

**Exploring Engagement in Science Museums: A Comparative Study of Static and  
Interactive Exhibitions**

Britt M. ten Voorde (s2589990)

Department of Psychology, University of Twente

202200364: Bachelor Thesis Educational Psychology

Dr A.H. Gijlers

June 25, 2023

APA: 7<sup>th</sup> edition

Wordcount: 5264 words

## **Abstract**

This study investigated the differences in engagement among children between static and interactive museum exhibitions, to provide insights that can inform future museum exhibition designs and improve the engagement of young museum visitors. Here, engagement is subdivided into three components: cognitive, behavioural, and affective. The study involved 17 Dutch children aged 6-12 years, who visited both a static exhibition on “the beetle” and an interactive exhibition on “thunder and lightning” at “de Museumfabriek” in Enschede, the Netherlands. Children's engagement was assessed through observations and semi-structured interviews conducted after their visits. The Activity Engagement Scale by Ben-Eliyahu et al. (2018) served as the foundation for the interview questions and observational measures. The findings revealed significant differences in engagement between the static and interactive exhibitions. In terms of cognitive engagement, participants mentioned that they learned something more often while visiting the interactive exhibition. Regarding behavioural engagement, the interactive exhibition stimulated more interactions and discussions among participants, both with peers and adults. Lastly, affective engagement was found to be more positive in the interactive exhibition, where children reported feelings of excitement and interest. These findings highlight the importance of interactivity in enhancing engagement in science museums.

## **Introduction**

People of all ages will learn science in an ever-increasing diversity of ways (National Research Council, 2009). Formal education is just one element of a wider learning system in science, technology, engineering, and mathematics (STEM) which also unfolds throughout life. A consensus report by the National Research Council (2009) identified everyday experiences, designed environments, and learning programmes as three settings in which people learn science outside the classroom. When addressing the topic of informal STEM education, one refers to experiences, settings or programmes that are designed, implemented, and reviewed outside of the classroom by a collective of committed, educated practitioners (National Research Council, 2009).

Among these settings are museums, which are important providers of public science education. They provide ample experiences and expertise to assist young people and communities in exploring and expanding STEM learning opportunities (Chi et al., 2015). However, they do not compete with formal education but are a complementary source for formal as well as informal learning (Teachernet, 2004, as cited in Haywood & Cairns, 2006). For instance, a lot of museum visitors are part of student groups who are visiting the museum as a component of their formal schooling. Furthermore, a high number of museum visitors are families, with parents wanting to introduce their children to topics they might not otherwise encounter (Jensen, 1994). Museums also function as a means of relaxation and entertainment and are indeed a central facility for entertainment that is easily accessible to the mass public. Therefore, science museums should strive to offer entertainment that is informative and educational at the same time (Falk & Dierking, 2000). Increasingly, museums are using interactive exhibitions to achieve this goal (Haywood & Cairns, 2006). In this report, interactive exhibitions refer to exhibitions that enable a form of interaction other than purely visual observation. Often this interaction includes physical manipulation like visitors pushing buttons or flipping switches in response to questions or requests displayed on screens. Interactivity thus gives visitors the ability to control what the exhibition displays. In many interactive exhibitions, for example, visitors can control the order of displayed information and determine if they want further information on a particular interest area (Vom Lehn et al., 1999, as cited in Haywood & Cairns, 2006).

Over time, the understanding of visitor engagement within the museum context has evolved. Early studies targeted motivation and interest, while later research shifted to exploring engagement as a multifaceted process involving visitor actions and behaviours

(Boisvert & Slez, 1995; Wood & Wolf, 2008). Nevertheless, defining and documenting engagement in museums continues to be challenging due to its intuitive and multifaceted nature. The concept of engagement has been debated in prior research studies, recognizing its multiple dimensions (e.g., Archambault & Dupéré, 2017). To address this multifaceted nature of engagement, Ben-Eliyahu et al. (2018) presented a comprehensive framework that differentiates between cognitive, behavioural and affective engagement, considering them as separate but interrelated components.

Cognitive engagement, as defined by Ben-Eliyahu et al. (2018), encompasses the mental processes involved in learning activities. It refers to the extent to which individuals actively think about a learning activity and pay attention to it. This component highlights cognitive activities such as information processing, concept analysis, and making connections. It goes beyond mere attendance or surface-level engagement and delves into the depth of cognitive engagement. Although cognitive engagement does not incorporate motivational or self-regulated learning aspects, it does focus on the thoughts and attention individuals devote to the learning activity. It can be detected through moments where individuals are thinking about questions, critically evaluating the information, and mentally elaborating on concepts that are presented (Ben-Eliyahu et al., 2018).

Behavioural engagement, according to Ben-Eliyahu et al. (2018), includes the observable actions and interactions that individuals exhibit during a learning activity. It goes beyond attendance and conduct to include a wide range of behaviours that suggest active participation and engagement. These behaviours may consist of reading out loud, raising a hand in order to ask or answer questions, participating in conversations with peers or adults about the activity, or actively exploring the learning materials. This expanded definition of behavioural engagement acknowledges that learning occurs through social interactions and communication with others. It emphasizes the importance of both peer and adult interactions in promoting meaningful engagement and learning experiences (Ben-Eliyahu et al., 2018).

Affective engagement, as described by Ben-Eliyahu et al. (2018), assesses individuals' emotional experiences and overall feelings regarding the learning environment. It includes the affective aspects of engagement, including individuals' attitudes, interests, and emotional reactions. Measurements of affective engagement assess often the preference, excitement, joy or interest of individuals in the learning activity or topic. Positive affective experiences have been associated with increased motivation, curiosity, and willingness to explore and learn. These emotional dimensions have a crucial role in shaping individuals' engagement and can

significantly impact their motivation to learn and their overall learning outcomes (Ben-Eliyahu et al., 2018).

In the various fields that contribute to learning sciences, the desire for empirical research on how to engage in learning through an active participation lens - or what the museum field refers to as engagement - is growing. At the core of all these studies, new and old, is the idea that exhibition development and design add to the visitor's overall experience, including engagement (Wood & Wolf, 2008). As museums develop themselves as informal learning institutions, a deeper examination of both the easily observable behaviour as well as its subtleties is fundamental. Engagement, being a multifaceted construct with diverse applications across institutions and disciplines (Archambault & Dupéré, 2017), is subdivided into three components in this study: cognitive engagement, behavioural engagement, and affective engagement, as proposed by Ben-Eliyahu et al. (2018).

