CONTENT ANALYSIS OF EXHIBIT LABELS IN SCIENCE CENTERS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

İREM GEZER

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
SCIENCE EDUCATION IN MATHEMATICS AND SCIENCE EDUCATION

SEPTEMBER 2022

Approval of the thesis:

CONTENT ANALYSIS OF EXHIBIT LABELS IN SCIENCE CENTERS

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ABSTRACT

CONTENT ANALYSIS OF EXHIBIT LABELS IN SCIENCE CENTERS

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Master of Science, Science Education in Mathematics and Science Education
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September 2022, 105 pages

Exhibit labels are powerful tools for initiating communication between visitors and exhibits in science centers. Exhibit designs and labels can change according to the educational goals in science centers. Previous studies have focused on the aesthetic aspects of labels rather than the content, and they can hardly give us educational messages behind the exhibit labels. The purpose of this study is to investigate variations of labels used for interactive exhibits in science centers. To investigate the variations in exhibit labels, the method of content analysis was used. For this purpose, the data were obtained from six different science centers located in Turkey. Exhibit labels were examined in terms of content and the ways of providing information about the contents. The contents of labels were categorized as directions, explanations, and extensions. Each content was also analyzed and categorized according to the ways of providing information about the content. This study described these three main categories and emerging subcategories with detailed examples. The main categories and subcategories in the study were also analyzed across fields of science and science centers.

Keywords: Labels for Interactive Exhibit, Exhibit Label, Poster on Interactive Exhibits, Interactive Exhibit Design, Science Centers

ÖZ

BİLİM MERKEZLERİNDEKİ SERGİ ETİKETLERİNİN İÇERİK ANALİZİ

Gezer, İrem
Yüksek Lisans, Fen Bilimleri Eğitimi, Matematik ve Fen Bilimleri Eğitimi
Tez Yöneticisi: Doç. Dr. Ömer Faruk Özdemir

Eylül 2022, 105 sayfa

Etiketler (poster), bilim merkezlerinde ziyaretçiler ve sergiler arasında iletişimi kuran temel araçlardır. Bilim merkezlerinde, merkezlerin eğitim hedeflerine göre sergi tasarımları ve etiketleri değişmektedir. Daha önce yapılan çalışmalarda, ağırlıklı olarak etiketlerin estetik yönleri ele alınmış ve hedeflenen içeriklerin nasıl sunulduğu istenilen seviyede incelenmemiştir. Bu çalışmanın amacı, bilim merkezlerinde etkileşimli sergiler için kullanılan etiketlerin içeriklerini ve bu içeriklerin nasıl sunulduğunu araştırmaktır. Bu amaç için içerik analizi yöntemi kullanılmıştır. Türkiye'de bulunan altı farklı bilim merkezinden elde edilen veriler içerik ve içerikteki bilgiyi verme şekli açısından incelenmiştir. İçerikler; yönergeler, anlatımlar ve genişletme şeklinde 3 genel kategoriye ayrılmıştır. Her bir içerik hedeflenen bilgilerin veriliş şekline göre de alt kategorilere ayrılmıştır. Çalışmada bulunan ana kategori ve alt kategoriler toplanan veriye, bilim dallarına ve bilim merkezlerine göre incelenmiş ve örneklerle desteklenmiştir.

Anahtar Kelimeler: İnteraktif Sergi Etiketleri, Sergi Etiketi, Etkileşimli Sergi Posterleri, Etkileşimli Sergi Tasarımı, Bilim Merkezleri

To My Family and My Friends

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my supervisor, Assoc. Prof. Dr. Ömer Faruk Özdemir for his comments, suggestions, support, and encouragement throughout my research.

I would also like to thank my examining committee members, Prof. Dr. Ahmet İlhan Şen and Prof. Dr. Ömer Geban, for their feedback, suggestions, and comments.

I would like to thank the science centers, Bursa Bilim ve Teknoloji Merkezi, Feza Gürsey Bilim Merkezi, Kocaeli Bilim Merkezi, Konya Bilim Merkezi, Polatlı Belediyesi Alparslan Türkeş Bilim Merkezi ve Uluğ Bey Gök Evi, and ODTÜ Toplum ve Bilim Uygulama ve Araştırma Merkezi Bilim Merkezi, for their support and help throughout my work.

I would like to thank my friends and colleagues, Dilber Demirtaş, Belkıs Garip, Simay Köksalan, and Ayşe Nihan Şatgeldi who always encouraged and helped me to complete this work. Also, a very special thanks go to my friends Özlem Karadaş, Özge Karadaş, Nermin Uçgun, and Cansu Karataş for their support throughout my life.

I would like to express my deepest gratitude to my extended family who made me who I am.

Lastly and mostly, I would like to emphasize my deepest gratitude to my beloved husband Ali Gezer for his support, motivation, and understanding during this thesis work. I could not have completed this work without his love.

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CHAPTER 1

INTRODUCTION

With the development of technology, the point of view toward science education has begun to change. The rapidly changing world has also led to reforms in science education (Odden et al., 2021). Social, economic, and political issues have also influenced science learning perspectives that bring 21st-century skills (Churchill et al., 2013). With the changes in educational strategies, science education environments have become places where learners can be active participants. In a way that, out of school learnin has been important in science education. Consequently, the public interest in science has increased and science learning in informal settings has become widespread (Phipps, 2010).

