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The Development of an Instrument for Assessing Pre-Service Teachers' and Graduates' Perceptions of the Physics Education Curriculum (PPEC)

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Abstract

This study describes the development of an instrument to evaluate pre-service teachers' and graduates' perceptions of the physics education curriculum in Indonesian higher education institutions in four categories namely, (1) approaches to teaching physics (AT), (2) the aims and objectives of the physics education curriculum (AO),(3)interest in physics (IP), and (4)approaches to learning physics (AL). The Perceptions of the Physics Education Curriculum (PPEC) questionnaire, consisting of 47 items, was administered to 287 pre-service teachers and graduates from two universities, who varied in grades, sex, and achievement level. Based on item-scale correlations and factor analysis, nine items were removed. The rotated factor matrix, using varimax rotation, supported the four-scale structure of the final version of the 38-item PPEC questionnaire. The four categories had high Cronbach's alpha values ranging from 0.75-0.84. These results confirmed that the instrument has satisfactory reliability, statistical validity and a good factor structure. (148 words; limit: 150 words)

Keywords: pre-service teachers; physics education curriculum; perceptions

Introduction

In Indonesia, physics education curricula are designed and used to produce secondary school physics teachers. Like other study programs in all universities in Indonesia, the physics education curricula can be divided into the core curriculum and the institution curriculum. The core curriculum consists of several subjects that aim to (1) develop the personality of students (for example, *Bahasa Indonesia, English, and nationality education*), (2) develop the foundations of students' knowledge and skills for example, *fundamental of physics, mechanics, optics, electricity and magnetism, etc.* in physics pre-service teachers' programs, (3) develop professionalism for example, *educational profession, teaching and learning, study of secondary curricula, etc.* in physics pre-service teachers' programs, (4) to nurture students' attitudes and abilities related to their knowledge and skills (for example, *micro-teaching* and *teaching practice*), and (5) to develop student abilities to live in society (for example, *basic humanities* and *culture*). Institution curriculum on the other hand consists of several subjects involving university characteristics related to its environment's needs and conditions, for example, *workshop* and *computer in science education*.

Subsequently, each higher education institution has different physics education curricula because of the diverse size, scope, and variation of the institutions. Some institutions focus on broader and deeper theories while others offer more practical work because they have better laboratory facilities. Some institutions provide more opportunities for their students to practice teaching in micro-teaching programs as well.

Theoretical background

Several differences are evident in the components of each curriculum. According to van den Akker (2003) there are ten curriculum components, i.e. (1) rationale, (2) aims & objectives, (3) content, (4) learning activities, (5) teacher role, (6) materials & resources, (7) grouping, (8) location, (9) time, and (10) assessment. All components are connected with each other and can be represented completely by six types of curriculum representations, i.e. the *ideal*, the *formal/written*, the *perceived*, the *operational*, the *experiential*, and the *learned* curriculum. The PPEC questionnaire focused only on the experiential curriculum that is, the learning experiences as perceived by learners.

Learners' perceptions of the physics education curriculum rely on several factors namely (1) *lecturers' approaches to teaching*; (2) the *aims and objectives*; (3) *interest in physics*; and (4) *students' approaches to learning*. There have been several studies related to these issues (see for examples: Entwistle, McCune, & Walker, 2001; Hidi, Renninger, & Krapp, 2004; Kember & Kwan, 2000; Schiefele, 2009; Trigwell, Prosser, & Waterhouse, 1999).

Lecturers' approaches to teaching vary between two broad approaches – content-centred and learning-centred – and are characterised by a motivational component and a strategy component (Kember & Kwan, 2000). On the other hand, students' approaches to learning are related to students' ways of experiencing and handling learning situations (Entwistle, McCune, & Walker, 2001). Any learning approach includes not only process, but also intention. Students who are consistently relying on a surface approach, prefer and appraise lecturers who provide pre-digested information ready for 'learning', whereas students with a deep learning approach prefer lecturers who challenge and stimulate (Entwistle & Tait, 1990). Furthermore, teachers' approaches to teaching associated with students' approaches to learning (Trigwell, et al., 1999). Therefore knowing student approaches to learning will provide valuable information related to the curriculum.

One important question when people learn relates to the goals that they are learning. This question is related to the aims and the objectives of the curriculum e.g. to support students to be professional teachers, to provide knowledge and skills necessary for their future careers, to support students to be skilled teacher researchers, etc.

The concept of interest is also very important because it can be used to predict students' school subject preferences and choices (Elsworth, Harvey-Beavis, Ainley, & Fabris, 1999), their expected success in higher education and their career satisfaction (Silvia, 2006). It is appropriate therefore that studies on attitudes towards science and technology included the concept of interest in science (e.g. Cheung, 2009; Fraser, 1978; Gardner, 1975).

