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BEGINNING BIOLOGY– INTEREST AND INQUIRY IN THE EARLY YEARS

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Abstract

In a German botanic garden, Kindergarten children were presented opportunities for first hand observations of plants. The experiences were facilitated by educators from the venue who did not instruct but provided challenges and supported the children during their investigations. We wanted to find out if this approach facilitated the development of situational interest and whether theoretical categories postulated by researchers in interest theory (e.g. the need for competence) were identifiable in the responses of young children.

Data were collected using a multi-method approach. In this paper, we focus on data from participant observation of the children's behaviour and conversations. The data have been validated with data from post-visit interviews and questionnaires. Analysis was performed by reiterative reading of the completed observation sheets. Categories that emerged were matched with those that had been postulated in previous research.

The data indicate that the children's interest was caught and maintained. The novel situation, which consisted of being self-directed learners in an out-of-school environment responding to the opportunity for hands-on/minds-on experiences, engaged the children. Meaningful science challenges and the responsibilities given to children, maintained their interest. The theoretical categories postulated by researchers in interest theory were identifiable within the data from these children.

1. Introduction

Learning biology often starts with a child's first hand observations of the living world. A novel experience can catch the learners' interest and lead to further engagement with the environment and its contents (Dohn, 2011). Through urbanisation and a reduced freedom for children to play unsupervised, there has been a loss of opportunity for children to readily engage with natural objects and living things in their home environment – especially in big cities. Children in the developed world are increasingly referred to as being out of touch with nature (Louv, 2006). In order to develop an understanding of the natural world in such children, educators should seek ways to bring children into contact with more living organisms, animal and plant in particular. Opportunities for school children and children with their families/carers to encounter living things in their natural and human constructed environment such as gardens need to be planned. However, teachers' limited content knowledge in primary science (Harlen, 2001), including biology and biology teaching pedagogy, their low science teaching efficacy and the pressure to teach language, literacy and numeracy are probable reasons why early childhood teachers devote less time to plan such opportunities for living world encounters. One possible solution could be a stronger focus on programs organized in out-of-school/Kindergarten environments.

In such a program, provided free of charge in a German botanic garden, Kindergarten children (between 4 and 6 years of age) were presented opportunities for first hand observations of plants in greenhouses as well as open gardens and associated animals. The children were afforded time to first observe natural phenomena (Tomkins & Tunnicliffe, 2007) and to investigate them afterwards, assisted by adults, from both the school and the gardens.

Children, in groups of twelve, and their Kindergarten teachers, visited the garden for three successive days to explore basic botanical phenomena. The rationale was to develop the interest of children in plants through a variety of interactions, including cultural and inquiry-based activities. These included listening to fairy tales with plants as main actors, handicraft activities, an Asian tea ceremony and cooking. The learners were actively involved in inquiry (Harlen & Qualter, 2004), e.g. investigating plant growth. The accompanying teachers were expected to be learning partners and supportive facilitators, not instructors. The personnel from the botanical garden, a biologist/gardener and an educator, combined content knowledge and pedagogical skills, facilitated the experiences, provided challenges and supported the children inside the greenhouses and out in the gardens as appropriate to the task.

2. Theoretical background

As theoretical framework we used the Person-Object-Theory of Interest (Krapp, 1999; Schiefele, 1991) where interest represents a specific relationship between a person and an object (Figure 1).

An object of interest can refer to a concrete thing, for example a plant, as well as to a topic, a subject-matter, such as pollination, or an abstract idea, such as aesthetic properties of plants.

The realization of an interest requires an interaction between person and object – both concrete hands-on (e.g., child smelling flowers) as well as abstract cognitive working on a specific problem and to having ideas without conscious control (e.g., day-dreaming). If experiences during this interaction are positive, interest is likely to emerge in response to situational cues (= situational interest).

