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Exploring the PCK-PE factors of Physical Education Teachers

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Abstract: This study aimed to exploring PCK-PE factor of physical education teachers, develop a scale and verify its validity. It was divided into preliminary surveys and main survey. First, a scale was developed through the Delphi verification process after data were collected through an open questionnaire given to 97 physical education teachers. Then, a descriptive statistical analysis and an exploratory factor analysis was performed on data collected from 163 physical education teachers in February 2020. And the reliability of the scale was analyzed. Based upon the analysis, the PCK-PE of physical education teachers was found to have 6 factor structures. The scale developed in this study is expected to more accurately and properly evaluate PE teachers' PCK-PE

Keywords: *PCK-PE, PE teacher, factor structure*

1. Introduction

Teachers lie at the heart of successful education. Students' academic achievement is proportional to teachers' instructional expertise [1]. A substantial number of classes facilitates students' understanding of content and serves to engage them in a variety of activities. Because the basic job of a teacher is to direct class activities [2], teachers should have instructional expertise that is reflected in the classroom. Instructional expertise refers to an ability to combine and reconstruct the pedagogical content knowledge (PCK) and the pedagogical knowledge necessary to teach it in the classroom [3]. Interest in instructional expertise first emerged when [4] used the term PCK, defining it as 'a method of expressing and formulating the pedagogical content to enhance the understanding of students'. Specific subject matter, problems, or issues (such as a PE class' unique teaching-learning method, environment, and evaluation) of the pedagogical content are transformed into an organizational expression for learners with varying levels of interest and competency, ensuring a harmonious blend of knowledge with the method used in class. Although studies related to PCK-PE have been reported [5-8], a study on scale development and validity verification for PCK-PE has not been conducted. Accordingly, considering the current emphasis on the instructional expertise of PE teachers, the development of a PCK measurement tool is needed. Building upon existing studies related to the PCK-PE, [5] conducted a study of structuring sub-elements and constructing achievement standards to examine how PE teachers form and develop PCK-PE in class. [6-8] all conducted studies that investigated PCK formation processes and development in various settings. Thus, in addition to existing research, the development of a highly valid PCK-PE measurement tool for PE teachers is required. To develop this tool, the realm of PCK-PE needs to be explored—specifically, the knowledge base of PE teachers. This study aimed to exploring PCK-PE factor of physical education teachers' explored—specifically, develop a scale and verify its validity.

2. Methodology

This study used convenience sampling, a non-probability sampling method that samples subjects who can be accessed at a time and place convenient to the researcher. In this study, 265 PE teachers

working in South Korea in 2020 were selected. The preliminary survey, in January 2020, was conducted online with 100 PE teachers using an open questionnaire; data from 97 participants were used for analysis (three did not respond). The main survey, in February 2020, was also conducted online with 200 PE teachers; data from 168 participants were used for analysis (32 did not respond).

Table 1. Demographic characteristics of the study subjects

Variable	Category	1st preliminary survey	2nd preliminary survey	Main survey	total
Gender	Male	76 (78.4%)	141 (83.9%)	229 (84.2%)	446 (83.1%)
	Female	21 (21.6%)	27 (16.1%)	43 (15.8%)	91 (16.9%)
Age	20s	18 (18.6%)	22 (13.1%)	34 (12.5%)	74 (13.8%)
	30s	33 (34.0%)	83 (49.4%)	139 (51.1%)	255 (47.5%)
	40s	41 (42.3%)	58 (34.5%)	93 (34.2%)	192 (35.8%)
	Over the age of 50	5 (5.2%)	5 (3.0%)	6 (2.2%)	16 (3.0%)
Teaching experience	Less than 5 tears	21 (21.6%)	29 (17.3%)	45 (16.5%)	95 (17.7%)
	6-10 years	39 (40.2%)	47 (28.0%)	78 (28.7%)	164 (30.5%)
	11-20 years	34 (36.1%)	83 (49.4%)	139 (51.5%)	256 (47.7%)
	Over 21 years	3 (3.1%)	9 (5.4%)	10 (3.7%)	22 (4.1%)
total		97 (100.0%)	168 (100.0%)	272 (100.0%)	537 (100.0%)

To achieve the research objectives, data were collected through the preliminary and main surveys. In the preliminary survey, data collected through an open questionnaire were consolidating into questions and content validity of the expert group was verified through the Delphi technique, producing 43 preliminary questions. In the main survey, data were collected through preliminary questions produced from the first survey. A descriptive statistical analysis of mean and standard deviation, skewness, and kurtosis was then performed on the collected data. Next, an exploratory factor analysis (EFA) was conducted to ensure construct validity for the scale. The data obtained were analyzed using SPSS 18.0 program (IBM Corp., Armonk, NY, USA). The study was conducted with the approval of the Jeonju National University of Education IRB (JNUE-IRB-2020-012).

