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Factors from informal learning contributing to the children's interest in STEM – experiences from the out-of-school activity called Children's University

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ABSTRACT

Background: Previous studies have investigated effects of out-of-school STEM activities aimed at stimulating children's interest in science with positive results. However, research has not discussed the reasons why such activities are successful.

Purpose: In this study, we address this gap by investigating which factors children themselves identified as interesting when they visited events at an out-of-school activity named The Children's University.

Sample: Children aged 8–12 participated in the study. Altogether, there were 353 children involved in the data collection.

Design and methods: A mixed method design was used, including a questionnaire and semi-structured interviews in which children's self-reported experiences were collected. Likert scale questions in the questionnaire were analysed based on descriptive statistics. The open-ended questions and data from the interviews were categorized by content analysis and analytically interpreted through 'the Ecological framework for understanding learning across places and pursuits'.

Results: The children were positive about their visit, and these utterances could mainly be related to the development of the individuals' interest and knowledge according to the Ecological framework. We identified two new factors influencing student's interest in STEM in out-of-school activities: appreciating the spectacular and learning; verifying two factors of importance previously suggested in the literature: appreciating the content and the learning environment.

Conclusions: The study highlights the specific factors the children actually appreciated from their visits to out-of-school activities, which could be of interest for stakeholders arranging different kinds of STEM events promoting informal learning. The content in the activities is important as well as spectacular features. To have the opportunity to learn something new in an environment that is conducive to learning is also of importance for children.

KEYWORDS

Interest in STEM; content; spectacular; learning; informal learning environment

Introduction

This study explores the factors that trigger young children's interest in Science, Technology, Engineering and Mathematics (STEM) in informal learning. Several studies discuss the decline in students' interest in future studies or careers within STEM (e.g. Fitzgerald,

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Dawson, and Hacklin 2013; Hofstein, Eilks, and Bybee 2011; Osborne and Dillon 2008). For many years now, there have been concerns worldwide regarding the need to improve and stimulate students' interest in STEM (Osborne, Simon, and Collins 2003). Researchers such as Lindahl (2003) and Osborne, Simon, and Collins (2003) claim that it is important to stimulate students' interest in STEM at an early age. An argument for focusing on activities that stimulate interest in STEM at an early age is that interest developed already in primary school influences future choices in school programmes and careers (Osborne, Simon, and Collins 2003). Furthermore, Potvin and Hasni (2014) claim that if children are interested in science and technology early on in their lives, their interest, motivation and attitudes are less likely to diminish. However, during the last few years, there have been reports on declining interest in science among young students (e.g. Murphy and Beggs 2003; Sokolowska et al. 2014). Hence, more efforts seem to be needed in this respect.

There are also studies investigating effects of efforts aiming to stimulate students' interest in STEM (e.g. Potvin and Hasni 2014). Wellington argued already in (1990) that informal learning environments are important contributions to stimulate learning and interest in science. Several studies have also investigated the potential of out-of-school activities (also referred to as informal learning activities) to stimulate interest in STEM (Krishnamurthi et al. 2013; Shaby, Assaraf, and Tal 2017; Stocklmayer, Rennie, and Gilbert 2010; Tal 2012). However, based on a systematic review of research literature on student's interests in STEM, Potvin and Hasni (2014) claim that there is still a gap in research on studies investigating the reasons behind the success or lack thereof of out-of-school activities in evoking students' interest in STEM. This study intends to fill that gap by investigating young children's (aged 8–12 years) self-perceived change of interest due to an out-of-school activity, *The Children's University*. The aim of the study is to identify and explore factors in out-of-school STEM activities that children themselves find interesting, possibly having these effects. The results are discussed through the *Ecological framework for understanding learning across places and pursuits*, as outlined by Bell and colleagues in order to determine at what levels (people, places and cultures) these factors might be important and spark interest in STEM (Bell et al. 2009).

Students' triggered interest in learning STEM subjects

Interest in learning has been investigated for a long time, and various frameworks addressing interest have been developed (e.g. Krapp and Prenzel 2011). In this study, we relate to a theoretical framework addressing interest, as outlined by Hidi and Renninger (2006) because it divides interest into four phases that are useful for purposes of this study. Hidi and Renninger (2006) argue that the process, which initiates interest in science occurs in different phases, from being initiated in particular situations (a triggered situational interest) to becoming a well-developed individual interest. Specific features in the environment may, for instance, spark interest. One example is the results from the study by Jarvis and Pell (2005), in which about 20 per cent of children who had visited a science centre wanted to become a scientist directly after the visit. Interestingly, after two months, some were still interested in a future as a scientist, however, not to the same extent.

In this study, factors that influenced the first phase, the triggered interest, were in focus when children visited *The Children's University*.

Effects of informal learning environments on stimulated interest in STEM

Previous literature shows that informal learning environments are of great importance in stimulating interest in STEM in a number of ways. Some researchers have discussed this in general terms, arguing that out-of-school activities are a good complement to school and can develop students' interest in these subjects (e.g. Cleaves 2005; Rennie 2007; Stockmayer, Rennie, and Gilbert 2010; Tal 2012). Other researchers have been more specific and discussed particular aspects, such as that participation in these kinds of activities are voluntary (Falk 2001; Falk and Dierking 1992; Potvin and Hasni 2014) and students are not assessed in the activities (e.g. Tal 2012). Furthermore, out-of-school activities such as exhibitions are successful if they are interactive (Shaby, Assaraf, and Tal 2017), and the outcomes are positive when students can develop positive identities relating to STEM (e.g. Bell et al. 2009).

