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DEVELOPMENT OF AN INSTRUMENT TO MEASURE PRESCHOOL TEACHERS´ BELIEFS IN INQUIRY-BASED ACTIVITIES

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Abstract. *Professional beliefs is an important factor that influences activities that preschool teachers organize and manage in the classroom. In order to determine how strong these beliefs are, valid and reliable instruments must be at disposal. This research aimed to develop and validate DPBA, an instrument designed to measure teachers´ beliefs toward the use of inquiry-based activities in preschool classes. A sample of 1,004 Czech preschool teachers was used to obtain the validation data. From the initial set of 40 items, a final version of DPBA with 22 items was created in a series of analyses. Principal component and maximum likelihood methods with Varimax rotation were used to extract an appropriate scale structure. DPBA is composed of three subscales, Benefits (12 items), Teacher competence (6 items) and Concerns (4 items), which have reliabilities of .906; .847 and .729, respectively. The overall reliability of the instrument is .883. Consistently high reliability coefficients were obtained in subsamples of respondents of varied years of practice and education, thus verifying a solid internal consistency of the instrument. Confirmatory factor analysis proved a theoretical model with the three subscales with adequate model fit indices. Overall, DPBA possesses sound psychometric properties when used with Czech preschool teachers.*

Keywords: *inquiry-based activities, preschool teacher, instrument development, teacher beliefs.*

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Introduction

Science activities are an integral component of preschool education worldwide. They are based on children´s interest and curiosity about the world around them, and - if organized efficiently - they bring valuable learning benefits (Byrne, Rietdijk, & Cheek, 2016; Eshach, 2003; Hollingsworth & Vandermaas-Peeler, 2017). Inquiry-based activities require that the teacher possesses professional knowledge and experience but also holds *beliefs* that such activities are developmentally adequate, stimulate children´s understanding of science and generate children´s enjoyment in inquiry. However, the current knowledge of preschool teachers´ beliefs towards science education is limited because of a lack of reliable and valid research instruments to measure this concept (Maier, Greenfield, & Bulotsky-Shearer, 2013). This does not mean that there are no such instruments. Rather, they were developed, validated and implemented in specific social, cultural and educational environments, like Head Start classes or racially and ethnically mixed classes in the United States (Maier et al., 2013) or in Asian countries like Turkey or Taiwan (Temel, Şen, & Özkan, 2017; Wahono & Chang, 2019). Pre-school in any country may be specific in curriculum aims, emphasis on science education, science discovery facilities, or teachers´ educational styles, qualifications and beliefs. Therefore, research instruments developed and validated in one country cannot be safely employed elsewhere without danger of producing biased findings that might result in incorrect educational decisions. The purpose of this article is to describe a research instrument to measure preschool teachers´ beliefs in inquiry-based activities, which was developed and validated in the Czech Republic.

Inquiry-Based Activities

Inquiry-based activities are actions of a teacher and children within a broader concept of science education. These activities stimulate curiosity and provide opportunities for the children to make observations, investigate, ask questions, and search for solutions. Children learn to make predictions

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of experiments they observe or organize and evaluate their outcomes. The aim is to understand science concepts and processes at a developmentally appropriate level and develop a favourable attitude towards science and scientific inquiry (Bell, Urhahne, Schanze, & Ploetzner, 2010; Dostál, 2015; Minner, Levy, & Century, 2010; Osborne & Dillon, 2008). This all is done within teacher-guided, individual or group work of children. They learn through posing questions and discovering answers on their own. The teacher´s focus is more on facilitation and monitoring than on stringent structural managing of children´s actions. It is generally accepted that there are three levels of "openness" of the inquiry activities. On the lowest level, there is "structured" inquiry, in which the children follow the steps designated by the teacher. This is the least independent children´s activity. On the middle level, the teacher prepares the framework and the inquiry environment and the children engage to provide the answer, with a degree of independent or collaborative work. On the top there is open inquiry, in which children pose questions, develop experiments and communicate their results. The teacher selects the level according to the children´s abilities and in respect to the teacher's own pedagogical competence. Collaborative group work of children should be introduced and fostered from an early age to ensure that the benefits of this way of learning are maximised. The research confirmed that this level of inquiry-based science was difficult, but with a teacher´s support it is possible for even very young children to work in groups (Byrne et al., 2016).

