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Preschool children’s knowledge about the environmental impact of various modes of transport

Farhana Borg a,b, T. Mikael Winberg c and Monika Vinterek d

ABSTRACT
This study explored Swedish preschool children’s knowledge about the environmental impact of various transport modes, and investigated whether or not eco-certification has any role to play in relation to this knowledge. Additionally, this study examined children’s perceived sources of knowledge. Using illustrations and semi-structured questions, 53 children, aged five to six years, from six eco-certified and six non-eco-certified preschools were interviewed. Qualitative and quantitative data were analysed using content analysis and Orthogonal Partial Least Squares Discriminant Analysis (OPLS-DA), respectively. Findings revealed that most of the children had acquired some knowledge about the environmental impact of various transport modes, although some children were not familiar with the word ‘environment’. Although the complexity of children’s justifications for the environmental impact of different modes of transport tended to be higher at eco-certified preschools compared to non-eco-certified preschools, no statistically significant differences were found. Parents were reported to be a major source of knowledge.

Introduction
Young children are affected, both physically and socially, by increased traffic, pollution and loss of green space (Davis, 2015). The climate change report (IPCC, 2014) claims that anthropogenic emissions of greenhouse gases are at the highest levels in history. Chapman (2007) pointed out that the world is obsessed with the combustion engine car, which is the second greatest contributor to greenhouse gas emissions in the transport section. Emissions from the transport sector have a negative impact not only on the environment, but also on people’s health, safety and well-being (Baslington, 2009; Kopnina & Keune, 2010). Children as future global citizens are the potential victims of these consequences (Farrant, Armstrong, & Albrecht, 2012). Furthermore, they will be the bearers of values and norms that shape future society. Societies have a remarkable capacity for conserving their distinctive cultures (Hofstede, Hofstede, & Minkov, 2010). Therefore, changing the values and norms of a culture, and ultimately the behaviour of the individuals within it, is a daunting task that requires adults not only to change their way of thinking, but also to convey this way of thinking to younger generations, as their attitudes are influenced by the norms and values of socializers (Eagly & Chaiken, 1993; Kopnina, 2011).
Wals and Corcoran (2012) argue that raising awareness about environmental hazards does not ensure a change in human behaviour or practice; rather, alternative forms of education and learning are needed to develop a capacity to act. Researchers stress that education for sustainability (EfS) can play an important role in early childhood education, because children develop their attitudes, conceptions and behaviour, as well as intellectual potential, during this time in their lives (Davis, 2005; Pramling Samuelsson, 2011). A central starting point in EfS is building on children’s participation, and viewing them as active agents and stakeholders for the future (Gothenburg Environmental Centre, 2010). EfS allows people to acquire the knowledge, attitudes, values and capacity necessary to promote a sustainable future (United Nations Educational, Scientific and Cultural Organisation [UNESCO], 2016). Studies show that high-quality early childhood education is effective in developing young children’s attitudes and forming their behaviours as well as in having positive effects on children’s well-being, health and intellectual and social behavioural development – especially children from disadvantaged backgrounds (Muennig et al., 2011; Siraj-Blatchford, Taggart, Sylva, Sammons, & Melhuish, 2008).

To promote sustainability within all areas of education and learning, the years from 2005 to 2014 were declared the Decade of Education for Sustainable Development (UNESCO, 2005). This was followed by the 2030 agenda for sustainable development, which contains the outline of a plan of action for people, the planet and prosperity (United Nations, 2015). These issues are reflected in Swedish education policies. According to the Swedish National Curriculum for the Preschool Lpfö98 (Rev. 2010), all schools should strive to ensure that each child develops respect for all forms of life and cares for the surrounding environment (Skolverket, 2011). In Sweden, preschool refers to early childhood education and care for children until they start school, which normally is at the age of six or seven. The Swedish National Agency for Education can certify preschools with a ‘Diploma of Excellence in Sustainability’ if they apply for the recognition and meet a number of sustainability-related criteria. The criteria include the need for preschool personnel and children to work together to plan, implement, follow up and evaluate learning related to sustainable development. The Swedish National Agency for Education has certified 248 preschools for their work with EfS: these are called ‘Preschool for Sustainable Development’ (Skolverket, 2014).

