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Do children express curiosity at school? Exploring children's experiences of curiosity inside and outside the school context☆

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1. Introduction

In the last decade, the stimulation of children's epistemic curiosity in primary school has gained much attention (e.g., Engel, 2011; Jirout & Klahr, 2012; OECD, 2015; Pellegrino & Hilton, 2012; Spencer, Lucas, & Claxton, 2014). Epistemic curiosity is the desire to seek and acquire new intellectual information (Berlyne, 1954; Loewenstein, 1994; Piotrowski, Litman, & Valkenburg, 2014). International education policies increasingly promote the implementation of school curricula that aim to teach children about the epistemological importance of curious thinkers to society (National Research Council, 2012; Osborne & Dillon, 2008; Spencer et al., 2014). Such understanding is believed to entail not only factual knowledge about (scientific) discoveries made in the past, but also an understanding of the nature of knowledge-development itself and the social interaction that it requires (Fouad, Masters, & Akerson, 2015; Osborne & Dillon, 2008; Trevors, Muis, Pekrun, Sinatra, & Muijselaar, in press). To this end, education policy-makers increasingly call for investigative approaches to learning in primary school that engage children with discussions about knowledge-development or current socio-scientific issues. Such interactions may teach them about the tentative nature of scientific ideas and the epistemological importance of curious questions and ideas (Abd-El-Khalick, 2012; Kashdan, 2004; Lucas, Claxton, & Spencer, 2013).

In addition to fostering children's conceptions about the importance of curious question asking for the development of knowledge in general, researchers increasingly advocate the educational value of developing children's *own* epistemic curiosity (Baehr, 2013; Claxton, 2007; Claxton & Carr, 2004; Engel, 2011; Engel & Randall, 2009; Jirout & Klahr, 2012; Pellegrino & Hilton, 2012; Ritchhart, 2002; Tamdogon, 2006). Decades of developmental studies have shown that children's epistemic curiosity forms a key driver of their intellectual development (Chouinard, 2007; Cook, Goodman, & Schulz, 2011; David & Witryol, 1990; Kashdan & Roberts, 2004; Kashdan, Rose, & Fincham, 2004; Loewenstein, 1994; Piaget, 1952; Spielberger & Starr, 1994). Within educational settings, children's epistemic curiosity is associated with wonderment (Opdal, 2001; Pluck & Johnson, 2011), question-asking (Jirout, 2011; Jirout & Klahr, 2012), and explanation-seeking behavior (Arnone & Grabowski, 1992; Berlyne, 1954; Litman, Hutchins, & Russon, 2005). Epistemic curiosity is believed to enhance children's persistence with learning (Metz, 2008; Simon, 2001; von Stumm, Hell, & Chamorro-Premuzic, 2011) and to improve children's memorization of information (e.g., Gruber, Gelman, & Ranganath, 2014; Hassan, Bashir, & Mussel, 2015; Jepma, Verdonschot, Van Steenbergen, Rombouts, & Nieuwenhuis, 2012; Kang et al., 2009). Thus, researchers suggest that primary education should not only aim at developing children's *understanding* of how knowledge is developed, but also at fostering their *willingness* to express and pursue their own epistemic questions and ideas about subject matter to improve their own learning (Lucas et al., 2013; OECD, 2015; Pellegrino & Hilton, 2012; Spencer et al., 2014).

However, despite the seemingly widespread agreement on the importance of curiosity-eliciting educational content and pedagogy in primary schools, it seems that most primary school teachers devote little time to fostering children's curiosity (Engel, 2011, 2013; Engel & Randall, 2009). Research suggests that teachers often feel uncomfortable with stimulating children to express curious questions about topics that the teachers themselves often do not know the answers to (e.g., van Aalderen-Smeets, van der Walma, and

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Asma, 2011; Ramey-Gassert, Shroyer, & Staver, 1996; Ricketts, 2014; Schoon & Boone, 1998; Van Booven, 2015). Furthermore, in many countries, children are generally taught that there is just one correct answer to teachers' questions and that alternative explanation seeking – by being curiously minded and critically reflective – is disruptive to teacher-directed instruction (Claxton, 2007; Claxton & Carr, 2004; Rojas-Drummond et al., 2017). It seems likely that such everyday school practices will, over time, lead children to develop misconceptions about the educational value of being curious and may guide them away from their natural habit of questioning and exploring (Marx & Harris, 2006; McCombs, Daniels, & Perry, 2008). This reality is clearly not in line with the assumption that children's curiosity is vital to meaningful and complex learning and that, therefore, curiosity-eliciting learning activities should be made an integral part of children's education.

The question thus arises how we could bridge this gap between theory and practice. Unfortunately, scientific progress has been generally slow in this regard. While Maw and Maw (1964) were among the first to develop a measuring procedure for teachers to assess curiosity in children, it was only recently that researchers such as Jirout and Klahr (2012) and Engel (Engel, 2011, 2013; Engel & Randall, 2009) brought a renewed urgency to its scientific investigation (see also Luce & Hsi, 2014). For the last 60 years, curiosity research has been mostly negligent of the formal education context and focused primarily on the study and measurement of curiosity in adults. Or, when studies did concern children, mostly focused on their curiosity behavior in isolated or artificial laboratory settings (e.g., measuring the extent to which a child investigates a particular toy). Most notably, there seems to be a lack of understanding of what children *themselves* think of curiosity. Many researchers and policy-makers have attempted to define curiosity *for* children, but curiously enough, in our review of the literature, we did not come across any studies that investigated children's *own* conceptions of what it means to be curious, either in or outside of the school setting.

