Full research paper

CZECH PRESCHOOL TEACHERS' CONTRASTING BELIEFS ABOUT INQUIRY-BASED ACTIVITIES

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ABSTRACT

Using a self-reporting measure, the study examined IBA-related beliefs of Czech preschool teachers (n = 1,004). In addition, it explored the beliefs of teachers who strongly agreed (n = 564) and those who strongly disagreed (n = 67) with the implementation of IBA in preschool classes. The findings show that teachers within the full sample, as well as those within the contrasting subsamples, hold considerably strong beliefs about the potential of IBA for children´s cognitive development. At the same time, teachers are aware of the challenges associated with implementing IBA. Teachers who strongly favour IBA have significantly stronger beliefs in the benefits that IBA bring to children and also have stronger beliefs about the knowledge and skills teachers need for IBA planning and implementation than has the group that strongly rejects IBA. In contrast, teachers who strongly reject IBA have stronger beliefs that IBA cause problems in preschool classes. The group of teachers who strongly favour IBA have higher levels of education and fewer years of practice than the contrasting group. They are mostly younger teachers who received a modern professional education and who are more open to newer instructional strategies such as IBA.

KEYWORDS

Inquiry-based activities, preschool, teachers' beliefs

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Highlights

- *The study describes inquiry-based activities (IBA) as a means to engage children to motivate and learn.*
- *Preschool teachers hold considerably strong beliefs about the positive potentials of IBA for children's cognitive development.*
- *However, some teachers strongly oppose introduction of IBA in preschools and believe less favourably about IBA benefits for children.*
- *They also rate their IBA-related competence lower than teachers who strongly favour introduction of IBA in preschool classes.*

INTRODUCTION

Science teaching in early childhood classes is an important educational domain because it lays the foundations for science achievement in later grades. However, in spite of its importance, it is less researched compared to that of science education in primary and secondary schools (Greenfield et al., 2009; Leuchter, Saalbach and Hardy, 2014). Even less frequent is a line of research focusing on what beliefs preschool teachers hold about the developmental potentials of science education mediated through inquiry-based activities (IBA). This knowledge deficiency prevents teacher educators from employing efficient approaches towards preparing preservice teachers as well as influencing in-service professionals to adopt modern instructional strategies such as IBA in preschool classes.

IBA are generally accepted as a prominent way to draw pupils into the culture of science. By participating in IBA, pupils are enculturated in scientific practices and traditions and learn to appreciate scientific values (Abrams et al., 2008; Cobern and Aikenhead, 1997; Lee, 2003). IBA are a pathway for pupils to understand science concepts and develop scientific reasoning. Though in preschool classes such high aims cannot be achieved, teachers can implement inquiry to develop children's attitudes toward science by activities based on observation and object manipulation, thus drawing on children's natural curiosity, imagination and enthusiasm

to learn about the world around them (Eshach and Fried, 2005; Howitt, Morris and Colvill, 2007; Watters et al., 2000). The challenge for preschool teachers is to fuel this curiosity and enthusiasm through the provision of appropriate learning experiences and an engaging preschool classroom environment. By implementing inquiry in preschool, teachers lay the foundations of children's abilities and skills needed for teaching science in higher schooling levels (Chesloff, 2013; Merino et al., 2014; Morrison, 2012; Tao Oliver and Venville, 2012).

Even though many studies describe the implementation of IBA in preschool classrooms (Edson, 2013; Edwards and Loveridge, 2011; Hamlin and Wisneski, 2012; Smith and Trundle, 2014), there is little knowledge of how teachers' beliefs influenced adoption of these activities. Identifying and understanding such beliefs, and the teacher characteristics with which they are associated, enable a fuller understanding of the preschool teacher as a professional. The implementation of IBA is challenging for teachers because they must draw on a sizeable repertoire of practices and combinations thereof. What remains undetermined are the levels of IBA teacher acceptance in the preschool context and the IBA-associated beliefs of preschool teachers.

This study offers two research perspectives on preschool teachers' IBA beliefs. The first perspective considers teachers to be a population with rather homogenous levels of beliefs, attitudes, knowledge and skills. Such a perspective enables an appropriate generalisation of research findings for the entire teacher population. We adopted this perspective in an analysis of the IBA-related beliefs of a large sample of Czech preschool teachers and inspected their demographic characteristics associated with their beliefs, these being gender, level of education and years of practice. The subsequent findings served as comparison data for later analyses.

The other research perspective considers teachers as a heterogenous population because they studied in diverse teacher-training institutions and work under varied conditions, and their beliefs were influenced by specific professional, social and cultural conditions; consequently, they have diverse belief profiles (Park et al., 2017; Jamil, Linder and Stegelin, 2018; Rubie-Davies, Flint and McDonald, 2012). Therefore, in addition to exploring the IBA-related beliefs of a full teacher sample, we examined beliefs and belief-related characteristics of two subsamples extracted from the whole: teachers who strongly favour and teachers who strongly reject the implementation of IBA in preschool classes. Besides their IBA-related belief profiles, we examined their demographic characteristics. This research strategy was motivated by the assumption that analysing the beliefs of contrasting teacher subsamples would provide more elaborate insights into teachers' IBA-related beliefs than an examination of the full sample.