By understanding and exploring these three forms of engagement in the context of informal science learning, particularly within museums, researchers gain valuable insights into the various ways visitors engage with the exhibitions. Cognitive engagement allows for an investigation into visitors' cognitive processes and learning activities, shedding light on their mental engagement with the exhibits. Behavioural engagement offers an understanding of the observable actions and interactions shown by visitors, capturing their active involvement and participation during their museum visit. Affective engagement focuses on visitors' emotional experiences and overall feelings toward the learning environment, thereby influencing their motivation and interest in science (Ben-Eliyahu et al., 2018).

This research carries particular importance as it focuses on cognitive, behavioural, and affective engagement within the informal setting of families visiting the museum. The context of this research provides a unique perspective for exploring how engagement unfolds completely outside the formal school environment. By examining the differences in engagement between classical static exhibitions and interactive exhibitions, this study aims to inform future museum exhibition designs and enhance the overall engagement of young museum visitors. The findings will contribute to the growing body of knowledge in informal STEM education in the museum context and offer valuable insights for museum practitioners, educators, and researchers striving to optimize engagement and learning outcomes in informal learning contexts. Thereby leading to the following research questions:

*RQ1: Does the engagement of children in a classic static exhibition differ from the engagement in an interactive museum exhibition?*

*RQ1.1: What is the difference in cognitive engagement of children between a classic static exhibition and an interactive exhibition?*

*RQ1.2: What is the difference in behavioural engagement of children between a classic static exhibition and an interactive exhibition?*

*RQ1.3: What is the difference in affective engagement of children between a classic static exhibition and an interactive exhibition?*

## **Methods**

The current study focused on exploring the differences in the engagement of children in static versus interactive museum exhibitions. Children were observed when visiting and interacting with both exhibitions, one static and one interactive. After the children visited both the exhibitions they were interviewed about their experiences, thoughts, and feelings regarding both exhibitions.

### **Participants**

Participants were purposively selected for the study based on their age range of 6-12 years old, having visited both the static and interactive exhibition and their willingness to participate. After the participants were observed visiting both exhibitions they were approached and invited to take part in the interview section of the study. The final sample consisted of 17 Dutch children ( $M_{age} = 8.88$ ,  $SD_{age} = 2.74$ , 41.2% female 58.8% male). Consent was given by all participants and their caregivers. The Ethics Committee of the Faculty of Behavioural, Management, and Social Sciences (BMS) approved the study.

### **Materials**

#### ***Setting***

The setting for the data collection of this study was “de Museumfabriek” in Enschede, the Netherlands. It is a small museum with a great variety of compact exhibitions covering several topics related to science and history. For this study, the exhibitions regarding “thunder and lightning” and “the beetle” were selected, which will be described in more detail.

**Interactive Exhibition.** The interactive exhibition which was used in this study was on the topic of “thunder and lightning”. The exhibition consisted of a big table with different elements related to thunder and lightning on it. There were plasma balls, a rain machine, a fog machine, and an electricity machine, among other things. Moreover, behind the table, there was a wall with videos and labels explaining the origin of thunder, clouds, rain, and wind. On the side of the exhibition, there was a wind machine that visitors could interact with. See Figure 1, Figure 2 and Figure 3 for a visualisation of the interactive exhibition. Next to this, every now and then there would be sounds imitating a rainstorm and thunderclaps accompanied by a lightning flash.

**Figure 1**

*The Interactive Exhibition About “Thunder and Lightning” at the “Museumfabriek”*



**Figure 2**

*The Table With Different (Interactive) Elements Related to Thunder and Lightning*



### Figure 3

*The Interactive Wind Machine*



**Static Exhibition.** The static exhibition in this study focused on the topic of “the beetle”. It consisted of a wall displaying various types of beetles. On the left side, there was an old police car on display - a Volkswagen Beetle - which was intended to highlight its resemblance to the beetles. On the other side of the exhibition, there was a video playing that displayed how beetles can create a dress, which was portrayed as well. See Figure 4, Figure 5, and Figure 6 for a visualisation of the static exhibition.

### Figure 4

*The Static Exhibition About “The Beetle” at the “Museumfabriek”*





**Figure 5**

*The Wall Displaying Various Types of Beetles*



**Figure 6**

*The Showcasing of the Dress Created by Beetles*



### ***Instruments***

To measure the engagement of participants during their visit to each exhibition and to be able to compare them later on, a set of interview questions and observational measures were used. The interview questions were derived from the survey developed by Ben-Eliyahu et al. (2018) by selecting relevant items and transforming them into open-ended questions suitable for the interview format. Likewise, the observation instrument focused on selected core concepts from the Activity Engagement Scale, allowing for observing and capturing specific behaviours and interactions. The survey included fifteen different questions that aimed to assess participants' emotional, cognitive, and behavioural engagement. You can find

the full survey in Appendix A. The survey showed reliability with a good Cronbach's Alpha of 0.87 for the overall engagement scale. The affective engagement scale had a Cronbach's Alpha of 0.72, the behavioural engagement scale had a Cronbach's Alpha of 0.79, and the cognitive engagement scale had a Cronbach's Alpha of 0.68, which were all considered to be acceptable according to Tavakol & Dennick (2011).

**Interview.** Semi-structured interviews measuring affective and cognitive engagement were conducted so the participants could express their thoughts and feelings about the exhibitions in a more in-depth manner. The interview questions were derived from the instrument developed by Ben-Eliyahu et al. (2018) (see Appendix A for the full survey), specifically focusing on the affective and cognitive engagement factors identified in their scale, excluding the behavioural factors for this measurement, as for this research the assessment of behavioural engagement was based on actual behaviours observed during the visit. For this study, the interview questions were translated from English to Dutch. Items measuring affective engagement like 'I felt happy or excited' or 'I felt relaxed or calm' were transformed into interview questions like 'How did you feel while visiting the exhibition? Could you describe your feelings and reactions?' This adaption was made to encourage participants to express their own genuine thoughts, feelings and interests without being influenced by specific examples in the survey items, thereby ensuring more authentic and unbiased responses. Items regarding cognitive engagement like 'I figured out something about science' or 'I thought about how ideas in the activity related to other things' were transformed into interview questions like 'Has this exhibition taught you something new about this topic?' and 'Did you see or learn anything during the exhibition that was related to something you already knew? What?' This adjustment was intended to assess participants' actual learning and connections made during the exhibition, making sure that they provided genuine responses rather than socially desirable answers that could not be checked, and for the participants to share their own experiences and discoveries (See Appendix B for the full interview guide in Dutch).