Science education environments are divided into two broad categories: formal and informal learning. Formal learning generally occurs in schools with organized learning environmentsnd definite characteristics (Eshach, 2007). However, informal learning is defined as learning that a person engages in throughout their life, which is self-motivated, voluntary, and driven by their needs and interests (Dierking et al., 2003). Informal learning is also known as “out-of-school learning,” “out-of-classroom learning," “nonformal learning,” and “outdoor learning.” The settings in which learning takes place also might affect learning because each provides different opportunities. While formal areas are designed according to a specific curriculum with measurable outcomes, non-formal areas are semi-designed learning environments. Learning can occur consciously or unconsciously in out-of-school learning areas, and informal settings can be designed to facilitate learning. Informal science settings have offered many opportunities for teachers and students. NSTA stated that these opportunities could be listed as increasing students’ interest in science, contributing to the professional development of pre-service and in-service teachers, and bridging the gap between teaching science at school and real life (Learning Science in Informal Environments | NSTA, n.d.).

The present worldwide aim for science education is scientific literacy, which transfers and develops the culture of science knowledge to future generations. Scientific literacy may not be sufficient only in schools as learning environments (Fensham, 1997 as cited in Javis &Pell, 2002; Stefanidou &Panagopoulou, 2019). Out-of-school learning settings are one of the environments like science museums and science centers that have a complementary role in science education, and they can be a stakeholder in the aim of scientific literacy (Stefanidou &Panagopoulou, 2019). The importance of science museums and science centers and their role can be clarified in the following words of Kroto, who was the winner of the1996 Nobel prize in the realm of chemistry (Jarvis & Pell, 2002; Stefanidou & Panagopoulou, 2019):

"*Unless the young people of the twenty-first century appreciate the importance of science, we stand no chance whatsoever of economic, social or cultural survival. In my view, science museums and science centers must play an appropriately active part in the educational program on which this survival depends.*"

Informal science learning is also known as lifelong and life-wide learning, in which we spend most of our lives in such settings. Informal learning settings include the environments we live in, from home, street, and playground to museums, aquariums, and industrial settings (National Research Council, 2009). One of the informal science learning settings is science centers and museums. Science centers and museums have a vital role in science learning, which is one of the sources of increasing the public interest in and sustainable development of science. Science centers and museums also contribute to developing skills and capacities necessary for science (*The Role of Science Centers in Increasing the Public Understanding of Science - Association of Science and Technology Centers*, n.d.). To increase the need for experience-based learning, science centers and museums have complementary roles in science learning in school and bridging the gap between science and the public (*Science Centres and Museums Vitally Important for Sustainable Development – UNESCO | | UN News*, n.d.).

Science centers consist of instructional materials that can directly help visitors gain experience in science, apart from the traditional education at school. According to Feher (1990), learning processes in formal and informal settings are different, so the instructional material used in informal learning differs from formal learning. The instructional materials and techniques have been changed from passive to active, and learners' hands and minds have also become the focus of instructional materials in science learning (Hofstein & Rosenfeld, 1996). These instructional materials are different from the ones in school. One of the essential teaching materials and tools is the exhibits in science centers and museums. Many exhibits in science centers are interactive and manageable exhibits based on hands-on and minds- on which visitors have a direct experience within science content (Allen, 2004; Feher, 1990). The exhibit in science centers has different approaches and processes in terms of forming science knowledge for learners. The interactive exhibit in science centers is mainly intended to surprise visitors because visitors' thoughts and the result of the interactive exhibit may conflict (Feher, 1990; Gutwill, 2008). It is important to base scientific knowledge on experience and to clarify the scientific understanding that the information given in the interactive exhibit should not cause misconception and misunderstanding. Therefore, the design of the interactive exhibit and the components in the interactive exhibit should be in harmony and guide the visitors appropriately.

An exhibit unit consists of exhibit components and configurations among them. The exhibit components are objects, communication media, and text information (Bitgood, 1992a). Text information is one of the essential components of the exhibit as a communication tool between visitors and the exhibit. The text information in the exhibit might convey an educational message to visitors, so they can offer a scaffold for cognitive gains of the visitors (Bitgood, 1992a; Gutwill, 2006; Yoon et al., 2013).

When the studies in the literature are examined, labels for the exhibit have been evaluated as a part of the exhibit in science centers and museums. The physical characteristics and content of the exhibit labels have been examined in terms of visitor’s responses and design(Bitgood, 1989, 1991; Mcmanus, 1990; Screven, 1992; Serrell, 2015). For example, Serrell (2015) outlined the contents of exhibit labels in terms of “*To Do”*, “*What To Notice”*, and “*What’s going on”* parts in an Exploratorium, and also different types of exhibit label style was identified such as explanations, questions, and suggestions. Also, several studies have focused on visitor communication due to the design of exhibits and labels (Gutwill, 2006; Hall, 2009; Hohenstein & Tran, 2007; Wang & Yoon, 2013). These studies showed the content and variety of labels in the exhibit.