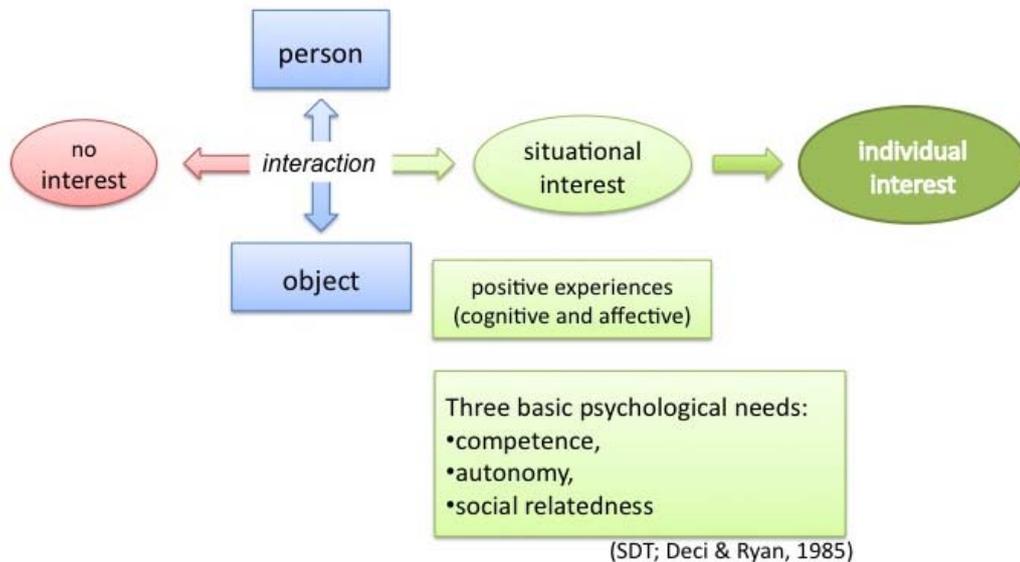


Figure 1. Person-Object Theory of Interest (Krapp, 1999; Schiefele, 1991): Illustration of the main components.

Situational interest (SI) is captured by three factors (Linnenbrinck-Garcia et al., 2010) (Figure 2): The first, triggered situational interest, reflects the positive affective reaction learners can have to presentation of learning material. Triggered-SI, similar to the conceptualization of ‘catch’ (Mitchell, 1993), involves ‘grabbing’ a person’s interest. In contrast, maintained situational interest, also referred to as ‘hold’, is a deeper situational interest form. Learners begin to build a meaningful connection between themselves and the object. Maintained-SI refers to reactions to the material itself, in this case biological specimens and phenomena. It consists of feeling-related components (maintained-SI-feeling), which characterize a person’s affective experiences while engaging with the object (e.g. amazement), and value-related components (maintained-SI-value), which emerge as individuals come to believe the focus of such attention is meaningful. According to Krapp (2002), emotional feedback depends on whether or to which level the three basic psychological needs (Self-Determination Theory = SDT by Deci and Ryan, 1985) are satisfied, i.e. the need for competence, autonomy, and social relatedness. The need for *competence* is centered on skills, and the desire to feel effective in interacting with the environment. *Autonomy* refers to the degree to which behaviours are perceived to be caused by the self and to experience freedom versus being directed by others. Satisfaction of *relatedness* needs means one feels connected to others (e.g. to be a member of a group). Just as the fulfilment of basic biological needs (e.g. for food and water) is a natural necessity, sufficient fulfilment of the three psychological needs is a necessary requirement for optimal functioning of the psychological system (Deci & Ryan,

1985). With respect to interest development, the need-related qualities of experience are important because they provide positive emotional feedback and thus contribute to the emergence of object-related preferences. It is postulated that a person will only engage continuously in a certain area of tasks or topic-related objects if he or she assesses these engagements as meaningful and if the person experiences the interaction with the object as positive and emotionally satisfactory (Krapp, 2000).