Purpose of the research

The purpose of the study was to develop an instrument (the PPEC) that could be used to identify and evaluate students' and graduates' perception of their physics education curriculum. Students and graduates are in a good position to form accurate impressions about their physics education curricula because they have encountered various learning environments during their higher education studies. The development of an instrument for assessing pre-service teachers' and graduates' perceptions of the physics education curriculum would be very useful for higher education institutions that are responsible for the supply of physics teachers.

Methodology

After the conceptual framework for the instrument was established, several issues were carefully considered: (1) as no existing suitable instrument was available to evaluate the physics education curriculum in Indonesia, several items could be adopted or modified from various questionnaires; (2) the items should be easy to understand and do not have ambiguity; (3) each item should be meaningful from the students' and graduates' perspectives.

Eleven to fourteen items of PPEC questionnaire were developed in each of the four scales/categories. Several items were developed by modifying and adopting items from questionnaires that have been used in various studies. Each of the items required respondents to make a selection on a 5-point Likert-type scale ranging from 1 for strongly disagree, 2 for disagree, 3 for not sure, 4 for agree, and 5 for strongly agree.

The instrument was validated based on suggestions from two experienced lecturers. These items were translated into Indonesian by the first author and back-translated into English by an Indonesian science lecturer without reference to the original items. The authors then compared and checked the meaning of the back-translation and the original instrument in order to decide whether or not any items needed to be revised.

Several items were modified in order to make them more meaningful. For example, the item 'I prefer to do physics experiments more than any other experiments', was deleted because students in physics education programs only conducted physics experiments during their studies. The item 'I understand that my major future job will likely be related to schools' was changed to 'I understand that my major future job will likely be related to schools and learning societies'. Finally, 47 items were established in the PPEC questionnaire in four scales – Approaches to teaching physics (AT), Aims & objectives of physics education curriculum (AO), Interest in physics (IP), and Approaches to learning physics (AL).

A summary of the sources of the 47 items in the PPEC is provided in Table 1.

Table 1
Development of items in the PPEC questionnaire

Item numbers	Sources
AL6, IP7	Approaches to studying (Leathwood & Phillips, 2000)
IP2, IP3, IP4, IP5, IP8, IP9, IP10, IP11, AO1	Attitudes toward Chemistry Lesson Scale (ATCLS) (Cheung, 2009)
AO3, AO6, AO10, AL1, AL2, AL3, AL5, AL8	Science Motivation Questionnaire (Glynn, Taasoobshirazi, & Brickman, 2009)
AT1, AT3, AT5, AT7, AT8, AT9, AT10	Student Perceptions of Teachers' Knowledge (SPOTK) (Tuan, Chang, Wang, & Treagust, (2000).
IP1, IP6, AO2, AO4, AO5, AO7, AO8, AO9, AO11, AO12, AO13, AO14, AL4, AL7, AL9, AL10, AL11, AT2, AT4, AT6, AT11	Developed by authors

The 47-item PPEC questionnaire was pilot-tested by administering to 117 pre-service teachers and graduates from Bengkulu University and 170 pre-service teachers and graduates from Jambi University, who varied in grades, sex, and achievement level. Based on data analysis involving item-scale correlation and factor analysis, nine items were removed. All items which had item-scale correlation values higher than 0.4 and factor loadings 0.4 or above were retained. The items 'I like to do better than the other students on the physics test', 'I believe that physics knowledge in a physics pre-service teachers' program forms the basis for teaching practice', 'I think the content of education curriculum can support me to be a critical thinker', and 'I am confident that I have enough competencies to be a physics teacher' had item scale correlations of 0.47, 0.42, 0.43, and 0.46 respectively, but their factor loadings were less than 0.4, so these items were dropped from the final version of the PPEC questionnaire.

The final version of the PPEC questionnaire consisted of 38 items; a summary of the final version is provided in Table 2.

Table 2
Structure of the final version of the PPEC questionnaire

Scale name	No. of items	Examples of items
Approaches to teaching physics (AT)	11	My teacher's teaching methods keep in interested in physics (AT1). My teacher's assessments encourage me to be a self regulated learner (AT11).
Aims and objectives of physics education curriculum (AO)	13	I think physics education curriculum can support me to be a professional teacher (AO4). I think learning physics can help me to be a good physics teacher (AO12).
Interest in physics (IP)	6	I really enjoy learning physics (IP6). Physics subjects are interesting (IP2).
Approaches to learning physics (AL)	8	I put enough effort into learning the physics (AL1). I prepare well for the physics test and labs (AL2).

Results and discussion

Students' and graduates' responses to the 38 items of the instrument to evaluate their perceptions of the physics education curriculum were analysed using SPSS (Version 17). The descriptive statistics (Table 3), factor analysis (Table 4), and reliabilities (Table 5) are provided below.