In our view, these shortcomings hinder the effective development of curiosity-focused lesson content and pedagogy. Our lack of insight into children's general (mis)conceptions, feelings, and experiences of curiosity at school prevents us from classifying what aspects of their curiosity are generally underdeveloped and may thus hamper their potential curiosity engagement in the classroom. As has been well-established in the learning-sciences, in order for any educational change to occur, we should first understand children's pre-existing knowledge concepts and experiences about the topics or issues at hand, before we can effectively build-up their awareness, knowledge, skills, or attitudes (e.g., Bransford, Brown, & Cocking, 2000). In our view, this approach applies to the development of any pedagogy, and thus also to fostering children's curiosity.

Therefore, in the present study, we attempted to gain a better understanding of children's pre-existing concepts and experiences about 'being curious learners' at school and at home. Our goal ultimately is, of course, to design educational interventions and to set up teacher professionalization and we are aware of the importance of teacher-pupil and parent-child interactions in the development of children's epistemic curiosity. However, in order to effectively develop such curiosity-focused lesson content and pedagogy, for the present study, we deemed it necessary to focus specifically on children's *own* perceptions and experiences of curiosity.

In the following section, we first provide a brief overview of the main perspectives that have been postulated to describe the concept of 'curiosity' and we will touch on some of the methodological issues that have been raised to stimulate and measure children's curiosity behavior. Subsequently, we present the rationale of the present study and our research questions.

1.1. Defining, measuring, and promoting curiosity

Traditionally, curiosity is described in terms of behavioral characteristics. Berlyne (1954, 1960, 1978) was the first to classify four types of curiosity behavior: *perceptual* curiosity (i.e., aroused by novel visual, auditory, or tactile experiences and reduced by exploration), *epistemic* curiosity (i.e., a desire for intellectual engagement or acquiring knowledge), *specific* curiosity (i.e., a desire for specific knowledge or information), and *diverse* curiosity (i.e., aroused by boredom or stimulation seeking). Berlyne's multidimensional view of curiosity received much attention in subsequent research (e.g., Byman, 2005; Kashdan et al., 2009; Litman, 2008; Loewenstein, 1994) and encouraged others to characterize more 'specialized' curiosity behaviors, such as *scientific* curiosity (e.g., Jirout & Klahr, 2012), *information-seeking* curiosity (e.g., Litman & Spielberger, 2003), and *cognitive, physical* and *social* curiosity (e.g., Litman & Pezzo, 2007; Reio, Petrosko, Wiswell, & Thongsukmag, 2006).

These efforts have resulted in many curiosity behavior descriptions and related measurement instruments. However, many of these curiosity descriptions were later criticized for showing poor psychometric validity and reliability, containing too much conceptual overlap (Grossnickle, 2014), or requiring too demanding, complex or subjective measuring procedures (Mussel, 2010; Woo, Harms, & Kuncel, 2007). For instance, Silvia (2006) notes that behavioral observation measures of curiosity often show positive correlations with respondents' IQ levels or teachers' perceptions of students' intellectual status, rather than measuring curiosity per se. Furthermore, many scholars equate 'interest' with 'curiosity' and thus perceive curiosity as possessing cognitive, affective, and character variables (Ainley, 2006; Baehr, 2013; Kashdan & Silvia, 2009). Others have indicated that many self-report measures include item descriptions of states and traits of curiosity that are too abstract, such that respondents – especially children – find it difficult to understand and self-assess such descriptions (Chambers & Johnston, 2002; Jirout & Klahr, 2012).

In addition, no widely accepted conceptualization yet exists of what exactly causes children to be curious (Grossnickle, 2014). Berlyne (1954, 1960, 1978) suggested that curiosity could be best understood in terms of both state aspects (i.e., evoked by situational determinants) and trait aspects (i.e., relatively stable aspects that are explained by individual differences). Berlyne viewed curiosity as a psychological drive that is predominantly caused by environmental conflict (e.g., experiences of complexity, novelty, and surprise). Loewenstein (1994) suggested that curiosity is produced by unpleasant feelings of knowledge deprivation that motivate information-seeking behavior to diminish such feelings (see also Jirout & Klahr, 2012). Deci (1975), on the other hand, suggested that curiosity might be caused by the degree to which a person perceives himself or herself to be competent to bridge a particular knowledge gap.

In the past decade, scholars have argued the division of generally two types of curiosity, namely the distinction between interest-type curiosity (i.e., enjoying the acquisition of new information) and deprivation-type curiosity (i.e., feelings of relief when resolving unpleasant feelings of not-knowing) (Litman, Crowson, & Kolinski, 2010). Studies suggest that interest-type curiosity relates positively to mastery goal orientation motivations, while deprivation-type curiosity relates more to performance approach and avoidance orientations (Litman, 2008).

Based on the above descriptions, a variety of educational change projects have been suggested to stimulate the development and expression of children's curiosity. Some involved the use of child portfolios that require children to document their epistemic curiosities to enhance their awareness and curiosity about scientific topics over time (e.g., Jones & Shelton, 2011). Other studies suggest the organization of extra-curricular activities that introduce children to unfamiliar projects and topics that may broaden their interests, such as field trips, school exchanges, or company visits (e.g., Davidson, Passmore, & Anderson, 2010; DeWitt & Storksdieck, 2008; Post and van der Walma, 2014). Engel (2011, 2013) proposes that curiosity-evoking lesson activities should foremost spring from teachers' own curiosity-driven role modeling to their pupils (see also Spektor-Levy, Baruch, & Mevarech, 2013). Similarly, Pluck and Johnson (2011) suggest that teachers should 'trigger' children's curiosity by confronting them with thought-provoking questions that make children aware of their own knowledge gaps.