Potvin and Hasni (2014) reported that the majority of research articles discussed in their review used questionnaires to investigate students' interest, motivation or attitudes towards science and technology. Only a few articles reported the use of interviews. Besides studies reporting from students'/children's perspective, there are also articles that discuss effects of activities in informal learning environments based on earlier research (e.g. Stockmayer, Rennie, and Gilbert 2010) providing a researcher perspective. In addition, there are reports based on responses from policymakers as well as providers and funders of informal learning settings (Falk 2001; Krishnamurthi et al. 2013).

Despite the research mentioned reporting the effects of informal learning environments on stimulated interest in STEM, Osborne and Dillon (2007) and Krishnamurthi et al. (2013) argue that the amount of research investigating interest in STEM in informal contexts is far less than research in school environments, calling for more research on informal out-of-school activities.

Other factors influencing students' interest in STEM

Besides the influence of informal learning environments in stimulating children's interest in STEM, the literature shows that other factors have an impact, such as the content being taught or presented, the role of teachers and family and the possibility to conduct hands-on activities. Since the last factor was not included in The Children's University, this will not be further discussed in the literature review; however, the other factors mentioned will be reviewed in the following sections.

The topic being taught or presented

Many studies suggest that the content or the topic being taught or presented has significance in stimulating interest in learning STEM subjects. Not all topics have the same ability to spark interest; often, topics related to the research frontier or children's everyday life evoke students' interest (Hidi and Renninger 2006). When Bathgate, Schunn, and Correnti (2014) compared the impact of learning environments, it was shown that students' interest in science was mostly influenced by the topic. Likewise, earlier studies have examined students' preferences and found that they differ for various topics (e.g. Baram-Tsabari and Yarden 2005; Dawson 2000; Jones, Howe, and Rua 2000; Newton 1988; Sjøberg and Schreiner 2010). As can be seen from all these studies, the choice of topic is important

for making science or STEM relevant to students. In some studies, it has even been found that many students might not be interested in learning science or STEM because they perceive science education as irrelevant, depending on topic presented (e.g. Holbrook 2008; Osborne and Dillon 2008). Thus, relevance of the topic is of importance in order to motivate students and interest them in science and STEM.

In the Relevance of Science Education (ROSE) project, results from a large-scale survey study showed that traditional school topics such as how plants grow and reproduce, chemicals and their properties, and reactions were not popular topics among students (Sjøberg and Schreiner 2010). Baram-Tsabari and Yarden (2005) had another approach when investigating students' interest in STEM. They analysed questions, which children aged 9–12, sent to a television programme. Their results pointed to the popularity of biology, technology and astrophysics over other sciences, but confirmed a variation of interest.

However, in all those studies (Baram-Tsabari and Yarden 2005; Hidi and Renninger 2006; Sjøberg and Schreiner 2010), it was also shown that students' and children's preferences for the topic might depend on background variables such as gender and age. In the ROSE study, boys appreciated the technical, mechanical, spectacular, explosive, etc., while girls had preferences for topics such as health issues, ethics and the human body (Sjøberg and Schreiner 2010). Earlier, Dawson (2000) reported that boys were more interested in physics and topics like electricity and lasers, while girls preferred biology-related topics. Similar findings have also been reported in a more recent study (e.g. Jidesjö 2012). In the study by Baram-Tsabari and Yarden (2005), they found, for example, that children showed a decreased interest in questions about animals, but an increased interest in issues related to human biology with age. Hence, interest in a topic is often related to other variables, and not easy to outline in a general way.

To conclude, much of the literature has emphasised the importance of content or topic of out-of-school activities for the potential of evoking students' interest in science. In the next section, the role of teachers and families will be explored.

Teachers and families role in stimulating children's interest in STEM

Teachers (e.g. Osborne, Simon, and Collins 2003) and families (e.g. Sha et al. 2016) have been found to be important for evoking interest in STEM. From the teacher's perspective, it is important that they have good content knowledge. However, content knowledge is not enough if the teachers fail to communicate their subject effectively, for example, by not using varied learning opportunities (Osborne, Simon, and Collins 2003). In line with that argument, Braund and Reiss (2006) suggest that science teaching in schools needs to be complemented by out-of-school learning, hence, providing variation in learning opportunities. In an out-of-school activity such as visiting a science centre, it is important that teachers show engagement before and during the visit (Jarvis and Pell 2005). This can result in positive effects on children's interest in STEM subjects.

The role of families supporting children's interest in STEM has been discussed, in terms of perceived family support and physical resources within the family (Sha et al. 2016). Students' access to physical resources in their homes had an indirect impact on interest and learning science for the children, as it facilitated the perception of family support. However, it was even more obvious that family involvement in children's learning possibly strengthened feelings of relatedness to family members. As a result, children's perceptions of being capable were strengthened, and stimulated their interest in exploring science further. In

a slightly different approach, Rodrigues, Jindal-Snape, and Snape (2011) investigated parent's impact on students' choices in future careers, and found that the influence was related to if the parents believed science careers to be the best choices for their children. Similarly, Alexander, Johnson and Kelley (2012) suggest that the development of children's interest in science is related to parent's ability to answer questions related to science.

From the literature review above, the following factors were identified that could be argued to contribute to students' interest in STEM (*the informal learning environment itself, the topic being taught or presented, and teachers and families role in stimulating children's interest*). However, few studies verify aspects that actually investigate the factors in the out-of-school activities that contribute to this interest (Potvin and Hasni 2014). Hence, in this study, we will investigate if there is empirical evidence to support these factors, or if there are additional factors not outlined above. Therefore, we designed a mixed-method methodology in which we investigated factors that children report and identify as important for their interest in science.