Preschools can also be certified with ‘Green Flag’ certification by the Keep Sweden Tidy Foundation, which is part of the Eco-Schools programme of the Foundation for Environmental Education (FEE). The Keep Sweden Tidy Foundation supports preschools in their systematic work with EfS for active and long-term sustainable development. Participating preschools draw up action plans for their educational work, which are submitted to the foundation and evaluated periodically. About 1600 preschools in Sweden are certified with ‘Green Flag’ (Keep Sweden Tidy, 2016). In this paper, preschools that are certified ‘Green Flag’ or ‘Preschool for Sustainable Development’ are called ‘eco-certified’ preschools. As eco-certified preschools work explicitly with environmental and sustainability issues, people may expect some positive outcomes of those schools in relation to children’s learning of sustainability, compared to non-eco-certified preschools (Olsson, Gericke, & Chang Rundgren, 2015).

The Swedish preschool curriculum Lpfö98 (Rev. 2010) emphasizes the importance of helping children at preschool to understand that daily living and activities can be organized in ways that can contribute to a better environment, both at present time and in the future (Skolverket, 2011). This is particularly relevant to Goal 13 of the 2030 agenda for sustainable development (United Nations, 2015, s. 20), which calls for taking ‘urgent action to combat climate change and its impacts’. Despite being seen as a pioneer country in the field of sustainable development, the amount of research in early childhood education for sustainability in Sweden is still limited (Ärlemalm-Hagsér & Engdahl, 2015). Studies are needed to identify sustainability-related activities that are important to include in the preschool curriculum and to facilitate evidence-based policy-making. As children are the transport users of the future, there is a need to address this issue to help children ‘find new ways for sustainable transportation use’ (Kopnina, 2011, p. 575).
Aim and research questions

The purpose of this study was to explore Swedish preschool children's knowledge about the environmental impact of various modes of transport and to investigate whether or not eco-certification has any role to play in relation to children's knowledge about transport modes. Additionally, this study examined children's perceived (self-reported) sources of knowledge on this issue. The following research questions were addressed:

- How do children describe the word ‘environment’?
- What do children know about the impact of cars, buses, bicycles and walking on the environment and living beings?
- What are children’s perceived sources of knowledge on the environmental impact of different transport modes?
- Is there any relationship between children’s knowledge about the environmental impact of various transport modes and the type of preschool they attend?

The term ‘knowledge’ in this text does not refer to the theory of knowledge, which is often associated with the notion of truth (von Glasersfeld, 1990); rather, it refers to the descriptions of children’s self-reported ideas about and thoughts and views on various modes of transport and their impact on the environment- and sustainability-related issues. The sources of children’s actual knowledge are difficult to trace (Palmer, Grodzinska-Jurczak, & Suggate, 2003). Therefore, the term ‘perceived’ is used to indicate that the sources of knowledge are reported by the children themselves rather than there having been a search conducted for the actual sources of knowledge. This paper used the terms ‘sustainable development’ and ‘sustainability’ synonymously as they both are widely recognized in this field.

Conceptual and theoretical framework

The transport use theme is directly related to environmental and sustainability issues, as it contributes to increased air pollution and carbon dioxide emissions, and furthermore has significant consequences for natural resources and human health and well-being (Chapman, 2007). Defined as ‘development that meets the needs of the present without compromising the ability of future generations to meet their needs’ (Brundtland, 1987, p. 43), the sustainable development concept was introduced with three intertwined dimensions: environmental, social and economic. The environmental dimension of sustainability includes natural resources, climate change, rural development and sustainable urbanization; the social dimension addresses human rights, gender equality, cultural diversity and health issues; and the economic dimension refers to equity, poverty reduction and market economy (UNESCO, 2006). The transport use theme of this study ties with all three dimensions of sustainable development (see Figure 1). Pramling Samuelsson (2011) argues that environmental issues have always been an integral part of children's lives and that, therefore, these issues can be used as a starting point for children's learning. Researchers have stressed the need for introducing issues related to sustainable development in early childhood education, acknowledging that children are capable of sophisticated thinking (Davis, 2005; Siraj-Blatchford, Smith, & Pramling Samuelsson, 2010). It is therefore of great importance to study how early childhood education – for example, preschool – influences children's perceptions of sustainability issues, including the choice of various modes of transport.