To be able to analyse the data, coding schemes were developed using the Atlas.ti software. These coding schemes helped to organize and interpret the information gathered from the interviews. To establish the reliability of the interview coding process, a subset of interviews (20% of the total interviews) was independently coded by a second researcher. The interrater reliability was calculated by comparing the coding decisions made by both researchers. Out of the 40 codes that were examined, there was agreement on 37 of them. This

resulted in a Cohen's Kappa of 0.85 for the interrater reliability of the coded interviews, indicating an almost perfect agreement between the two coders (McHugh, 2012). For a complete overview of the coding scheme check Appendix D.

**Observation.** Observations were used to measure participants' behavioural engagement. The observational measurements used in this study provided a unique opportunity to directly capture participants' actual behaviour during their museum visits, rather than relying solely on self-reported beliefs. The observational data collected in this study consisted of recording the time participants spent at each exhibition in minutes and observing specific behaviours of the participants. The time period that participants spent at each exhibition was recorded with the use of a stopwatch, noting the start and end of their engagement with the exhibition. The behaviours of interest were categorised into two main variables 'Interaction' and 'Discussion.' These behaviour concepts were derived from the behavioural questions of the Activity Engagement Scale (Ben-Eliyahu et al., 2018). Questions like 'I explained things to others,' 'I asked questions or talked with an adult' and 'I asked questions or talked with another student' were classified as 'Discussion.' Whereas questions like 'I tried out my ideas to see what would happen,' 'I was doing what I was supposed to be doing,' and 'I worked hard on the activity' were classified as 'Interaction.' The 'Interaction' variable captured instances where participants actively interacted with the exhibition, including manipulating exhibition components, reading exhibition labels, and observing the exhibitions. The 'Discussion' variable captured instances where participants engaged in discussions with other visitors, such as family members, friends, or other museum visitors, regarding the content of the exhibition. This variable also included instances where participants asked questions related to the exhibition (see Appendix C for the observation template).

## **Procedure**

Upon entering the exhibitions, each participant was observed and timed using the above-described observation template and stopwatch in both the interactive and static exhibitions. After the participants had experienced both exhibitions, they were approached for a one-on-one interview using the above-mentioned interview guide. The interviews were conducted individually with each participant and recorded for further analysis. It is important to note that during the interviews, each question was asked twice: once in relation to the participant's experience in the interactive exhibition and then again in relation to their experience in the static exhibition.

## Data analysis

### *Interview*

The data analysis of the interviews involved examining the interview data to identify key patterns and themes related to the affective and cognitive engagement of the participants in the interactive and the static museum exhibitions. Firstly, each interview was transcribed and read to fully understand the data. After that, codes were created by the researcher to capture the main concepts that emerged from the interview data. These codes were created based on the content of the interviews with the use of the software Atlas.ti. The codes were further examined, organised, and connected into broader themes. This involved looking at whether relationships and connections existed between the different codes and grouping and combining them based on their similarities. By doing this, the codes as stated in Table 1 were identified for affective and cognitive engagement. When coding the interviews, a distinction was made between the answers relating to the interactive exhibition and the static exhibition, allowing for comparison later on. After the coding of the interviews, the frequencies of each code were compared between the two exhibition types. By examining these frequencies, differences, and similarities in affective and cognitive engagement patterns between the interactive and static exhibitions could be identified. Additionally, a chi-square test was conducted in R-studio to examine whether the exhibition type (interactive or static) influenced the frequencies of the coded themes.

**Table 1**

### *Identified Codes for Affective and Cognitive Engagement*

Affective Engagement	Cognitive Engagement
Interactive Elements	Learned Something New
Content	Not Learned Something New
Design	Connected Previously Learned Content
Positive Emotions	Not Connected Previously Learned Content
Negative Emotions	
Neutral/No Emotions	
Increased Interest	
No Increase in Interest	

## ***Observation***

The data analysis of the observational data involved counting the frequencies of each measure for the interactive and static exhibition and comparing them. Moreover, the time participants spent at each exhibition was timed and compared. To visually present the findings, bar graphs were created using R-studio, to illustrate the frequencies of different behaviours and the time spent at each exhibition. Additionally, a chi-square test was conducted in R-studio to examine whether the exhibition type influenced the frequencies of the observed behaviours.

## **Results**

Participants' engagement in the interactive and static museum exhibitions was compared by analysing both interview and observational data. Specifically, the study focused on cognitive and affective engagement in the interviews and behavioural engagement in the observations.

### **Cognitive engagement**

A comparative analysis was conducted to examine the differences in cognitive engagement of children between interactive and static exhibitions. The chi-square test revealed a significant association between the exhibition type and cognitive engagement,  $\chi^2(3) = 9.13, p = .028$  for all the themes combined.

The interview codes that were analysed to examine the difference in cognitive engagement included Learned Something New, Not Learned Something New, Connected Previously Learned Content, and Not Connected Previously Learned Content. Table 2 presents a summary of the frequencies of each code in both exhibition types. For a more detailed understanding of the coding scheme and specific examples, see Appendix D, which provides an in-depth overview of the codes. Out of the 17 participants, 10 participants indicated that they had learned something new when they visited the interactive exhibition and 7 participants mentioned not having learned anything new, mostly because they already knew everything or because they did not read the labels. In contrast, out of the 17 participants, only 7 participants indicated that they had learned something from the static exhibition, with 10 participants stating that they did not learn anything new. Moving on to the instances of the participants being able to connect previously learned content to the exhibitions, only 2 participants mentioned that they were able to connect previously learned content to the

interactive exhibition. In the static exhibition, there was only 1 participant who could connect previously learned content. In some cases, the participant mentioned that they could connect something they learned before to something they saw in the exhibition but could not elaborate on what they connected, these instances were not coded as ‘connected previously learned content.’