A theoretical perspective on activities in informal learning environments

In this study, we will use the *Ecological framework for understanding learning across places and pursuits* as a theoretical tool when discussing the findings. The framework is outlined in a report by Bell et al. (2009) for the National Research Council in the United States, as a way of theorising informal learning. The term 'ecological' refers to relations between individuals and their physical and social environments, with particular attention to relations that support learning. In the framework, informal learning is described through three lenses: *people, places* and *cultures*. The people-centred lens is used to shed light on phenomena and learning at an individual level, which is relevant due to purposes and outcomes in informal learning environments, such as development of interest, knowledge and identity. The place-centred lens focuses on physical features such as available materials, locations and activities in the social learning environment. The culture-centred lens sheds light on how individuals can develop through their involvement in cultural practices. The *Ecological framework* describes how learners can experience the culture of being a scientist in informal learning environments and how this is not always the case in classrooms (Bell et al. 2009).

Barron (2006) found the *Ecological framework* to be useful when investigating interest and self-sustained learning. He argued that because interest can develop in very different contexts and that development is boundary-crossing, the framework includes analytical tools that can capture these aspects. Hence, Barron (2006) recommended the framework as a conceptual tool to investigate other outcomes than learning, including interest. In this study, the focus is on how students' interest can be triggered (Hidi and Renninger 2006) by informal learning settings and activities. Therefore, we use the *Ecological framework* when discussing how the different lenses of the framework can trigger students' interest in STEM. In this study, interest is considered as a potential for learning; moreover, because the context of the study is informal learning, it makes sense to use the framework.

Bell et al. (2009) also discussed that 'learning science in informal environments is a diverse enterprise and serves a broad range of intended outcomes' (p.41). In this study, the intended outcome of the informal learning environment is to stimulate students' interest in STEM. With the knowledge that many visitors only experience one or a few visits, the idea is still that triggering of interest must first be achieved before learning can take

place. In the report by Bell and colleagues (2009), it is also argued that triggering of interest can motivate students' further participation in science activities.

This study will make a contribution in investigating the influence of an out-of-school activity on triggering children's interest in STEM, using a research design including both a questionnaire and interviews with children.

The context of this study

In this study, we investigate an out-of-school activity, The Children's University, which takes place in a mid-sized university in Sweden. The Children's University has been an ongoing activity every year since 2007. The aim of The Children's University is to stimulate young students' (in the ages of 8–12) interest in STEM, with particular focus on science. The university is situated in a region of Sweden where there is a low number of students entering higher education, and many of the children do not have parents with academic careers. Therefore, it could be assumed that many of the children in this region have a low degree of science capital. Archer et al. (2015) discuss the concept science capital as a tool to explain patterns of aspiration and educational participation among young people. Several aspects are included in the concept, such as science-related behaviours and participation in out-of-school science learning contexts. Hence, the major rationale of The Children's University is to bring the children to the university to improve the science capital for these children. If children have family members working with science, they are more likely to choose science careers compared to those who do not have parents working within the field (Archer et al. 2012). Since the role of families in helping children and young people engage with STEM probably is limited in the region, the visit to The Children's University could help alleviate the development of science capital. Archer et al. (2015) also argued that participation in out-of-school science learning contexts may provide forms of science capital through the opportunities they provide to enhance science dispositions.

Six lectures take place every autumn in The Children's University programme. Researchers from the university give a lecture, informing children about their specific research areas. The lecture lasts approximately 45 minutes and sometimes includes interactions with the children, such as voting yes or no in different situations. There are several reasons for limited hands-on activities available for the children during these events. First, it is difficult to arrange such activities since often there are between two and three hundred children visiting. Second, there is also a notion that the children can try hands-on activities in other situations; the main purpose is for the children to actually meet a researcher and to visit a university. In this study, none of the events included hands-on activities, except for one occasion involving dancing and making of bracelets, which will be explained below.

So far, about 10,000 children have visited The Children's University. Most of the children accompany their school class even though the lectures are held after the school day is concluded. The teachers plan the visit as a special tour and often combine it with other activities such as visits to museums or industries. Some school classes visit more than once a year. Grandmothers and grandfathers also bring children to The Children's University, often returning several times over the years; hence, these children experience The Children's University on several occasions.

Aim and research questions

In this study, we first want to investigate the effects of the Children's University initiative on students' interest in STEM and from that baseline, explore what factors within this out-of-school activity the children recognise as creating this increased interest. The aim is investigated through the following two research questions:

Research question 1 (RQ1): How was children's interest in STEM affected by visiting The Children's University?

Research question 2 (RQ2): What factors at The Children's University did the children themselves identify as interesting?

Finally, we discuss the findings within the *Ecological framework for understanding learning across places and pursuits*.

Method

In this study, we used a mixed method approach, including both a questionnaire and semi-structured interviews. The questionnaire was designed specifically for The Children's University visits, with the overall aim to capture children's interests in the activities as well as their general interest in science, hence providing data for RQ1. It included closed Likert style items and open-ended questions. The closed Likert-scale items from the questionnaire study were included in order to validate if the students reported an increase in interest due to participation in the out-of-school activity (RQ1). The reasons for choosing a five-grade scale were to provide the possibilities to give a neutral answer and also to afford some kind of discrimination between negative and positive responses (Cohen, Manion, and Morrison 2007). A larger scale could offer respondents more choices, but it may not be easy for children to discriminate between categories that have only subtle differences. The grades were: 1 = Not interesting at all, 2 = Not so interesting, 3 = No opinion, 4 = Interesting and 5 = Very interesting.

The open-ended items of the questionnaire were used to inform the second research question (RQ2). However, these questions were few, and based on earlier experiences we know that young children might have difficulties to express their thoughts in writing. Therefore, follow-up interviews were conducted with some of the children to collect more 'thick descriptions' of children's thoughts in order to answer the second research question.