In sum, the scientific literature on 'curiosity' presents a multitude of theories about the nature, determinants, and behavioral characteristics of curiosity. Although decades of research have clearly shed light on the complexity of 'curiosity', we agree with Jirout and Klahr (2012) that these efforts may also have steered us away from finding common ground. In our view, in order to find this common ground, we should first attend to the fact that thus far we have insufficient knowledge of children's *own* perceptions of curiosity, their curiosity experiences, and the potential learning-value that they adhere to being curious.

1.2. Present study

To fill the above void in research, in the present study, we made a first attempt to measure primary school children's conceptions of curiosity inside and outside the school context by means of a structured interview procedure. Because of the exploratory nature of the study, we formulated research questions, rather than hypotheses. Research questions of interest were: In what way do children understand what it means to be 'curious'? How do they describe their feelings of being curious? What do they believe is the relevance of being curiously minded? To what extent do they recognize their own curiosity experiences when prompted by different types of curiosity behavior? And what differences might exist between children's responses when we take into account context (inside or outside the school context) or children's age?

To investigate children's own curiosity experiences, we prompted them with examples about: (a) *sensory* curiosity (e.g., wanting to know the origins of novel or sudden sounds, determining the particular taste of novel food, etc.); (b) *cognitive* curiosity (e.g., wanting to know how computers work, where babies come from, whether there is intelligent life on other planets, etc.); (c) *epistemological* curiosity (e.g., wanting to know how television was invented, how medicines were developed, how electricity was discovered, etc.); and (d) *wonderment*, which we defined as consciously noticing or 'being struck by' everyday particularities that seem valuable or meaningful (e.g., noticing the way tree leaves show many different vibrant colors from season to season, being struck by the way that birds fly, feeling perplexed about the complexity of new technologies, etc.).

We selected these four types of curiosity behavior in close conjunction with commonly used descriptions of the 'curious learner' in current international education policy documents (e.g., Lucas et al., 2013; OECD, 2015). The educational value of children's *sensory* and *cognitive* curiosity is widely recognized and believed to be especially prominent in young children's exploratory behavior (Berlyne, 1960; Kashdan & Steger, 2007). *Epistemological* curiosity, on the other hand, only recently gained more attention by education policy-makers as a result of the renewal of science curricula that specifically aim to engage children in the process of knowledge development (Olson & Loucks-Horsley, 2000; Tai, Liu, Maltese, & Fan, 2006). Lastly, the assumed educational value of *wonderment* – as a possible precursor or after effect of exploratory curiosity – is often referred to by educators in non-academic work, but has hardly ever been researched before (Opdal, 2001).

2. Method

2.1. Participants

Two Dutch primary schools from medium-sized towns participated in the study. From both schools, 4 boys and 4 girls were randomly selected from Grade 1 through Grade 6 to be individually interviewed by the principal researcher. Four child interviews were later excluded from our dataset because they were found to be largely incomplete, due to disruptions of the interview by parents or teachers. Thus, the total number of child interviews that we examined was 92 (46 boys and 46 girls; please see Table 1 for the number of boys and girls per grade level that participated in the study). Teachers and children were not made aware of the goals of the interview but were debriefed after the study was completed.

2.2. Interview measures

The principal researcher held structured interviews with each individual child. We used a standardized format of open-ended questions that were consistently repeated to all children. At the beginning of the interview, children were asked to provide their age and gender. The next section of the interview consisted of four consecutive subdivisions with open-ended questions that measured:

Table 1
The number of boys and girls per grade level that participated in the study.

Grade level	Boys	Girls	Total
Grade 1	8	8	16
Grade 2	8	8	16
Grade 3	8	8	16
Grade 4	8	8	16
Grade 5	7	7	14
Grade 6	7	7	14
Total	46	46	92

(1) *Children's personal description of curiosity* (i.e., 'Can you explain what curiosity means? Please give us your own description'), (2) *Examples of general self-reported curiosities and related feelings* (i.e., 'What are you usually curious about? And how do you feel in that particular case?'), (3) *Examples of self-reported curiosities and related feelings, specific to the school context* (i.e., 'What are you usually curious about at school, during class? And how do you feel in that particular case?'), (4) *Children's perceived relevance of being curious* (i.e., 'Do you think that it is important for people to be curious? Please explain your answer'). In this section, children were allowed to provide as many answers as came to mind.

In the second part of the interview, we asked children to share examples of their "curiosities" separately for each of our proposed curiosity behavior dimensions (i.e., sensory curiosity, cognitive curiosity, epistemological curiosity, and wonderment). For each dimension, we provided two to three curiosity behavior questions that were related to potential, everyday curiosity experiences. For each curiosity behavior question, we first prompted children with a *context-free* question that asked them to share up to two personal curiosities that first came to mind and we next prompted them with a *context-specific* question that explicitly asked them to share up to two curiosities that were specific to their time at school (i.e., a child could provide a maximum number of four curiosity accounts per curiosity behavior question). This approach allowed the children to share school-specific curiosities also in response to our initial context-free question prompts (for each curiosity behavior dimension), if such accounts would first come to mind. In this way, we intended to gain additional insight into the degree to which children implicitly associated each type of curiosity behavior with their time in school, prior to asking them explicitly to share any school-specific accounts. In this second part of the interview, we limited the number of possible accounts that children could provide here to two for each context (i.e., context-free and school-specific prompts), in order to keep the administration time short and to avoid taxing children's attention span too much.