**Table 2**

*Comparison of Cognitive Engagement Themes and Frequencies of codes by Exhibition Type*

Exhibition Type / Code	Interactive	Static
Learned Something New	10	7
Not Learned Something New	7	10
Connected Previously Learned Content	2	1
Not Connected Previously Learned Content	15	16

### **Affective engagement**

A comparative analysis was conducted to examine the differences in the affective engagement of children between interactive and static exhibitions. The chi-square test revealed a significant association between the exhibition type and affective engagement,  $\chi^2(7) = 15.95, p = .026$  for all the themes combined.

The interview codes that were analysed to examine the difference in cognitive engagement included Interactive Features, Content, Design, Positive Emotions, Negative Emotions, Neutral/No Emotions, Increased Interest, and No Increase in Interest. Table 3 presents a summary of the frequencies of each code in both exhibition types. For a more detailed understanding of the coding scheme and specific examples, see Appendix D, which provides an in-depth overview of the codes. Out of the 17 participants, 14 participants mentioned that they liked the interactive features the most about the interactive exhibition. For the static exhibition, however, 16 participants mentioned that they liked the content that the exhibition presented the most. Regarding their emotions, most participants mentioned feeling positive emotions in both exhibitions. When looking at the negative emotions, however, 5 participants mentioned feeling uninterested, scared, or disgusted in the static exhibition, while only 3 participants mentioned feeling scared in the interactive exhibition. Lastly, regarding interest, there is a clear difference between both exhibitions. 12 out of 17 participants mentioned that they wanted to learn more about the topic of the interactive

exhibition, while only 6 participants mentioned that they wanted to learn more about the topic of the static exhibition.

**Table 3**

*Comparison of Affective Engagement Themes and Frequencies of Codes by Exhibition Type*

Exhibition Type / Code	Interactive	Static
Interactive Features	14	-
Content	1	16
Design	1	3
Positive Emotions	12	9
Negative Emotions	3	5
Neutral/No Emotions	3	2
Increased Interest	12	6
No Increase in Interest	5	11

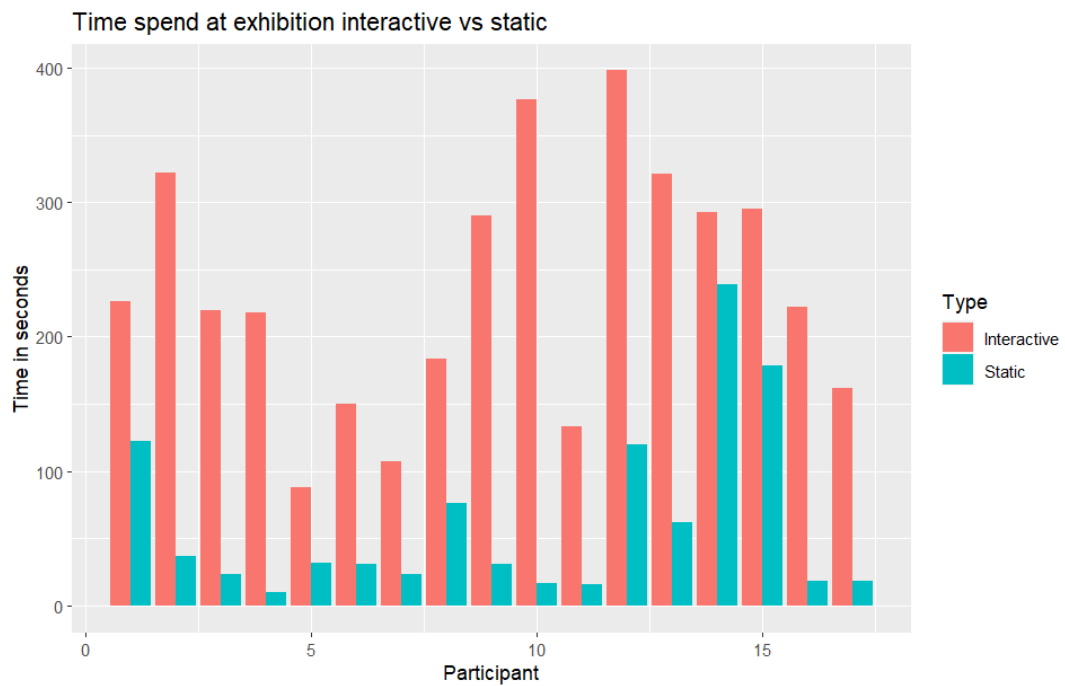
### **Behavioural engagement**

A comparative analysis was conducted to examine the differences in behavioural engagement of children between interactive and static exhibitions. The chi-square test was performed on all observed behaviours together, as there was insufficient data to perform the test for each subcategory separately. The results revealed a significant association between the exhibition type and behavioural engagement,  $\chi^2(16) = 26.46, p = .048$ .

The behaviours that were observed are Interaction, Discussion, and Time spent. As can be seen in Figure 7, all 17 participants spent more time at the interactive exhibition than the static one. Next to that, all 17 participants showed a higher frequency of behaviours related to Discussion in the interactive exhibition, as shown in Figure 8. Lastly, 16 participants showed a higher frequency of behaviours related to Interaction in the interactive exhibition, and 1 participant showed the same frequency of behaviours related to Interaction in both exhibition types, as can be seen in Figure 9. When looking at the frequencies of both engagement behaviours combined, it can be seen that all 17 participants portrayed a higher frequency of engagement behaviours in the interactive exhibition, as shown in Figure 10.