Context for the data collection

We investigated children's responses relating to five lectures in 2015 and 2016. The number of lectures attended by the participating students varied from one to all five. The different lectures had various themes: *Harry Potter and chemistry*, *Einstein and laser*, *To crack the code*, *A journey into space* and *Fairy tales and chemistry*, each briefly described below:

- In the *Harry Potter and chemistry* theme, parts from the Harry Potter books were read, and experiments related to activities in the stories of the books were demonstrated. The demonstrations included spectacular experiments with fire, changing colours and liquid nitrogen. The experiments did not focus on a specific topic in chemistry, but the main idea was to connect chemistry to the stories in the books through chemical effects such as invisibility, smoke, phase transitions, etc.
- The *Einstein and laser* theme related to findings made by Einstein. The researcher holding the presentation explained about the nature of light and how it can be used, demonstrating a laser show with different lasers.
- In the *To crack the code* theme, the researchers involved the children in a dance to show them how computer programming is done based on binary notation. The children also made bracelets with pearls to symbolise coding with binary notation.
- In *A journey into space* theme, the researcher presented live pictures from space, using an advanced computer programme connected to satellites from NASA. The topic included facts about planets, stars, satellites, galaxies and humans in space (e.g. what astronauts are doing at the International Space Station and explorations on Mars with robots).
- The *Fairy tales and chemistry* theme was very similar to the *Harry Potter and chemistry* theme, including spectacular chemistry. However, during this event, stories about the historical development of chemistry served as a context for demonstrations of spectacular experiments. The stories related to how scientists explored the use of plants for medicine, how alchemists sought a way to produce gold with luminescence, how oxygen was detected and its importance for fire, the development of dynamite, etc.

The idea with all of the themes was to stimulate students' interest in STEM by presenting topics, which have been identified in earlier research as being of interest for children (e.g. interest in space as exemplified by Sjøberg and Schreiner 2010). The primary purpose was not to actually teach, but rather to fascinate, engage and stimulate children's curiosity, i.e. to trigger interest in science by influencing affective rather the cognitive perceptions among the students, as outlined in the first stage of interest development by Hidi and Renninger (2006).

Sample and data collection

After The Children's University lectures in 2015, a questionnaire was distributed to all children who visited four of the six lectures that semester. More than 80 per cent of the children responded (325 responses in total). The children accompanied either their teacher or a relative (in all cases reported in this study, their grandparents). The questionnaire was distributed to the children in paper format after the event, and those adults that accompanied the children were informed about the questionnaire and asked to help the children if there were any questions they did not understand and to send the questionnaire back to the researchers. A majority of the children responding to the questionnaire visited The Children's University with their school class (Table 1). Of all children responding to the questionnaire, those that came with their school class had visited one event, and those that came with their grandparent had visited all of the events.

Table 1. Overview of respondents, data collection methods and number of visits to the Children's University made by the respondents.

Respondents	Data collection method	Number of visits to the Children's University
310 children from schools	Questionnaire	1
15 children with relatives	Questionnaire	All events
18 children from schools	Interview	10 children visited 1 event, 8 children visited 2 events
10 children with relatives	Interview	All events

The questionnaire included both Likert style questions and open-ended questions with room for comments. The items used in this paper can be found in Appendix I (translated into English). In the questionnaire, the children were asked questions about science, not STEM, since they are not familiar with the STEM-concept. Nonetheless, the lectures not only covered science but also included aspects from the whole range of STEM. Hence, in the section presenting the results and the following discussion, both science and STEM concepts have been used. The questionnaire only covered four of the events since two of the six occasions did not focus on STEM topics, but rather on media reports and sports.

After The Children's University lectures in 2016, semi-structured interviews were conducted with 28 children who visited with their school classes as well as those who came to the lectures together with a relative. Eighteen children from two schools were interviewed based on the group of students visiting with their school class. These schools were chosen based on convenience and were located 35 respectively 60 kilometres from the university in smaller towns. The children volunteered to participate in the interviews, and parental consent was obtained. The interviews were conducted in focus groups of four to six students to stimulate discussions and to allow children to be more talkative. These interviews took place at the schools where the children came from and were conducted by one of the researchers (the first author) and were based on five events at The Children's University since one of the events this year was about how to learn English and not connected to STEM.

In addition to the interviews with children from the schools, children who had visited The Children's University with their grandparents were invited to participate in interviews when they attended the lectures. These children were interviewed during the first and second week after The Children's University was closed for the season. The interviews took place at the university and were conducted by one of the researchers (the first author). The children were interviewed with their grandparent present. From this group, ten children volunteered and participated. These children were also interviewed in focus groups. An overview of the samples, both from the questionnaire and the interviews, is presented in [Table 1](#).

Altogether, 28 children were interviewed from both groups of students in six interviews ([Table 1](#)). Each of the interviews were audio-recorded and lasted about 20–30 minutes. The interview guide can be found in Appendix II. All of the interviews were conducted within one month after the visits, depending on when it was possible to visit the schools.

Summarising the data collection, the questionnaire was distributed after four of six visits in 2015. The interviews were based on visits after another four occasions in 2016. Altogether, five different themes from The Children's University were covered.

We (the authors of this paper) work at the university, where the activities took place, but were not involved in the actual activities. Furthermore, we work in other departments than those who conducted the lectures; thus, there were no specific relations between the researchers holding the presentations at The Children's University and us.

Analysis of data

Since the questionnaire was of a self-reported design (Rattray and Jones 2007) in which the students reported how they experienced the out-of-school activity, and not through pre- and post-design, the Likert style questions in the questionnaire were mainly analysed based on descriptive statistics to outline the basic features of the children's change of interest in response to RQ1. The open-ended items of the questionnaire were analysed through the use of content analysis as described by Cohen, Manion, and Morrison (2007), as described in detail in the next paragraph. The audio recordings from the interviews were transcribed verbatim and were also analysed using content analysis. The transcripts (from open-ended questionnaire items and interview transcripts) were read repeatedly, searching for emerging patterns that could be classified into different categories (Cohen, Manion, and Morrison 2007) in order to answer RQ 2.