The text has the following structure. First, we explain the context of the Czech preschool. Then we introduce the theoretical concepts of IBA and teacher beliefs. In the research section, we present the research aims, teacher samples and the research instrument used. The results section reports about the IBA-related beliefs of the full teacher sample and two subsamples. The final sections of the study deal with discussion and implications.

The Czech Preschool Context

In the Czech Republic, preschool offers an education programme to children from two to six years of age. Most of the children attend a full-day programme. Under the current legislation, preschool attendance is obligatory for children in the pre-primary year, i.e., children who are 5 years old. Preschool education is based on a personalistic theory and is focused on developing a child into a holistic person. Under the Education Act, the preschool programme promotes the development of a child's personality, contributes to their emotional and physical development, supports personal satisfaction and well-being, and teaches the child to understand societal norms and values. The preschool curriculum is divided into five content areas: the child and their body, the child and their mind, the child and others, the child and society, the child and the world (Ministry of Education, Youth and Sports, 2018). To follow an integrative educational approach, which is the core idea of the didactic model in Czech preschools, these areas are interconnected. It is a strongly held belief that pre-primary education creates foundational prerequisites for children's continued learning. In the upper years of preschool, increased importance is placed on supporting the knowledge and skills required for the successful transition to primary education. Thus, preschool teachers pave the way for children's success in their first years of primary school.

Preschool teachers plan and organise children's activities with varying teacher involvement. They provide guidance, support and scaffolding to children's learning, but they also enable children-choice play. Teachers employ a range of educational strategies, in both large and small group instruction. Preschools provide a variety of materials and resources for children to manipulate and use, both in learning and play activities. The preschool physical environment is usually segmented into circles or corners to enable learning in a specific domain, e.g., science, pre-literacy, visual arts or music. Instructional activities are managed by teachers, with emphasis on the needs of individual children.

Basic inquiry activities, such as observation, measurement or sorting, are typically used in the content area of the child and the world. The goal of this area is acquiring the knowledge and skills needed to learn about the surroundings and creating a responsible attitude towards the environment. Activities such as interpreting phenomena, identifying variables, or experimenting are less common in Czech preschool classrooms. Many teachers describe, clarify or explain phenomena rather than let children actively engage in their explorations.

The basic preschool teacher qualification requirement is the completion of pedagogical vocational schooling. Such schooling provides the professional theories and skills necessary to perform the responsibilities of a preschool teacher, including planning and organising activities, adjusting them to children's needs, and efficiently communicating with parents and the community. A growing number of teachers in the Czech Republic have successfully completed bachelor's or master's programmes in preschool education, which provide broader theoretical foundations than vocational schools in pedagogy, psychology and sociology, in addition to the provision of teaching practice.

Inquiry-Based Activities

Inquiry-based activities are educational practices that aim to stimulate children's curiosity about the world around them and provide opportunities for active learning (Eshach and Fried, 2005; Hollingsworth and Vandermaas-Peeler, 2017). IBA are an array of classroom practices that promote pupils' learning through guided and, increasingly, independent investigations of questions and problems, often for which there is no single answer (Lee et al. 2004). IBA are intentional educational practices during which pupils verbalise a problem, assess, plan and experiment. Subsequently, they draw conclusions and thus expand their knowledge (Stuchlíková, 2010). If organised efficiently, IBA bring valuable learning benefits. Children can develop cognitive skills like observing, investigating, questioning, predicting, planning and recording the obtained evidence. They learn to understand concepts and processes at a developmentally appropriate level and develop a favourable attitude towards science and scientific inquiry (Bell et al., 2010; Dostál, 2015; Osborne and Dillon, 2008; Hubáčková et al., 2014; Minner, Levy and Century, 2010; Pavlovičová, 2012). The focus of IBA is that children make sense of the phenomena they explore and with which they work (Crawford, 2007).

IBA are based on the educational principle that learning is most effective when children are active participants in the learning process when the learning proceeds from experiences to explanations, and when teachers are well prepared to support children in the learning process (Anderson, 2002; Hackling, 2007). The teacher's focus in class is more on facilitation and monitoring the children's learning rather than on stringent structural managing of children's actions. Instead of supplying children with new knowledge, teachers trigger children's interests so that they might self-discover knowledge.

Though IBA can be used in all educational domains, they are most frequently favoured in teaching science and in learning about physical phenomena (Bell et al., 2010; Crawford, 2007; Dostál, 2015; Minner, Levy and Century, 2010; Osborne and Dillon, 2008). Researchers suggest that science education should begin in early childhood (Eshach and Fried, 2005; Watters et al., 2000), so as to build foundations for children's interest in science (Aldemir and Kermani, 2014) and to provide scientific literacy (Osborne and Dillon, 2008). Science is apt for early learning because it involves hands-on activities, using resources and instruments like lenses, scales or magnets to explore the physical world. If IBA are implemented effectively, they facilitate the developing of children's problem-solving, communication and collaborative skills and foster children's self-confidence and independence. However, there are obstacles that prevent teachers using IBA in preschool classrooms or prevent using them adequately. A major difficulty in adopting IBA in preschool teaching, which has been of concern for decades, is that many teachers either lack confidence or have weak beliefs concerning IBA (Byrne, Rietdijk and Cheek, 2016; Murphy, Neil and Beggs, 2007).

