scale. Expert opinion of teacher educators and language specialists with regard relevance of each item was sought. The items in the TPACK pool of 55 items were assessed for content validity by experts. Experts reviewed the content validity of the scale and the clarity and conciseness of each item using a 3-point Likert scale: (0: absolutely inappropriate, 1: slightly appropriate, 2: absolutely appropriate). Based on expert’s comments and feedback, revisions were made.

• **Factorial Validity**

With factor analysis, the construct validity of a questionnaire can be tested. The Kaiser-Meyer-Okin measure of sampling adequacy (KMO) falls within the last category (KMO=0.967) which means the data set is superb for factor extraction. The data set was then subjected to Bartlett’s test in order to determine whether the data set was suitable for the EFA or not. Bartlett’s test yielded a significant result (χ^2 : 16098.568; $p < 0.01$), suggesting that the data set was suitable for exploratory factor analysis. Promax with Kaiser Normalization- Principal axis factoring was performed with these 55 items and their factor loadings are represented in table 5.

Table 5: Distribution of factors & their loadings in the Final Version of the Scale

Item No.	Factor 1	Factor 2	Factor 3	Factor 4
11	.798			
10	.763			
7	.753			
14	.736			
5	.721			
20	.657			
19	.647			
3	.620			
4	.617			
9	.611			
21	.592			
12	.578			
15	.559			
18	.559			
23	.507			
24	.487			
13	.434			
6	.431			
22	.428			
16	.422			
17	.376			
34		.847		

30		.727		
28		.719		
37		.697		
36		.683		
26		.667		
38		.665		
31		.662		
33		.650		
27		.643		
40		.634		
32		.619		
39		.604		
35		.602		
29		.577		
25		.464		
42		.462		
41		.449		
48		.372		
55			.845	
54			.823	
53			.766	
56			.646	
52			.572	
57			.562	
58			.437	
51			.398	
46				.784
45				.672
44				.661
47				.572
43				.508
49				.418
50				.387

Extraction Method: Principal Axis Factoring.
Normalization

Rotation Method: Promax with Kaiser

The factor loadings for the final 55 items varied between **.847 (Item 34)** and **.372 (Item 48)**. The scale accounted for **52.904% of the total variance**. This suggests that the amount of variance accounted for in the present study (52.9%) was sufficiently good.

d) Items and Components of Final TPACK Scale

The scale comprised of 55 items from seven different dimensions. Distribution of items and dimensions of TPACK Scale is given below in table 6.

Table-6

Sr. No.	Dimensions	Nature of Items	Item No.	Total
1	Technological Knowledge	positive	1 to 5	5
2	Pedagogical Knowledge	positive	6 to 13	8
3	Content Knowledge	positive	14 to 21	8
4	Technological Pedagogical Knowledge	positive	22 to 32	11
5	Technological Content Knowledge	positive	33 to 38	6
6	Pedagogical Content Knowledge	positive	39 to 45	7
7	Technological Pedagogical and Content Knowledge	positive	46 to 55	10
	Total			55

Table 7 represents the correlations among the factors of the scale. A positive and high correlation was revealed between the factor 2 and factor 1. Besides, it can be argued that there was a positive, satisfactory and intermediate correlation among all the other factors.

Factor	1	2	3	4
1	1.000	.777	.601	.552
2	.777	1.000	.589	.598
3	.601	.589	1.000	.633
4	.552	.598	.633	1.000

Extraction Method: Principal Axis Factoring.
Rotation Method: Promax with Kaiser Normalization.

e) Scoring

The scoring of TPACK Scale is easy and objective. Each item response is scored with a value of 1 assigned to Strongly Disagree, 2 for Disagree, 3 for Neither Agree nor Disagree, 4 for Agree and 5 for strongly Agree. For each dimension the participant’s responses are simply added up. At the end all the scores of seven dimensions are added up to give the total value of TPACK Scale. It can also be represented by the following equation:

$$\text{Total TPACK Score} = \text{TK} + \text{PK} + \text{CK} + \text{TPK} + \text{TCK} + \text{PCK} + \text{TPCK}$$

f) Norms

Table 8

	N	Mean	Std. Deviation
Total TK	400	15.22	4.114
Total PK	400	23.20	6.878
Total CK	400	23.08	7.290
Total TPK	400	35.03	9.960
Total TCK	400	19.10	5.370
Total PCK	400	22.43	6.658
Total TPCK	400	31.10	9.580
TPACK	400	169.16	43.103