In addition to supporting the studies in the literature, this study examined the contents of labels for an interactive exhibit and their instructional techniques for each part from the educational point of view. In addition to elements in the exhibit labels available in the literature, the extension was found in the interactive exhibit labels, which extend the content given in the interactive exhibit. In this study, each element of the interactive exhibit labeled was categorized as how the information is delivered. When examining previous studies in the literature, labels for the interactive exhibit have been examined through an exhibit setup or more than one exhibit in a science center (Hall, 2009; Serrell, 2015). In this study, the labels for the interactive exhibit were collected from six accessible science centers in Turkey during the COVID-19 pandemic period. All labels in each science center were examined in detail by variations on instructional and educational message styles. Also, variations were given to each element of labels for the interactive exhibit. While choosing these science centers, they were classified under how they were supported, and the researcher paid attention to analyzing at least one science center from this classification.

1.1 Purpose of the Study

In the last couple of decades, the number of informal settings for learning science, such as science centers and museums, has been increasing. These settings could make visitors engage in the science actively and make them enhance their positive attitude towards the science (Daneshamooz et al., 2013; Falk & Needham, 2011; Jarvis & Pell, 2005; Şentürk & Özdemir, 2014). Science centers, especially, have a important role in science learning. In science centers, there are exhibits related to how science works, and these exhibits are usually interactive exhibits in which visitors can engage actively.

The exhibit's design is important for visitors to engage in the exhibits (Gutwill, 2006); however, there is a severe problem with the exhibit's design (Allen & Gutwill, 2004). When examining the exhibits in science centers, there are many elements of the interactive exhibits. One of the elements of the exhibit in science centers is label text. Communication in museums has occurred through different media, but one of the primary communications is written text in the exhibit (Kjeldsen & Jensen, 2015; Ravelli, 2007). Labels for the exhibit are also known as "museum text", "label text", "introductory labels", "subject labels", and "explanatory text"(Kjeldsen & Jensen, 2015). According to Serrell (2015), the label for interactive exhibits is designed for visitors to help how to use the exhibit and what the topic of the exhibit is. Also, the label text for the interactive exhibit includes instructions for using the exhibit and results of the exhibit, and an explanation of phenomena on the exhibit (Borun & Adams, 1992; Serrell, 2015).

Serrell (2015) said, "poor label texts will fail to complete with visitors' impulses to do rather than to read" (p.190). Therefore, the label for the interactive exhibit has a important role in visitors' engagement. Most written labels didactically serve as instructors and are independent of the exhibit; however, such labels may be more suitable for learners who learn by reading materials rather than other styles (Borun et al., 1993). Therefore, the labels' content and sequence may be important to accomplish the educational goal of interactive exhibit in the science centers.

In addition to supporting the studies in the literature, this study examined the contents of labels for interactive exhibits and their instructional techniques for each part from the educational point of view. In this study, the content of the interactive exhibit label was categorized as how the information is delivered. In the literature, a few studies were found on the content of the labels for interactive exhibit, and these studies were limited descriptions of the contents and sequence in the labels (Humphrey et al., 2005; Serrell, 2015). When examining previous studies in the literature, labels for the interactive exhibit have been examined through an exhibit setup or more than one exhibit in a science center (Hall, 2009; Serrell, 2015). Also, a few studies found related to remidiate misconceptions with interactive exhibitsing appropriate label design (Borun et al., 1993; Borun & Adams, 1992; Gutwill, 2008). However, the previous studies have not been sufficient to show how to convey information through labels.

In this study, the contents of the interactive exhibit labeled was categorized as how the information is delivered. In this study, the labels for the interactive exhibit were collected from six accessible science centers in Turkey during the COVID-19 pandemic period. All labels from science centers were examined in detail by variations on ways to provide visitors information. Also, variations were given to each content of labels for the interactive exhibit. While choosing these science centers, they were classified under how they were supported, and the researcher paid attention to analyzing at least one science center from this classification. The purpose of the study is to show variations of the exhibit labels in science centers.

The research questions are:

1. What are the contents of labels used for visitors in science centers?

2. What are variations in each content (e.g., directions, explanations, extensions) of labels across fields of science and science centers?

1.2 The Significance

Science learning occurs in classroom teaching, laboratory work, or informal learning settings (Şentürk, 2015). Therefore, science centers and museums have an important role in science learning. The exhibit's design also has an essential role in attracting visitors' attention and increasing visitors’ science communication with the interactive exhibit labels (Gutwill, 2006). Generally, visitors can engage in the exhibits by themselves while following the instructions on the exhibit label (McManus, 1989). Even though some studies are about the exhibit labels (Bitgood, 1989, 1991, 2000; Kanel & Tamir, 1991; McManus, 1989; Mcmanus, 1990; Serrell, 2015), the results are limited to inform about the nature and variations of the labels. These previous studies were related to aesthetics of labels, length of sentences and words, and readability in brief. Kanel and Tamir (1991) investigated the effects of label design and the content of labels on visitors’ behavior. They changed the labels according to appearance, legibility, and position, so these broad editorials and aesthetic design correlated with higer level of visitors’ behaviour and learning. However, these aesthetic changes were not related to ways of providing information.