In this structured manner, we derived children's accounts of: (1) *Sensory curiosities* (i.e., 'Do you like to explore the environment? If so, please provide an example', 'If you experience something that is unfamiliar to you, would you like to know what it is? If so, please provide an example', and 'Do you enjoy experiencing novel things? If so, please provide an example'), (2) *Cognitive curiosities* (i.e., 'Do you consider yourself a questioner? If so, please provide an example', 'Do you like to find out about how things work? If so, please provide an example', and 'Do you have follow-up questions when you find out about something new? If so, please provide an example'), (3) *Epistemological curiosities* (i.e., 'When you find out about something new, do you like to know how someone discovered that knowledge? If so, please provide an example' and 'Are you interested to know how people made certain inventions? If so, please provide an example'), and (4) *Wonderment* (i.e., 'Do you sometimes suddenly notice something particular about ordinary things? If so, please provide an example', 'Do you sometimes suddenly notice something particularly interesting in your surroundings? If so, please provide an example' and 'Do you enjoy noticing things that are special? If so, please provide an example').

2.3. Procedure

Children were individually interviewed during school time in a separate room outside of the classroom. The researcher used a pre-structured paper format to administer children's responses. When children experienced difficulty answering a particular question, the researcher provided encouragement only once by providing a possible answer example before continuing the interview (when children copied these responses as their own answers, they were coded as 'copies of encouragements'). In some cases, when it was unclear whether a child's personal account of curiosity was related or unrelated to the school context, the researcher asked the child to clarify. We kept the administration time to a minimum by alternating between two versions of the interview. Both versions contained all of the above-described questions about age and gender, children's description of curiosity, their self-reported general curiosities, their self-reported school-related curiosities, and their perception of the relevance of being curious. The two versions differed in the types of curiosity behavior dimensions that were covered in the second part of the interview. One version only covered the dimensions of sensory curiosity and cognitive curiosity, while the other version covered epistemological curiosity and wonderment. These alternate versions of the interview were administered randomly among boys and girls for each grade level, which resulted in 47 children who were asked about sensory and cognitive curiosity and 45 children who were questioned about epistemological curiosity and wonderment. This way, the average duration of the interview was kept to about 10 min. Children were presented with a small gift after they had completed the interview.

2.4. Coding and scoring

The principal researcher and a second assessor coded all children's responses. For each interview question, responses were

analyzed and categorized into a large set of detailed categories that were based on distinct 'domains' of curiosity examples that emerged from the data. These specific categories were later aggregated to create more general, higher-order categories by combining closely related categories. Both assessors then independently coded children's responses by marking categories as either applicable or not. If a response could not be categorized, both the principal researcher and the second assessor reviewed the response and decided if a new code should be added or if it should be put under the *Other* category. Approximately five new codes were added in this manner during the coding process. Inter-rater agreement was calculated using Cohen's kappa for 10% of the total number of child interviews. Overall inter-coder reliability was found to be good, as indicated by reliability levels that ranged between 0.89 and 0.93 across all sections of the interview. Our final set of categories, along with the response frequencies and types of curiosity examples given for each category, are reported for each interview section in the Results section below.

3. Results

Children's responses are organized below in the same structured format that we used to administer the interviews. To investigate potential differences between children's responses from different grades, we started off with grouping children into lower (Grade 1 and 2), middle (Grade 3 and 4), and upper grade levels (Grade 5 and 6). However, we observed that children's responses were very much alike across these different grade levels, with respect to our research objectives: (1) children's curiosity definitions and their perceived relevance of curiosity were largely similar; (2) most children shared a similar number of curiosity accounts in response to all of our context-free curiosity question prompts for each curiosity behavior dimension; and (3) while children mostly shared personal curiosities from their time *outside of school*, they barely shared any personal curiosities related to their time *in school* in response to both our context-free and school-specific question prompts for all curiosity behavior dimensions. Because we observed no differences across age levels in children's responses in these respects, we disregarded the group variable from subsequent result descriptions.

3.1. Children's definitions of curiosity

We started the interview with asking children to define what it means to be curious ('Can you explain what curiosity means? Please give us your own description'). In total, 91 children were able to provide a definition (one child in the first grade was unable to do so). Most children framed their curiosity definitions as a *desire to know*, but differed in the objects of curiosity that they described. Based on these differences, we derived the following four categories that best fitted children's curiosity definitions: (a) *Novelty*, a desire to get to know something new (46%); (b) *Gossip*, a desire to know a rumor about someone else (24%); (c) Secret, a desire to know someone's secret (7%); (d) *Planning*, a desire to know what someone has planned for me/us to do next (3%); the remaining number of curiosity descriptions were categorized as other (20%) and concerned ambiguous responses (e.g., 'Feeling excited', 'To hear something', etc.). This result reveals that, while almost half of the children defined 'curiosity' as a general desire for new information, about a third of the children associated curiosity specifically within the social context, in particular, to acquire private or secret information about others.

3.2. Children's curiosity accounts

The next section of the interview invited children to share any personal curiosities from their everyday lives that first came to mind ('What are you usually curious about?'). Children were allowed to share as many curiosities as they could. Once children had no more curiosities to share, we asked them to describe their feelings for each reported case ('And how did you feel in that particular case?').

In total, children initially provided 120 personal accounts of curiosity, indicating that on average children provided at least one account each ($M = 1.30$, $SD = 0.53$). Most curiosities that were shared in response to our first context-free question were related to the context of children's everyday lives outside of school (83%). The remaining 17% of accounts were school-specific. Only 13 children (14%) spontaneously shared curiosities from both contexts. When we subsequently asked the children to share any curiosities specific to formal lesson activities at school ('What are you usually curious about at school, during class?'), 68 (74%) children shared an additional 76 curiosities. This result reveals that, while children reported relatively few school-specific curiosities in response to our initial context-free question, children did report a greater number of school-specific curiosities when they were prompted to do so explicitly.