One example of the questions is as follows: ‘What kind of PCK-PE do you think teachers should have in PE class?’ Inductive content analysis was performed on 97 responses obtained. The questions focused on content with high frequency among the acquired data. Responses with representativeness were selected, and 85 questions were produced. Next, for the Delphi Verification, a group of ten experts (one PE professor, three Ph.D. scholars in pedagogy, and six PE teachers with a master’s degree in pedagogy) were surveyed using a two-point closed scale (Yes or No). In the process, question items that

did not meet the 50% standard were removed; 42 questions were deleted and 43 questions were used as preliminary questions.

After a descriptive statistical analysis (see detailed results in Table 1), the second survey was conducted on a five-point scale. The mean was distributed from 3.71 to 4.52, and the standard deviation was distributed from 0.57 to 0.89. Next, skewness and kurtosis were examined. The absolute value of skewness was distributed from 0.53 to 1.78, and the absolute value of kurtosis was distributed from 0.86 to 3.91. It met the skewness of $< \pm 3.0$ [9] and the kurtosis of $< \pm 10.0$ [10], which are criteria for violation of univariate normality of skewness and kurtosis.

Table 2. Descriptive statistical analysis of preliminary questions

Question	Mean	Standard deviation	Skewness	Kurtosis
PCK1	4.37	0.67	-0.72	-0.05
PCK2	4.12	0.72	-0.57	0.27
PCK3	4.24	0.74	-0.59	-0.31
PCK4	4.52	0.59	-0.96	0.90
PCK5	4.49	0.58	-0.61	-.60
PCK6	4.20	0.69	-0.40	-0.41
PCK7	4.19	0.72	-0.50	-0.24
PCK8	4.00	0.80	-0.77	0.86
PCK9	4.01	0.71	-0.31	-0.15
PCK10	4.04	0.73	-0.35	-0.24
PCK11	3.82	0.89	-0.72	0.45
PCK12	4.03	0.75	-0.40	-0.17
PCK13	3.80	0.86	-0.36	-0.44
PCK14	4.02	0.70	-0.34	-0.03
PCK15	4.03	0.77	-0.37	-0.40
PCK16	4.10	0.74	-0.43	-0.23
PCK17	4.17	0.68	-0.22	-0.84
PCK18	4.42	0.61	-0.56	-0.59
PCK19	4.29	0.59	-0.37	0.38
PCK20	4.20	0.61	-0.29	0.27
PCK21	3.89	0.79	-0.23	-0.50
PCK22	4.15	0.63	-0.13	-0.52
PCK23	4.13	0.63	-0.11	-0.54
PCK24	4.17	0.63	-0.15	-0.54
PCK25	4.24	0.57	-0.04	-0.37
PCK26	4.16	0.62	-0.12	-0.49
PCK27	4.14	0.57	0.01	-0.08
PCK28	4.19	0.62	-0.15	-0.50

PCK29	4.23	0.62	-0.20	-0.56
PCK30	4.08	0.72	-0.71	1.47
PCK31	4.17	0.64	-0.31	-0.06
PCK32	4.11	0.70	-0.47	0.15
PCK33	3.71	0.86	-0.28	-0.21
PCK34	3.79	0.89	-0.59	0.20
PCK35	3.98	0.78	-0.43	-0.16
PCK36	4.02	0.71	-0.33	-0.12
PCK37	4.27	0.57	-0.04	-0.48
PCK38	4.24	0.58	-0.08	-0.41
PCK39	4.20	0.65	-0.35	-0.10
PCK40	4.32	0.59	-0.24	-0.62
PCK41	4.21	0.58	-0.06	-0.34
PCK42	4.20	0.62	-0.17	-0.55
PCK43	4.33	0.57	-0.12	-0.67

3. Results

EFA was performed to construct sub-factors of the questions for PCK-PE (table 2). In this study, a principal component analysis was used for extracting constituent factors, and Varimax, an orthogonal rotation method, was used to simplify factor loading. In this study, an eigenvalue of 1.0 or more and factor loading of .4 or more were set as criteria.