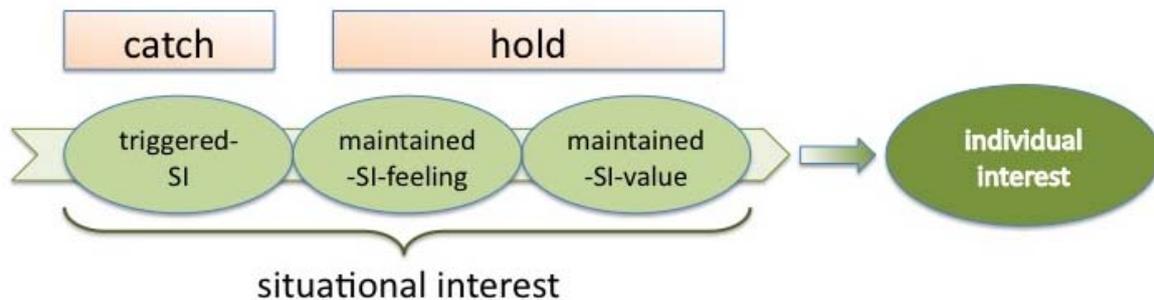


Figure 2. Three-factor structure of situational interest (Linnenbrick-Garcia et al., 2010; Mitchell, 1993).

Maintained-SI differs from triggered-SI because the enjoyment of engagement with the object is based in the domain rather than peripheral aspects e.g. learning material or environment. Maintained-SI provides the link between triggered-SI and individual interest, a more or less stable preference for a particular object. The interest relation to an object is characterised by cognitive and affective components (e.g. knowledge about the object and fun during person-object interaction). Other characteristics refer to the individual's values (e.g. readiness to spend both time and money).

3. Key objectives

We wanted to find out if the approach used during this program in the botanic garden facilitated the development of situational interest in these early years children. According to the theory, we postulated that the three basic psychological needs (for competence, autonomy and social relatedness, Deci and Ryan, 1985) have a critical influence on the development of situational interest: we argue that if the children feel competent and can choose from different activities as well as experiencing supportive relationships with teachers, other adults involved and other children, situational interest will be triggered. Through collecting appropriate data from the different groups involved in the activities, we sought to ascertain if these theoretical categories (*basic needs*) were identifiable in the responses of individual young children and hence verify the theory.

4. Research design and methodology

Data were collected from different perspectives using several different instruments. In this paper, we focus on the children’s perspective. This perspective was obtained through a multi-method approach (*triangulation*, Cohen et al., 2007, Figure 3) to enhance confidence in the ensuing findings: The first research approach – participant observation – was that the researcher observed the children’s behaviour during the entire program using a predesigned observation schedule (Figure 4) and recording and transcribing the children’s conversations. Appropriate permissions were obtained. The goal was to find out which specific factors support the development of interest (e.g. What catches the children’s attention? Which activities do the children choose, concentrate on and stay with for a longer time?). A special focus was on the children’s reaction to different kind of activities and to the level of support by the accompanying adults (e.g. more guided or more open). The second research approach was the obtaining of the opinion of the children themselves through post-visit individual interviews. These interviews took place 2-4 days after the program, back in the Kindergarten. Children were asked what they liked most and why. Photographs, which had been taken during the program, were shown to the children to encourage them talk about their individual experiences. If specific behaviour had been noticed during the program, children were asked for explanations (e.g. ‘I have noticed that you...’). Responses were tape-recorded and transcribed afterwards.