To operationalize the transport use theme for young children, it is assumed that young children, to some extent, have used different modes of transport. Preschool children often travel with their parents from home to preschool by car, bus or bicycle or by foot. Children learn about different transport modes by interacting with family members, friends and peers, as well as by seeing what others do (Baslington, 2009). Bruner (1960) proposes that a child of any age is capable of understanding
complex information; even very young children are capable of doing so if instruction is organized appropriately. Bruner (1966) argues that young children (from the age of one to six) construct their knowledge by organizing and categorizing information through *Iconic* representation (image-based) in which information is stored visually in the form of images and diagrams. Bruner (1960) suggested that development is a continuous process and is not fixed in a series of stages. He also emphasizes how the social environment and social interactions are key elements in the learning process of children.

Wals (2007) argues that social learning is a powerful tool for the development of a sustainable world. Social learning is described as being ‘a transitional and transformative process that can help create the systemic changes needed to meet the challenge of sustainability’ (Wals & van der Leij, 2007, p. 32). This study uses the constructivist theories, namely Bruner’s (1966) ‘iconic representation’ and Bandura’s (1977) ‘social learning theory’, to design research questions, and to analyse and interpret children’s responses. Children are surrounded by many influential models in society, for example, parents, friends, teachers and TV characters. According to Bandura (1986), learning is a cognitive process which takes place in a social context. Evidence from empirical studies supports this claim (Musser & Diamond, 1999; Palmer, Suggate, & Matthews, 1996).

**Method**

This study was designed from a child-centred perspective, intended to ensure that children’s voices be heard and respected (Sommer, Pramling Samuelsson, & Hundeide, 2009). Data were collected from children using closed- and open-ended questions.

**Participants and data collection**

An overview of the participating children and the preschools is shown in Table 1. To be included in the study, each preschool had to have at least three final-year children. The preschools were situated in six municipalities in two counties: four non-eco-certified preschools were located in towns (≤12,000 inhabitants), four eco-certified and two non-eco-certified preschools were located in small cities (>12,000 inhabitants), and two eco-certified preschools were located in a large city (>500,000 inhabitants). The intention was to include an equal number of children from eco-certified

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**Figure 1.** Relational aspects of transport use theme with the three dimensions of sustainable development.
and non-eco-certified preschools from all areas to explore whether or not eco-certified preschool has any role to play in relation to children’s knowledge about the environmental impact of different transport modes. However, there are few eco-certified preschools in Sweden, and those that do exist are mainly located in cities. Therefore, an equal distribution of eco-certified preschools throughout the areas could not be achieved.

All participating children \( (n = 53) \) were between five and six years old and enrolled in the final year of preschool. Research has shown that young children are capable of being involved in research as informants and can provide valuable information (Clark & Moss, 2011; Einarsdottir, 2005; Sheridan & Pramling Samuelsson, 2001). The reason for selecting final-year preschool children was to explore the level of their knowledge on the environmental impact of transport modes upon their completing preschool. Giving children a voice will ‘empower them to greater levels of participation and involve them as young citizens’ (Lloyd-Smith & Tarr, 2000, p. 70).

A semi-structured interview instrument was utilized along with illustrations. Each child was interviewed individually and, if permitted by guardians and the children themselves, the interviews were audio-taped so that note-taking could be avoided during the conversation. The researcher spent time with the children ahead of the interviews, showing illustrations and playing with soft toys, the intent being that this might facilitate ‘equal, confidential and open interaction’ (Kyronlampi-Kylmanen & Maatta, 2011, pp. 87–88). Guardians of 49 children granted permission for audio recording, whereas guardians of four children did not. Four children were interviewed in the presence of their teachers as per their own wishes. To facilitate understanding, the interview questions were sometimes repeated or asked in different ways. Each interview took about 5–10 minutes. All interviews were conducted in Swedish, and most parts were transcribed and then translated into English. The interviews were carried out between February and June, 2015.