Beliefs

Beliefs are psychologically-held understandings, premises, or propositions about the world that are felt to be true (Richardson, 1996) and are a component of a person's self-regulatory system. In the educational area, teachers' beliefs are reflected in their interaction with the school, pupils, and colleagues (Stuchlíková, 2003; Woolfolk Hoy, Hoy and Davis, 2009; Vítečková, 2018). They regulate teachers' thinking, motivation, and behaviour as well as mediate their skill development and teaching (Pajares, 1992). Teachers' beliefs are frequently described as "filters" that guide the perception and interpretation of classroom situations (Fives and Buehl, 2012) and through which new knowledge and experiences are interpreted (Handal and Herrington, 2003). Teachers' beliefs are also related to their attitude to teaching, goal orientation, wellbeing or burnout (Natovová and Chýlová, 2014; Yildizli, 2019).

Teacher beliefs influence teaching in a variety of complex ways. First, they function as a foundation for classroom decision-making. The decisions teachers make in planning and organising classroom environments, interactions with children, and decisions about classroom practices are, in part, based on their beliefs (Vartuli, 2005). Teachers' instructional decisions, in turn, influence learning opportunities provided to children (Rubie-Davies, Flint and McDonald, 2012). Teachers' beliefs about the nature of education influence their teaching through content selection, teaching style, and the type of learning opportunities provided to pupils. Thus, exploring teachers' beliefs is an important research aim because they help us understand their practices (Maggioni and Parkinson, 2008; Richardson, 2003; Smith and Croom, 2000).

Beliefs must be distinguished from knowledge. Beliefs are more experience-based, while pedagogical 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. 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. Managing the demands of the teacher profession requires both specific knowledge and skills, and beliefs in their own abilities to be resilient and persistent in the face of teaching challenges.

Teachers' beliefs are of utmost importance in teachers' practices. Beliefs affect the way and extent the teacher addresses the demands of the teaching process (Pajares, 1992; Richardson, 2003; Woolfolk Hoy, Hoy and Davis, 2009). Teachers with strong beliefs have a firm intention to engage their proficiency to attain educational goals that are prescribed by the curriculum. This study examines Czech teacher beliefs about implementing IBA in preschool classrooms. By using a valid self-rating instrument, it explores how strong preschool teachers' beliefs are about their potential to plan and implement IBA, what benefits they think IBA bring to children and to themselves, but also how they view the problems and obstacles that arise during the implementation of IBA. Uncovering how strong preschool teachers' beliefs are in IBA and with which teaching factors IBA is associated will expand the understanding of this important teacher characteristic.

RESEARCH AIMS

The study aimed to examine IBA-related beliefs of a sample of preschool teachers in the Czech Republic in three belief

components, which are described in the methods section. In addition, the aim was to examine two teacher subsamples: those who strongly agreed and those who strongly disagreed with the implementation of IBA in preschool classes. Though many Czech preschool teachers endorse IBA and enthusiastically use them in classes, some reject the idea of implementing such activities with preschool age children and are reluctant to carry them out. Exploring contrasting groups of teachers was intended to increase insight into the teachers' IBA-related beliefs. Because teacher beliefs have been shown to be associated with teacher characteristics, we also explored the relationships between teacher IBA-related beliefs and teacher demographics. The study asks these questions:

1. What is the beliefs level of teachers in the full sample about planning and implementing IBA in preschool classes?
2. How is this level associated with teachers' demographic characteristics?
3. What is the beliefs profile of teachers who either strongly favour or strongly reject IBA implementation in preschool classrooms?
4. Which demographic characteristics distinguish these teachers?

Two hypotheses were stated that relate to research questions 1 and 2.

H1: There are no statistically significant differences among the three components of teachers' IBA-related belief ratings.

H2: There are no statistically significant differences in IBA-related belief ratings between the teachers who strongly agreed and those who strongly disagreed with the implementation of IBA in preschool classes.

SAMPLES

Full Sample

A total of 1,004 preschool teachers from all fourteen regions of the Czech Republic participated in the study. The sample represents 3.2% of all teachers that actively taught in Czech preschools in 2020 (Ministry of Education, Youth and Sports, 2021). The teachers were addressed at their particular preschools, told of the purpose of the study, and informed about privacy protection through answer anonymisation. The gender composition of the sample is heavily disbalanced - 980 teachers (97.8%) are female[1]. Teachers provided information on their highest attained level of professional education. The majority of teachers (67%) completed pedagogical vocational schools, 21% earned a bachelor's degree, and 12% had master's degrees in preschool education. The average number of years of teaching experience within the sample was 17.6 (SD = 13.1), with a range of 0 to 46 years. The teachers taught in preschools in both rural and urban areas of the Czech Republic, in locality sizes ranging from 500 to 100,000+ inhabitants. Though the sample is not technically representative, it well reflects the demographics of Czech preschool teachers and thus is satisfactory for exploratory purposes.