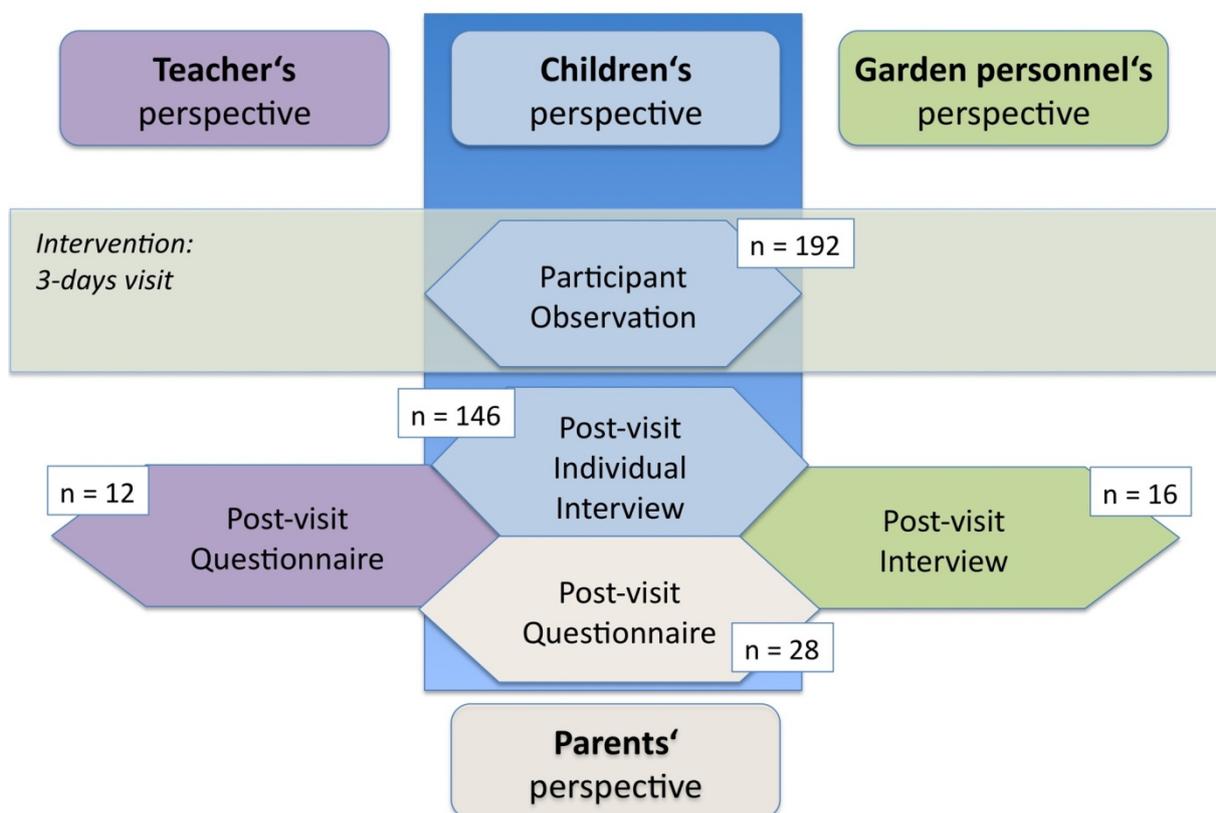


Figure 3. Multi-method approach to capture the children’s perspective.

The third research approach was the accompanying teachers reflecting on their children's responses in post-visit questionnaires (open and closed questions). They were for example asked to characterize the group of children (e.g. cultural background), if they had noticed unusual or unexpected behaviour or if their children seemed to be either bored or overloaded (being signs for lack of feeling of competence). These questionnaires were handed out after the program. The teachers were asked to fill them out at home or back in the kindergarten and send them back afterwards. Fourthly, the garden's personnel were asked in post-visit interviews about special incidents that may have occurred during the intervention to be able to relate this information to special behaviour of the children that may have been noticed by the observer. Lastly, the children's parents were asked about their children's conversations and behaviour concerning the program at home, using a short questionnaire with closed questions. This questionnaire was given to the parents during a special one-day family program in the botanical garden which took place some weeks after the main program.

Date:		Observer:				
Group (Kindergarten name, No. of children/adults):						
Group characteristics (age, cultural background...):						
Time	Responsible person (adult)	Part of the program/ Program phase	Media use	Activities/ Course of action	Observed behaviour, striking incidents	Interpretation, possible explanation

Figure 4. Observation sheet used to capture the children's behaviour during their visits to the botanical garden (Participant observation).