Overall, in response to our initial context-free question, most children reported being curious about the *Gifts* that they would receive for their birthday or for Christmas (33%). This particular curiosity was closely followed by curiosities about the *Planning* (28%) of upcoming family trips or lesson activities; *Eavesdropping* (26%) on private conversations between friends, classmates, or parents; and other trivial examples (13%). When we asked children to share the contents of their curiosities specifically related to formal lesson activities, most reported curiosities remained related to getting to know the teacher's lesson *Planning* (41%); followed by seeking for the teacher's *Help* (20%) with regard to operational questions, such as how to complete a math assignment or spell a word; *Eavesdropping* (17%) on social gossip between classmates during class; anticipating one's test *Score* (11%); and other trivial examples (12%).

These results show that, although children did report a fair number of personal curiosities related to the school context, most of these accounts seem to have little meaningful relation to investigative learning. They rather concern more trivial curiosities about lesson planning, operational tasks, or obtaining private or secret information about classmates. We were particularly struck by the

fact that a few children responded quite surprised or even disturbed when we asked them to share their school-specific curiosities: 'No one is curious about what we learn in class. We just need to do whatever the teachers tell us to do', 'No, of course not. It does not matter whether I am curious, because we just need to learn whatever we are assigned to do', 'Are you joking? There is nothing to be curious about, when doing boring math or reading'.

We continued by asking them to describe, for each reported case separately, how they recalled 'their feeling of being curious'. Irrespective of context, all children consistently described their accompanying curiosity feelings as mixed feelings of excitement and frustration. Children elaborated on their responses by explaining that, while it may feel exciting to get to know something new and interesting, it simultaneously feels frustrating that someone else is already knowledgeable of the desired information that 'you' have been excluded from. Other children specifically described curiosity as feeling 'nosy' or 'intrusive', and reported that others (e.g., classmates, teachers, friends or family members) explicitly discouraged them from poking their nose in certain matters. These responses reveal that, although children's accompanying feelings of being curious strongly relate to deficit-type definitions of curiosity in the literature (i.e., as a psychological drive that is caused by unpleasant feelings of not-knowing), their conception of curiosity predominantly relates to 'being nosy about personal matters', rather than to other types of knowledge exploration.

3.3. Perceived relevance of curiosity

We continued the interview by asking children to what extent they believed curiosity is valuable to people's lives ('Do you think that it is important for people to be curious? Please explain your answer'). Eight lower graders and one middle grader were unable to provide a sufficient answer, suggesting that this particular question might have been too difficult for some of the younger children to understand. For those children who were able to respond, we derived the following four categories that best fitted their answers: 42% of the children responded with 'Yes it is important, because curiosity makes us discover new things about others'; 22% responded with 'Yes it is important, because being curious about others makes life exciting'; 17% responded with 'No curiosity is not relevant, because a lot of things should remain private'; 13% responded with 'No it is not important, because we will eventually come to know things about the world through the teachings of others anyway'; the remaining 6% of the children provided miscellaneous other answers.

These results again suggest that the children in our sample predominantly perceived curiosity as something that occurs within the social context (i.e., being nosy, wanting to know information about others). While this led some children to reason that people's curiosity should in fact be encouraged because it makes you learn more about other people (64% in total), other children believed that the development of curiosity should be discouraged (17%), because being curious about other people's private lives is often considered intrusive and disrespectful. It should be noted that the remaining 13% of the children did consider the potential value of curiosity in a broader, educational context. However, these children mostly disregarded the educational value of curiosity, because they believed that they would come to learn about the world through the teachings of others anyway, irrespective of whether they would be curiously engaged or not. Only one child (upper grade level) answered that curiosity is important because it may lead to new inventions.

All in all, the results on our question about the perceived relevance of curiosity clearly show that most children (from every age group) held naïve notions or misconceptions about what it means to be curious and did not seem to connect the concept of curiosity to education.

3.4. Children's personal curiosities for each separate curiosity behavior dimension

In the last section of the interview, we invited children to share their personal curiosities in response to each of our proposed curiosity behavior dimensions (i.e., sensory curiosity, cognitive curiosity, epistemological curiosity, and wonderment). Because we observed very similar patterns in children's responses across all four categories, below, we only outline our overall findings. Please see Table 2 for an overview of the number and kind of responses to our context-free and school-specific questions, for each separate curiosity category and related curiosity behavior question prompts.

More than half of the children were able to report at least one curiosity example for each of our curiosity behavior questions. In response to our context-free prompts, for all curiosity behavior dimensions, most curiosities that were shared by the children related to their everyday experiences outside of the school setting (91%). Only 9% of children's spontaneous responses were school-specific. In line with our earlier observations, children reported a greater (but still marginal) number of school-specific curiosities when we continued with specifically asking them about their curiosities in the school context. In line with several responses to our earlier interview questions, some children were surprised or even distressed when we asked for school-specific curiosities, as according to these children, everyday lesson activities in school 'obviously' did not stimulate their curiosity, let alone, allow for room to further pursue them. This result again shows that, irrespective of which one of the four curiosities we asked children to relate to, children associated their curiosity experiences mostly with their lives outside the school setting.

Our results showed that most reported *school-specific* curiosities, either in response to our context-free or school-specific prompts, were unrelated to investigative, explorative learning. For example, in case of children's sensory curiosities, children mostly reported being curious about the introduction of new lesson books because they wanted to browse for new and attractive images, or that they were curious about sudden sounds coming from neighboring classrooms. In the case of cognitive curiosities, children reported being curious about the correct answers to assignments and teachers' help in this respect, figuring out the teacher's lesson planning, eavesdropping on private conversations between classmates, or how the touch screen of the interactive whiteboard works. Children indicated that these curiosities did not originate from any formal lesson activities, and that their teacher had not acknowledged their

Table 2
Children's curiosity accounts in response to each separate curiosity category and related curiosity behavior question, for both context-free and school-specific prompts.