The second research question focused on factors, which were identified by the children as stimulating their interest in STEM during their visit to The Children's University. Therefore, attitudinal words with a positive connotation that were repeatedly used by the children were marked as keywords (e.g. like, enjoyed, the best, interesting, cool). The categories were then defined by the keywords themselves (i.e. like, enjoy, interesting) and how they were linked to the object that evoked interest (e.g. 'I liked the space pictures'; 'I enjoyed being at the university'; or 'It is interesting to learn'). These keywords, and the sentences in which they were placed, were then grouped together in emerging categories based on the nature of the object in an iterative process, where the utterances were compared and regrouped until consensus was reached between the two researchers. The categories were named based on the student's own naming of the keywords and objects, and we tried to link to the categories that we identified in the literature review presented in the introduction. The categories were first identified by one of the researchers and then verified by the second researcher. Some quotations could be interpreted to be included in two categories; in those cases, they were placed in both.

Quotations from the children have been translated into English. In their original version, many of the written answers may have had incorrect spelling; however, this is not included in the translations. The quotations are referred to as a number correlating to the respondent of the questionnaire, and identifying whether it is a boy or a girl, for example, QB230, (B short for boy, followed by the number of the respondent) or from the interviews, IG10, (G short for girl).

The children who participated in the interviews have been coded as I = interview, B or G for boy or girl, and the number of the respondent, e.g. IG4 stands for interview with girl who was identified as number four out of all the respondents from the interviews.

Results and discussion

Reports about activities aiming to stimulate interest in STEM have commonly reported positive effects (Potvin and Hasni 2014). This was also the case in our study, where the children enjoyed visiting The Children's University; they all wanted to return, and many of the children claimed that their interest in science had grown. First of all, we investigated how the children were affected by their visit to The Children's University.

How was children's interest in STEM affected by visits to the children's university?

Data from the questionnaire were only used for descriptive analysis. The results from the questionnaire were used to identify the children's interest in STEM, both in general but also specifically, in relation to the visit to The Children's University. In total, 325 children completed the questionnaire. The children were positive about science in general (Figure 1).

About 45 per cent (147 children) rated that they found science to be interesting, and 28 per cent (91 children) rated science as being very interesting before visiting The Children's University. In this question, the answers could be ranked from not interesting at all, to very interesting; hence, the answers could be considered as ranked on a five point Likert scale, with five as the most positive answer. The mean value was 3.7 out of 5.0 for the total responses.

Most of the children rated their experience from their visit to The Children's University as very interesting (140 children, 43%) or interesting (114 children, 35%) (Figure 2). Using the same five point Likert scale as in the previous question, the mean value was 4.1 out of 5.0 for the total responses.

Regarding the question of whether the interest had changed after visiting The Children's University, the children found science to be at least as interesting as they did before the visit (131 children, 40%), or even more interesting (177 children, 54%) (Figure 3). This could be considered as a three point Likert scale, giving a mean value of 2.5 out of 3.0.

During the interviews, all of the 28 children answered that they enjoyed the visit and wanted to return to The Children's University. The positive experiences from the visits made many of the children curious, and they wanted to know more about different STEM related issues. Some examples:

I would like to know more about how you can make clouds. [IB7]

I would like to know more about this carbon dioxide thing and climate. [IB16]

I want to know more about how they actually did that experiment when the colours changed. I want to know how that works. They did not tell us how it worked. [IG19]

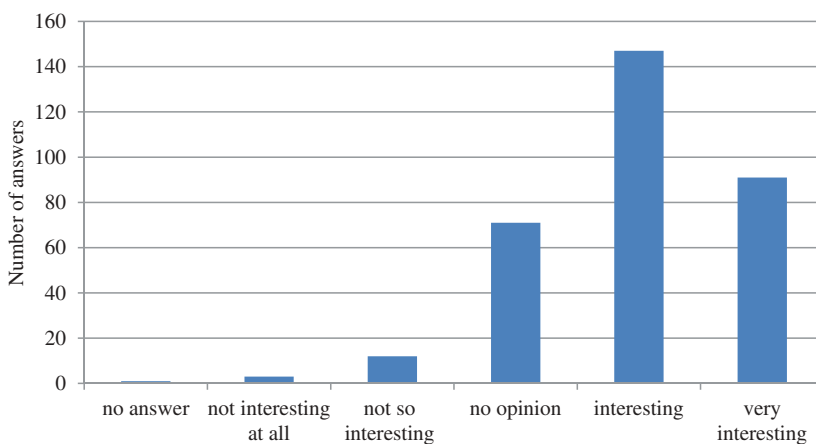


Figure 1. The children's interest in science in general.

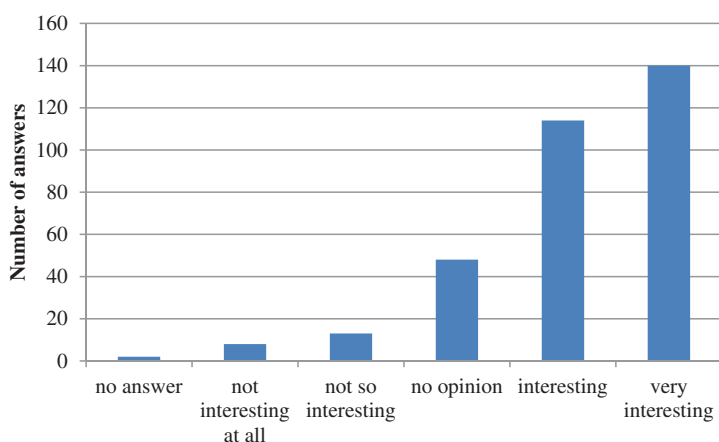


Figure 2. The children's experiences of their visit to the Children's University.