Some studies found about content of exhibit label(Allen & Gutwill, 2004; Borun et al., 1993; Borun & Adams, 1992; Borun & Miller, 1980; Gutwill, 2008; Humphrey et al., 2005; Serrell, 2015). In previous studies, label contents were limited to titles and general information. There have been limited studies about the ways of providing content, and only inferences can be made from the studies. The content in the labels and the variations on the content can provide more information to construct more productive labels.

The suggestions generated through the analysis of broad range of labels are important for text writers (Bitgood, 1989; Serrell, 2015), but the nature of the interactive exhibit is different from other exhibits (Allen, 2004; Allen & Gutwill, 2004; Caulton, 2006). Therefore, the nature of the labels is also expected to be different. According to Bitgood (2000), labels should be used to help visitors who wish to know want to pay attention and how to focus their attention. Therefore, the content of labels should serve visitors' needs. Overall, these studies have shown the general ideas on writing labels, and they were the bases of how to write a label for the exhibit (Bitgood, 2000; Serrell, 2015).

Some studies are related to using questions in the labels (Gutwill, 2006; Hohenstein & Tran, 2007). While interacting with the exhibit, the labels are expected to guide visitors to use the exhibit and learn the intended concepts from the exhibit. Gutwill (2006) presented three types of labels for interactive exhibits: only question, only suggestion, and question-suggestion for visitors to engage with the exhibit actively. Although there were no significant differences among label types in terms of cognitive gains, the question- the suggestion was more helpful for visitors than others. Visitors preferred the question-suggestion type. The questions were open-ended and related to engaging the exhibit. In addition, Hohenstein and Tran (2007) used three different exhibit labels styles in different three exhibits in the study, and they integrated questions into two labels. Then, they examined the conversation between visitors. They concluded that the nature of the exhibit affected designing labels that support conversations. In this study, the labels' explanation was original and simplified the original text, and just added the questions. The exhibit labels were not examined in terms of providing information, and the questions were limited in the conversation between visitors. The questions used in the exhibit labels were limited in these studies.

Kanel and Tamir (1991) emphasized that visitors focused on explaining the phenomena in the label. Moreover, Borun and Miller (1980) studied the explanatory nature of the labels there were four labels: how it works, science principle, historical information, and everyday application for a specific exhibit. Although visitors favored the how it works and scientific knowledge in the labels, the study investigated that historical and everyday themes in labels were more effective in teaching than others. Therefore, the explanation style in labels may affect visitors' understanding of the exhibit. The other available studies in the literature were related to conversations among visitors and ways of providing information to them (Crowley et al., 2001; Eberbach & Crowley, 2005; Hall, 2009). For example, the conversation between visitors about explaining the phenomena consists of causal relationships, scientific facts, and analogical relationships. The content of the labels for interactive exhibits can even affect transferring knowledge among visitors so that it can shape the conversation between visitors (Hall, 2009). Crowley et al. (2001) and Eberbach and Crowley (2005) examined the visitors' conversations during their interaction with the exhibit and found different categories. These categories were principle, causal, analogical, and process, conveying scientific facts to visitors. Then, in the light of the findings obtained in these studies, the exhibit labels were arranged and the effect of the exhibit setups belonging to these different explanations on the dialogue between the visitors was examined. However, these categories were broad and limited to specific exhibits or science centers.

The studies considering labels in museums and for interactive exhibits detailed in were covered in Chapter 2. Approaches in science education, this research topic shows the current variety of labels for the interactive exhibit for exhibit designers. Moreover, how scientific activity and knowledge are transferred in labels is shown in current science centers in Turkey. This study is intended to put some light on the nature of the labels for interactive exhibits available in science centers.

This current research topic is significant in showing the exhibit label pattern in science centers from the educational goals. This research will improve the design of the exhibit label in the science centers in terms of using different ways of providing information and scientific activity. Visitors can engage more in exhibits and have more valuable time in science centers because exhibit labels can encourage a visitor to engage in exhibits more. Furthermore, science centers will contribute to scientific literacy and the public's interest in science which is some of the current goals of science education.

The findings presented in light of this research will primarily guide interactive exhibit designers. The findings in this study will inform the science center educators about the different ways of helping visitors interact with exhibits and get the most from this experience. In addition, the findings of this study will allow teachers, students, and other visitors to see where and what information about the exhibit setups is provided. The variations in this study reveal that science teaching cannot only include monotony instruction and can be enriched with different teaching styles in science centers even though the instructional material is text.

The current study aims to reveal the difference between the content on the labels and ways of tranferring information to visitors rather than descriptions of content in the label. This study revealed variations in labels in terms of content and ways of providing information. Variations in labels for interactive exhibits may provide information on current exhibit designs and scientific activities in science centers.