### Interview instrument

With the age of the participants in mind, a set of coloured illustrations of the four modes of transport bus, car, bicycle and walking was developed (see Figure 2) and these were used as artefacts to facilitate the interview process, because such artefacts have been found to be useful in previous studies (Clark, 2005). Given the importance of play as a natural component in children’s lives (Pramling Samuelsson & Asplund Carlsson, 2008; Pramling Samuelsson & Pramling, 2013), the interviewer (first author) used a cuddly puppet, some toys and a special sitting mat with a picture of two puppies to initiate a friendly and informal conversation with the child. The cuddly puppet (a teddy bear that was named Kim) was used for asking children questions in a way that made as though the children were Kim’s friend. For example, instead of asking a child a question, they were told that ‘Kim is curious (wants) to know what the word environment means. She has heard the word but does not really understand what it means. Would you like to tell Kim what “environment” means?’ By using this question, it could be determined whether or not the child knew the word ‘environment (miljö)’. If the word ‘environment’ appeared to be unknown to the child, then the interviewer added the word ‘nature (natur)’. If both words seemed to be unknown to the child, the subsequent questions were asked differently using examples of trees, flowers, birds, animals and people. The children were asked ‘How good is it [for environment/nature/trees, flowers, birds, animals or people] if someone who lives close to the preschool goes to preschool by [transport mode]?’ with the four Likert-type response options ‘Very good = 3’, ‘Good = 2’, ‘Quite good = 1’ and ‘Bad = 0’.

<table>
<thead>
<tr>
<th>Table 1. Overview of participating children and preschools.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green flag (eco-certified)</td>
</tr>
<tr>
<td>Preschools</td>
</tr>
<tr>
<td>Children</td>
</tr>
<tr>
<td>Girls</td>
</tr>
<tr>
<td>Boys</td>
</tr>
</tbody>
</table>
This was followed by an open-ended question: ‘Why is going by [transport mode] [response option selected by child] for the [environment] if someone lives close to the preschool?’ Finally, the children were asked where they had learnt about this.

**Pre-testing**

The wording of the questions, appropriateness of illustrations, interview techniques and duration were pre-tested with eight children, aged five to six years, at a non-eco-certified preschool, which was not included in the main study. The pre-test results showed that the term ‘environment (miljö)’ was unknown to most of the children; rather, they used the word ‘nature (natur)’. The children were also better acquainted with the word ‘day-care centre (dagis)’ than with ‘preschool (förskola)’. These findings were considered in the final version of the interview questions. The use of coloured illustrations, a cuddly puppet, some toys and a sitting mat with pictures of puppies was found to be helpful in creating a friendly atmosphere during the pre-testing. The face validity of the instrument was assessed by the authors and an external researcher.

**Ethical considerations**

This study adheres to the relevant ethical codes and guidelines that are applicable when research is being conducted on children’s perspectives (Lindsay, 2000). An ethical vetting was sought from the Regional Ethical Board in Umeå, Sweden, and the study was conducted after the board granted ethical approval. Informed consent to participate voluntarily in the interviews was obtained from the guardians and the children. Confidentiality was taken into consideration while the study was being conducted. Children’s participation was voluntary and could be discontinued at any time without any reason being given. The integrity of participants was taken into consideration while conducting the study – for example, by anonymizing all data once the links between data from the different sources had been established.

**Data analysis**

A content analysis was performed with the children’s interview data to gain a deeper understanding of the phenomena. After this, the children’s responses were quantified and subjected to statistical
analysis to discern differences between eco-certified and non-eco-certified preschools with regard to children’s knowledge about the environmental impact of transport modes.

**Qualitative data analysis**

A content analysis of children’s responses was conducted to describe the patterns and trends in communicative content (Weber, 1990). Children’s interview data were read and re-read as a means of familiarization, and notes were kept of interesting patterns, inconsistencies and contradictions within and between individuals and groups (Hammersley & Atkinson, 1983). The data were coded and categorized starting with small samples of text and then with the whole text. The categories were then examined to find relationships and links as well as to find the overarching categories or sub-categories.