Sixteen groups, each of twelve children ($N = 192$), were observed during all of their three-day visit (48 days altogether). Observational data were validated with data from individual post-visit with the children ($N = 146$) and from questionnaire responses of the accompanying teachers (post-visit, $N = 12$) as well as the parents (post-visit, $N = 28$).

The categories that emerged from qualitative analysis, performed by reiterative reading of the completed observation sheets and dialogue transcripts were matched with those that had been postulated from the previous research. These categories can be grouped according to their function: a first group of categories helps to explain why interest develops or not; they refer to the *basic needs* (for competence, autonomy and social relatedness, see above). A second group of categories helps to detect developing interest relations; according to the theory, interest relations are characterised by cognitive, affective and value components (see above); the more a person knows or requires to know about a certain object of interest, the more

positive emotional feedback he or she experiences during the engagement with the object and the more the person values this engagement, the higher developed is the interest relation. The observation of a child being unable to cope with a certain task is for example categorized as lack of competence and will be used to explain why interest development was probably hindered in this situation. The observation of a child being eager for knowledge, having fun and spending a lot of time doing a certain task is interpreted as beginning or existing interest relation (maintained situation interest, see above). During the individual interviews, children were asked about their specific behaviours to prevent false interpretations. In addition, the teachers and parents responses from the questionnaires were used to provide even more robust results.

5. Findings

According to the theory, we postulated that the three basic psychological needs (for competence, autonomy and social relatedness) have a critical influence on the development of situational interest. We argued that if the children feel competent, and can choose from different activities as well as experiencing supportive relationships with teachers, other adults involved and other children, situational interest will be triggered.

5.1 Signs of situational interest

The data that we collected indicate that the children's situational interest was caught and maintained:

- a) *Knowledge gain (cognitive component of interest)*: The children in the project were able to apply knowledge which was highlighted or acquired during the tasks and interactions in the gardens. This claim is evidenced by the conversations of the children in the botanical garden's greenhouses where they recognized the different plants they had learned about before. The children, through their observations, noticed differences and were able to name the specific characteristics e.g. bamboo with its thin, pointed leaves and 'nodes' on the stems. These characteristics were mentioned by them in the post-visit interviews as well. The teachers noticed the children's increased interest and were surprised by their receptiveness ('Some children were more curious – both during the program and afterwards they asked more questions than they normally do. '; 'I was positively surprised by the enormous receptiveness of the children during these long program days.' - answers from post-visit teacher interviews).
- b) *Affective component of interest*: The children enjoyed working during the different activities (laughing, use of expressions like 'wow' and 'cool') and remarked in the interviews that they had fun working on the activities requested in the program. This was also mentioned by the teachers in the post-visit interviews who have noted the children's excitement (e.g. 'All of them were full of enthusiasm.').

- c) *Value component of interest*: The children respected the plants and valued specimens by investigating and taking them home. For example, they collected plant parts during their visits of the gardens and observed them closely with aid of magnifiers or microscopes when back in the educational area. Some of them also started small collections in shoe boxes which they took home to keep the things which they had collected and to show them to their parents.

Moreover, the teachers reported that they were astonished at the dedication of the children to tasks (e.g. ‘No child was bothered by the trips through the Gardens, long ways to walk, putting on and off their clothes.’).

5.2 Favourite activities

According to the observational data as well as the post-visit interviews with the children, favourite activities were those where the children fulfilled new and meaningful tasks with hands-on involvement (e.g. preparing the meal – some of them had never before helped in the kitchen – and planting a small plant to take at home afterwards). They also enjoyed ‘playing’ very much – activities which were self-directed and not determined by the teachers. These results are in accordance with the data from the parents’ questionnaire (e.g. ‘Did your child at home talk about the plant program?’ Figure 5).