Subsamples

Two subsamples were extracted from the full sample: teachers who strongly agreed or teachers who strongly disagreed with the implementation of IBA in preschools. The selection criterium was their response on the questionnaire statement "IBA *do* belong in preschool". Thus, two contrasting teacher groups were constituted, the "pro-IBA group" of 564 teachers (56.2% of the total sample) and the "anti-IBA group" of 67 teachers (6.7% of the total sample). The demographic characteristics of both groups are displayed in Table 1.

		pro-IBA group	anti-IBA group
Gender	Female	514 (96.8%)	67 (100%)
	Male	17 (3.1%)	0
Education	Vocational	332 (63.1%)	52 (77.6%)
	Bc.	119 (22.6%)	13 (19.4%)
	Mgr.	75 (14.3%)	2 (3.0%)
Years of experience	0–3	106 (19.7%)	5 (7.6%)
	4–10	130 (24.1%)	14 (21.2%)
	11–30	189 (35.1%)	33 (50.0%)
	31–46	114 (21.2%)	14 (21.2%)

Note: pro-IBA = teachers who strongly agreed with using IBA in preschool; anti-IBA = teachers who strongly disagreed with using IBA in preschool.

Table 1: The demography of teachers who strongly agreed or disagreed with using IBA in preschool

METHODS

The teachers filled in the Czech version of *Preschool Teachers' IBA-related Beliefs Questionnaire* (DPBA, initials for the Czech title *Dotazník přesvědčení o badatelských aktivitách v mateřské* škole). Because the researchers were not sure if all teachers were aware what inquiry is and what is not, the first section the questionnaire provided two examples:

The teacher shows children two transparent glasses with daffodils. One has a white daffodil and the other a blue daffodil. The teacher tells the children, "I poured ink into a glass of blue daffodil. This is what happened." THIS IS NOT INQUIRY!

The teacher starts conversation with children about what the plant needs so that it does not wither. Children pour water into the glass.… One child notices a flask with ink on the table and asks, "What will happen after we pour ink in the glass?" The teacher says, "Let's explore it", and she pours ink in the glass. Children observe what is happening. After a while, the narcissus turns blue. Children discuss why this happened. THIS IS inquiry!

1 The gender proportion roughly corresponds to the Czech preschools census of 2021, in which 98,7% teachers are female (Ministry of Education, Youth and Sports, 2021).

The questionnaire consists of 22 items distributed into three components: Benefits, Teacher Concerns and Teacher Competence. The Benefits component includes items describing the teacher's beliefs about the child's learning outcomes due to IBA, and also about the satisfaction and enjoyment these activities bring to the teacher (12 items). The Teacher Concerns component includes items that express beliefs about the difficulties or complications awaiting the teacher when using IBA in classes (4 items). The Teacher Competence component contains items related to the teacher's belief in what professional knowledge and skills are needed for these activities (6 items). Teachers responded on a scale ranging from *strongly disagree* (1) to *strongly agree* (5). Higher values equate to stronger beliefs. Examples of items include the following:

- IBA foster the child's observation skills.
- The performance of IBA by children brings joy and satisfaction to the teacher.
- IBA take more time than traditional activities.
- The teacher has knowledge about how to explain doing experiments to children.

The questionnaire development and validation are described in the study of (Gavora and Wiegerová, 2019). Here we present only a short description.

The three questionnaire components have reliability as follows: Benefits 0.904; Teacher Concerns 0.733; Teacher Competence 0.847 (McDonald's omega). The slightly lower reliability coefficient for the Teacher Concerns component reflects the small number of items (only 4). The reliability of the entire questionnaire is 0.875. The three factors explain 47.7% of the common variance. A confirmatory factor analysis with a model of three "latent" factors, i.e., Benefits, Teacher Concerns and Teacher Competence, provided satisfactory indices: RMR = 0.079; AGFI = 0.922; CFI = 0.937; TLI = 0.962 and RMSEA = 0.054.[2] The wording of items, the item means and the standard deviations of the questionnaire components are presented in Table 2.[3] In addition to filling in the belief items, teachers provided information about gender, highest education completed, years of experience and the size of the locality of their preschool.

RESULTS

Results are presented in two parts. In the first part, descriptive statistics are provided about the IBA-related beliefs of the full teacher sample. These beliefs are further associated with teacher demographic characteristics. In the second part, descriptive statistics are provided about the two teacher subsamples as described above, and again, their IBA belief scores are related to their demographics.