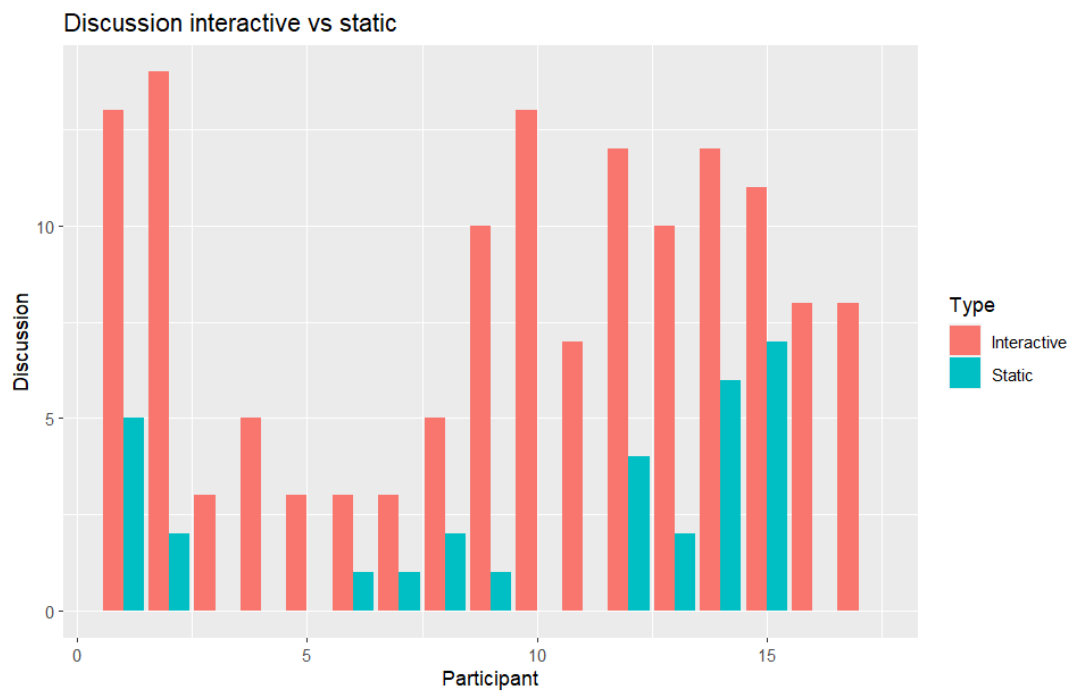
**Figure 7**

*Comparison of Time Spent in the Interactive and Static Exhibitions*



**Figure 8**

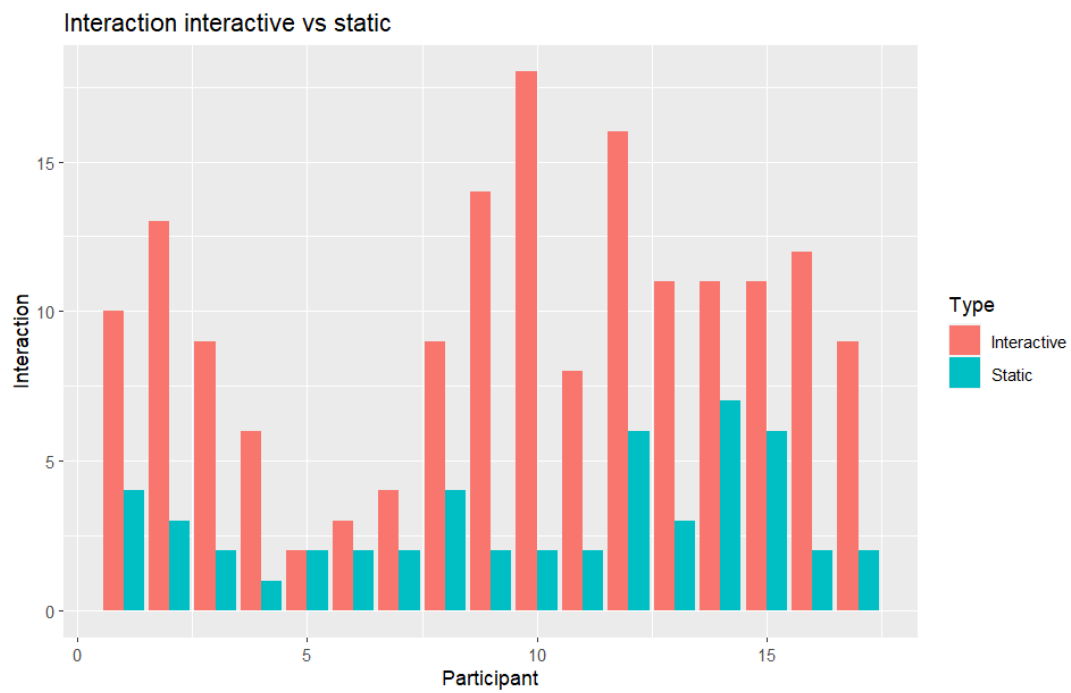
*Comparison of Frequency of Observed "Discussion" in the Interactive and Static Exhibitions*





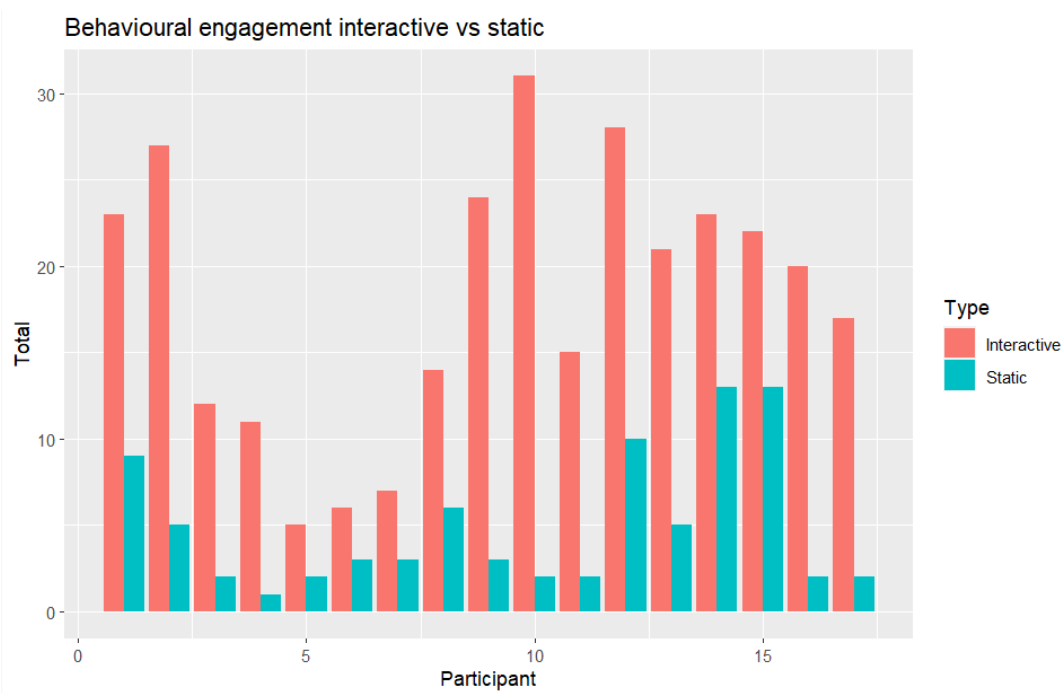
**Figure 9**

*Comparison of Frequency of Observed “Interaction” in the Interactive and Static Exhibitions*



