PRE-SERVICE TEACHERS' ATTITUDES TOWARD TEACHING SCIENCE AND THEIR SCIENCE LEARNING AT INDONESIA OPEN UNIVERSITY

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ABSTRACT

This study focuses on attitudes toward (teaching) science and the learning of science for primary school among pre-service teachers at the Open University of Indonesia. A three-year longitudinal survey was conducted, involving 379 students as pre-service teachers (PSTs) from the Open University in Surabaya regional office. Attitudes toward (teaching) science' (ATS) instrument was used to portray PSTs' preparation for becoming primary school teachers. Data analyses were used, including descriptive analysis and confirmatory factor analysis. The model fit of the attitudes toward (teaching) science can be described from seven dimensions: self-efficacy for teaching science, the relevance of teaching science, gender-stereotypical beliefs, anxiety in teaching science, the difficulty of teaching science, perceived dependency on contextual factors, and enjoyment in teaching science. The results of the research also described science learning at the Open University of Indonesia looks like. Implications for primary teacher education are discussed.

Keywords: **Open University, Indonesia, attitudes toward (teaching) science.**

INTRODUCTION

Science is a compulsory subject for Indonesian students from the primary school. For the preparation of teachers, the government, through several public and private universities has set up a program for primary school teachers. For becoming teachers in primary schools are required to have a minimum of a bachelor degree. However, the current conditions indicate that many of those who have not reached these requirements, they still possessed a Diploma two (D-2), Diploma three (D-3), or even still high schools (*Sekolah Pendidikan Guru*). For that reason, through the Open University - *Universitas Terbuka* (UT), which spread out throughout Indonesia, they can improve their competence as a teacher who appropriates in terms of academic and legality. UT is a state university which established in 1984 and the only one in Indonesia that is a wholly distance education institution. It has three main missions (Belawati, 2001): (1) increasing access to higher education, (2) increasing numbers of students, especially in areas demanded by the economic and cultural development or difficulties groups (Gandhe, 1999), and (3) upgrading the qualifications of primary and secondary school teachers.

In Open University, tutors have strategic importance to the effectiveness of distance education, especially when it comes to technical competencies and behavioral competencies, which encourage the learner to engage and not to drop out (Borges et al., 2014). Therefore, distance education via Open University has played a key role in the acquisition of students' competencies. University students are adults who have unique

needs, motivations, goals, and self-concepts (Rovai, Ponton, & Baker, 2008). Logically, the philosophy of learning that open university and distance education is constructivism. Each individual constructs knowledge through their interaction with the environment and other learners.

Specifically for preparing primary school teachers, Open University of Indonesia provides education programs for primary school teachers (*Pendidikan Guru Sekolah Dasar* --PGSD). From those subjects were taught in PGSD, this study only focuses on the course 'science content and science learning in primary schools' (*Materi dan pembelajaran IPA di SD*). Science teachers need to possess a content knowledge and pedagogical content knowledge through this course. Moreover, pre-service science teachers should be part of the science itself, sensitive to Nature of Science (NOS), and have a great responsibility on their science lessons. Osborne, Simon, and Collins (2003) indicated that science teachers should have the better perception of the nature of science, including: anxiety towards science, the value of science, self-esteem at science, motivation towards science, enjoyment of science, attitudes of peers and friends towards science, attitudes of parents towards science, the nature of the classroom environment, achievement in science, and fear of failure on the course. As Nigam and Joshi (2007) argued that promotion of science courses and programs by distance education is the need of the hour. In this study, therefore, the authors only focus on attitudes toward science among PSTs at the Open University of Indonesia.

LITERATURE REVIEW

A previous study, such as Osborne, Simon, & Collins (2003) listed some factors influence students' attitudes toward science, including demographic factor (gender) and environmental factors (structural variables, classroom/teacher factors, curriculum variables, perceived difficulty of science, and enhanced subject choice). Regarding the ages, research on students' attitudes toward science consistently points to an increasingly negative attitude towards science in students when they get older (Denessen, Hasselman, & Louws, 2015). In this case, PSTs belongs to the older students and takes responsibility for preparation of teaching science. In addition, the attitude of in-service and pre-service primary teachers toward teaching science also affected by cognitive beliefs, affective states, and perceived control (van Aalderen-Smeets & van der Molen, 2012).