IBA-Related Beliefs of the Full Teacher Sample

Table 2 shows the descriptive statistics of teachers' beliefs in the three belief components. The average score on the Benefits component is much above the midpoint of the five-point scale used (M = 4.05, SD = 0.67), signifying that teachers seem to be comfortable using IBA to support children's learning. They strongly believe that IBA support children's cognitive learning, developing specific knowledge, observation skills, comprehension, language and communication ability as well as their relationship to science. Teachers also understand the personal benefits, like joy, satisfaction and self-confidence that IBA implementation bring to them. Moreover, teachers rated high the belief that IBA are a way of preparing preschool children for primary school science. The lowest scores were earned by the item stating that IBA are the best way to educate children, probably because of the general nature of the item.

The Teacher Concerns component results indicate that teachers seem to feel discomfort with using IBA in their classes. The component's average score is above the midpoint of the scale used (M = 3.72, SD = 0.79), as are the averages of all the items, indicating teachers are uncomfortable when implementing IBA. Teachers demonstrated significant concerns about planning and organising IBA, the increased teaching time required for IBA, and about the classroom disorder IBA cause.

The Teacher Competence component describes teachers' beliefs about the knowledge and skills necessary for planning and organising IBA. Also, this component produced averages above the scale midpoint (M = 3.50, SD = 0.81). Three highly rated items specifically relate to doing experiments with children, an activity that is the core feature of science learning. These items concern explaining principles of experiments to children, organising experiments, and finding resources that support planning in-class experiments. Other items refer to knowledge about organising IBA and about children's learning through IBA. The component included an item related to teacher feelings about classroom disorder when performing IBA, which was rated the lowest.

To compare the relative strength of beliefs in the three IBA belief components, we submitted each component pair to a Wilcoxon rank test. The results show that teachers rated beliefs in the Benefit component significantly higher than those in the Concerns component (Z = -10.356, $p < 0.001$) and higher than in the Teacher Competence component (Z = -18.840, $p < 0.001$). They also rated beliefs in the Concerns component higher than those in the Teacher Competence component (Z = -4.804; $p < 0.001$). Thus, the H1 stating that there are no statistically significant differences among the three components of teachers' IBA-related belief ratings was rejected. The ratings of the three belief components show a distinct pattern. The Benefit component was rated the highest, followed by the Concerns component and then by the Teacher Competence component.

Table 3 presents IBA-related belief scores by gender.

2 RMR = root mean square residual; AGFI = adjusted goodness of fit; CFI = comparative fit index; TLI = Tucker Lewis index; RMSEA = root mean square error approximation.

3 The Czech version of the DPBA will be provided on request.

	Questionnaire components and component items	M	SD	Omega
Item	**Benefits**	4.05	0.67	0.904
24	IBA foster the child's thinking.	4.36	0.87	
27	IBA make children familiar with science phenomena.	4.26	0.85	
5	IBA foster the child's relationship to science.	4.25	0.96	
18	IBA foster the child's observation skills.	4.25	0.90	
34	IBA help children comprehend physical phenomena.	4.15	0.95	
9	Hands-on activities are the best way of learning.	4.15	0.95	
3	IBA (e.g., with life materials) foster the child's language and communication skills.	4.10	0.96	
6	Doing IBA by children brings joy and satisfaction to the teacher.	4.08	0.94	
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	
21	IBA are an efficient way to engage inattentive children.	3.75	1.01	
17	IBA is the best way to educate children.	3.49	1.00	
	Teacher Concerns	3.79	0.79	0.733
28	Implementing IBA is more difficult than organizing traditional activities.	4.00	1.02	
4	IBA take more time than traditional activities.	3.91	1.07	
7	Preparation for IBA is demanding for the teacher.	3.63	1.10	
20	IBA make a mess in class.	3.34	1.08	
	Teacher Competence	3.50	0.81	0.847
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	
32	The teacher can easily find ideas for planning experiments in resources.	3.49	1.09	
10	The teacher has sufficient knowledge about inquiry-based learning.	3.49	1.08	
31	The teacher does not worry about seeming disorder in class during IBA.	3.18	1.13	

Note: N = 1,004 preschool teachers. IBA = inquiry-based activities. Beliefs scale ranges from strongly disagree (1) to strongly agree (5); Omega = McDonald's reliability coefficients. Items translated from Czech.

Table 2: DPBA components with means, standard deviations and McDonald's reliability coefficients

The Kruskal-Wallis H test demonstrates a statistically significant difference in IBA-related beliefs between female and male teachers only in the Teacher Concerns component ($H(2) = 5.21$, $df = 1$, $p = 0.02$). Female teachers gave somewhat higher ratings than male teachers to benefits that IBA bring to children as well as to the teacher. They also rated higher problems accompanying planning and implementing IBA in preschool classes. However, the result is arbitrary because of the small number of male teachers in the sample.