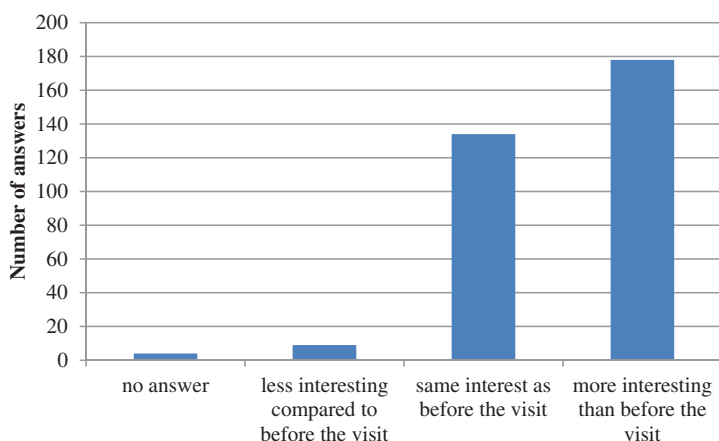


Figure 3. The children's interest in science after the visit to the Children's University.

Some of the children expressed their curiosity about learning more on STEM related issues, however, not necessarily about phenomena they had experienced at The Children's University. One example:

I wish you could show and tell something about animals. I would like to know how they see through their eyes. I would like to do research on how they see because I know that horses ... they can see almost behind their back. Because their eyes are at the side, and I also know that flies can see ... if you move ... I know they can see in slow motion. .they manage to fly away ... [IG3]

The overall picture of children's responses regarding their visits to The Children's University was positive. According to the students' own evaluations, the visits had made them more interested in science than they were before the visits. Many of the children discussed how their interest had been stimulated and curiosity aroused, making them want to know more about how certain phenomena can be explained and how scientific inquiries are conducted, etc.

What factors in the children's university did the children themselves identify as interesting?

As argued by Potvin and Hasni (2014), few studies have investigated the reasons as to why different STEM activities are successful in terms of stimulating interest in STEM. Hence, the main interest in this study was to determine what factors in The Children's University the children themselves identified as interesting, which were:

- *appreciating the topic*
- *appreciating the spectacular*
- *appreciating learning*
- *appreciating the learning environment*

As evident from our categorisation of suggestions in previous literature in the background section, two of the four identified factors (*the topic* and *the learning environment*) are confirmed in our study. Here, follows a description of the categories found in this study, including excerpts from the interviews and open-ended items of the questionnaire.

Appreciating the topic

We did not compare how children appreciated different topics from The Children's University since many of the children had only attended one or two lectures (the children that came with their school classes). However, ten of the children from the interviews had attended several lectures. When questioned about what they specifically appreciated from the visits, the answers often referred to chemistry and experiments. Some examples:

Interviewer: What was the best thing about visiting The Children's University?

IB16: The chemistry was best.

Another example relating to chemistry topics was presented by a boy:

I think it was interesting when they made the cloud. It made me curious. I want to know how they did that. [IB7]

Visitors to the *Einstein and laser* lecture also made comments about what they found particularly interesting during their visit, which was related to the topic.

I thought it was exciting to hear about Einstein and his research. [QG65]

I think it was interesting to hear about Albert Einstein and light and cosmos. [QB125]

Some children particularly liked the presentation about lasers and how they work. There were some children who found the topic difficult to understand, but still they thought it was interesting.

I think this about laser was the best. It was interesting, even though some things were difficult to understand. [QG141]

From the *Crack the code* lecture, we identified some examples where the children identified the topic as being the best thing with the visit.

I think it was fun with the numbers ... that they could be words. [QG104]

I think it was interesting to listen when they talked about programming. [QG207]

There were also examples from this particular lecture, where children found it difficult to understand the topic, but appreciated it anyway.

It was interesting to find out how a computer works, but I didn't quite understand. [QG147]

Children who had visited during *A journey into space* lecture made comments about how they found the topic interesting, one example:

It is interesting to see what it is like in space, because there is so much out there that does not exist on earth. [QG13]

Appreciating the spectacular

Appreciating the spectacular revolves around those attitudinal keywords expressing amazement, i.e. words like 'cool', 'like', 'fun' that was related to phenomena or representations (i.e. not the theoretical content or concepts as in the previous category) in the lectures, which were intentionally or unintentionally included in the lectures to get the reaction of amazement from the students. Children who had visited the *Harry Potter and chemistry* and the *Fairy tales and chemistry* lectures referred to the demonstration of experiments as being what they appreciated most from the visit.

I liked when they did that thing with the foam and when they made the fire. [QG255]

I liked when they made the cloud and how it was glowing in the dark. [IB19]

I think the cloud and the banana in the liquid nitrogen were the most interesting and cool things. [IB20]

I enjoyed the experiment when they poured liquid in the beaker and then it started to shine. [QG239]

Children who visited during the space theme had the opportunity to look at live pictures from space, which were of good quality, broadcasted via satellites from NASA. Hence, especially from these lectures, the children found the pictures to be spectacular and the most interesting, often referring to them as really cool.

It was a really cool tour in space. Cool pictures. [QB39]

It was interesting and fun. You know, to see the planets with the help of satellites. That was exciting and really cool. [QG290]

Appreciating learning

When the children were asked why they liked the visit to The Children's University, many of the responses related to some kind of learning. In some cases, the children only stated that they had learnt a lot, but they could not exemplify what they had actually learnt.