1.3 Definition of the Basic Terms

Informal Learning Environments: The places include everywhere experiences, design settings, and programs where an individual has free- choice about their learning ways (Bell et al., 2009; Fenichel & Schweingruber, 2010)

Informal Science Learning: Informal science learning, which occurs outside the classroom with multiple aspects of learning, is defined as a person engaged in throughout their life which is self-motivated, voluntary, and driven by their needs and interests (Dierking et al., 2003; *Informalscience.Org*, n.d.; Krishnamurthi et al., n.d.)

Science Centers: "Science centers or centres present exhibits, installations, and educational programs that are supposed to engage visitors for self-education on a subject and to inspire the visitors to learn more."(Leister et al., 2015)

Exhibit: The exhibit in which visitors engage in a science center or science museum has specific learning goals and objectives (Serrell, 2015).

Hands- on Interactive Exhibit: “A hands-on interactive museum exhibit has clear educational objectives which encourage individuals or groups of people working together to understand real objects or real phenomena through physical exploration which involves choice and initiative.” (Caulton, 2006, p.2)

Label: “Written words used alone or with illustrations in museum exhibits to provide information for visitors, presented as text on the exhibit graphic panels or computer screens” (Serrell, 2015).

CHAPTER 2

LITERATURE REVIEW

This chapter summarizes the literature review about informal science learning settings and exhibit design for science centers. The first part presents information about research on informal science learning and informal science learning settings. Research about science centers and science museums is summarized. In the second part, the exhibit design for science centers is given. The parts of exhibits and exhibit labels are given in this part.

2.1 Informal Science Learning

Learning consists of a change in knowledge and understanding, thinking, and acting in particular subjects. Thus, learning is a lifelong and endless process (Krishnamurthi et al., n.d.). During learning, experiences obtained from everyday life are important to construct meaningful learning. According to Dewey, experiences from daily life can challenge or support a learner's understanding (as cited in Allen & Gutwill, 2004). Also, Piaget (1957) emphasizes that interaction with the environment and concrete materials supported learners in reconstructing their prior understanding (as cited in Allen & Gutwill, 2004). Informal science education, one of a part of the learning, occurs in informal and outside school contexts. Informal science learning occurs everywhere, around the learners, from visiting a museum to watching Tv channels (Falk & Needham, 2011; Krishnamurthi et al., n.d.). Learning must not require a place in order to happen.

According to Ad Hoc Committee, the definition of informal science education, which has still been a controversial issue, is "learning that is self-motivated, voluntary, and guided by the learner's needs and interests, learning that is engaged in throughout his or her life" (Dierking et al., 2003). In terms of this definition, informal science education is the learner's journey on their learning that occurs out of formal education (Dierking et al., 2003). Moroever, Dierking et al. (2003) emphasised that elements strongly shape a learner's learning: prior knowledge and experience, interest, and motivation toward subjects. Learning is not a short-term process; on the other hand, it is a long- terms process in which learners can collect and integrate their existing knowledge and experience. Therefore, informal science education can provide learners to gain experience about topics and collect knowledge in their minds.

Informal science learning, as mentioned before, occurs outside school, and it is not planned like school- learning or traditional education. Learning actually occurs outside school as well inside school. Science learning is hard to define only one way because science learning is, like learning, both porcess and product (Dierking et al., 2003), which takes time, and is influenced by other dimension such as characteristics of person, features of physical environment as well as variaty aspects of society (Rennie et al., 2003). Strands of science learning were adopted to informal science learning to enhancenformal learning settings(Bell et al., 2009; Fenichel & Schweingruber, 2010). There are six strands for informal science learning which try to establish meaningful learning for learners (Bell, Lewenstein, et al., 2009; Dierking et al., 2003; Fenichel & Schweingruber, 2010; Rennie et al., 2003).

Table 2.1. Strands for Informal Science Learning

Strands	
1	Sparking and Developing Interest and Excitement
2	Understanding Science Knowledge
3	Engaging in Scientific Reasoning
4	Reflecting on Science
5	Engaging in Scientific Practice
6	Identifying with the Scientific Enterprise

These strands give deep insight into the importance of science learning and science learning in informal environments. Also, these strands tell science educators as well as science learners how science learning occurs in informal settings, which are important statements for science educators in order to understand outcomes of learning, characteristics of learning as well as behaviors of learners in informal settings (Bell et al., 2009; Fenichel & Schweingruber, 2010).

2.1.1 Informal Science Learning Environments

Informal science learning environments or settings varies a wide range of settings which are different from formal education setting like school. These are science museums, park, aquarium, zoo and arberetum,V shows, Internet and magazine (Falk & Needham, 2011; Rennie et al., 2003). Even though the school is one of the major sources for learners to obtain knowledge, informal science learning settings are complementary to science learning (Hofstein & Rosenfeld, 1996) . These spaces are important for learners to construct experience and to establish motivation in terms of the definition of informal science learning.

Libraries, churches, and museums were seen as informal learning environments to enhance scientific communication among citizen learners in accordance with Conn's study in 1998 (as cited in Bell, Lewenstein, et al., 2009). What's more, the Chautauqua movement, which was summer school for family, brought entertainment and education together (Bell et al., 2009), which was so important to informal learning settings. Institutions and other activities like farming and gardening are part of the informal learning settings because of using engaging public in scientific knowledge.