	Benefits		Teacher Concerns		Teacher Competences	
Teacher gender	Female	Male	Female	Male	Female	Male
n	980	24	980	24	980	24
M	4.05	3.87	3.73	3.39	3.50	3.48
Md	4.17	3.92	3.75	3.50	3.67	3.67
SD	0.66	0.84	0.79	0.72	0.81	0.79
Min	1	1.08	1	2.25	1	1.33
Max	5	4.92	5	4.75	5	5

Note: Beliefs scale range from strongly disagree (1) to strongly agree (5)

Table 3: Descriptive statistics of the three IBA-related belief components by gender

Because we assumed that level of education might influence teachers' views of IBA, and consequently their IBA-related beliefs, we computed the belief scores in each of the three teacher education levels: vocational school, bachelor's degree and master's degree. Table 4 presents the descriptive data. The education level groups exhibited similar patterns of IBA-related belief scores as the full sample. In each of the education level groups, the highest average score went to the Benefit component, followed by the Teacher Concern component and then the Teacher Competence component. The differences in

IBA-related belief ratings among education levels in the Benefit component, as computed by the Kruskal-Wallis test, are small and are nonsignificant (H(3) = 5.61, df = 2, p = 0.06). Similarly, there were non-significant differences among education levels in the Teacher Concerns component (H(3) = 3.51, df = 2, p = 0.22) and among education levels in the Teacher Concerns component (H(3) = 4.62, df = 2, p = 0.10).

	Benefits			Teacher Concerns			Teacher Competence		
Education	Vocational	Bc	Mgr	Vocational	Bc	Mgr	Vocational	Bc	Mgr
n	645	198	114	645	198	114	645	198	114
M	4.03	4.02	4.13	3.76	3.73	3.53	3.52	3.38	3.60
Md	4.08	4.17	4.29	3.75	3.75	3.75	3.67	3.50	3.50
SD	0.65	0.72	0.74	0.75	0.80	0.93	0.79	0.89	0.81
Min	1.08	1	1.33	1	1.5	1	1	1	1.5
Max	5	5	5	5	5	5	5	5	5

Note: The beliefs scale ranges from strongly disagree (1) to strongly agree (5).

Table 4: Descriptive statistics of the three IBA-related belief components by teachers' education levels

Further, we examined how teachers' IBA-related beliefs are associated with years of teaching experience. Experience was divided into four categories: 0–3 years, 4–10 years, 11–30 years and 31–46 years. Descriptive statistics are presented in Table 5. The Kruskal-Wallis H test shows that there is a statistically significant difference in IBA-related beliefs between the experience categories in the Teacher Concerns component (H(4) = 49.5, df = 3, p < 0.001). The Bonferroni post hoc test shows a significant difference between the shortest experience (0–3 years) and 11–30 years of experience, as well as between 4–10 years of experience and 11–30 and 31–46 years of experience, respectively. Thus, teachers with less experience see fewer problems with planning and implementing IBA in preschool classes, or they do not worry about these problems. Furthermore, there was a statistically significant difference among teacher experience in the Teacher Competence component (H(4) = 13.74, df = 3, p < 0.001). The Bonferroni post hoc test shows a significant difference between the two longest experiences. Teachers who taught for more than 31 years showed higher beliefs on Teacher Competence than teachers with experiences between 11 and 30 years.

	Benefits				Teacher Concerns				Teacher Competence			
Years of experience	1–3	4–10	11–30	31–46	1–3	4–10	11–30	31–46	1–3	4–10	11–30	31–46
n	173	231	342	225	173	231	342	225	173	231	342	225
M	4.12	3.96	4.06	4.05	3.49	3.53	3.84	3.93	3.54	3.49	3.39	3.64
Md	4.08	4.00	4.25	4.08	3.50	3.50	4.0	4.0	3.50	3.50	3.58	3.67
SD	0.55	0.73	0.70	0.61	0.82	0.81	0.76	0.70	0.74	0.72	0.88	0.83
Min	1.83	1	1.08	1.83	1	1	1	1	1	1.50	1	1
Max	5	5	5	5	5	5	5	5	5	5	5	5

Note: The beliefs scale ranges from strongly disagree (1) to strongly agree (5).

Table 5: Descriptive statistics of the three IBA-related beliefs components by years of teacher experience.

Teachers who Strongly Favour or Strongly Reject IBA

The previous analyses produced data on the IBA-related beliefs of the full teacher sample. However, because we wanted to achieve a more structured picture of teachers' beliefs, in the further analyses, we concentrated on the contrasting teacher groups that were extracted from the full sample, i.e., the pro-IBA group and the anti-IBA group.

The scores of both groups on the three belief components are presented in Table 6. Results show that the two groups' scores on belief components varied. As the Kruskal-Wallis test confirmed, the pro-IBA group scored significantly higher than the anti-IBA group on the Benefits component (H(2) = 111.49; df = 1; p < 0.001) and also on the Teacher Competence component (H(2) = 12.98; df = 1; p < 0.001). Contrarily, the anti-IBA group scored significantly higher than the pro-IBA group on the Teacher Concerns component (H(2) = 12.32; df = 1; p < 0.001), thus expecting more problems and difficulties in planning and carrying out IBA in preschool classes than the other group. It can therefore be concluded that the two teacher subsamples are strongly differentiated in all three belief component ratings. Therefore, H2 stating that there are no statistically significant differences in IBA-related belief ratings between the teachers who strongly agreed and those who strongly disagreed with the implementation of IBA in preschool classes was rejected on Teacher Competence and Teacher Benefit scores, but it was failed to reject on Teacher Concerns scores.