I liked it, I knew some things already, but I learnt a lot more. [QB10]

Everything was good, because it was possible to understand adult-things. [QG1]

It is fun to learn, at least when you understand. [QB74]

Other children expressed a little bit more about what they had learnt in relationship to the lectures. The difference from the first category is that the children here explicitly mention the attitudinal words to learning.

I thought it was interesting because it was possible to learn a lot about laser. [QG5]

I learnt what you can do if your nose is stuffy. To take a towel and hold your head above a bowl with hot water and those green leaves ... menthe was it? [IG13]

I learnt how to look out for crooks on the Internet, to protect your passwords. [IB14]

Well, it was great. Everything. We learnt things in a new way, not like in school. But I did not learn enough, but I learnt in a fun way, but the visit was too short. [IG28]

Appreciating the learning environment

In some of the responses from the children, different things in the environment of the site seemed to have stimulated their interest. These could be things they saw at the university, or simply being in the localities.

I liked to look at the racing cars the students had built. [QB4]¹

I like to visit The Children's University. I think it is nice here and many nice people. [IG3]

It was cool to be there, because I had never been to the university. I did not expect it to be so big. [IB19]

I liked it at the university; it was nice just to sit there, the chairs and how they made the presentations, it was easy to follow. [IG22]

One girl emphasised the opportunity to watch things live:

I think it was interesting to visit The Children's University because there you see things live. I watch a lot of movies on YouTube, like experiments and stuff like that, but this is even more fun because it is live and you can actually see it with your own eyes. [IG2]

We have only presented factors the children identified as being interesting during their visits to The Children's University, since this was one of the research questions, to identify the positive factors. However, although only a few, there were also some children who expressed mild disappointment with the visit to The Children's University, because they wanted to be more active. This was mostly expressed as a wish to engage in more hands-on experiments.

It was not so fun because we were not able to test things. [QB142]

I had hoped that we were going to do experiments ourselves. [IB17]

Summarising the findings related to the second research question, what factors in The Children's University did the children themselves identify as interesting, we found four categories. The children identified that they appreciated *the topic*, *the spectacular*, *learning* and *the learning environment*. The category of teachers and families' role in stimulating children's interest, also suggested in the literature, was not confirmed, although the children visited the events with their teachers or relatives. Perhaps the low degree of interaction by

both the children and the adults at The Children's University might explain why the children did not recognise the importance of their teachers or families.

Instead, two novel categories, which were not mentioned to in the literature, were found: *appreciating the spectacular* and *appreciating to learn*. Appreciating the spectacular, for example, laser shows and chemistry experiments, shows that there is some merit in experiencing scientific phenomena at the university that cannot be provided by teachers in elementary schools. However, many children also recognised the joy in learning something new, in contrast to the spectacular. Here, we might also recognise the importance of the expert knowledge of university scholars in providing insightful conceptual explanations as well as anecdotal or 'nerdy' knowledge related to the science topic that the primary teachers probably are not able to provide.

Discussing the results through the ecological framework

In the following section, we discuss triggered interest through the four key factors identified in the study through the three different lenses (*people, places and culture*) of the *Ecological framework*.

Factors identified as stimulating interest in STEM, in light of the people-centred lens

The majority of the findings in our study can mainly be related to the people-centred lens from the perspective of development of the individuals' interest, knowledge and identity. In the open-ended questionnaire items and the following interviews, individual perspectives were the most referred to aspects by the children. We found that most of the comments made by the children relating to the STEM-activity categories: *appreciating the topic*, *appreciating the spectacular* and *appreciating to learn*, were related to the children's own interest, knowledge and identity development.

The importance of the content, or the topic presented, has previously been suggested as being important only if it engages students (Hidi and Renninger 2006). In our study, we found that children were engaged, which was reflected, to large degree, by children referring to the topic. From all of the lectures, we could identify children who emphasised the content as being of interest. We did not compare if there were any differences between the various topics, since many of the children only visited one or two lectures. However, from interviews with students who attended several lectures, we found that factors that especially aroused their interest and made them curious were connected to experiments from chemistry to questions about space. Still, it is not possible to generalise these results, and earlier studies have also found that students generally have diverse preferences and are more or less interested in different topics (e.g. Baram-Tsabari and Yarden 2005; Dawson 2000; Jones, Howe, and Rua 2000; Sjøberg and Schreiner 2010). Many researchers (e.g. Holbrook 2008; Newton 1998) argue that the relevance of the topic is of importance in order to motivate students and interest them in science subjects. Since most of the children in our study appreciated the topic, the choice of various themes in the investigated lectures at The Children's University seems to do 'its job', i.e. to stimulate interest in STEM.

The fact that the lectures related to chemistry were popular among children was not only connected to appreciating the topic, but it was also identified as appreciation of the spectacular. Aspects in The Children's University lectures that were discussed among the children and appreciated because they were spectacular were experiments with fire

and changing colours. This might have to do with students' interest in experiments (Agranovich and Assaraf 2013; Venville et al. 2013). Indeed, the experiments were of interest, and as already mentioned some children were disappointed with the visit to The Children's University because they were not able to do hands-on experiments themselves. As a result of this study, this is something that should be seriously considered when planning future out-of-school activities. Another important finding is that the spectacular is not only related to experiments but also fascination for pictures from space. Hence, it is not only the 'action' that can be perceived as spectacular and increase interest but also representations of scientific phenomena.

Another factor identified, as being of importance for the children in our study, was that they *appreciated learning* and found learning to be more enjoyable compared to lessons in school. Hence, the children (8–12 year old) not only expressed interest, but they could themselves, at a meta-level, express the importance of gaining new knowledge. As shown in earlier research (Rennie 2007; Stocklmayer, Rennie, and Gilbert 2010; Tal 2012), learning in informal contexts, or out-of-school, is good complement when it comes to stimulating learning of STEM subjects. Furthermore, *learning science* is often considered as positive among children in those out-of-school activities (Agranovich and Assaraf 2013).