Curiosity category	Context-free						School-specific		
	Outside of school			Inside of school			Inside of school		
	N	*n*	Response categories	N	*n*	Response categories	N	*n*	Response categories
Sensory curiosity									
Do you like to explore the environment?	44	47	Abroad, local, accidents, sound, other	1	1	Sounds	30	30	Local, accidents, sounds
If you experience something that is unfamiliar to you, would you like to know what it is?	41	49	Sounds, animals, tastes, eavesdropping, words, other	2	2	Sounds, words	23	24	Eavesdropping, sounds, words, animals, other
Do you enjoy experiencing new things?	46	52	Trips, holidays, other	4	7	Books, other	28	29	Books, other
Cognitive curiosity									
Do you consider yourself a questioner?	33	35	Eavesdropping, help, planning, other	3	6	Help	32	33	Help, planning, eavesdropping
Do you like to find out about how things work?	45	57	Computers, vehicles, biology, astronomy, society, other	2	2	Help	26	27	Help, interactive whiteboard, other
Do you have follow-up questions when you find out about something new?	24	25	Computers, vehicles, help, eavesdropping, other	7	7	Help, other	16	16	Help, other
Epistemological curiosity									
When you find out about something new, do you like to know how someone discovered that knowledge?	31	34	Eavesdropping, other	1	1	Eavesdropping	11	11	Teacher, other
Are you interested to know how people made certain inventions?	42	50	Computers, machines, physics, astronomy, other	0	0	n.a.	27	29	Math, computers, machines, other
Wonderment									
Do you sometimes suddenly notice something particular about ordinary things?	25	27	Objects, structures, other	5	8	Objects, structures, other	19	19	Objects, structures, other
Do you sometimes suddenly notice something particularly interesting in your surroundings?	36	36	Abroad, local, instructions, other	2	3	Instructions, accidents, other	24	25	Instructions, animals, objects, other.
Do you enjoy noticing things that are special?	26	28	Funny, danger, other	2	2	Danger	12	12	Funny, schoolyard

Notes. N is the total number of children who provided an answer with respect to the particular response group; *n* is the total number of curiosity accounts shared by the children with respect to the particular response group; the response categories are ordered from most to least often reported by the children.

curiosities nor provided room to further pursue them as part of class or a later project. In case of children's epistemological curiosities, children reported being curious about the invention of math, computers and, strikingly, how the teacher could have become so knowledgeable about all sorts of things in the world. Finally, children's responses to our wonderment behavior prompts revealed only trivial examples that were related to the school setting, such as children noticing the use of unfamiliar instructions or words by the teacher and children spotting new desktop accessories or printers in their classroom.

Contrary to the above-described results, children did report a fair number of investigative, explorative curiosities that were related to their lives outside the school setting. Especially in the case of cognitive and epistemological curiosities, children shared many instances where they used the Internet (e.g., Wikipedia, YouTube, etc.) at home to learn about complex topics, such as computers (e.g., 'Where does the Internet come from?'), physics (e.g., 'What is electricity?'), astronomy (e.g., 'Why are planets always round?'), biology (e.g., 'Where do babies come from?'), machines (e.g., 'How does a microwave work?'), and society (e.g., 'Who pays for the workers that build new roads?'). These results reveal that, while children hardly reported any curiosities relevant to learning that were related to the school context, outside of school, they apparently experienced a far greater number of explorative curiosities about complex topics that seem highly relevant to formal learning.

4. Discussion

We set out to explore children's own notions of what it means to be curious. We used a structured interview procedure to ask 92 primary school children about their own beliefs, feelings, and expressions of curiosity inside and outside the school context. As far as we know, these aspects of children's curiosity have not been investigated before. In our view, this lack of understanding has thus far prevented us from examining what aspects of children's curiosity may require particular attention in curiosity-eliciting content and pedagogy. Below, we outline and discuss the main findings of our study. In the second part of this Discussion, we argue that curiosity-focused pedagogy should not only aim at developing children's *skills* to pose epistemic questions and ideas in school, but should also aim at cultivating a positive classroom climate in which children value the educational importance of posing questions and ideas, derive pleasure from being curious learners, and perceive that their epistemic questions and ideas are appreciated by their teachers. We conclude our paper with how such a positive classroom climate may be cultivated by teachers.

4.1. Main findings of the present study

4.1.1. Children's reported curiosity at school

Overall, did we find that children experience curiosity at school? Yes, we did to some extent, if we go along with children's reported conception of curiosity as something that predominantly concerns being curious about other people's private affairs or about lesson planning. While such a concept of curiosity does form an important aspect of children's general development (e.g., Dewey, 1910), it does not necessarily relate to the sense of epistemic wonderment and interest that we would like to stimulate in a formal school setting (e.g., Arango-Muñoz, 2014; Claxton & Carr, 2004; Engel, 2009, 2011; Jirout & Klahr, 2012; Kashdan & Steger, 2007). Irrespective of children's age or the types of curiosity behavior that we asked them to respond to, the children in our sample reported few spontaneous examples of epistemic questions that related to the formal school setting. When children did recount examples of curiosity at school, these were almost exclusively directed at either social issues, such as eavesdropping, or generic school-related issues, such as lesson planning or wanting to know an answer to a math problem.