**Figure 10**

*Comparison of Frequency of Observed Total Behaviours in the Interactive and Static Exhibitions*



## Discussion

This study examined the differences in engagement between children in a classic static exhibit compared to an interactive museum exhibit. By examining cognitive engagement, behavioural engagement and affective engagement, this study attempts to understand how different exhibition types affect children's overall engagement. Understanding these differences can provide valuable insights for museum staff and exhibit designers and help develop more engaging and interactive museum experiences. By exploring these three components of engagement, this study contributes to a better understanding of the multifaceted nature of children's engagement in museum settings.

Regarding cognitive engagement, the findings showed a significant difference between the two types of exhibitions. The interactive exhibition elicited a higher frequency of cognitive engagement among children compared to the static exhibition. Participants reported learning something new more frequently in the interactive exhibition, suggesting that the interactive elements and opportunities for hands-on exploration enabled deeper cognitive processing and knowledge acquisition. This is in line with previous research that highlights the positive impact of interactivity on cognitive engagement (Allen, 2004; Schwan et al., 2014; Pallud, 2017).

In terms of behavioural engagement, the results also showed a significant difference between the two exhibition types. Children showed a higher frequency of engagement behaviours, such as interaction with exhibition components and discussions with others, in the interactive exhibition. This finding indicates that the interactive features of the exhibition effectively stimulated participants' active engagement and interaction, making them stay longer at the interactive exhibition, which is also in line with previous research of Schwan et al. (2014) and Allen (2004).

Regarding affective engagement, the findings indicated significant differences between the two exhibition types as well. Participants reported more positive emotions and increased interest in the interactive exhibition compared to the static exhibition. The interactive features evoked positive emotions and a sense of enjoyment among children. In contrast, the static exhibition elicited a greater number of negative emotions, such as disinterest, suggesting that the lack of interactive elements might have limited the emotional engagement of participants. These findings align with previous research that emphasizes the role of interactivity in enhancing affective engagement and overall visitor experience (Skydsgaard et al., 2016).

Drawing further upon the existing research, particularly the comprehensive literature review by Spadoni et al. (2022), the findings of the current study align with the positive influence of interactive exhibitions on engagement. They gathered findings from numerous studies and identified common themes and trends in visitor engagement with interactive exhibitions. The review highlighted the positive effects interactive exhibitions may have on cognitive engagement, gathering knowledge, emotional experiences, and visitors' social interactions. When comparing those findings with this study's findings several similarities are found. Both this study and the literature review emphasize the positive influence interactive museum exhibitions may have on cognitive engagement. Specifically, this study found that participants reported learning something new while visiting the interactive exhibition, which aligns with the findings from the literature review. Additionally, both studies recognise the importance of emotional experiences in visitor engagement.

The findings of this study have important theoretical and practical implications, as they contribute to the understanding of the impact of interactivity on children's engagement in museum exhibitions. By highlighting the positive influence of interactive elements on cognitive, behavioural and affective engagement, this study emphasizes the importance of integrating interactivity into exhibition design and visitor experiences. In addition, the study highlights the importance of taking multiple dimensions of engagement into consideration in the evaluation and design of museum exhibitions. Moreover, the innovative element of this study lies in the use of a new methodological approach, combining observations and interviews based on the Activity Engagement Scale by Ben-Eliyahu et al. (2018) to capture and assess participants' engagement. This approach surpasses the former reliance on just the scale itself and provides a more elaborate understanding of the multifaceted nature of engagement in museum settings. By incorporating this new method, the study provides valuable insights into how these dimensions of engagement (cognitive, behavioural, and affective) can be measured and evaluated effectively in the context of museum exhibitions.

From a practical perspective, these findings can help museum staff and exhibit designers develop more interactive and engaging exhibitions aligned with the needs and preferences of young visitors. Through creating stimulating and inviting experiences using interactive elements and opportunities for hands-on exploration, museums can improve overall engagement and learning outcomes for children. This study presents valuable insights that can guide the development of innovative and impactful museum experiences for a diverse audience.

Despite the valuable insights provided by this study, it is important to recognise limitations related to the different topics of the interactive and static exhibitions. The variation in topics may have impacted participants' engagement because they may have already had an interest or prior knowledge about one of the exhibition topics. This prior interest or familiarity with a particular topic could have influenced their engagement, potentially confounding the results. Future research should take this moderating factor into account by using exhibitions with similar or related topics to make a more direct comparison of the impact of interactivity on engagement regardless of participants' existing interest or knowledge in specific exhibition topics. By addressing this limitation, future studies may present a clearer picture of the influence of interactivity on engagement in museum exhibitions.

Another limitation relates to the interview questions used to assess cognitive and affective engagement. While efforts were made to develop comprehensive and relevant questions, there is always room for improvement. The wording and structure of the questions could have been refined to ensure clarity and avoid potential bias or leading responses. Future studies could consider a stricter validation process for interview questions to enhance the reliability and validity of the data collected.

Furthermore, the reliance on a single observer for the observational data introduces a limitation in terms of interobserver reliability and potential observer bias. Different observers may have different interpretations and judgments when coding the participants' behaviours. To minimise this limitation, future research should include multiple observers to ensure greater objectivity and reliability in the collected data.