A major factor that influences implementing inquiry-based activities in class is teachers´ beliefs in their professional potentials. If they have strong beliefs, they are comfortable with planning science activities and implementing valuable exploration tasks that support children´s curiosity, creativity and enjoyment in exploration of the world (Byrne et al. 2016; Pendergast, Lieberman-Betz, & Vail, 2017; Wang, Kinzie, McGuire, & Pan, 2019).

The Concept of Beliefs

Beliefs can be generally defined as one´s subjective representations of objects, people or actions. Richardson (2003) stated that beliefs are psychologically held understandings, premises, or propositions felt to be true. Beliefs are important characteristics of teachers. They are considered a personal theory on teaching, learning, children, parents and the school context. Beliefs designate individual, subjectively true, value-laden mental constructs that are the results of substantial social experiences and have a significant impact on one´s interpretation of and contribution to classroom practice (Skott, 2012) and are significant constituents of teachers´ implementations of change (Haney, Lumpe, Czerniak, & Egan, 2002).

Teachers´ beliefs constitute a (belief) system, the elements of which are integrated. Mansour (2009, 26) described it as "an idiosyncratic unity of thought about objects, people, and events, and their characteristic relationships that affect [teacher] planning and interactive thoughts and decisions." Despite the widespread agreement that teachers' beliefs are well integrated, few empirical investigations have examined beliefs as a complex system (Fives & Buehl, 2012).

Beliefs should be distinguished from teacher pedagogical knowledge. These two are different concepts. Beliefs are more experience-based, while knowledge is more theory-based (Mansour, 2009). However, the teacher must possess pedagogical knowledge – in addition to classroom experience – in order to generate professional beliefs. Because of the central role of knowledge in human representations, Skott (2012) considered knowledge as a subset of beliefs. Beliefs are situated, while knowledge is more abstract. Beliefs are more evaluative and affective than knowledge. The relationship between teacher beliefs and teacher pedagogical knowledge is interactive. They affect each other.

One important characteristic of beliefs is that they are implicit and cannot be observed. However, they can be inferred in interviews or self-rate scales filled in by teachers. Researchers argued whether beliefs are static or dynamic (Skott, 2012). Both views were supported by research evidence and have implications for practice. Many teachers have relatively stable beliefs and are more or less resistant to change even after some intervention. Other studies documented that teachers' beliefs do change over time, e.g., they altered beliefs about classroom practices, management and children´s learning (Fives & Buehl, 2012).

Teachers´ beliefs are important because they help us understand teachers´ practices. Beliefs are filters through which experience is screened for meanings, so it is reasonable to expect that teachers' beliefs influence classroom decisions and practices (Maggioni & Parkinson, 2008; Richardson, 2003; Smith & Croom, 2000). The research of associations between teacher beliefs and teacher practices is therefore of utmost importance.

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Research Focus

The aim of the present research was to develop an instrument, DPBA, to measure preschool teachers´ degree of beliefs in inquiry-based activities in class and validate it with a large sample of teachers. The quantitative method was used in this research. It employed procedures ranging from planning the research project on preschool teachers beliefs in inquiry-based activities in classes, generating the research instrument idea, creating a bank of instrument items, administering the instrument and its validation in exploratory and confirmatory factor analyses.