Children's conception of curiosity – as something that predominantly belongs to the social domain – also characterized their reported feelings of curiosity. Children consistently described their curiosity feelings to be a mix of excitement and unpleasantness. To some extent, these reported feelings of interpersonal curiosity resemble the deficit-type descriptions of curiosity as suggested by others (e.g., Litman et al., 2010; Litman & Pezzo, 2007). The children in our sample on the one hand felt interested in 'getting in on' the private affairs of others, while on the other hand felt socially 'excluded from' and 'insecure about' not having obtained the information earlier. Some children further explained that peers and family often discouraged them to 'stick their nose into private affairs', leading them to perceive 'curiosity' as a particular behavior that others often disapprove of. Studies in the domains of social and developmental psychology suggest that this particular focus on social curiosity during childhood is not related to possible cultural differences in pedagogy, but seems to be a cross-cultural phenomenon (e.g., Dewey, 1910; Grossnickle, 2014; Litman & Pezzo, 2007) that may facilitate the forming of friendships (e.g., Rosnow, 2001) or prevention of social confrontations (e.g., Galen & Underwood, 1997).

Nevertheless, for educational purposes these findings are discomforting because they show that the children in our sample held rather narrow and naive conceptions about the meaning and use of being curious. Although not empirically tested before, our results do confirm observations by others. For example, Engel (2009, 2011) attempted to investigate what kinds of curiosity children express at school but was surprised by the lack of curiosity expressed. In line with Engel, our findings suggest that at school most children (a) barely engage in epistemic curiosity, (b) generally perceive their curiosity behavior as something that their teachers (or their peers or family members) disapprove of, and (c) attribute little value to curiosity as a learning strategy. Overall, children reported only few meaningful school-specific curiosities and, in some cases, even responded surprised or distressed about the possibility of such curiosity to be allowed in educational settings in the first place.

Although discomforting, our results are highly relevant. They suggest first that many children may hold misconceptions about the nature and value of curiosity as a driver for learning. Second, our results suggest that teachers seem largely inattentive to children's curious questions, fail to make children aware of the educational and scientific value of curiosity, and do not seem to act themselves as curiosity-eliciting role-models to their students. Lastly, our results suggest that children predominantly perceive curiosity as a

desire for new information about other people, which is referred to as interpersonal curiosity (Litman & Pezzo, 2007).

4.1.2. Children's reported curiosity outside of school

Does this mean that children experience no meaningful curiosities at all? No, not entirely. The remaining results of our study indicated that about half of the children did report being curious about a diverse range of complex (mainly scientific and technological) topics in settings *outside* of school, especially in response to our cognitive and epistemological question prompts. For example, children reported being curious to learn about the governmental organization of society, the discovery of electricity, dinosaurs and the planets, the invention of computers, car engines or refrigerators, etc.

Given this result, it seems to us that we do not necessarily need to teach children how to *be* curious. This finding is promising and confirms once more the well-established notion that many children are naturally curious about many complex (scientific) phenomena, even without the use of formal education (Berlyne, 1960; Kashdan & Steger, 2007; Piaget, 1952). At the same time, however, our findings suggest that the lack of curiosity expressed by children in the classroom is not so much because children's inquiry skills fall short, but because our schools' social norms, beliefs, reward systems, and pedagogy insufficiently stimulate children's curious expressions in the classroom.

As part of the debriefing, we presented our main findings to the teachers of the children who participated in the current study. Most teachers were distressed to learn about their pupils' reported lack of cognitive and epistemological curiosity experiences in their schools. Moreover, many teachers expressed their concern about some of our children's reports in which they recounted that their teachers provided them little opportunity to reveal their cognitive and epistemological curiosities, and that some teachers even discouraged them to do so. However, many teachers also emphasized the educational importance of pupils' epistemic curiosity and that they believed to provide sufficient inquiry opportunities to curiously explore and study subject matter.

In many countries, however, inquiry-based teaching often reflects a 'learning *about* inquiry by *doing* inquiry' approach (Lederman, Antink, & Bartos, 2014). In these terms inquiry is interpreted by many teachers as involving a "mechanical" process of cyclical inquiry activities, such as formulating hypotheses, gathering and interpreting data, and drawing conclusions (National Research Council, 2012). Such an interpretation of inquiry addresses the *cognitive* aspects of inquiry, but often overlooks the *metacognitive* aspects of inquiry that are deemed equally important to children's inquiry performance (Deng, Chen, Tsai, & Chai, 2011; Khishfe & Abd-El-Khalick, 2002), such as addressing the epistemic use of curiosity as an important metacognitive strategy to discover useful subject matter or to come to new ideas (e.g., Cook et al., 2011; von Stumm et al., 2011). In fact, observations by Claxton (2007) and Engel (2011) suggest that many primary school teachers seem to perceive children's curiosity to be a natural 'byproduct' of inquiry and thus believe that the stimulation of children's curiosity does not require their explicit attention. Our current findings suggest that this perception may be false. Furthermore, research indicates that this omission may even help to explain why inquiry-focused teaching often fails to engage children in authentic inquiry and, consequently, fails to lead to improved knowledge attainment (Hodson, 2014). When left to their own discoveries, children may likely not interpret teachers' prompts for inquiry as opportunities for curious thinking and thus not achieve the kind of curiosity-driven inquiry that teachers seek.

4.2. Promoting children's curiosity in the classroom

To remedy this problem, we believe that teachers should adopt a more explicit approach to teaching children *about* curiosity, alongside inquiry-focused lesson activities. Prior research shows that inquiry can foster changes in children's views about inquiry when used together with explicit reflection and discussion activities (Abd-El-Khalick, 2012); Deng et al., 2011; Southerland, Johnston, & Sowell, 2006).