After the Cold War and Sputnik event, science education has become increasingly important dail(Bell et al., 2009). Learning in daily- life experience also has a wide range of environments, including all experiences from family, hobbies, TV series, books or magazines, searching on the Internet, and even walking around (Fenichel & Schweingruber, 2010).

According to Esbach, learning takes place in three different environments: formal, non-formal, and informal learning areas. Learning environments, also known as out-of-school learning, are divided into non-formal and informal. This classification was made according to whether the environments were designed for learning purposes or not. While non-formal learning is designed and facilitated by formal education, the motivation for learning may be entirely internal to the learner in informal education, which can happen anywhere (Eshach, 2007). However, because pedagogical tools and processes can occur in all three learning environments, it can be difficult to separate these definitions from each other (Malcolm et al., 2003). According to Malcolm et al. (2003)' perspective, it can be a different approach to examining the formality and informality of learning circumstances because learning can vary from condition to condition and is not the same in all conditions.

Informal learning settings consist of everyday experience. In terms of informal learning environment, the environments are everyday routine, designed settings, and sort of programs in Figure 2.1. Designed environments are defined as arranged by staff, instution for peole to engage in interactive learning environment to the aim of the certain learning goals which includes planned and unplanned outcomes. Designed environments are museums, aquariums, zoos, botanic gardens, planetariums, and science centers, which can be extended from libraries to other institutional settings. Programs are known as after-school programs, summer camps, and programs arranged by museums with formal educational goals and plans (Bell et al., 2009; Fenichel & Schweingruber, 2010).

Even though there are several different places in informal learning settings in accordance with varies freedom of choice in learning, learning in such environments has multiple outcomes in terms of cognitive, affective, and psychomotor domains and involves the learner's interaction with phenomena directly by using prior knowledge as well as construction prior knowledge by engaging in phenomena. The common characteristic of these environments is that learners can choose their learning level intuitively and manage their learning levels (Fenichel & Schweingruber, 2010).

These informal learning settings, known as out-of-school environments, support formal learning at school (Oktay & Şen, 2018). Oktay and Şen (2018) argued that out-of-learning environments generally offer advantages for linking to everyday life. Pre-service physics teachers' views on informal learning settings are that students' learning is affected positively and affects formal learning(Kılıç & Şen, 2014). Also, there were found that students learn concepts linked to daily life (Ertaş et al., 2011). Therefore, informal science settings can support effective learning for students.

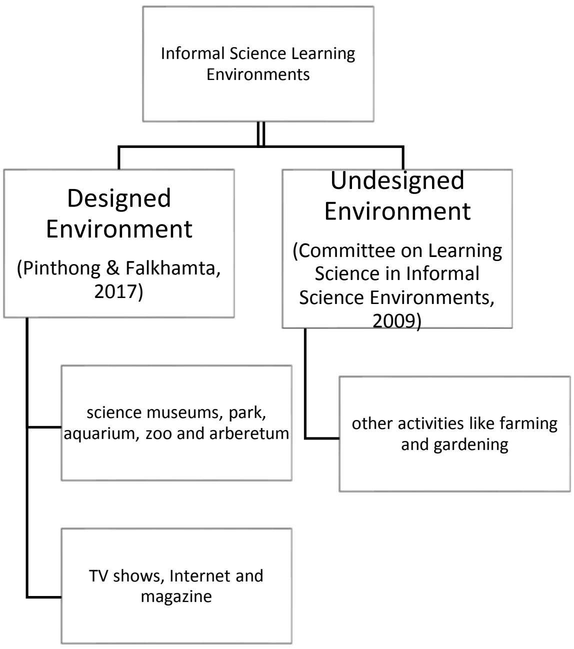

Figure 2.1. Informal Science Environments

(Adopted from Bell, Lewenstein, et al., 2009)

2.1.1.1 Science Centers

Learning from museum has been getting more popular day by day. Learning occurs everywhere, from home to educational institutions, and experience and prior knowledge are more important to construct new knowledge. Learning in a museum differs from other types of learning because visitors can choose his/ her learning level, topics, etc. (Falk & Dierking, 2000). In the science center, visitors can engage in interactive exhibits about phenomena (Fenichel & Schweingruber, 2010), so visitors can establish an experience. This experience is as prior knowledge to construct new knowledge. Museums can facilitate visitors' learning by engaging in phenomena, and there is an important role in learning (Falk & Dierking, 2000). The visitors. Many factors affect visitor learning in science centers in Figure 2.2.