The identity part of the people-centred lens was not as easy to find in the results of this study. A factor that was not discussed by the children was the role of adults as role models, or identity creators. The children did not talk much about the researchers holding the lectures. Some children mentioned that one presenter was very good at explaining; otherwise, there were hardly any comments. When the children were asked questions about the researchers presenting at The Children's University, they simply did not have any comments. Perhaps, the presenters did not catch the children's interest enough to be talked about. This result is somewhat unexpected since the researcher is the main character in The Children's University and thought to be a role model for students to build their identity around. This is a key area for future studies, and an area with room for improvement for this out-of-school activity.

Factors identified as stimulating interest in STEM, in light of the place-centred lens

Using this lens, the learning environment itself becomes the foci of interest. Aspects from the *learning environment* at The Children's University, such as the localities, people being friendly and nice furniture were also identified as being of importance for the children when they attended lectures at The Children's University. To experience activities in another environment, in this case a university, made the visit more interesting for many of the children. Earlier research has shown how influential a learning environment is, especially in science, compared to other subjects (e.g. Haworth et al. 2008). When discussing the importance of place for learning in the *Ecological framework*, the focus has often been on typical artefacts such as telescopes and calculators but also on activities, for instance, conducting observations (Bell et al. 2009). In our study, the children did not talk about specific STEM artefacts in the learning environment but rather the environments as a whole, and the importance of being in the localities of the University. Most of the children had never visited the university before, and many of the buildings are quite new and modern; hence, this aspect seemed to be appreciated by the children, affecting how they experienced their visit.

Factors identified as stimulating interest in STEM, in light of the culture-centred lens

It is difficult to find any support in the children's statements that the culture at The Children's University had any importance for their interest in STEM. To some extent, this might be explained by the methodology used in the study, in which the children were asked to express their viewpoints from an individual perspective, which might have directed the children's responses. Furthermore, we did not directly ask the children about how they work with science in school and if, and in what ways, this might be experienced as culturally different from what occurred at The Children's University. However, we were interested in what happened after the visits, in cultures where the children spend their time (in their homes and back in school). The children were asked whether they discussed the lectures afterwards with their teachers and relatives. All of the school children claimed that there were no discussions in their classes after the visit. Some of the children who visited The Children's University with their grandparents explained that they had told their parents about the visit when they came home. However, there was no focus on this issue from the children's point of view. Potvin and Hasni (2014) argue that the family background is of importance, in terms of stimulating and supporting children's interest in STEM. The fact that the grandparents in our study continuously brought their grandchildren to The Children's University could be of importance even though the children themselves did not identify this as a contributing factor. Jarvis and Pell (2005) emphasise the importance of engagement from the teacher, in relation to visits to a science centre with their school classes. In our study, it seems as though the teachers did not follow up with any discussions after the visits to The Children's University. None of the teachers interviewed confirmed this aspect; it is a conclusion drawn based on the claims from all of the children participating in the interviews. Thus, the children did not mention the role of the teachers as a contributing factor. Hence, this is also an important area for improvement, which The Children's University ought to develop, i.e. collaboration with schools, teachers and children's relatives in order to improve preparation and integration into school activities to create a common culture of learning science.

Conclusions and implications

As shown in this study when arranging out-of-school activities, it is important that the students experience something that is different from their ordinary teaching. First of all, the place, i.e. the learning environment, is important and it should offer a learning experience that clearly differs from the school. Second, topics should be selected with the potential to amaze the students and finally, the programme should aim high for the cognitive level of the activities, as the children expect to learn something.

Even though out-of-school activities in science are important factors contributing to students' interest (Woolnough et al. 1997), we do not claim that one visit to The Children's University as a single activity will have an effect on children's future choices when it comes to studies and careers in STEM. Still, together with other activities and hopefully good teaching in school, the visits to out-of-school STEM activities, such as in this study, The Children's University, can serve as a triggering phase for interest development (Hidi and Renninger 2006).

The results from our study highlight the specific factors the children actually appreciated from their visits to The Children's University, which could also be of interest for stakeholders arranging different kinds of STEM activities in order to trigger interest in learning these subjects. The topic in the activities is important as well as spectacular features. To have the

opportunity to learn something new in an environment that is conducive to learning, in nice localities, is also of importance for children. Hence, actors planning for out-of-school activities should consider these factors when designing their activities. Moreover, even though it was not highlighted in this study, we believe the opportunity to have hands-on experiments is appreciated by many children and hence, should be included, as it already is in many STEM activities.

In this study, we have used reflective research methods, i.e. questionnaires and interviews, in which students' own experiences and perceptions are investigated. These methods have limitations, and children at these ages (8–12 years) might not be able to express and verbalise all factors of importance. Hence, in the future, our study ought to be complemented with studies using action approaches, such as observations and interaction studies. In addition, these studies should include out-of-school activities, including aspects of student participation that were not investigated in this study.

Our study has focused on what triggers interest, but not how it evolves. Therefore, for future research, we would suggest more longitudinal studies, following how the effects of these factors change over time as students become older. There are variations, which are of interest for science among different groups of students as shown, for example, in the ROSE study (Sjøberg and Schreiner 2010). Nonetheless, how do these change over time within the same students?

Note

1. On their way from the entrance of the university to the event at The Children's University, university students presented a project in which they built racing cars. The students talked with the children about the project and showed the cars. The idea was that the students could serve as role models for the children.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Ethical considerations

All of the participants in the study were informed that their participation was voluntary and it was emphasized that the participants' identities would be protected throughout and after the completion of the projects. All the collected data were handled in such a way that the participants' identity would not be traceable and the data kept safe. Since the participants were children permissions were made by their parents to participate.

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