Research Methodology

General Background

The history of developing research instruments to measure preschool teachers´ beliefs in using inquiry-based activities is short. The existing instruments in this domain, P-TABS (Maier et al., 2013) and "The Early Childhood Teachers' Attitudes towards Science Teaching" (Cho, Ang, Kim, & Choi, 2003), were developed and used in social and educational environments that are dissimilar to that of the target population of this research. For instance, P-TABS was developed and validated using a sample of Head Start teachers in the United States. It, as well as "The Early Childhood Teachers´ Attitudes towards Science Teaching", were validated with a multi-ethnic population. There are also instruments that measure teachers´ beliefs in science education in primary, secondary and higher education (Nathan, Tran, Atwood, Prevost, & Phelps, 2010; Temel et al., 2017; Wahono & Chang, 2019), but their attributes are not appropriate for measuring preschool teachers. Therefore, rather than taking time to adapt one of these instruments for Czech preschool teachers, it was found more convenient to develop and validate a new instrument, which is described in this article.

Sample

The sample comprised 1,004 Czech preschool teachers, based on stratified sampling of gender, years of teaching practice, highest professional education and size of population where the preschool is located. The participants' demography is described in Table 1.

Table 1. The structure of the sample.

	N	%
Gender		
Female	982	97.8
Male	22	2.2
Years of practice		
1 - 5 years	239	23.8
6 – 20 years	317	31.6
21 – 45 years	397	39.5
Missing	51	5.1
Highest education		
Pedagogical vocational school	613	61.0
Bachelor´s degree in preschool ed.	197	19.6
Master´s degree in preschool ed.	112	11.6
Missing	82	8.7
Sample size by localities		
0 – 999	110	11.0
1,000 – 4,999	200	19.9

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		N	%
	5,000 – 9,999	106	10.6
	10,000 – 19,999	94	9.4
	20,000 – 49,999	121	12.1
	50,000 – 99,999	141	14.0
	100,000+	232	23.1
	Total	1,004	100

Procedures

An instrument, DPBA, was developed in several steps (DPBA are initials for the Czech title *Dotazník přesvědčení o badatelských aktivitách v mateřské škole*). In the first step, the theoretical underpinning of science education in preschool was considered by the researchers. Agreement was reached on the concept of professional belief and its relationships to professional knowledge. Next, the components of inquiry-based instruction were listed. Existing instruments that measure inquiry-based beliefs, attitudes and practices were inspected for content and item formats to find inspiration. In the next step, three researchers generated a pool of 40 items covering inquiry activities in preschool. The items were checked for clarity by three experienced preschool teachers, and upon their recommendations, wording adjustments were made. A 5-point Likert scale was added to statements (1 = strongly disagree, 5 = strongly agree). Some items were converted to negative statements in order to avoid agreement bias (cf. "The preschool teacher doesn´t have enough knowledge to organize inquiry-based learning").

Initially, the instrument was presented to 55 preschool teachers for a pilot in-field examination. Item averages, standard deviations, skewness and kurtosis were inspected. A principal component analysis in IBM SPSS 21 was performed with the aim to reveal potential factors and possible overlaps of items (cross-loading) in factors. The latter was done because, generally, multiple loading of an item on factors indicates an unclear solution, and such cross-loaded items must be excluded from further investigation (P. Kline, 2000). A principal component method with Varimax rotation was performed that resulted in a four factor solution, as suggested by scree plot (graphical presentation of the eigenvalues of factors). Items that loaded on two factors were reworded or dropped, while the rest were retained. This produced a preliminary instrument version with 35 items.

Data Analysis

The 35-item instrument was administered to a sample of Czech preschool teachers (N = 1,004). Before the analysis, items with negative wording were reverse-coded, i.e., item scores 1, 2, 3, 4 and 5 were coded as 5, 4, 3, 2 and 1. By this arrangement the high scores meant a high level of teachers´ beliefs in all instrument items. The check revealed no missing values on any of the 35 items.

Before the analysis was performed, the KMO values and the Bartlett´s test were computed. The value of KMO (.931) indicated that the participants´ sample was adequate for analysis, and the Bartlett´s test result (χ^2= 14597, df = 595, p = .0001) showed that the observed correlation matrix was statistically different from an identity matrix (Beavers et al., 2013). The following criteria were applied to determine the number of retained factors: eigenvalues greater than one, scree plot, minimum of four items for a subscale, and interpretability (Field, 2018). The analysis output showed five eigenvalues greater than one, while the scree plot suggested a three factor solution. The analysis was performed with five, four and three factors, and it was decided that three factors produced the best interpretable solution.