More detailed information about the two contrasting groups was obtained by comparing their demographic characteristics. Table 1 presents the comparison data. The gender distribution between the two teacher groups was strongly imbalanced: 514 females and 17 males in the pro-IBA group and no males in the anti-IBA group. This imbalance reflects the typical disproportion of teacher genders in Czech preschools. As concerns the education level, the pro-IBA group has a somewhat

	pro-IBA group						anti-IBA group					
Belief Components	***n***	***M***	***Md***	***SD***	***Min.***	***Max.***	***n***	***M***	***Md***	***SD***	***Min.***	***Max.***
Benefits	564	4.36	4.42	0.44	2.67	5.00	67	3.19	3.42	0.88	1.00	4.67
Teacher Concerns	564	3.61	3.63	0.82	1.00	5.00	67	3.95	4.00	0.87	1.50	5.00
Teacher Competence	564	3.66	3.67	0.76	1.00	5.00	67	3.11	3.50	1.11	1.17	5.00

Note: pro-IBA = teachers who strongly agree with using IBA in preschool; anti-IBA = teachers who strongly disagree with using IBA in preschool. The Beliefs scale ranges from strongly disagree (1) to strongly agree (5).

Table 6: Beliefs of teachers who strongly agreed or disagreed with using IBA in preschool

higher proportion of teachers with a bachelor's degree (22.6%) than the anti-IBA group (19.4%), as well as a higher proportion of teachers holding master's degrees (14.3% compared with 3%). A Chi-squared test shows that the difference in education levels between the two groups of teachers is statistically significant: χ^2 (2, N = 598) = 8.02, p = 0.018. Thus, it may be concluded that it is the level of education that differentiates teachers who favour or reject IBA in preschool.

With regard to teaching experience, the pro-IBA group considerably differs from the anti-IBA group in two practice categories. This group has a larger proportion of teachers with shorter teaching experience (0-10 years) than the opposite group, and a smaller proportion of those with 11-30 years of teaching experience (Table 1). A Chi-squared test confirmed that the years of teaching experience is a factor that differentiates the pro-IBA group from the anti-IBA group of teachers in this sample (χ^2 (3, N = 605) = 8,47, p = 0.037).

DISCUSSION

Findings about the Full Sample of Teachers

The present study expands the current understanding of teachers' implementation of IBA in preschool classes by examining three belief components: Benefits, Teacher Concerns and Teacher Competence. Teachers rated highest their beliefs in benefits that IBA bring. They are convinced that IBA provide appropriate opportunities to support science learning by stimulating children's cognitive abilities and developing favourable attitudes towards science. They also believe that IBA engage non-attentive children through hands-on tasks. If preschool teachers believe that IBA are a stimulating tool for children's development, they are inclined to implement instructional activities of higher quality and of a larger amount (Kluczniok, Anders, and Ebert, 2011). In contrast to other studies on teacher beliefs about science in early childhood education (Maier, Greenfeld and Bulotsky-Shearer, 2013; Pendergast, Lieberman-Beltz and Vail, 2017), in this study the benefits component also included IBA-related benefits to *teachers.* Teachers noted personal benefits they acquire when using IBA, such as enjoyment, satisfaction and increase in self-confidence.

The Teacher Concerns component had the second highest beliefs scores, which reflect the problems teachers incur when planning IBA, employing the activities or managing the class. They also worry about the "mess" the children make when they experiment with objects and substances. This study supports the evidence that though doing science with children brings teachers enjoyment, many of them perceive associated difficulties or threats (Banko et al., 2013; Cho, Kim and Choi, 2003; Maier Greenfeld and Bulotsky-Shearer, 2013; Pendergast Lieberman-Beltz and Vail, 2017). Research documents tensions teachers must negotiate between existing beliefs and difficulties they encounter in their science teaching (e.g., Capps and Crawford, 2013; Crawford, 2000; Crawford, 2007).

Though Benefits and Teacher Concerns embody contrasting beliefs, they well represent the intricacy of teachers' believing and thinking. The relatively high scores on these opposite components indicate the disparate character of teachers' beliefs about IBA. However, contrasting beliefs do not refute the theory that teacher beliefs constitute a system (Kagan, 1992; Mansour, 2009; Schommer-Aikins, 2004). Rather, they demonstrate the dialectical unity of the polarised attributes that are integrated within a person's belief system.

Teacher Competence scores were somewhat lower than on the other two components but are above the midpoint of the scale, indicating teachers in this sample are quite confident that knowledge and skills are needed for planning and conducting IBA in preschool classes.

Two demographic characteristics were associated with IBA-related beliefs. Regarding the education levels, the differences in IBA-related beliefs are small and insignificant. This is an unexpected finding because higher education levels generally bring more advanced teacher competencies and might lead to stronger teacher beliefs. However, level of education is a robust variable that does not reveal the content of the teacher training curricula and the extent to which it covered IBA.