To systematically categorize, classify and analyse qualitative data, the five levels of Biggs and Collis (1982) Structure of the Observed Learning Outcomes (SOLO) Taxonomy were used. The levels include the prestructural level (a student misses the point), the unistructural level (a student has a simple idea or carries out a simple task), the multistructural level (a student has several ideas, but the relationship between them is missing), the relational level (a student links or connects the ideas) and the extended abstract level (a student has extended ideas and can generalize or create a new understanding). The SOLO Taxonomy has been used to measure cognitive learning outcomes and understanding in various subject areas among elementary and high school students (Biggs & Collis, 1982; Chan, Tsui, Chan, & Hong, 2002; Winberg & Berg, 2007). For preschool children, the five levels of the SOLO Taxonomy have been adapted with ‘no relevant idea (prestructural)’, ‘one relevant idea (unistructural)’, ‘many relevant ideas, but no link (multistructural)’, ‘linked ideas (relational)’ and ‘extended ideas (extended abstract)’ (Hook, Wall, & Manger, 2015). Examples of how the SOLO Taxonomy is used in this study are provided in Table 2.

The SOLO Taxonomy classifies ‘learning outcomes in terms of their complexity, enabling us to assess students’ work in terms of its quality not of how many bits of this and of that they got right’ (Biggs, 2016). According to Pam Hook (personal communication, February 7–24, 2016), an indicator of a relational learning outcome for an early learner is when a child explains ‘why’ by using ‘because’ or ‘so that’. Hook uses a ‘double because’ as an indicator of extended abstract

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**Table 2.** Operationalization of the SOLO Taxonomy for analysing children’s justification for the environmental impact of various transport modes.

<table>
<thead>
<tr>
<th>SOLO level</th>
<th>Prestructural = 0</th>
<th>Unistructural = 1</th>
<th>Multistructural = 2</th>
<th>Relational = 3</th>
<th>Extended abstract = 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Examples from children’s responses in this study</strong></td>
<td>No relevant idea</td>
<td>One relevant idea</td>
<td>Many relevant ideas</td>
<td>Linked ideas</td>
<td>Extended ideas</td>
</tr>
<tr>
<td>I don’t know</td>
<td>Driving a car is bad for the environment</td>
<td>Driving a car is bad for the environment. Harmful gas comes from the car</td>
<td>Driving a car is bad for the environment. (Because) The air gets polluted by the harmful gas from the car</td>
<td>Driving a car is bad for the environment. If you drive a lot, there will be too much pollution in the air, and people and animals will suffocate. If we walk to preschool instead, we don’t pollute the air, and walking is good for our health</td>
<td></td>
</tr>
</tbody>
</table>
understanding. The example in Table 2 ‘… walking is good for our health’ shows that the respondents’ ideas are extended into a new context.

**Quantitative data analysis**

The SOLO scores of children’s justifications for the environmental impact of various transport modes and their responses to the closed-ended questions were subjected to Orthogonal Partial Least Squares Discriminant Analysis (OPLS-DA, Eriksson et al., 2006). OPLS-DA is designed to identify differences between two entities that are characterized by many variables. In this paper, the ‘entities’ were eco-certified and non-eco-certified preschools, while the SOLO scores of children’s descriptions of environmental and sustainability issues and responses to close-ended questions were used as ‘characteristics’ of the preschools. Variable Importance for Projection (VIP) values were used for determining the relative importance of each ‘characteristic’ with regard to describing the differences between the two types of preschools. Although there is no consensus on how to best compare the relative importance of the characteristics when multicollinearity is present, as is the case here, their relative loadings on latent factors, that is, linear combinations of original variables, in the prediction model have been argued to provide good estimates (Johnson, 2000). VIP values build on this idea and have been shown to perform well for many types of data sets (Chong & Jun, 2005; Galindo-Prieto, Eriksson, & Trygg, 2015).

Wilcoxon 2-sample rank sum tests were conducted to investigate any differences between eco-certified and non-eco-certified preschools with respect to the individual aspects of the children’s knowledge of the transport issue, and to give a sense of the level of their knowledge about these aspects.