An exploratory principal component analysis was performed using Varimax rotation, which was preferred because it usually brings more interpretable solutions (Field, 2018). Item loadings of ≥ .40 were taken into consideration. Two items ("The teacher doesn´t have enough materials for organizing inquiry-based activities" and "During inquiry-based activities children can ask questions that the teacher is unable to answer") were eliminated because of low communality (.191 and .174 respectively), and another principal component analysis was performed without these items.

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One item loaded below the .40 cut-off on a factor and was not considered ("Inquiry-based activities can be accomplished several times during the week"), while two items were dropped because of loading on two factors ("It is premature to include science methods like experiments to preschool" and "Inquiry-based activities have no place in preschool.") Two items produced negative factor loadings, which was contrary to the concept of the factors ("Inquiry-based activities are the best way to foster interest of children" and "In Inquiry-based activities it is easier to employ images and drawings than organize experiments"). After these two items were eliminated, reliability of the respective subscales increased from .862 to .910 and from .606 to .749, respectively (Cronbach´s Alpha), which justified the exclusion.

Because of the dispute over the feasibility of the principal component analysis (Brown, 2015; Harrington, 2009), additional analysis was conducted with the maximum likelihood method. However, it brought an identical solution: three factors and the same items in each. Because principal component analysis produced more items, its results were used for further presentation.

In addition to exploratory analysis, as described above, confirmatory factor analysis was performed in order to confirm an emerged factor structure. As recommended (Harrington, 2009), the subscales generated in the exploratory analysis will become "latent variables" in confirmatory analysis, and the instrument items will become "observed variables". SPSS Amos 25 was used to prove the model structure with the latent variables. The aim was to achieve a good model fit with index values suggested by R. B. Kline (2005): RMR < .08, CFI > .90, and RMSEA < .80. With regard to χ^2, a statistically non-significant result was required. However, R. B. Kline claimed that large samples, such as ours, inflate the χ^2 value, and Brown (2015) explained that the recommended statistical non-significance for χ^2 value is based on a very stringent hypothesis.

Research Results

In the principal component analysis with the sample of 1,004 preschool teachers three factors were extracted. The first factor, *Benefits*, had 14 items that relate the teacher´s beliefs both to the child and herself as a teacher. They concerned fostering the child´s skills in thinking, language, communication and observation, as well as understanding the science phenomena. Other items highlighted the qualities of inquiry-based activities such as hands-on learning, engaging inattentive children and preparation for science in primary grades. Other items include the self-confidence, joy and satisfaction of the teacher when successfully organizing inquiry processes. Reliability of the subscale was .910 (Cronbach´s Alpha). The second factor, *Teacher Competence*, was composed of 6 items that relate to the teacher´s beliefs in knowledge and skills for planning and organizing inquiry-based activities. The Cronbach´s Alpha of the subscale was .847. The third factor, *Concerns*, had 8 items expressing the teacher's beliefs in inquiry-based activities producing challenges for the child and the teacher. These activities are more demanding, time consuming, causing a mess in class, and claiming that science phenomena are not developmentally appropriate for the child to learn and are absent in the national preschool curriculum. The Cronbach´s Alpha of the subscale was .749.

In sum, the DPBA appears to be tri-dimensional. The three factors extracted in the analysis had 28 items in total that explain 47.7 % of the overall variance. In the course of analysis, 12 items were dropped from the original 40 item pool – a typical outcome of exploratory analysis (Morgano, Meiereles, Neves, Amaral, & Ferreira, 2017). The largest number of items remained in the first factor, Benefits (14 items), which had the broadest range of topics relating to both the pupil and the teacher benefits from pursuing inquiry-based activities. The second factor, Teacher Competence, had 6 factors that relate to teacher knowledge and skills for planning and managing inquiry-based activities. The third factor, Concerns, had 8 items that relate to the pupils´ deficiency and teachers´ obstacles in organizing inquiry-based activities. The reliability coefficients indicated good internal consistencies in the first two factors, .910 and .847, and somewhat lower but still acceptable in the third factor, .749 (Costello & Osborne, 2005). Overall reliability of the three factors was .883. Table 2 shows the results of the principal component analysis with the 28-item version of DPBA.