In their fit model, van Aalderen-Smeets & van der Molen (2012) proposed some dimensions, such as perceived relevance, perceived difficulty, and gender beliefs are included in cognitive beliefs. Meanwhile, affective states are built from enjoyment and anxiety for teaching science. Then, self-efficacy and context dependency support the construct of perceived control. Accordingly, the hypothesized model of pre-service primary teachers' attitudes toward (teaching) science in this study is depicted in Figure 1. Furthermore, the researchers would like to confirm to what extent PSTs' attitudes toward (teaching) science in this study. To sum up, the researchers investigated to what extents of pre-service teachers' attitudes towards (teaching) science and to describe how science learning at the Open University of Indonesia looks like?.

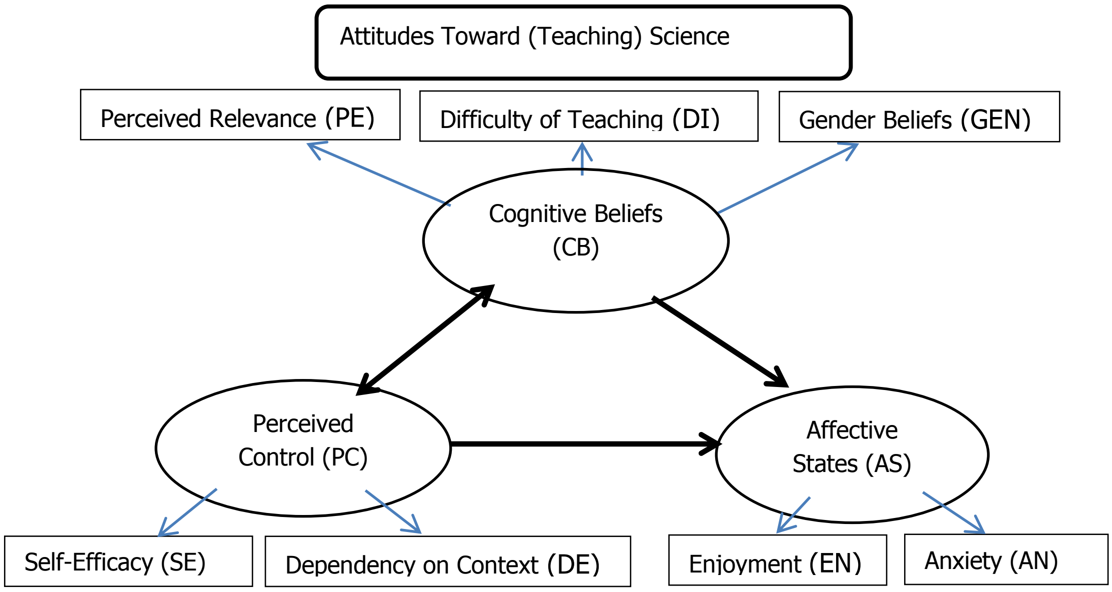


Figure 1. The construct of pre-service primary teachers' attitudes toward (teaching) science

Learning of Science for Primary School

The courses in the Indonesian Open University are developed by teams made up at the minimum of subject matter specialist and an instructional designer. Each course, depending on its credit units, is presented in several modules (Belawati, 2001). One of the fundamental content taught for preparing university students (pre-service teachers) to teach science in primary school was 'content and science learning of primary school' course (code: PDGK 4503). The course was designed for 8 weeks tutorial with 3 credits. The description of the course is reviewing the basic concepts of science, learning of science, and integrating content with its methodology. Meanwhile, the general competence of this course is 'students can improve their understanding of the basic concepts of science, learning of science, and able to integrate science content and its methodology for teaching (Rustaman et al., 2011). From this general competence are separated into eight (8) specific competencies following the number of tutorials:

- **Explaining the scientific work and application in science learning.**
- **Using a constructivist approach applied to science learning through teaching models of the learning cycle, interactive model, integrated model, and science-technology-society approach.**
- **Describing the classification and adaptation process of the organism.**
- **Explaining about healthy food.**
- **Explaining of family education.**
- **Explaining about the environmental damage control, the infusing of technology, and the natural phenomena.**
- **Analyzing the concept of energy in everyday life.**
- **Explaining the use of natural resources and its empowerment.**
- **Explaining the utilization of waste.**

The tutorial sessions for eight times meetings are depicted in Table 1. Print materials are the main medium of instruction. The evaluation emphasized the multistage course evaluation model (Rovai et al., 2008), including formative assessment in three times along 8 weeks tutorial. The focus of assessment is a diagnosis, reflecting, and outputs. That cover productive needs, students' progress, and students' performance. The Example of Evaluation*) and its criteria (rubrics) is shown in Table 2.

Table 1. Example of course outline

Content knowledge	Topic	Tutorial method	Evaluation
Scientific work	a. Inquiry and science process skills b. Scientific literacy and measurement	Direct instruction	Evaluation 1
▪ Models of science learning ▪ Classification and adaptation	a. Constructivism of learning science b. Learning models c. Classification d. Adaptation	Classroom discussion	
Healthy food	a. Nutrient content and balanced nutrition b. Rate nutrients in food	Classroom discussion	
Family education	a. Anatomy and physiology of human reproduction b. The decline in human nature c. Education prosperous and happy family	Direct instruction	Evaluation 2
Science and technology	a. The introduction of simple biotechnology b. Utilizes energy from nature	Classroom discussion	
Energy and its benefits for humans	a. Energy sources b. Electrical and simple circuit	Conceptual learning	Evaluation 3*
Natural resources and their utilization	a. Natural materials around us b. Use of plants	Contextual teaching and learning (CTL)	
Utilization of waste and environmental ethics	a. The type, characteristics, and sources of waste b. Environmental ethics	Classroom discussion	

Table 2. Example of Evaluation*) and its criteria (rubrics)

No	The skills measured**)	Aspects / concepts that have been assessed	Score
1	Explain and give examples of renewable and non-renewable energy	***Non-renewable energy*** is energy comes from sources that will run out or will not be replenished in our lifetimes.	5
		Examples of non-renewable energy: crude oil; natural gas; coal	5
		A renewable energy is an energy generated from natural resources, which are renewable (naturally replenished).	5
		Examples of renewable energy: solar energy; nuclear energy; wind energy; energy from the sea or ocean; geothermal energy; biomass energy; energy from waste; water energy.	5
2	Explain the differences between series and parallel circuits	The differences between series and parallel circuits:	
		Series circuit: a. The electric currents in each conductor are equal b. The total voltage is the sum of the voltage of each component	10
		Parallel circuit: a. An amount of voltage is similar to each conductor b. The total of electric currents is the sum of the current of each component	10

3	**Explain the difference between acid and bases**	**The difference between acid and bases** ***Acid*:** **a. Have the nature of the acid and corrosion** **b. Change the color of the pH indicator from blue to red** **c. Conduct an electricity** **d. Reacting to the metal** **e. Having pH < 7** ***Bases*:** **a. Have a bitter taste and damage to the skin, feel slippery as soap** **b. Change the color of the pH indicator from red to blue** **c. Neutralize acid** **d. Conduct an electric current** **e. Having pH > 7**	**10** **10**
4	**Explain the characteristics of water in terms of COD and BOD**	**The characteristics of hygiene water in terms of COD (Chemical Oxygen Demand) and BOD (Biochemical Oxygen Demand):** **- The level of COD and BOD is low.** **- Smaller value of BOD than COD means a little organic material that can be oxidized by chemicals** **- The higher BOD, the difficult for organism in water require oxygen to survive**	**6** **7** **7**
5	**Give an example of teaching of environmental ethics in primary school**	**Learning examples of environmental ethics in primary school (the answer at least should describe the activity of care for the environment that has been implemented in each school)**	**20**
		Total	**100**