The literature confirms (Pajares, 1992; Pendergast, Garvis and Keogh, 2011) that teacher beliefs are associated with teachers' years of practice. Findings from this sample show that novice teachers (0 – 3 years of experience) scored the lowest among the experience categories on the Teacher Concerns component. We find this result realistic. They view fewer problems with planning and implementing IBA in preschool classes than mid-career teachers, or they do not worry about these problems. Novice teachers generally underwent more up-to-date teacher training that more thoroughly prepared them for IBA implementation.

Findings about the Subsamples of Teachers

While the results of the full teacher sample provided an overall picture of teachers' IBA-related beliefs, with some unexpected findings, they conceal details about teachers with specific attributes. We examined IBA-related beliefs of two radically differing teacher groups: those who strongly favour and those who reject the implementation of IBA in preschool classes and inspected their demographic characteristics. We ascertained that almost three-quarters of the full teacher sample strongly support the idea of implementing IBA in preschool classes. On the other hand, only 6.7% hold an opposite attitude. This is not a surprise. Refusal or reluctance of IBA adoption, or more

generally, of science in preschool classes, exists in many school districts (Erden and Sönmez, 2011; Greenfield et al., 2009; Yoon and Onchwari, 2006). A range of reasons might contribute to negative attitudes towards IBA. IBA might be considered developmentally inappropriate for young children or difficult to implement in preschool, especially with younger classes (Maier, Greenfeld and Bulotsky-Shearer, 2013; Pendergast Lieberman-Beltz and Vail, 2017). Teachers might lack scientific knowledge or confidence to organise IBA, such as observations or experiments with children (Erden and Sönmez, 2011; Fleer, 2009; Jiménez-Tejada et al., 2016; Spektor-Levy, Baruch and Mevarech, 2013). Or teachers might believe that the preschool's main focus is to support socio-emotional aspects of children rather than teaching them science (Blömeke, Dunekacke and Jenßen, 2017).

Teachers who favoured preschool IBA adoption obtained higher levels of education than those who reject IBA. On the other hand, they have statistically fewer years of experience. These teachers received more recent pre-service training with greater emphasis on constructivist pedagogy than their older colleagues. This probably shaped their attitudes towards the adoption of current instructional strategies, such as IBA, in preschool education. IBA are, for them, personally significant because they are in line with modern educational trends that preschool teachers are expected to follow. Younger teachers might also consider IBA important as a way to contrast their pedagogy to that of older colleagues. They might manifest an intergenerational gap by considering different educational strategies than those of older teachers. We assume that implementing IBA allows children more freedom to make choices in the learning process, explore their own ideas, work collaboratively with peers or ask more questions than when engaging in more traditional modes of instruction (Wenning, 2005). This assumption, however, must be proved by examining their classroom behaviour.

Older teachers might reject preschool IBA adoption for a number of reasons. They are more set in their ways and are more frequently inclined to resist changes (Hargraves, 2005). They may be sceptical towards the adoption of new initiatives, like IBA, because they have long been employing traditional instructional strategies that they found to be efficient. They may also preserve nostalgic memories of their teaching (Goodson, Moore and Hargreaves, 2006) that they are not willing to abandon.

CONCLUSIONS AND RESEARCH IMPLICATIONS

The results of this study confirm that though it is important to examine a particular teacher attribute, such as IBA-related beliefs, within a broad sample, it is also relevant to explore segments of teachers with varying degrees of the particular attribute in order to create more structured data. The study also recognises the importance of analysing teacher demographics in association with teacher beliefs.

Three strong areas are suggested for prospective research. Because preschool teachers educate young children, it seems to be important to examine their conceptions of the child and childhood. Teachers make many fundamental belief-based instructional decisions that are determined by their viewing of children's cognitive, social and emotional potentials (Fleer, 2009; Kowalski, Pretti-Frontczak and Johnson, 2001; Lee and Ginsburg, 2007). Specifically, it would be valuable to explore teachers' views of children's autonomy, as manifested by children's agentic behaviours (Mayall, 2002). Teachers who align their pedagogical philosophy with children's agency allow children to initiate and perform purposeful actions in order to achieve certain goals.

Another suggested line of future research is to explore the relationship of teachers' IBA-related beliefs with their teaching self-efficacy (Voet and De Wever, 2019; Walan and Rundgren, 2014; Woolfolk Hoy, Hoy and Davis, 2009), which is a belief about one's abilities to plan and successfully execute actions to achieve desired outcomes (Bandura, 1977). A teacher with high self-efficacy would be more willing to engage, persist longer and face challenges than a teacher who doubts their own knowledge and abilities. A highly efficacious teacher would approach IBA as a challenge to be taken and not as a threat to be avoided.

Finally, another important extension of this research would be to relate teachers' beliefs in IBA to their instructional behaviours. Classroom observations might reveal how teachers with varying degrees of beliefs actually adopt IBA and how they align their beliefs with their instructional strategies and teaching methods. This knowledge would also provide concurrent validity of the beliefs questionnaire used. Because of the large sample size and the sample selection method, the findings of this study well represent IBA-related beliefs of Czech preschool teachers. The authors believe the study provides valuable data for cross-country comparisons in order to gain a wider perspective on the IBA-related beliefs of preschool teachers.

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