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Table 2. Results of DPBA in principal component analysis with Varimax rotation (*N* = 1,004).

		Factors		
Item	**Item wording**	**1**	**2**	**3**
2	IBA are mainly experiments.	.420		
3	IBA (e.g., with life materials) foster the child´s language and communication skills.	.703		
4	IBA take more time than traditional activities.			.589
5	IBA foster the child´s relationship to science.	.749		
6	Doing IBA by children brings joy and satisfaction to the teacher.	.636		
7	Preparation for IBA is demanding for the teacher. (R)			.671
9	Hands-on activities are the best way of learning.	.569		
10	The teacher has sufficient knowledge about inquiry-based learning.		.714	
12	IBA is a way of preparing preschool children for science in primary grades.	.728		
13	The child cannot understand phenomena through inquiry activities, even if organized well by the teacher. (R)			.470
15	The teacher doesn´t have enough time to organize IBA. (R)			.650
16	Successful IBA implementation increases the teacher´s self-confidence.	.613		
17	IBA are the best way to educate children.	.530		
18	IBA foster the child´s observation skills.	.740		
19	IBA are too difficult for the majority of children. (R)			.642
20	IBA make a mess in class. (R)			.630
21	IBA are an efficient way to engage inattentive children.	.591		
22	The teacher has knowledge about how to explain doing experiments to children.		.698	
24	IBA foster the child´s thinking.	.744		
25	Successful IBA planning increases the teacher´s self-confidence.	.621		
26	The teacher can manage organizing children in experiments.		.720	
27	IBA make children familiar with science phenomena.	.684		
28	Implementing IBA is more difficult than organizing traditional activities. (R)			.608
29	IBA are not included in the national preschool curriculum. (R)			.427
30	The teacher has good professional knowledge for organizing IBA.		.735	
31	The teacher doesn´t worry about seeming disorder in class during IBA.		.652	
32	The teacher can easily find ideas for planning experiments in resources.		.704	
34	IBA help children comprehend physical phenomena.	.729		
	Explained variance	28.8	10.4	8.4
	α	.910	.847	.749

Note: IBA = Inquiry-based activities; (R) = negative statement that was reverse-coded prior to analysis; Factor 1 = Benefits; Factor 2 = Teacher Competence; Factor 3 = Concerns. Item loadings ≥ .40.

This stage of research provided preliminary evidence of the construct validity of DPBA. However, exploratory analysis is not designed to test theoretical models. For this purpose, confirmatory factor analysis (CFA) has to be conducted. Accordingly, this analysis was performed with the instrument data with three latent variables, Benefits, Teacher Competence and Concerns.

The first round of CFA yielded indices beyond the acceptable range, except RMSEA, i.e., $\chi^2 = .0001$; RMR = .10; AGFI = .789; CFI = .873 and RMSEA = .072. To achieve a better fit, the model was repeatedly re-specified. Two items

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were eliminated from the Benefit subscale because of low factor loadings. These were item 2, "Inquiry-based activities are mainly experiments," and item 25, "Successful planning of Inquiry-based activities increases the teacher´s self-confidence." Four items in the Concerns subscale were dropped for low factor loading as well. Two of them relate to difficulties the child encounters while doing inquiry-based activities: item 13 "The child cannot understand phenomena through inquiry activities, even if organized well by the teacher" and item 19 "Inquiry-based activities are too difficult for the majority of children." Two other items that were dropped are related to teachers' time and knowledge: item 15 "The teacher doesn´t have enough time to organize inquiry-based activities" and item 29 "Inquiry-based activities are not included in the national preschool curriculum". Furthermore, eight error variances were added as suggested by modification indices. The changes resulted in a satisfactory model fit with the data: RMR = .079; AGFI = .922; CFI = .937 and RMSEA = .054. However, the χ^2 h value remained statistically significant. The path diagram of the model is depicted in Figure 1.