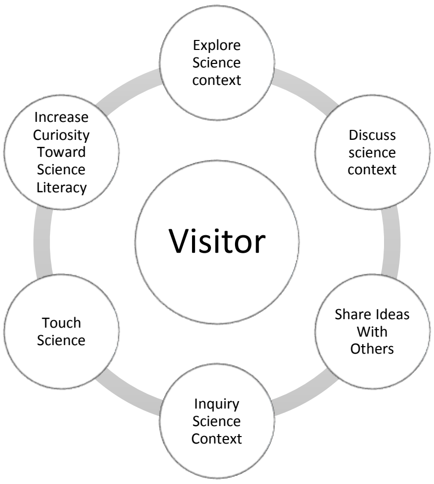

Figure 2.2. How visitors learn from museum

To illustrate the learning from museum, Falk and Dierking (2000, p. 135-148) emphasized the Contextual Model of Learning. This model, appropriate to define learning in museum, consists of personal context, sociocultural context, and physical context, which this model explains learning as an intersection of these contexts. Personal content is related to prior interests, beliefs and expectations, prior knowledge, and a person's desire to learn. Social context is related to sociocultural mediation within others and mediation facilitated by others, in which observation, symbols, language, and common shared culture affect a person's learning as a social being. Physical context is related to physical facilities offered by the environments, and one of the facilities is a design of exhibits and delivery of content and interpretation tools.

Science centers influence visitors' learning that they attract visitors' attention toward science and technology (Bell et al., 2009; Fenichel & Schweingruber, 2010). Science center has a personal, societal, political, and economic impact (Garnett & Ghislaberti, 2002). According to Garnett and Ghislaberti's report, engaging in science museums enhances science learning. Also, Falk and Needam (2011) found that science museums positively impact science literacy. Science museums and centers have a role in science literacy (Falk & Needham, 2011). Science centers and museums offer visitors to explore science context, discuss the science context with others and share ideas and questions with others, and also engaging in exhibit increases people's curiosity to engage in science literacy (*The Role of Science Centers in Increasing the Public Understanding of Science - Association of Science and Technology Centers*, n.d.). In addition, science centers appear to have a more significant influence on students' academic career decisions (Salmi, 2003).

The main purpose of the science centers is to engage the public in science within the culture of science: investigate, discover and explore (*TÜBİTAK Bilim Merkezleri*, n.d.-a). For this purpose, science centers have been established in Turkey, most belonging to municipalities and some universities. In 2008, TUBİTAK started support to establish science centers in cities through project 4003, and then the number of science centers in Turkey increased day by day (Ünalan, 2011). It is represented some examples of science centers in Turkey in Table 2.1. Çolakoğlu's study has shown that teachers and school authorities understood the role of science centers in formal education. Thus, the cooperation between science centers and schools has been increasing daily (Çolakoğlu, 2017).

Science centers have a key role in enhancing critical thinking. According to Kılıç and Şen's study (2014), 9th-grade students' critical thinking skills were enhanced with the help of out-of-school settings. Therefore, science centers are not only teaching concepts but also improving the science skills of students (Kılıç & Şen, 2014). In addition, pre-service science teachers argued that the science centers affect their professional development (Bozdoğan, 2008). Bozdoğan (2008) argued that science centers contribute to students' academic careers and scientific literacy.

Table 2.2. Some Science Centres in Turkey

Some Science Centers in Turkey
• Konya Science Center • Elazığ Science Center • Bursa Science Center • Üsküdar Science Center (Bilim Üsküdar) • Kayseri Science Center • Kocaeli Science Center • Feza Gürsey Science Center- Ankara • Polatlı Municipality Science Center and Uluğ Bey Planetarium- Ankara • Eskişehir Science Experiment Center- Eskişehir • Gaziantep Planetarium and Science Center- Gaziantep • Sancaktepe Municipality Science Center- İstanbul • Sultangazi Municipality Science Center- İstanbul • Karşıyaka Municipality Science Museum- İzmir • Ödemiş Municipality Experiment and Science Center- İzmir • Sultanbeyli Technology and Science Center • Pendik Municipality Science Centers- İstanbul • Bağcılar Municipality Science Center- İstanbul • Antalya Kepez Science Center- Antalya • Prof. Dr. Aziz Sancar Science Center - Mersin • METU Science and Technology Museum- Ankara • Şırnak University Science Center- Şırnak • METU North Cyprus Campus Science and Technology Center- North Cyprus

2.2 Exhibits in Science Center

In science centers, the important learning resources are exhibits such as demonstrations and interactive exhibits (Allen, 2004; Allen & Gutwill, 2004). The exhibit has an important role in science communication and communication tool in museums (Bitgood, 1992a). Therefore, exhibit techniques should be compatible with visitor learning (Ahmad et al., 2015). Visitors' participation level is the same as the type of exhibit techniques or method.

According to Falk and Dierking (2000), visitors can set learning outcomes by level of engagement in exhibits. Therefore, the exhibit is an important role in learning from science centers and science museums. Informal science learning has six stands, which give information about engaging in exhibits as learning resources (Bell et al., 2009; Fenichel & Schweingruber, 2010). Therefore, the materials in science museums and science centers show differences in educational approaches. In Figure 2.3, the exhibit is divided into two broad groups (Caulton, 2006): passive and active. The passive exhibit is described as “glass showcase” in which object(s) is on display behind the glass and not touchable by visitor. The active exhibit shows how models and machines work. However, both exhibit types cannot be touchable by visitors, so every active exhibit cannot be an interactive exhibit.