Table 3. Results of the EFA

Question	**Component**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
8	0.803	0.010	0.189	0.071	0.106	0.199	0.068
7	0.790	0.217	0.035	0.156	0.012	-0.015	0.164
9	0.769	0.157	0.180	0.102	0.178	0.172	-0.022
10	0.752	0.303	0.080	-0.008	0.225	0.011	0.124
12	0.699	0.227	0.054	0.049	0.261	0.157	0.077
11	0.644	0.055	0.255	-0.063	0.352	0.228	-0.063
16	0.611	0.303	0.173	0.327	0.114	0.058	0.106
15	0.533	0.114	0.332	0.480	0.115	0.141	0.027
13	0.447	0.117	0.415	0.082	0.438	-0.008	-0.161
27	0.132	0.706	0.224	0.182	0.049	0.226	-0.034
24	0.142	0.696	0.098	0.097	0.005	0.413	0.093
22	0.155	0.649	0.163	0.251	0.216	0.130	0.217
28	0.229	0.621	0.145	0.119	0.380	0.127	0.196
26	0.299	0.575	0.377	0.085	0.111	0.206	0.025

25	0.232	0.567	0.105	0.332	0.231	0.186	0.180
23	0.299	0.564	0.176	0.309	0.269	0.128	0.026
19	0.344	0.454	0.136	0.387	0.096	0.248	0.120
29	0.154	0.454	0.253	0.427	0.158	0.192	-0.032
30	0.281	0.453	0.101	0.277	0.428	0.278	0.093
1	0.147	0.119	0.780	0.174	0.134	-0.129	0.121
3	0.157	0.149	0.660	-0.017	0.260	0.140	0.183
6	0.116	0.184	0.646	0.169	0.035	0.193	0.175
2	0.190	0.214	0.638	-0.027	0.217	0.121	0.045
14	0.422	0.195	0.441	0.141	0.282	0.066	-0.015
37	-0.005	0.208	0.034	0.716	0.156	0.240	0.077
38	0.006	0.328	0.058	0.664	0.173	0.237	0.136
36	0.241	0.261	-0.002	0.485	0.460	0.091	0.131
17	0.220	0.357	0.237	0.471	-0.033	0.270	-0.037
32	0.274	0.011	0.203	0.397	0.261	0.329	-0.113
34	0.186	0.078	0.148	0.200	0.757	-0.033	0.093
33	0.208	0.146	0.293	0.030	0.647	0.266	-0.077
21	0.327	0.285	0.292	0.066	0.536	0.213	-0.166
35	0.302	0.154	0.203	0.303	0.525	0.228	0.176
31	0.212	0.459	0.132	0.205	0.524	0.192	0.212
42	0.179	0.260	0.203	0.280	0.188	0.651	0.018
41	0.108	0.358	0.163	0.172	0.238	0.634	-0.014
39	0.156	0.327	0.002	0.236	0.105	0.609	0.128
43	0.085	0.242	-0.048	0.322	0.116	0.557	0.450
20	0.344	0.371	0.229	0.304	-0.041	0.466	0.033
40	0.165	0.237	-0.153	0.450	0.236	0.451	0.270
18	0.114	0.269	0.235	0.331	0.024	0.406	0.309
4	0.151	0.138	0.451	-0.037	0.165	0.087	0.670
5	0.118	0.165	0.403	0.283	-0.115	0.142	0.605
Eigenvalue	5.802	5.229	3.824	3.714	3.642	3.416	1.706
Variance (%)	13.494	12.161	8.893	8.637	8.470	7.943	3.967
Cumulative variance (%)	13.494	25.656	34.549	43.186	51.657	59.600	63.568

To clarify, KMO's sample adequacy measure was found to be 0.910, which indicates that the size of the sample to be analyzed is suitable for the EFA. The result of the Bartlett's sphericity test was found to be 4952.680 (p=.000), which confirmed that it is appropriate enough to reject the null hypothesis that

'correlation matrix is 0' and to perform EFA between sample variables. In addition, the total variance explained was 63.568%, which suggests that seven factors account for 63.568% of the total variance.