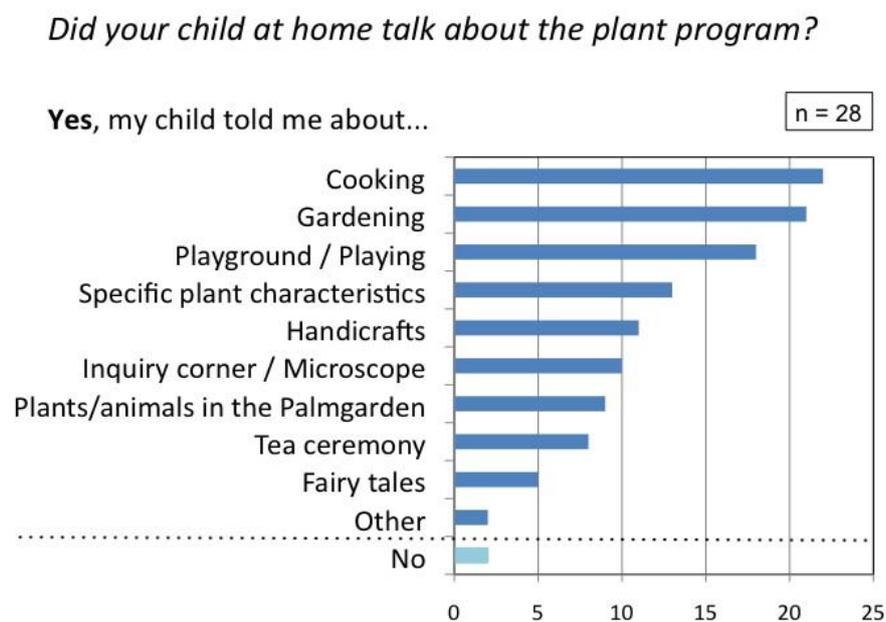


Figure 5. Activities that were mentioned by the children after the program at home.

5.3 Reasons for the development of situational interest

To explain why interest develops or not, these favourite activities were analysed more closely in relation to the theoretical categories postulated by researchers in interest theory (basic needs). Indeed, these were identifiable within the data from these young children:

- a) The *need for competence* is reflected by the children's different reactions to certain tasks: As soon as they were either working below their capacities or on the other hand were unable to cope, their attention became less and the children showed signs of boredom or confusion (e.g. during a situation when the teacher explained where and how far Asia was, using a map of the world, it was observed that the children did not listen and started to do other things). In contrast, when children achieved in tasks they showed they were happy and proud (e.g. while serving the meal which they had prepared). This is also true for situations where the children could demonstrate what they had learned before: During the visits to the garden's greenhouses for example, the children were asked to find certain plants. Full of enthusiasm, they ran along the paths, trying to find as many plants as possible. They were proud to be able to find them and explained to the teacher why they had recognized them.

During certain activities, opportunities were provided to the children to adopt special roles; the children enjoyed it very much being responsible for a certain task and took these tasks very seriously. As 'official photographer' for example, the children had to handle a digital camera and to take pictures of certain plants or situations (e.g. during the trips through the gardens). These pictures were printed by the garden personnel the same day and used afterwards during the program to reflect together with the children on selected contents. The observational data reveals that the 'photographer' was especially proud having competently fulfilled his task. This is in accordance with the data from children's post-visit interviews where these children proudly point on their photographs, emphasising that they (!) had taken them.

- b) The *need for autonomy* can be detected in the data in respect to the amount of self-directed learning and the children's reaction to it: Most of the activities in this program allowed the children to be autonomous and self-directed learners. This opportunity was used by the children to explore and to discover. They enjoyed being allowed to choose freely what to investigate and how to approach, and stayed with certain activities very long (e.g. using the microscope to investigate small objects which they had chosen before by themselves). During inquiry-based activities, the Garden personnel were open to the children's questions and gave them a feeling of being 'research partners': they encouraged the children to observe plant characteristics, formulate hypotheses and to investigate them, acting as role model but without instructing.