The three latent variables were in associations that are theoretically viable. Benefits correlated highest with Teacher Competence (.51), which is in congruence with assumptions. Teachers´ beliefs in the potentials of inquiry-based activities to stimulate the children´s cognitive abilities, their interest in science, and bring joy and satisfaction to the teachers were moderately related to teachers´ knowledge and skills to plan and implement inquiry-based activities in class. Benefits correlated negatively with Concerns (-.15), because they are inverse phenomena. Finally, Teacher Competence correlated low with Concerns (.19). Even if teachers have excellent professional knowledge and skills, they can only partially overcome attributes of inquiry-based activities, like extended time for preparation and implementation, or difficulty for children. In general, the correlations seemed to provide a realistic representation of associations among latent variables.

The three subscales covered 21 items, with unequal distribution. The largest number of items are in Benefits (12), followed by Teacher Competence (6) and Concerns (4). During the validation process, the total number of items shrank from the initial 40 to the current 21, a loss of 53 %. Such a reduction is typical for the development of a research instrument if it proceeds in recommended steps. The largest decrease of items was in the Concerns subscale, from 9 to 4 items, probably due to the mixed content of this subscale. Item means, standard deviations and reliabilities of the final version of DPBA after confirmatory factor analysis are in Table 3.

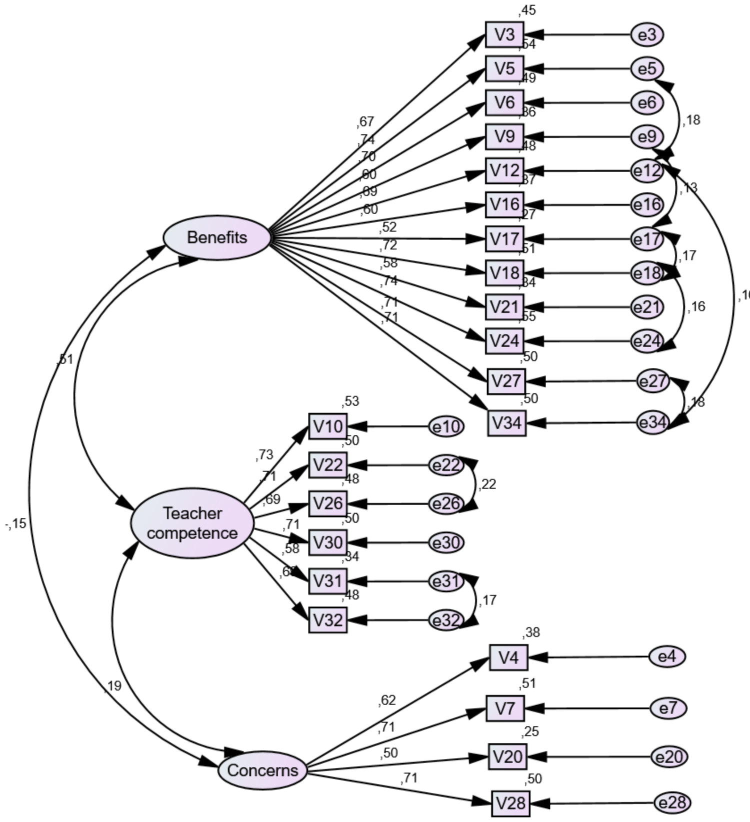

Figure 1. Path diagram of the confirmatory factor analysis of DPBA.

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Table 3. DPBA subscales and items after CFA.