Notes:**
Specific competencies:

- **Analyzing the concept of energy in everyday life**
- **Explaining the use of natural resources and its empowerment**
- **Explaining the utilization of waste**

Pre-Service Teachers' Learning at Indonesia Open University

Learning is everywhere. However, an instructor or a tutor armed with a textbook will no longer be the sole source of knowledge and educational experiences. Information resources will be everywhere, often separated from learners by time and space. Indonesian Open university students do learn best by direct experience as Chute, Thomson, & Hancock (1999): by experimentation, by seeing and doing, by mentoring others, and by sharing ideas. Therefore, learned-centered is suitable approached which the characteristics of learning environments are: facilitation, team learning, students as a collaborator, instructor as a guide, dynamic content, diversity, and performance. The learning environment should reduce in lecturing, individual learning, students as a listener, instructor as a source, stable content, homogeneity, and evaluation and testing (Chute et al., 1999; Hallissy, Butler, Hurley, & Marshall, 2010).

However, commonly attributed to Asian students as well as Problem in Indonesia students: rely on rote learning, high achievers, largely extrinsically motivated, which is usually regarded negatively, high level of achievement motivation, good at group projects, and willing to invest in education (Kember, 1999). There are some reasons and explanations: approaches to learning, including understanding, memorizing, and surface learning because of course design, achieving motive, and career motivation (Kember, 1999).

On the other hands, approaches to learning of school teachers studying distance education consists of three levels: a surface approach, an achieving approach, a deep approach (Tang, 1999). A surface approach usually uses rote learning while an achieving approach is achieving a high grade and emphasizing cost-effective of courses. Subsequently, a deep approach focuses on intrinsic motivation, curiosity, and the meaning of task. Ideally, the deep approach should be implemented at the Open University in Indonesia, however, the science learning is still in the position at the surface and achieving approach. Moreover, science higher education should be delivered using conventional as well as modern distance teaching-learning methodology. As Nigam and Joshi (2007) explored the difficulties faced by the students as well as their aspirations and needs. Observations during their study strengthened applicability of distance higher education and more so for science higher education and balanced between conventional and modern distance learning methods. In connection with the modern distance teaching-learning, the use of Massive Open Online Courses (MOOCs) in Indonesia is appropriate for consideration (Suprapto & Pai, 2015).

METHOD

Research Design

A longitudinal survey design with trend study was used in the study, with different participants over time. The study focused on PSTs (a population) and their attitudes toward science during the years 2012, 2013, and 2014. Trend studies are longitudinal survey designs that involve identifying a population and examining changes within that population over time (Creswell, 2012). The participants were students as pre-service primary teachers from the Open University at Ngawi district (Surabaya regional office). Totally, 379 pre-service teachers (22.96% male and 77.04% female) over three years (2012-2014) included in the study. The varied participant of general attributes is shown in Table 3.

Table 3. General attributes of participants (N= 379)

Year	Class code	Male (N)	Female (N)	Total (%)
2012	31 PDGK 4108 (A)	6	25	89(23.48)
	28 PDGK 4108 (B)	7	21	
	30 PDGK 4108 (C)	10	20	
	11PDGK 4209 (C1)	3	8	66(17.41)
	25 PDGK 4203 (D)	6	19	
	30 PDGK 4203 (E)	6	24	
2013	24 PDGK 4503 (C)	6	18	80(21.11)
	24 PDGK 4108 (B)	6	18	
	32 IDIK 4008 (E)	6	26	
	25 PDGK 4406 (E)	2	23	72(19.00)
	30 IDIK 4008 (B)	7	23	
	17 IDIK 4008 (D)	4	13	
2014	14 PDGK 4501 (B1)	5	9	72(19.00)
	30 PDGK 4500 (A)	5	25	
	28 PDGK 4500 (C)	8	20	
	Total (%)	87 (22.96)	292 (77.04)	379 (100)