**Results and discussion**

The results of the content analysis of children’s responses are presented and discussed in three sections, each related to a specific research question, which is followed by the results and discussion of the comparison of the eco- and non-eco-certified preschools in relation to children’s knowledge about the environmental impact of various transport modes.

**Children’s description of the word ‘environment’**

About half (49.1%) of the children described the word ‘environment’ as their world, their home or a place where all people can live. They considered forest, flowers and grass to be part of the environment. Their descriptions were related to personal experiences, emotions and values associated with their liking and disliking, where expressions were frequently mixed with a sense of responsibility towards Earth and all living creatures on it. One child responded that the environment is a place outside ‘… where people should not throw any rubbish or pieces of glass. Animals can eat them and get problems or pain in their tummies. People should pick up rubbish and put it in the rubbish bin’ (Child #43). This finding is consistent with previous studies in which children’s emotions, values and understanding were integrated into their expressions of sustainability issues (Alerby, 2000; Manni, Sporre, & Ottander, 2013). Findings in Alerby’s (2000) study showed that children frequently described environmental issues as either good or bad for the world and then they shared their ideas about what to do to protect the environment.

A few (3.8%) children connected the cause and effect of human acts on the environment, such as ‘It [environment] is a place where we live. People should not make the environment dirty and should not throw rubbish into in the sea because then fish will die’ (Child #39). About one-third (34.0%) of the participating children did not recognize the word environment or nature. One might expect that a final-year preschool child would have come across and be familiar with the words environment and nature because the Swedish preschool curriculum Lpfö98, (Rev. 2010) emphasizes issues related to the environment and sustainability (Skolverket, 2011).
Transport modes and their impact

Children’s responses about the environmental impact of different modes of transport were coded, categorized and grouped under two sub-headings: Car and Bus as Transport Modes, and Bicycle and Walking as Transport Modes, respectively.

Car and bus as transport modes

About half (47.2%) of the children reported that travelling by car was harmful for the environment: see Figure 3. In general, the children seemed to know that harmful gases from cars and buses cause air pollution, which they could relate to the extinction of life and damage to Earth. One child argued,

Driving a car is bad, because a car emits a lot of harmful gas. Walking is very good, then you don’t emit a lot of exhaust gas or you don’t fall on the ground [as one could fall from a bicycle]. That is why walking is very good for the environment. People may inhale harmful gas and can get sick. Trees can become sick. Cycling is good. But people can fall from the bicycle and get hurt. I ride a bicycle with training wheels. Travelling by bus is not that good either. I like cars, but people get exhaust gas from cars. (Child #2)

About half (52.8%) of the children viewed buses as being environmentally unfriendly modes of transport, whereas 16.9% of the children responded that travelling by bus was very good for the environment, at least to some extent. One child explained,

Travelling by bus is good, because there are seats for many people. When you walk, then you just walk. Many people can travel together on a bus and the bus can take them to school. You can also ride a bicycle or sit on the back seat of a bicycle. When I grow up, I will learn how to ride a bicycle. There are only four seats in a car, but when you travel by bus, there are seats for many people. (Child #43)

Here, the child’s argument in favour of travelling by bus showed that the child had knowledge about public transport, where many people could travel together. This finding is similar to the findings of Baslington’s (2009) study, where children responded in favour of public transport. Children’s justifications were often based on their likes, dislikes, comforts, personal experiences, as well as fascination for cars and their speed. One child stated,

Travelling by bus is not fun either, because then you must wait for the bus. Then people get hungry and you don’t have anything to eat. You should get at least a glass of water while waiting for a bus. (Child # 39)

A few children were able to associate the impact of the excessive use of cars and buses with the economic dimension of sustainability and the over-consumption of natural resources. One child stated that ‘if you drive a lot, then the fuel will run out’ (Child # 5). Both bus and car were generally considered to be harmful modes of transport: see Figure 3. The findings indicate that Swedish preschool children seem to be, at least to some extent, environmentally aware at an earlier age than the children in the study by Kingham and Donohoe (2002). Their study on the perceptions of transport use in England found that children had no environmental awareness before 10 years of age. One possible explanation for this could be that general awareness about environmental issues has increased over the past decade. Another explanation could be that the Swedish National Curriculum for the Preschool Lpfö98, (Rev. 2010) emphasizes environmental issues in early childhood education, which might have had an effect on children’s comprehension levels (Skolverket, 2011).