		M	*SD*	α
Item	Benefits	4.05	0.67	.906
3	IBA (e.g., with life materials) foster the child´s language and communication skills.	4.10	0.96	
5	IBA foster the child´s relationship to science.	4.25	0.96	
6	Doing IBA by children brings joy and satisfaction to the teacher.	4.08	0.94	
9	Hands-on activities are the best way of learning.	4.15	0.95	
12	IBA is a way of preparing preschool children for science in primary grades.	4.01	1.00	
16	Successful IBA implementation increases the teacher´s self-confidence	3.78	0.98	
17	IBA are the best way to educate children.	3.49	1.00	
18	IBA foster the child´s observation skills.	4.25	0.90	
21	IBA are an efficient way to engage inattentive children.	3.75	1.01	
24	IBA foster the child´s thinking.	4.36	0.87	
27	IBA make children familiar with science phenomena.	4.26	0.85	
34	IBA help children comprehend physical phenomena.	4.15	0.95	
	Teacher Competence	3.50	0.81	.847
10	The teacher has sufficient knowledge about inquiry-based learning.	3.49	1.08	
22	The teacher has knowledge about how to explain doing experiments to children.	3.76	1.03	
26	The teacher can manage organizing children in experiments.	3.62	1.00	
30	The teacher has adequate professional knowledge for organizing IBA.	3.49	1.09	
31	The teacher doesn´t worry about seeming disorder in class during IBA.	3.18	1.13	
32	The teacher can easily find ideas for planning experiments in resources.	3.49	1.09	
	Concerns	2.28	0.79	.729
4	IBA take more time than traditional activities.	2.09	1.19	
7	Preparation for IBA is demanding for the teacher. (R)	2.37	1.10	
20	IBA make a mess in class. (R)	2.66	1.08	
28	Implementing IBA is more difficult than organizing traditional activities. (R)	2.00	1.02	

Note: IBA = Inquiry-based activities; (R) = negative statement that was reverse-coded prior to analysis. Items were scored from 1 (strongly disagree) to 5 (strongly agree). α = Cronbach´s reliability coefficient

To further examine the quality of the final model of DPBA, reliabilities of the three subscales, as generated by the confirmatory analysis, were checked in each of the teacher demographic subsamples. This examination was possible because the number of cases in the subsamples was sufficiently large, ranging from 112 to 613 respondents, thus producing meaningful results. The subsamples were categorized by years of practice and the highest professional education of the teachers. The purpose was to inspect whether the reliabilities hold similarity across the subsamples, which would confirm the cross-validity of DPBA. Table 4 shows the results of the entire sample and of the subsamples. Generally, the reliability coefficients proved stability across subscales. In Benefits, the range of Alphas among subsamples was from .899 to .936, a difference of mere .037. In Teacher Competence, the range of Alphas among subsamples was from .795 to .882, a difference of .087. In Concerns, the range of Alphas among subsamples was from .687 to .830, a difference of .143. This result demonstrated stability of reliability across the subsamples and proved that DPBA is a reliable instrument to measure preschool teachers´ beliefs in inquiry-based activities in class. In addition, the scores manifested the same trend across subsamples. The highest scores were on Benefits, followed by Teacher Competence and by Concerns.

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Table 4. Reliabilities of DPBA subscales by subsamples.

		Teacher practice in years			Teacher highest education		
Subscales	Total (*N=1,004*)	1 – 5 (*n=239*)	6 – 20 (*n=317*)	21 - 45 (*n=397*)	VS (*n=613*)	BA (*n=197*)	MA (*n=112*)
Benefits	.906	.901	.917	.905	.899	.918	.936
Teacher Competence	.847	.840	.795	.874	.840	.857	.882
Concerns	.729	.721	.744	.708	.687	.745	.830

Note: Cronbach´s alpha coefficients. VS = pedagogical vocational school, BA = bachelor´s degree in preschool education; MA = master´s degree in preschool education

Discussion

Teachers´ beliefs are key factors in planning and implementing science. In preschool, these beliefs are as equally important as at primary or secondary levels of education. However, teachers´ beliefs toward science in preschool have not been a frequent research focus. This research attempts to alleviate this deficiency by reporting on the development and validation of a research instrument that can provide data about the level of teachers´ beliefs toward inquiry-based science activities in preschool.