Instrument

The Attitudes Toward Science (ATS) instrument was used to portray pre-service teachers' attitudes toward (teaching) science. The instrument is based on the work of (such as van Aalderen-Smeets & van der Molen, 2013; van Aalderen-Smeets, van der Molen, & Asma, 2012; van der Molen, van Aalderen-Smeets, & Asma, 2010). In this study, the scale was translated into Indonesian by the researchers and made appropriate for pre-service teachers. Totally, 3 experts, 2 of who specializes in science teaching and 1 of who specializes in distance education, were asked for their opinion. The scale includes a total of 28 items (in Indonesian version), with 7 dimensions, is shown in Table 4. Response options range from 1 (strongly disagree) to 5 (strongly agree).

Table 4. The dimension of ATS

Scale/ Dimension	Description	Number of items	α
Self-efficacy for teaching science (SE)	Investigating PSTs' perceived ability to teach science in primary school and to handle problems that may arise when teaching science.	4	.834
Perceived relevance of teaching science (PE)	Measuring the extent to which pre-service teachers find it important and relevant to teach science to primary school children.	5	.892
Gender-stereotypical beliefs (GEN)	Measuring the aspect of teaching science and its gender-related beliefs.	5	.887
Anxiety in teaching science (AN)	Measuring the experienced positive and negative impacts related to teaching science.	4	.784
Difficulty of teaching science (DI)	Investigating whether primary teachers think that science, in general, is more difficult to teach than other topics.	3	.709
Dependency on context factors (DE)	Measuring to what extent PSTs feel dependent on certain context factors in order to teach science.	3	.801
Enjoyment in teaching science (EN)	Measuring the PSTs feeling of teaching science.	4	.774

Data Analysis

The data analysis used confirmatory factor analysis for the fitting model of pre-service teachers' attitudes toward (teaching) science and descriptive data (narrative) for learning of science in primary school. SPSS 21 was used to measure the Cronbach's alpha coefficient for performing the internal consistency (Suprapto, 2016). Because the scale was translated into Indonesian language and tested at another university, we conducted a confirmatory factor analysis (CFA) on the attitudes toward (teaching) science with our participants by using AMOS 21 to perform the fit model. The cutoff of loading factor was 0.40 (Stevens, 2002). In addition, acceptable indexes according to Joreskog & Sorbom (1993); Schermelleh-Engel, Moosbrugger, & Müller (2003); Kline (2005); and Sarsar & Kisla (2016) are shown below.

Table 5. Statistical values as for confirmatory factor analysis

	Acceptable Fit Index	Good Fit Index
X^2/df		<3
RMSEA	.05<RMSEA<.10	<.05
S-RMR	.05<S-RMR<.10	<.05
GFI	.90<GFI<.95	>.95
AGFI	.85<AGFI<.90	>.90
CFI	.90<CFI<.95	>.95