The children stated in the interviews that they enjoyed 'playing' – undirected, self-determined activities – very much. In contrast, activities or phases where the Garden personnel took lead for a longer time, and the children were passive and supposed to listen, their attention was comparatively low. This was also mentioned by the teachers in the post-visit interviews (e.g. -'Some children were less attentive than I expected during 'learning

sequences' where the children sat down on a carpet and the Garden personnel talked/explained things.'). However, one activity of this kind was an exception: During an Asian tea ceremony, the children were supposed to sit and wait for about 5 minutes, watching the Garden personnel preparing the tea (ceremony with background music and special equipment). In this case, the children were very attentive and observed the preparations. Even the teachers were astonished about the children's reaction (e.g. 'I was positively surprised about the children's acceptance of the tea ceremony'; answer from post-visit teacher's interview). This fact might be explained in two different ways: For some children this type of ceremony was completely new and fascinating (novelty and surprise can play an important role in the development of situational interest; e.g. Dohn, 2011), for other children with Asian background this ceremony was known from home and could have caused a feeling of social relatedness. In both cases, the children had positive feelings about the situation/activity which was confirmed also during the post-visit children's interviews (e.g. 'The tea was nice and I liked the music with it').

- c) The *need for social relatedness* appears to be very important to children at this age and therefore has influence on their interest development as well: The children in the program cooperated both with peers, their adult learning partners and the garden personnel. They discovered things together and asked for assistance during more difficult tasks from peers and adult facilitators, thus experiencing 'scaffolding' from a 'significant other', as postulated by Vygotsky (1962), in construction of further understanding of – in this case – natural phenomena. To have 'the expert' (Garden personnel) working with them was acknowledged by the children, and the teachers stood back to support this special relationship ('The possibility to discover and work with a microscope, scaffolded by the biologist (dialogue), offered new kind of experiences to the children. '; answer from teacher's post-visit interview).

It was important to the children to exchange their ideas and discoveries with others and to find out about their opinion (e.g. asking the adult to have a look at the objects which they had found in the gardens) – if the others did not react immediately, the children insisted and sometimes even addressed several people.

The teachers noted more cooperation and less aggression than in the normal classroom (answers given in the post-visit questionnaires):

- 'I noticed less conflicts between the children'.
- 'I was very surprised by the group behaviour/positive interaction/cooperation.'
- 'The children complained less.'

In addition, results show that this kind of program also meets the needs of immigrant children. The strong focus on hands-on activities and visualization as well as the integration of cultural phenomena seems to help the children to overcome language barriers and restraint/timidity.

Furthermore, the program had a very positive influence on the self-confidence of the Kindergarten teachers: as Harlen (2001) pointed out, many teachers of primary science are

unconfident about their own subject knowledge. This is even more true for Kindergarten teachers. Working in partnership with personnel from the gardens assisted them in furthering their own scientific understanding. They stated in the post-visit questionnaires that they had learned a lot – both biological as well as pedagogical content knowledge.

6. Conclusion

The study shows that adults have a crucial role in facilitating the site and assisting the children in developing their interest and ideas. Meaningful challenges in a relevant and/or novel context (also cultural) offer an effective means to develop early inquiry-based science.

In out-of-school contexts, accompanying adults, if they do not instruct but offer to the children different activities to choose from and act as supportive partners in a co-constructive learning, encourage and enable such learning. The plants and the setting communicated a message to the young children who had their interpretative and educational experience enhanced by a significant someone, an adult facilitator or peer, enabling them to construct a further conceptual understanding.

Using a number of different approaches to establish the responses of early learners in novel biological tasks and an out of school location specifically designed for the study of biological phenomena provides a rounded view of such responses. Not only did we observe the spontaneous responses of the learner, we elicited their cued reactions through our questions to the tasks which were designed for them to be participants. Furthermore, we sought the views of the three categories of adults involved in the project, the teachers of the children, the personnel of the botanic garden involved with facilitating the experiences of the children and indeed the parents of the participating children for their estimation of the response of their children to this program.

The data shows that the approach used during this program facilitated the development of situational interest in these early years children and that the three basic psychological needs have a critical influence on this development.

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