To some extent, the children’s responses were related to environmental, social and economic dimensions of sustainability, such as air pollution, emission of exhaust gas and carbon dioxide, greenhouse effect and limited natural resources, and they connected the impact of using various transport modes with people’s health, well-being and safety issues, which are challenges for global sustainable development (UNESCO, 2006).

Bicycle and walking as transport modes

Cycling and walking were frequently mentioned as being environmentally friendly and zero-emission transport modes. The children’s views are summarized in Figure 3. Cycling was reported as being very
good for the environment and for one’s health by just over half (58%) of the children, because ‘... it is a way of doing exercise. Driving a car so much is not good for the environment. Harmful gas comes out from the car, the environment gets full of smoke and we can inhale harmful gas’ (Child #12). These findings are similar to those from a pilot study carried out with eight children from a non-eco-certified preschool where children reported that walking and riding bicycles are the most environmentally friendly modes of transport (Borg, 2015). These results are also consistent with the findings reported by Baslington (2009) regarding the perception and attitudes of children towards transport modes. Hardly any (1.9%) of the children viewed cycling as being bad for the environment; rather, the results indicate that many preschool children liked cycling and considered it exciting, although they were yet to learn how to ride a bicycle safely.

About half (54.7%) of the children opined that walking was very good for one’s health and the environment:

... because then you use your legs. If you walk, then you don’t emit any harmful gas. People can rest a bit when they travel by car or by bus. I don’t know so much about cycling, because I cannot ride a bicycle. (Child #23)

Nevertheless, some (20.8%) children considered walking to be bad for the environment. Their justifications were related to personal comforts, sore legs, and the risk of accidents, as well as to what they had heard from adults. For example, a child stated that ‘walking makes people tired and that’s why it is not good for the environment’ (Child #31), and ‘no one wants to walk long distances. My mother says that it is good to travel by car’ (Child #8).

The majority (66.0%) of the children under six years of age could justify their views and thoughts about the environmental impact of various modes of transport, but the level of justification varied. The content analysis showed that the complexity of the justifications among the children at eco-certified preschools tended to be higher compared with those at non-eco-certified preschools. These findings are consistent with the study by Davison, Davison, Reed, Halden, and Dillon (2003) on children’s attitudes towards sustainable transport in Scotland. Their findings indicated that children who participated in whole-school programmes, such as eco-schools or schools that promote a healthy lifestyle, had a deeper understanding of these issues.

Sources of knowledge

Parents were reported as being the main sources of knowledge for the children about the environmental impact of different transport modes (41.5%) (see Figure 4). About one-third (33.9%) of the children considered that they had acquired the knowledge by themselves. However, preschools
were also mentioned as being sources of knowledge by a few children (9.4%). Studies on environmental - and sustainability-related issues demonstrated that children, with support and guidance from their teachers, learned about different local and global issues through their participation in conversations and through being engaged in activities related to sustainability (Borg, Winberg, & Vinterek 2017; Davis, 2005; Lewis, Mansfield, & Baudains, 2010; Mackey, 2012).

**Children’s knowledge about transport modes and eco-certification**

The OPLS-DA found one significant predictive component using 8% of the variation in the independent variables (i.e. the different aspects of children’s knowledge, source of knowledge and location of preschool) to predict 35% of class membership (i.e. eco-certified or non-eco-certified preschool) of the children. The relative importance (VIP) of the measured variables for predicting eco-certification of the preschools is shown in Figure 5.