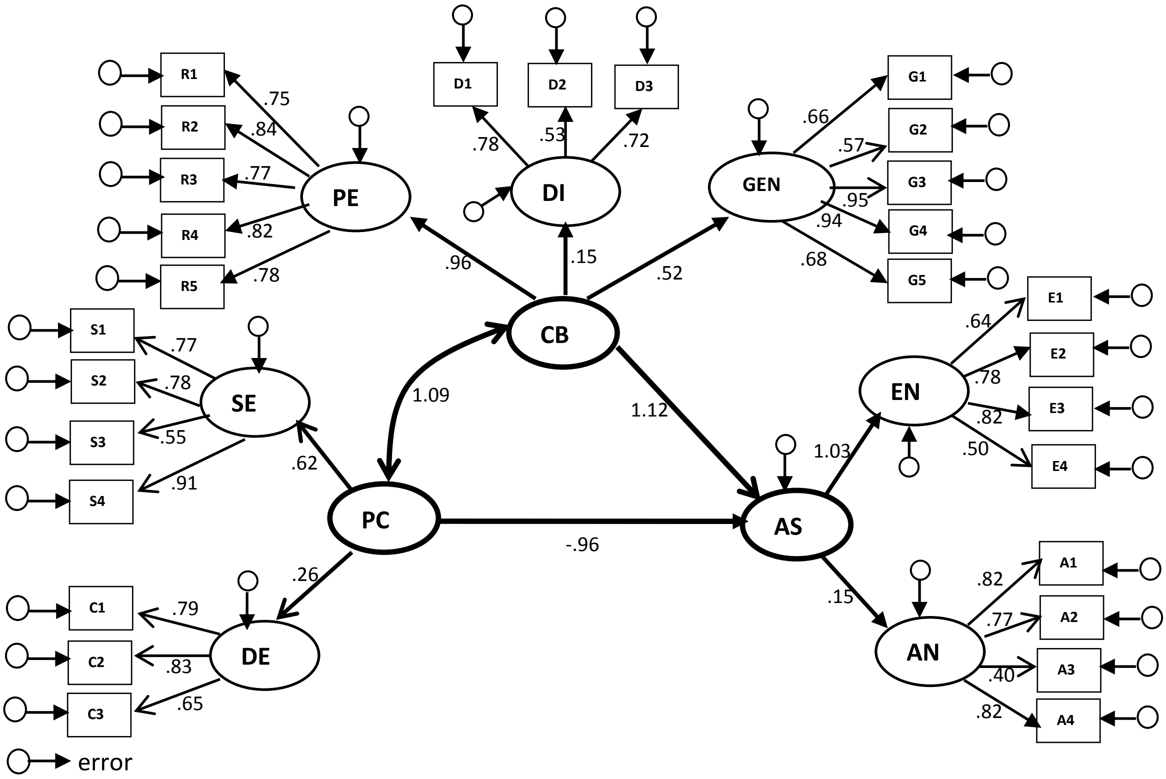
RMSEA : Root Mean Square Error of Approximation
GFI : Goodness of Fit Index
AGFI : Adjusted Goodness of Fit Index
S-RMR : Standardized RMR
CFI : Comparative Fit Index

FINDINGS

The findings of the study are presented as follows. The attitudes toward (teaching) science among PSTs are described. Subsequently, the model fit of attitudes toward (teaching) science among pre-services primary teachers is illustrated.

Attitude towards Teaching Science among Open University Students

The study utilizes a statistical technique called Structural Equation Model (SEM). The use of SEM is commonly justified in the education fields because of its ability to attribute relationships between latent variables (unobserved constructs) from observable variables. According to Ferdinand (2002) as cited by Arifin (2015), "SEM is used to: (1) confirm dimensional of various indicators for a dimension, (2) examine model compatibility as well as the causal relation of inter-observed or built factors in the model, and (3) examine compatibility or accuracy of a model based on the observed empirical data. Basically, a complete modeling consists of measurement model and structural model. The aim of the measurement model is to confirm a dimension or a factor based on its empirical indicator, while the structural model is a model concerning the structure of relationship which shape or explain causality of an inter-factor".



PC = Perceived Control
CB = Cognitive Beliefs
AS = Affective States
DE = Dependency on context factors
SE = Self-efficacy for teaching science

PE = Perceived relevance of teaching science
DI = Difficulty of teaching science
GEN = Gender-stereotypical beliefs
EN = Enjoyment in teaching science
AN = Anxiety in teaching science

Figure 2. Structural model of Open university students' attitudes towards (teaching) science

The ratio of Chi-square and degree of freedom obtained from Confirmatory Factor Analysis (CFA) are $\chi 2/df = 2.266$, ($p < .01$). That the ratio obtained from the selected samples is less than 3 is an indicator of a good fit index. In a CFA analysis, the value 0.05 or less in RMSEA index is an indicator of model-data fit; however, it is also stated that this

value can be acceptable to the value 0.08 (Browne & Cudeck, 1993; Hu & Bentler, 1999; Vieira, 2011). In this research, RMSEA value is 0.077, which can be considered acceptable.