Table-9: Z-score Norms for TPACK Scale

Mean = 169.16

Standard Deviation= 43.103

Raw Score	z-Score	Raw Score	z-Score	Raw Score	z-Score	Raw Score	z-Score
55	-2.28	72	-1.94	89	-1.60	106	-1.26
56	-2.26	73	-1.92	90	-1.58	107	-1.24
57	-2.24	74	-1.90	91	-1.56	108	-1.22
58	-2.22	75	-1.88	92	-1.54	109	-1.20
59	-2.20	76	-1.86	93	-1.52	110	-1.18
60	-2.18	77	-1.84	94	-1.50	111	-1.16
61	-2.16	78	-1.82	95	-1.48	112	-1.14
62	-2.14	79	-1.80	96	-1.46	113	-1.12
63	-2.12	80	-1.78	97	-1.44	114	-1.10
64	-2.10	81	-1.76	98	-1.42	115	-1.08
65	-2.08	82	-1.74	99	-1.40	116	-1.06
66	-2.06	83	-1.72	100	-1.38	117	-1.04
67	-2.04	84	-1.70	101	-1.36	118	-1.02
68	-2.02	85	-1.68	102	-1.34	119	-1.00
69	-2.00	86	-1.66	103	-1.32	120	-0.98
70	-1.98	87	-1.64	104	-1.30	121	-0.96
71	-1.96	88	-1.62	105	-1.28	122	-0.94
Raw Score	z-Score	Raw Score	z-Score	Raw Score	z-Score	Raw Score	z-Score
123	-0.92	156	-0.26	189	0.39	222	1.06
124	-0.90	157	-0.24	190	0.41	223	1.08
125	-0.88	158	-0.22	191	0.43	224	1.10
126	-0.86	159	-0.20	192	0.45	225	1.12
127	-0.84	160	-0.18	193	0.47	226	1.14
128	-0.82	161	-0.16	194	0.49	227	1.16
129	-0.80	162	-0.14	195	0.51	228	1.18
130	-0.78	163	-0.12	196	0.53	229	1.20
131	-0.76	164	-0.10	197	0.55	230	1.22
132	-0.74	165	-0.08	198	0.57	231	1.24
133	-0.72	166	-0.06	199	0.60	232	1.26
134	-0.70	167	-0.04	200	0.62	233	1.28
135	-0.68	168	-0.02	201	0.64	234	1.30
136	-0.66	169	0.00	202	0.66	235	1.32
137	-0.64	170	0.01	203	0.68	236	1.34
138	-0.62	171	0.03	204	0.70	237	1.36
139	-0.60	172	0.05	205	0.72	238	1.38
140	-0.58	173	0.07	206	0.74	239	1.40
141	-0.56	174	0.09	207	0.76	240	1.42
142	-0.54	175	0.11	208	0.78	241	1.44
143	-0.52	176	0.13	209	0.80	242	1.46
144	-0.50	177	0.15	210	0.82	243	1.48
145	-0.48	178	0.17	211	0.84	244	1.50
146	-0.46	179	0.19	212	0.86	245	1.52
147	-0.44	180	0.21	213	0.88	246	1.54
148	-0.42	181	0.23	214	0.90	247	1.56

149	-0.40	182	0.25	215	0.92	248	1.58
150	-0.38	183	0.27	216	0.94	249	1.60
151	-0.36	184	0.29	217	0.96	250	1.62
152	-0.34	185	0.31	218	0.98	251	1.64
153	-0.32	186	0.33	219	1.00	252	1.66
154	-0.30	187	0.35	220	1.02	253	1.68
155	-0.28	188	0.37	221	1.04	254	1.70
Raw Score	z-Score	Raw Score	z-Score	Raw Score	z-Score	Raw Score	z-Score
255	1.72	260	1.82	265	1.92	270	2.02
256	1.74	261	1.84	266	1.94	271	2.04
257	1.76	262	1.86	267	1.96	272	2.06
258	1.78	263	1.88	268	1.98	273	2.08
259	1.80	264	1.90	269	2.00	274	2.10
						275	2.12

Table 10: Norms for Interpretation of Level of TPACK

Sr. No.	Range of Raw Score	Range of z-Score	Grade	Level of TPACK
1	270 & above	+2.01 & above	A	Extremely High
2	232 to 269	+1.26 to + 2.00	B	High
3	195 to 231	+0.51 to +1.25	C	Above Average
4	144 to 194	-0.50 to +0.50	D	Average
5	107 to 143	-1.25 to -0.51	E	Below Average
6	69 to 66	-2.00 to -1.26	F	Low
7	68 & below	-2.01 & below	G	Extremely Low

TPACK is so influential today that there may be a tendency to take for granted the core ideas of the model, to assume that we have always know that. The present paper helped in construction and validation of TPACK scale through which we can measure TPACK time to time to see that TPACK core values are changing every time or not.

REFERENCES

- Akman, O., & Guven, C. (2015). TPACK survey development study for social sciences teachers and teacher candidates. *International Journal of Research in Education and Science (IJRES)*, 1(1), 1-10
- Archambault, L., & Crippen, K. (2009). Examining TPACK among k-12 online distance educators in the United States. *Contemporary Issues in Technology and Teacher Education*, 9 (1), 71–88.
- Bornstedt, 1977; Bornstedt, G. W. 1977. "Reliability and validity assessment in attitude measurement" In G. F. Summers (Ed.), pp 80-99. London, England.
- DeVellis, R.F. (2003). "Scale development: Theory and applications" (2nd ed.). Newbury Park: Sage
- Dikkartın-Övez, F.T., & Akyüz, G. (2013). İlköğretim Matematik Öğretmeni Adaylarının Teknolojik Pedagojik Alan Bilgisi Yapılarının Modellenmesi. *Eğitim ve Bilim*, 38, 170
- Chai, C. S., Koh, J. H. L., Tsai, C.-C. (2010). Facilitating preservice teachers' development of technological, pedagogical, and content knowledge (TPACK). *Journal of Educational Technology & Society*, 13(4), 63-73.
- Kelly, T. L. (1939). The Selection of Upper and Lower Groups for the Validation of Test Items. *Journal of Educational Psychology*. Vol. 30, p.p. 17-24
- Mishra, P., & Koehler, M.J. (2006). "Technological pedagogical content knowledge: A framework for teacher knowledge". *Teachers College Record*, 108(6), 1017–1054. doi:10.1111/j.1467-9620.2006.00684.x
- Rattray, J.C. and Jones, M.C. (2007), "Essential elements of questionnaire design and development", *Journal of Clinical Nursing*, 16, pp 234-243
- Sahin, I. (2011). Development of survey of technological pedagogical and content knowledge (TPACK). *Turkish Online Journal of Educational Technology*, 10(1), 97-105.
- Shulman, L.S. (1986). "Those who understand: Knowledge growth in teaching". *Educational Researcher*, 15(2), 4–14
- Schmidt et al. (2009)