The specific results of the EFA were extracted to create seven factors. However, question PCK32 was not tied to any factors, and for the seventh factor, two questions were grouped into one factor; thus, the factor was deleted. If there are less than three observed variables in one latent variable, there may be a problem with the validity and identification of the model [11]; thus, at least three observed variables are required for one latent variable. Through this process, three questions (PCK3, PCK4, and PCK32) were deleted. Based on the questionnaire items of six factors extracted through this process, each sub-factor was named by an expert group. Previous studies related to PCK-PE [5] suggested various components of PCK-PEs (PCK3, PCK4, and PCK32) were deleted. Of these, KICE presented six components: knowledge of PE as a subject, curriculum, pedagogy, learners for physical activity, evaluation of PE, and PE environment. With reference to the previous studies, the sub-factors were named (1) curriculum knowledge, (2) pedagogical knowledge, (3) educational philosophy knowledge, (4) class management knowledge, (5) educational evaluation knowledge, and (6) class environment knowledge by an expert group.

4. Discussion

This study aimed to provide basic data to promote teachers' professionalism by emphasizing the importance of PCK. Components of PCK-PE were identified. After developing 21 questions of 6 factors, the reliability of the developed measurement tool was verified. First, components were collected for the PCK-PE through an open questionnaire. Preliminary questions were produced based on the collected content, and the conceptual review of PCK-PE was performed for a group of experts. Questions that appropriately explained the relevant variables through Delphi verification, by combining and re-analyzing the results of the previous studies, [5, 12-15] were extracted. Factor structure and questions were determined through an internal structure review of 85 questions composed of preliminary measures. In EFA, the structure of 43 questions with 6 factors was determined by considering the eigenvalue of each factor, load and redundancy of the questions for each factor, conceptual representation, correlation between factors, and internal consistency of the questions.

Last, a comparison of the current study's results with those of previous studies confirmed factors and questions. [12] developed 22 questions in 3 areas relating to home economics knowledge reflecting the pedagogical content knowledge in home economics education, curriculum knowledge, and class strategy knowledge. [13] developed a mathematical PCK measurement tool for early childhood teachers and organized PCK into five domains: curriculum knowledge, content knowledge, knowledge on teaching and learning methods, knowledge of learners, and knowledge of professional development. [14] explored the components of elementary school teachers' PCK of science and developed a measurement tool for it. Teaching method, expression, content, assessment, curriculum, and environmental context knowledge and knowledge of students were established as components of PCK of science. More extensive teaching experience was associated with greater PCK. [16] developed a measurement tool for PCK of science for early childhood teachers and composed the PCK domain to include curriculum knowledge, knowledge of learners, teaching-learning method knowledge, content knowledge, and teaching expertise. Such studies became the theoretical basis for the application of the sub-variables identified in this study. [15] presented knowledge on PE as a subject and identified five components of PCK-PE: curriculum knowledge, teaching method knowledge, knowledge of learners for physical activities, PE evaluation knowledge, and PE environment knowledge. [5] analyzed the structuralization of sub-elements of PE and achievement standard components for six components. This theoretically supports the results of this study, which presented five factors, including curriculum knowledge, teaching method knowledge, educational philosophy knowledge, education evaluation knowledge, and class environment knowledge.

In the factor analysis process of this study, the partial factors (knowledge of learners, content knowledge, and expertise knowledge) presented by the KICE were not observed; thus, the results

differed. This can be seen as due to how there may be a difference in perspective on the importance of PCK-PE required in the field despite how teachers in the field operate a curriculum based on the developed standards of achievement. Class management knowledge, which comprised one factor in EFA, was removed from the main survey. It was deemed a factor hindering fitness and deleted because it had internal characteristics similar to teaching environment and method knowledge. These results confirmed whether the item analysis and EFA of the internal structure are important in the internal structure review. The results confirm that PCK-PE perceived by PE teachers consists of 6 factors.

5. Conclusion and Implications

This study aimed to exploring PCK-PE factor of physical education teachers. The limitations and implications of this study are as follows. First, because the subject of the study was limited to PE teachers in middle schools and high schools in Korea, it is difficult to generalize the research results and apply them to PE teachers in other countries. Future studies need to verify the validity and feasibility of using a PCK-PE scale by diversifying the country of study subjects. Second, a mixed study that simultaneously collects sufficient quantitative or qualitative data by using the PCK-PE measurement tool developed in this study is needed. As the level of PCK-PE of PE teachers is measured by using the developed tool, and various variables that affect the level of PCK-PE are explored, further studies can be undertaken by applying effective PE and teaching-learning methods. Third, the PCK-PE that appropriately integrates content and pedagogical knowledge by PE teachers and is conveyed to students may differ depending on students, subject content, class situation, and class environment. Thus, an exploration of the PCK-PE domain proposed here should continue.

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