In addition, the result of CFA determines GFI as 0.91, AGFI as 0.89, RMR as 0.03 and S-RMR as 0.04. Based on these results it can be asserted that model-data fit is acceptable. Obtaining CFI (Comparative Fit Index), NFI (Normed Fit Index) and IFI (Incremental Fit Index) values as 0.95 more is an indicator of a perfect fit between the model and the data (Bentler, 1990; Hu & Bentler, 1999). The results of the analysis determine CFI as 0.91, NFI as 0.86 and IFI as 0.91, which may be considered an acceptable model. Thus, in this research, it can be asserted that there is almost a perfect fit between the model obtained from the CFA and the data. Finally, structural model of Open university students' attitudes towards (teaching) science can be seen in Figure 2.

CONCLUSION

This study describes science learning at the Open University of Indonesia looks like. The discussions also imply the importance of using a deep approach in the learning process that considers about intrinsic motivation, curiosity, and the meaning of task. Subsequently, the result of the research also focuses on attitudes toward (teaching) science among pre-service primary teachers at the Open University of Indonesia. The model fit of the attitudes toward (teaching) science has already discussed.

Specifically, in science education, there are some variables should be considered in science learning among PSTs teacher in Open university: cognitive beliefs, affective states, and perceived control in science learning as well as the fit illustrated model above. All the three variables explore seven dimensions of the attitudes toward (teaching) science: self-efficacy for teaching science, the relevance of teaching science, gender-stereotypical beliefs, anxiety in teaching science, the difficulty of teaching science, perceived dependency on contextual factors, and enjoyment in teaching science. All dimensions should be accounted by the instructor or tutor when associated with pre-service teachers at the Open University.

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APPENDIX

Attitudes Toward (Teaching) Science

(Adapted from: van Aalderen-Smeets et al. [2013] and van der Molen et al. [2010])

Self-efficacy for teaching science (SE) (4 scales)

S1 I have enough knowledge of the content of science to teach these subjects well in primary school.
S2 I am well able to deal with questions from pupils about science.
S3 I have a sufficient command of the material to be able to support children well in investigating and designing in class.
S4 If primary school children do not reach a solution during assignments about science, I think I can succeed in helping them make further progress.

Perceived Relevance of teaching science (PE) (5 scales)

R1 I think that science education is essential for primary school children's development.
R2 I think that science must be anchored in primary education as early as possible.
R3 I think that science education is essential for making primary school pupils more involved in technological problems in society.
R4 Science education is so important in the primary school that inexperienced teachers should receive additional training in this area.
R5 I think that science education in the primary school is essential for pupils to be able to make good choices about their studies (e.g. profile choice and choice of a course).

Gender-stereotypical beliefs (GE) (5 scales)

G1 I think that male primary school teachers can do an investigation or technical assignment with pupils more easily than female teachers.
G2 I think that male primary school teachers experience more enjoyment in teaching science than female teachers.
G3 I think that I would unconsciously be more likely to choose a boy for a science demonstration than a girl.
G4 I think that boys in primary schools are more enthusiastic about experimenting with materials and chemical substances than girls are.
G5 I think that boys at primary school would be more likely than girls to choose assignments that are concerned with science.

Anxiety in teaching science (AN) (4 scales)

A1 Teaching science makes me nervous.
A2 I feel stressed when I have to teach science in my class.
A3 I feel nervous while teaching science.
A4 I feel tense while teaching science in class.

Difficulty of teaching science (DI) (3 scales)

D1 I think that teachers find the topics that come up in science complicated.
D2 I think that most primary school teachers find it difficult to teach subjects concerning science.
D3 I think that most primary school teachers find science a difficult subject to teach in terms of content.

Dependency on context factors (DE) (3 scales)

C1 For me, the availability of a science teaching method is decisive for whether or not I will teach science in class.
C2 For me, the availability of a ready-to-use existing package of materials (e.g. technology usage) is essential to teaching science in class.
C3 For me, the support of my colleagues and the school is decisive for whether or not I will teach science in class.

Enjoyment in teaching science (EN) (4 scales)

E1 Teaching science makes me enthusiastic.
E2 I enjoy teaching science very much.
E3 I feel happy while teaching science.
E4 Teaching science makes me cheerful.