The confidence intervals of the variable importance for projection values (VIP) in the OPLS-DA indicated that the location of the preschool was the only important variable for predicting eco-certification of the preschools (i.e. describing the differences between eco-certified and non-eco-certified preschools). Being knowledgeable (or not) about the environmental impact of bus transport, as well as the SOLO-levels of the children’s descriptions of the effect of cars on nature, was also significant – but of low importance for the prediction (Figure 5). The loading pattern of these variables, modelled together with all the other variables in the OPLS, mostly reflects the fact that the preschools located in towns were mainly non-eco-certified, while the eco-certified preschools were mainly found in large cities. Although the differences did not contribute strongly to the model, it did seem that children in eco-certified preschools were more knowledgeable about the environmental impact of buses and had higher SOLO scores on their narratives about the environmental impact of cars than children in non-eco-certified preschools. However, if the location of the preschool was removed from the model, no significant multivariate differences between eco-certified and non-eco-certified preschools were found. This indicates that the children’s knowledge about sustainability issues was not associated with the certification of the preschool.

Further evidence for this conclusion was provided by Wilcoxon 2-sample rank sum tests, which showed that there were no statistically significant differences between the eco-certified and the

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**Figure 4.** Sources of knowledge about the environmental impact of various transport modes as perceived by children.
non-eco-certified preschools with regard to any individual aspects of the children’s knowledge about various modes of transport, that is, the SOLO classification of the children’s descriptions of the environment (Mdn = 1 for both groups, $W = 1037, p = .83$) or the impact on the environment: of bicycles (Mdn = 3 for both groups, $W = 881, p = .90$), of walking (Mdneco = 3, Mdnnoneco = 2, $W = 973, p = .40$), of cars (Mdn = 0.5 for both groups, $W = 927, p = .84$) or of bus (Mdneco = 0, Mdnnoneco = 1, $W = 805, p = .33$) as a means of transport. Neither was there any significant difference in the quality of the children’s arguments for their choice of transport, assessed in terms of SOLO scores (Mdn = 2 for both groups, $W = 1037, p = .83$). All $p$ values are adjusted for ties.

Large-scale studies, using nationally representative samples of sufficient statistical power, would be required to clarify whether eco-certification of preschools has a role to play in a country where the preschool curriculum already addresses sustainability issues. Such evidence is needed for practitioners and policy-makers to improve educational practices and facilitate policy-making (Broekkamp & van Hout-Wolters, 2007).

Considering the limitations of this study, caution is called for when interpreting the findings and generalizing the results. Although the ratio of eco-certified to non-eco-certified preschools was equal, fewer children from non-eco-certified preschools participated. Thirty-five per cent of the guardians of children at eco-certified preschools consented to their children’s participation, while 20% of the guardians of children at non-eco-certified preschools consented. The reason for this is not known, although the reason could be assumed to relate to the guardians’ motivation and commitment to sustainable development issues; however, it could also be that the information about the study

Figure 5. Variable importance for projection values (VIP) of the independent variables used in the OPLS-DA model for characterizing eco-certified and non-eco-certified preschools.
was not received by the guardians in time. During the data-collection process, it was found that information letters given to one of the non-eco preschools were not delivered to any guardians in time, which resulted in less participation on the part of the children from that preschool.

**Conclusion and implications for research**

This study adds to the knowledge in the fields of environmental and sustainability education and early childhood education by contributing insights into preschool children's knowledge about the environmental impact of different transport modes from a Swedish perspective. First, by the time the children completed preschool, many had acquired some knowledge about the impact of different modes of transport on environmental and sustainability issues, despite there being children who were not familiar with the words environment or nature. Second, children perceived their parents and preschools as instrumental sources of knowledge. Third, although the complexity of the justifications about the environmental impact of the modes of transport among the children at eco-certified preschools tended to be higher compared with those at non-eco-certified preschools, no statistically significant differences were found between eco- and non-eco-certified preschools.

To protect Earth for future generations, environmental and sustainability education is fundamental. To effectively achieve global environmental and sustainability education targets, appropriate strategies need to be identified. To improve educational practices and to facilitate evidence-based policy-making, studies are needed to identify various factors that influence children's knowledge, attitudes and behaviour regarding transport use, as well as to explore how children's attitudes and behaviour in terms of transport and the environment are formed. This includes studies of the benefits of eco-certification systems for preschools. This is particularly relevant to Target 4.7 of Education 2030 Framework for Action (UNESCO, 2015), which calls for ensuring ‘that all learners acquire knowledge and skills needed to promote sustainable development.’

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