Through reflective group discussions, for example, teachers can help make children become aware of their predominant social concepts of curiosity and, subsequently, inspire them to adopt more epistemic images of curiosity (e.g., Abd-El-Khalick, 2012). Such discussions can either be held as stand-alone interventions or held in relation to particular curiosity-eliciting subject matter or project assignments (Deng et al., 2011). Both types of discussion can be understood as metacognitive activities that stimulate children to consider their existing concepts and experiences of curiosity, to compare these with more epistemic notions of curiosity, to discuss the possible uses of curiosity for their own learning, and to learn to recognize and articulate their epistemic wonderments and questions. In parallel, teachers may guide such group discussions by illustrating the ways that epistemic curiosity drives pupils (and professionals) to explore new subject matter, to creatively come to new ideas or alternative explanations to existing problems, and to improve their overall academic achievement. Such reflective group discussions may help to broaden children's naïve and narrow notions of curiosity and may offer teacher's opportunities to achieve sufficient 'cognitive dissonance' among children in order to re-orient their perspectives of curiosity (Bricker & Bell, 2008; Piaget, 1969) and to build-up their epistemic question-asking skills. However, this does not mean that children's social curiosity has no place in formal education. For example, teachers could deliberately employ children's social curiosity to foster forms of collaborative discovery learning (e.g., what do you think your classmates are thinking about a certain problem or assignment) or to use their curiosity for other people's thinking as a means to understand knowledge development in general (e.g., what do you think a scientist might have been thinking when he/she invented a new solution to a certain problem).

In addition, we strongly agree with Engel (2011) that teachers need to adopt a positive attitude toward epistemic curiosity *themselves* and need to experience first-hand why it is important and what it feels like to pose creative, explorative questions about any subject matter at hand (Spektor-Levy et al., 2013; Tsai, 2006). Studies show that children's views about inquiry and their learning goals are strongly influenced by teachers' views (Osborne, Simon, & Collins, 2003). Only when teachers genuinely act as curiosity-driven role models to their pupils will they be able to instigate a sense of what it means to be a curious learner in their pupils (e.g.,

Akerson, Abd-El-Khalick, & Lederman, 2000). They should pay explicit attention to cultivating and maintaining positive social classroom norms throughout their teaching in order to make children feel that their epistemic wonderments, questions, and ideas are appreciated (Amabile & Pillemer, 2012). Simple reward systems could further emphasize to children that their epistemic curiosities are very much encouraged and part of the assessment of children's overall learning in school (see also Teo, 2013).

Lastly, research suggests that children's scientific interests and ways of sense-making at home can be used as academic resources in teaching and learning at school (e.g., Warren, Ballenger, Ogonowski, Rosebery, & Hudicourt-Barnes, 2001). Our present findings suggest that many children may indeed be curious about diverse scientific topics at home, of which many topics seem highly relevant to science content taught in school. Thus, we suggest that teachers should adopt a more inclusive approach toward their teaching by offering children opportunities in class to exhibit and connect their cognitive and epistemological curiosities to the school curriculum. In addition, we believe that parents may be involved as well to further stimulate and facilitate this transfer. Naturally, teachers would need to learn how to effectively scaffold and guide such conversations with children and their parents.

In sum, while inquiry-based learning approaches have proven to be effective in improving children's question-asking skills, we do not believe that children will develop a genuine understanding of curiosity by simple engagement in hands-on inquiry. As others have stressed as well (e.g., Hodson, 2014), failing to distinguish between these two learning goals may likely lead to confused learning outcomes and misguide teachers' design of curiosity-eliciting lesson activities. Thus, if we want to be successful in addressing the longstanding and valued educational goals to help children become curiosity-driven thinkers (e.g., Lucas et al., 2013; Osborne & Dillon, 2008), we advocate an *explicit* approach to fostering children's curiosity in school, to be regarded as an integral element of the school curriculum. In our view, such an approach would enable teachers to deliberately cultivate a positive attitude toward curiosity and a positive classroom climate, in which children value the epistemic importance of asking questions, derive pleasure from expressing their wonderments and questions, and feel that their epistemic questions are appreciated by their teachers and peers.

5. Conclusion and future directions

In review, the structured interview procedure we used in the present study proved useful to evaluate children's conceptions and experiences of curiosity. The individual, face-to-face meetings with the children allowed us to explore their responses, provide encouragement and ask for clarifications if needed. Nearly all children provided comprehensive answers to each of our interview questions, including most of the younger children. In addition, our pre-structured interview format also assisted us in keeping the time duration of each interview session less than 10 min, which made it possible to conduct the interviews at the schools without disrupting on-going lesson activities too much.

Despite these advantages, we are well aware of the fact that the results presented in this paper are based on data from only two Dutch primary schools. More work is needed to find out how well these findings apply to a wider range of schools. In addition, we should investigate to what extent classroom culture is related to children's inquiry behavior. Therefore, the development of survey instruments is needed and classroom observation procedures will be useful to explore potential individual differences in the responses of children to curiosity-eliciting lesson activities and guidance by their teachers. Since our study was the first to investigate children's curiosity through the use of children's self-reports, our interview instrument and procedure may also require further validation and optimization in future studies.

Based on the results of the current study, we propose that fostering children's images, beliefs, and feelings about epistemic curiosity in the context of their formal education may prove to be a vital stepping-stone to evoke children's inquiry behavior in the classroom. In fact, based on children's reports in our current sample, we believe that any other efforts to foster children's curiosity in school may turn out to be fruitless, as children seem to generally hold naïve and narrow notions about the nature and educational value of curiosity. In other words, no matter how much we try to stimulate children's curiosity with attractive and diverse curiosity-eliciting lesson activities, if we do not make children aware of *why* we prompt them to be curious, they might just consider these attempts as simple and discrete stimulation strategies and remain reluctant to curiously engage in other learning. The scientific investigation of children's attitudes toward epistemic curiosity may thus allow us to develop measurement instruments that are in line with children's own developing conceptions of curiosity and thereby enable us to design, evaluate and optimize learning activities that aim to foster children's curious thinking in school.

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