Descriptive statistics

In Table 3, the mean response for the AT scale (Approaches to teaching physics) was 3.52, indicating that respondents' perceptions of the approaches to physics teaching that their lectures used ranged between 'not sure' and 'agree'. For the AO scale (Aims & objectives of physics education curriculum), the mean response was 4.12, indicating that in general the respondents were in agreement with the aims and objectives of the physics education curriculum. For the IP scale (Interest in physics), the mean response was 3.77, indicating that respondents in general had an interest in physics. For the AL scale (approaches to learning physics), the mean response was 3.90, indicating that the respondents on the average agreed with the approaches to learning physics portrayed by the items.

Among the above four scales about the physics education curriculum, students' and graduates' mean scores from highest to lowest were: aims & objectives of physics education curriculum (AO), approaches to learning physics (AL), interest in physics (IP), and approaches to teaching physics (AT).

Table 3
Descriptive statistics for the four scales of the PPEC questionnaire to measure students' and graduates' perceptions of the physics education curriculum

Scale	No of items	Mean	Standard Deviation
AT	11	3.52	5.37
AO	13	4.12	5.06
IP	6	3.77	2.94
AL	8	3.90	3.38

Validity of the instrument

The rotated factor matrix, using varimax rotation, shown in Table 4 supports the four-scale structure of the PPEC questionnaire based on the scree plot as recommended by Catell (1966) and described by (Preacher & MacCallum, 2003). Each factor contains high positive loadings on all eleven, thirteen, six, and eight items, respectively, for the AT, AO, IP, and AL scales. These results suggest that the questionnaire has statistical validity.

Table 4
Factor Analysis of Items in Final Version of the PPEC-survey

	Factor			
Item Number	*Approaches to Teaching*	*Aim & Objectives*	*Interest in Physics*	*Approaches to Learning*
1 (AT1)	0.67			
2 (AT2)	0.68			
3 (AT3)	0.43			
4 (AT4)	0.60			
5 (AT5)	0.69			
6 (AT6)	0.63			
7 (AT7)	0.50			
8 (AT8)	0.59			
9 (AT9)	0.41			
10 (AT10)	0.54			
11 (AT11)	0.45			
12 (AO1)		0.47		
13 (AO2)		0.44		
14 (AO3)		0.56		
15 (AO4)		0.49		
16 (AO5)		0.53		
17 (AO6)		0.42		

18	(AO7)		0.60		
19	(AO8)		0.45		
20	(AO10)		0.55		
21	(AO11)		0.56		
22	(AO12)		0.57		
23	(AO13)		0.54		
24	(AO14)		0.62		
25	(IP2)			0.66	
26	(IP3)			0.49	
27	(IP5)			0.66	
28	(IP6)			0.72	
29	(IP8)			0.49	
30	(IP9)			0.52	
31	(AL1)				0.47
32	(AL2)				0.54
33	(AL3)				0.57
34	(AL5)				0.58
35	(AL6)				0.51
36	(AL8)				0.47
37	(AL9)				0.50
38	(AL11)				0.58
	Eigenvalue	8.30	3.05	2.46	1.98
	% Variance	19.00	6.49	5.24	4.20
	Cumulative % variance	19.00	25.49	30.73	34.93

Note. Loading less than 0.4 removed; eigen > 1.632 (based on scree plot); n = 287;
Extraction method: Principal components analysis;
Rotation methods: Varimax with Kaiser Normalization (KMO: 0.842)

Reliabilities

The scales for each category had high Cronbach's alpha values ranging from 0.75 to 0.84 (see Table 5), indicating that the scales were reliable measure of the physics education curriculum being investigated. DeVellis (2003) states that, the Cronbach's alpha coefficient should ideally be above 0.7.

Table 5
Reliability of the PPEC-survey

Scale	*No. of Items*	*Cronbach's alpha Reliability*
AT	11	0.84
AO	13	0.82
IP	6	0.75
AL	8	0.77

Conclusions

The data analysis indicated that the instrument on student and graduate perceptions of the physics education curriculum in relation to their lecturers' approaches to teaching physics, aims & objectives, their interest in physics, and their approaches to learning physics have satisfactory validity and reliability measures. The uniqueness of the PPEC questionnaire is that it is specifically related to the experiential curriculum. This is important because the instrument has the potential to assist lecturers to identify pre-service teachers' and graduates' perceptions on their own physics teaching as well as their student views about the curriculum. By examining the results from administration of the instrument, researchers and lecturers can recognise those aspects of the physics education curriculum that need to be improved in order to match pre-service physics teachers' and graduates' needs and expectations.

To establish the instrument's usefulness, future research is required to provide in-depth information concerning pre-service teachers' and graduates' perceptions of the physics education curriculum by conducting interviews. Also, further research needs to be conducted with a larger number of institutions with varying standards of physics education programs in order to ascertain the reliability of the PPEC questionnaire.

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