The instrument, DPBA, was constructed in several phases, including item pool assembling, item wording refinement, piloting, and exploratory and confirmatory factor analyses. The analyses revealed three factors of preschool teachers´ beliefs, i.e., Benefits, Teacher Competence and Concerns. The Benefits subscale measured teachers´ beliefs in the favourable effects of inquiry-based activities both on children and teachers themselves. It related to children´s abilities, skills and attitudes towards science and teachers´ satisfaction and self-confidence while teaching science. The Teacher Competence subscale relates to beliefs in teachers´ knowledge and skills of planning and implementing inquiry-based activities. The Concerns subscale measures teachers´ worries about problems in preparation and implementing these activities in preschool classes. The final version of DPBA has 22 items. Although small, its subscales prove good reliability (.906; .847 and .729, respectively). A favourable feature of this research was a large research sample. The number of participants (*N* = 1,004) resulted in obtaining solid data that balanced possible distortions. Furthermore, the large sample made it possible to segment demographic subsamples of sufficient sizes to provide additional reliability examinations. This research concentrated on instrument development and validation. A detailed analysis of the teachers´ scores on the three subscales in each of the demographic subsamples was beyond this article's scope and will be provided in a future publication.

It is worthwhile to compare DPBA with existing instruments that measure the same construct. To date, there are only two that were retrievable from databases, P-TABS developed by Maier et al. (2013) and "The Early Childhood Teachers' Attitudes towards Science Teaching" developed by Cho et al. (2003). Because the latter instrument was validated insufficiently (small sample, no confirmatory factor analysis), it is more appropriate to compare our instrument with the former one. P-TABS shares many similarities with DPBA. It has three subscales that in part resemble those from DPBA. Child Benefit is similar to our Benefit subscale, however, it covers only beliefs in children´s potentials in learning science, and not teachers´ benefits, like enjoyment and satisfaction, as it is in our subscale. In addition, it contains two items that express children´s deficiency in learning science. In DPBA, such items belong to the Concerns subscale. Teacher Comfort measures teacher satisfaction with teaching science and partially overlaps with Teacher Competence in DPBA. Finally, Challenges express problems that teachers come across when teaching science, which resembles Concerns in DPBA. Because this subscale proved low reliability in some American subsamples, the authors removed it from P-TABS. In sum, a comparison of DPBA and T-TABS showed some universal attributes shared by these instruments, the existence of teachers´ satisfaction but also worries and pupils´ learning gains.

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Conclusions

The analysis indicated that DPBA, an instrument to measure preschool teacher beliefs in inquiry-based activities, is psychometrically sound in terms of construct validity, reliability and stability across subsamples. This conclusion is true for Czech preschool teachers, but cannot be safely extrapolated to teachers working in dissimilar educational environments, where re-validation is recommended.

The potential uses of DPBA are large. It can be administered to large samples of preschool teachers or subgroups of teachers with specific characteristics, e.g., novice teachers, middle-career teachers, female or male teachers. The instrument is sensitive to detect areas of both benefits and problems of respondents, which are associated with their beliefs in planning and conducting inquiry-based activities in preschool. Such benefits are, for instance, enjoyment and satisfaction in science instruction, increase in self-confidence, or pleasure in fostering children´s favourable attitudes to science. On the other hand, DBPA can identify problems teachers feel in conducting inquiry-based activities, for instance, lack of science materials, deficiency in their science knowledge, or insufficient time for organizing children´s exploration. The instrument can be also used to measure influence of teacher development programmes focused on science teaching. Administration of DPBA before and after an intervention can reveal how much it affected beliefs of teachers involved in the programme. Finally, DPBA can be used to measure pre-service beliefs in inquiry-based activities at the beginning and at the end of their study programme.

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