Lastly, even though the interactive exhibition showed increased engagement, it is important to recognise that there is potential for increasing engagement even more and for longer periods of time. The relatively short duration of interaction with the interactive exhibitions that was recorded in the present study suggests an opportunity to look for ways to create exhibitions that promote long-term engagement. It could be interesting for future research to examine strategies and design elements that can encourage long-term interaction and engagement.

In conclusion, the findings in this study indicated that children show higher frequencies of engagement in interactive museum exhibitions compared to static exhibitions. These findings elaborate further on the understanding of the impact of different types of exhibitions on visitor engagement and offers insights into the role interactive exhibitions can play in enhancing the

engagement of young visitors. However, it is important to realise that limitations of the study should be considered for future research. Furthermore, some recommendations were provided to improve and enhance future research in this area.

## Reference List

- Allen, S. (2004). Designs for learning: Studying science museum exhibits that do more than entertain. *Science education*, 88(S1), S17-S33. DOI: 10.1002/sce.20016
- Archambault, I., & Dupéré, V. (2017). Joint trajectories of behavioral, affective, and cognitive engagement in elementary school. *The Journal of Educational Research*, 110(2), 188-198. <https://doi.org/10.1080/00220671.2015.1060931>
- Ben-Eliyahu, A., Moore, D., Dorph, R., & Schunn, C. D. (2018). Investigating the multidimensionality of engagement: Affective, behavioral, and cognitive engagement across science activities and contexts. *Contemporary Educational Psychology*, 53, 87-105. <https://doi.org/10.1016/j.cedpsych.2018.01.002>
- Boisvert, D. L., & Slez, B. J. (1995). The relationship between exhibit characteristics and learning-associated behaviors in a science museum discovery space. *Science education*, 79(5), 503-518. <https://doi.org/10.1002/sce.3730790503>
- Chi, B., Dorph, R., & Reisman, L. (2015). Evidence & impact: Museum-managed STEM programs in out-of-school settings. *National Research Council Committee on Out-of-School Time STEM*. Washington, DC: National Research Council. [https://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse\\_089887.pdf](https://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_089887.pdf)
- Falk, J. H., & Dierking, L. D. (2000). Learning from Museums: Visitor Experiences and the Making of Meaning. <https://ci.nii.ac.jp/ncid/BA52561241>
- Haywood, N., & Cairns, P. (2006). Engagement with an interactive museum exhibit. In *People and computers XIX—The bigger picture: Proceedings of HCI 2005* (pp. 113-129). Springer London. <http://www.ucl.ac.uk/paul>
- Jensen, N. (1994). Children's perceptions of their museum experiences: A contextual perspective. *Children's Environments*, 300-324. [https://www.jstor.org/stable/41514951?seq=1&cid=pdfreference#references\\_tab\\_contents](https://www.jstor.org/stable/41514951?seq=1&cid=pdfreference#references_tab_contents)
- McHugh, M. L. (2012). Interrater reliability: the kappa statistic. PubMed Central (PMC). <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3900052/#:~:text=Cohen%20suggested%20the%20Kappa%20result,1.00%20as%20almost%20perfect%20agreement.>

- National Research Council. (2009). *Learning science in informal environments: People, places, and pursuits*. National Academies Press.
- Pallud, J. (2017). Impact of interactive technologies on stimulating learning experiences in a museum. *Information & Management*, 54(4), 465-478.  
<https://doi.org/10.1016/j.im.2016.10.004>
- Schwan, S., Grajal, A., & Lewalter, D. (2014). Understanding and engagement in places of science experience: Science museums, science centers, zoos, and aquariums. *Educational Psychologist*, 49(2), 70-85. <https://doi-org.ezproxy2.utwente.nl/10.1080/00461520.2014.917588>
- Skydsgaard, M. A., Møller Andersen, H., & King, H. (2016). Designing museum exhibits that facilitate visitor reflection and discussion. *Museum Management and Curatorship*, 31(1), 48-68. <https://doi.org/10.1080/09647775.2015.1117237>
- Spadoni, E., Porro, S., Bordegoni, M., Arosio, I., Barbalini, L., & Carulli, M. (2022). Augmented reality to engage visitors of science museums through interactive experiences. *Heritage*, 5(3), 1370-1394. <https://doi.org/10.3390/heritage5030071>
- Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, 2, 53-55. <https://doi.org/10.5116/ijme.4dfb.8dfd>
- Wood, E., & Wolf, B. (2008). Between the lines of engagement in museums: Indiana University and the Children's Museum of Indianapolis. *Journal of Museum Education*, 33(2), 121-130. <https://doi.org/10.1080/10598650.2008.11510593>

## Appendix A Activity Engagement Survey by Ben-Eliyahu et al. (2018)

	% Of research team rated as Affective	% Of research team rated as Behavioural	% Of research team rated as Cognitive	Final Engagement Factor
During today's activity				
1. I felt happy or excited	100	0	0	Affective
2. I felt relaxed or calm	94	6	0	Affective
3. I felt frustrated or annoyed <sup>a</sup>	100	0	0	Affective
4. I felt tired or sad <sup>a</sup>	100	0	0	Affective
5. I felt bored <sup>a</sup>	75	6	19	Affective
6. I was thinking during the activity	0	6	94	Cognitive
7. I explained things to others	0	75	25	Behavioural
8. I tried out my ideas to see what would happen	0	75	25	Behavioural
9. I thought about how ideas in the activity related to other things	0	0	100	Cognitive
10. I was paying attention during the activity	0	44	56	Cognitive
11. I was doing what I was supposed to be doing	0	100	0	Behavioural
12. I did more than was required of me	0	94	6	Behavioural



13. I worked hard on the activity	0	94	6	Behavioural
14. I asked questions or talked with an adult	0	88	12	Behavioural
15. I asked questions or talked with another student	0	88	12	Behavioural
Did you do any of these things during today's activity?				
16. I figured out something about science	0	12	88	Cognitive
17. I checked to make sure I understood what we were doing	0	56	44	Behavioural

*Notes:* <sup>a</sup> Indicates reverse coded item.

## Appendix B Interview Guide in Dutch

Voor mijn eindopdracht van de opleiding psychologie aan de Universiteit Twente doe ik onderzoek naar het verschil tussen statische en interactieve museum tentoonstellingen en hoe kinderen dit ervaren. Om dit te onderzoeken hou ik interviews met kinderen die beide soorten tentoonstellingen hebben bezocht. Ik zag dat jullie bij de tentoonstellingen over de kever en donder en bliksem hebben gekeken, zou ik uw kind/jou daar een paar vragen over mogen stellen?

Voordat we beginnen, wil ik uitleggen hoe het onderzoek werkt.

We willen graag weten wat jij zelf hebt meegemaakt. Er zijn geen goede of foute antwoorden, want jij bent de expert over jouw ervaringen.

Ik wil het gesprek graag opnemen zodat ik het later preciezer kan uitwerken en zo analyseren en vergelijken met andere antwoorden van deelnemers. Jouw antwoorden blijven anoniem: ik haal namen, data en plaatsen weg. Het kan wel zijn dat ik jouw citaten gebruiken in het rapport, maar die blijven ook anoniem. Je kunt op elk moment stoppen met het interview of besluiten om niet mee te doen aan het onderzoek.

Ga je akkoord met deze afspraken? Als dat zo is, zou je dan duidelijk willen zeggen ‘ik ga akkoord met deze afspraken en ik vind het goed dat dit opgenomen wordt’

1. Hoe oud ben je?
2. Wat vond je het leukst aan de tentoonstelling over donder en bliksem? Waarom?
3. Wat vond je het leukst aan de tentoonstelling over de kever? Waarom?
4. Hoe voelde je je tijdens het bezoek aan de tentoonstelling over donder en bliksem?  
Kun je je emoties en reacties beschrijven die je voelde terwijl je met de tentoonstelling bezig was?
5. Hoe voelde je je tijdens het bezoek aan de tentoonstelling over de kever? Kun je je emoties en reacties beschrijven die je voelde terwijl je met de tentoonstelling bezig was?
6. Heeft deze tentoonstelling je geholpen om meer over donder en bliksem te weten te komen? Waarom wel of niet?
7. Heeft deze tentoonstelling je geholpen om meer over de kever te weten te komen?  
Waarom wel of niet?
8. Heeft deze tentoonstelling je interesse gewekt voor het onderwerp donder en bliksem?  
Zo ja, hoe?

9. Heeft deze tentoonstelling je interesse gewekt voor het onderwerp de kever? Zo ja, hoe?
10. Heb je tijdens de tentoonstelling over donder en bliksem iets gezien of geleerd wat te maken had met iets wat je al wist? Wat?
11. Heb je tijdens de tentoonstelling over de kever iets gezien of geleerd wat te maken had met iets wat je al wist? Wat?

## Appendix C Observation Template

<b>Participant</b>	<b>Time period</b> <i>Starting and ending time of checking out the exhibition</i>	<b>Recording Interaction</b> <i>Participant interacted with the exhibition (e.g., manipulating exhibition components, reading exhibition labels, observing exhibition)</i>	<b>Recording Discussion</b> <i>Participant discussed the exhibition content with/or asked questions to other visitors (family members, friends, or other museum visitors)</i>	<b>Total</b>
Participant 1 Interactive	... min ... sec			
Participant 1 Static	... min ... sec			
Participant 2 Interactive	... min ... sec			
Participant 2 Static	... min ... sec			
Participant 3 Interactive	... min ... sec			
Participant 3 Static	... min ... sec			
Participant 4 Interactive	... min ... sec			
Participant 4 Static	... min ... sec			
Participant 5 Interactive	... min ... sec			
Participant 5 Static	... min ... sec			
Participant 6 Interactive	... min ... sec			
Participant 6 Static	... min ... sec			
Participant 7 Interactive	... min ... sec			
Participant 7 Static	... min ... sec			
Participant 8 Interactive	... min ... sec			
Participant 8 Static	... min ... sec			
Participant 9 Interactive	... min ... sec			
Participant 9 Static	... min ... sec			
Participant 10 Interactive	... min ... sec			
Participant 10 Static	... min ... sec			

## Appendix D Overview of the Coding Scheme

Codes	Definition	Example	Code Frequency Interactive Exhibition	Code Frequency Static Exhibition
Interactive Features	Participants mentioned they liked the interactive features of the exhibition the most	<i>"Dat die ballen euh die je zo aan kan raken"</i>	14	0
Content	Participants mentioned that they liked the content of the exhibition the most	<i>"Ik vond de kevers leuk omdat ze zo kleurig waren"</i>	1	16
Design	Participants mentioned that they liked the design of the exhibition the most	<i>"Al die kevers aan de muur"</i>	1	3
Positive Emotions	Participants felt positive emotions while visiting the exhibition (e.g., interested, fun, happy)	<i>"Ik was wel geïnteresseerd."</i>	12	9
Negative Emotions	Participants felt negative emotions while visiting the exhibition (e.g., not interested, scared, disgusted)	<i>"Ja ook gewoon bang, maar dat is omdat ik niet van insecten hou"</i>	3	5
Neutral/No Emotions	Participants felt neutral or no specific emotions while visiting the exhibition	<i>"Gewoon neutraal"</i>	3	2
Increased Interest	Participants mentioned that the exhibition sparked their	<i>"Ja, want ik wil wel weten hoe"</i>	12	6

	interest, and they want to learn more about the topic	<i>dat dan ontstaat enzo"</i>		
No Increase in Interest	Participants mentioned that the exhibition did not spark their interest and they do not want to learn more about the topic	<i>"Ook niet echt"</i>	5	11
Learned Something New	Participants stated that they learned something new while visiting the exhibition	<i>"Ja, dat ze een jurk kunnen maken"</i>	10	7
Connected Previously Learned Content	Participants mentioned they could connect previously learned content to something they learned or saw at the exhibition	<i>"Ja die ballen had ik al wel op school gehad. Maar op school heb ik ze dan weer niet gevoeld, dus dat kon ik nu wel doen"</i>	2	1
Not Learned Something New	Participants mentioned that they did not learn something new	<i>"Nee niet echt want ik heb de bordjes niet gelezen"</i>	7	10
Not Connected Previously Learned Content	Participants mentioned that they were not able to connect previously learned content to something they learned or saw at the exhibition	<i>"Niet echt, ik wist nog niet zoveel over bliksem"</i>	14	14