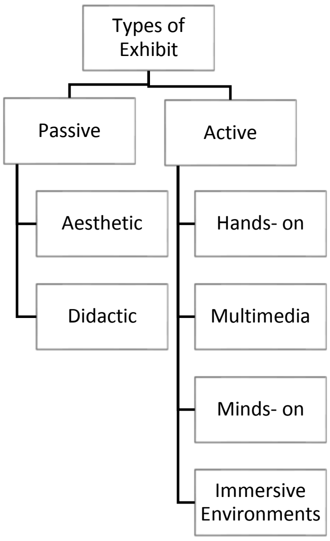

Figure 2.3. Types of exhibit

Hands-on and interactive exhibits invite visitors to engage in the exhibit actively. Hands-on and interactive exhibits can be seen as the same things, but there is an important difference between these terms. Hands-on exhibits can be defined as touchable objects; on the other hand, interactive exhibits also involve action-reaction so that visitor is a part of the exhibit. According to (Caulton, 2006) assumption about using the terms is:

"A hands-on or interactive museum exhibit has clear educational objectives which encourage individuals or groups of people working together to understand real objects or real phenomena through physical exploration which involves choice and initiative."

Interactivity has a key role in science museums and science centers. Interactivity is an experience involving personally, physically, and emotionally engaging visitors (Adams et al., 2004). Also, interaction with exhibits or phenomena can change low to high, from pushing buttons to investigating scientific knowledge by using the exhibit (Fenichel & Schweingruber, 2010).

Hands-on interactive learning is important at science centers because of the nature and purpose of the science museums and centers. Learning in science museums and centers is generally based on practice, which has an interactive exhibit. Through interactive exhibits in science centers, visitors can directly touch and experience. Science centers with the first examples of interactive exhibits can be Exploratorium and Ontario Science Center; however, the educational perspective in the interactive exhibit is enhanced by Frank Oppenheimer, Exploratorium (Allen, 2004; Hillman, 2006). According to Oppenheimer (Oppenheimer, 1968), the objects and materials in the science centers should also serve a pedagogical purpose, which means to be intended to clarify something rather than to encourage only science fiction.

When the exhibit are used with pedagogically planned, students' cognitive gains are affected positively (Kanlı & Yavaş, 2021). Therefore, students should connect the knowledge they learn in school and science centers. Exhibits should include outcomes from the curriculum (Kanlı & Yavaş, 2021). In addition to that, interactive exhibits in science centers supported the effective learning of 7^{th}-grade students. These exhibits affected visitors' motivation toward science as well as visitors' learning at school (Çığrık & Özkan, 2016). Çığrık and Özkan (2016) argued that interactive exhibits can provide effective learning not only in science centers but also schools.

2.2.1 Design of Exhibit

Shaby, Ben- Zvi Assaraf, and Tal indicated that exhibit design is important in pedagogical perspective and learning facilitation strategies (Shaby, Assaraf, & Tal, 2019). The study was mentioned that an exhibit is more than materials and scientific content, it is also related to social interaction; thus, the design of the exhibit should be eligible for social interaction with cognitive activeness in scientific content (Shaby, Ben-Zvi Assaraf, et al., 2019). Bitgood (1994) illustrates the exhibit's design approach and showed success in the exhibit design in terms of learning style, cognitive ability, interest level, and visitors' demographic information. However, the role of social interaction in learning has been getting important since Vygotsky's social theory (Shaby, Ben-Zvi Assaraf, et al., 2019). What's more, individual differences are important to learning science, so the designing exhibit in accordance with different approaches influences individuals learning (Rowe, Lobene, Mott, & Lester, 2014). The visitors interact with the interactive exhibits during their visit (Laçin-Şimşek & Öztürk, 2022).

The exhibit is included different elements in Figure 2.4: objects, communication media, and text information briefly (Bitgood, 1992b). An exhibit object is related to the material in the exhibit that is not shown as text information. Communication media is related to how visitors communicate with exhibits, which means all things visitors engage. Text information is to give information about the exhibit to visitors. Three elements have interacted with each other, and they form an exhibit. There are different exhibit designs(Bitgood, 1992b, 1994).

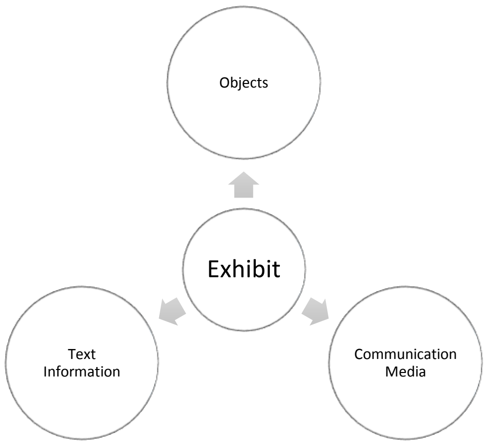

Figure 2.4. Elements of exhibit

Mortensen's study (2010) tried to express how content would be transformed into three-dimensional educational furniture in a didactical approach. Exhibit design should be considered the exhibit medium, the exhibit content and the learners in the exhibit, and their interaction among them. Mortensen described the museography triangle through the didactic triangle and established coherent implications for designing the exhibit. The didactic triangle that consists of knowledge, teacher and student is transformed into museographic triangle that consists of content, medium and learner. In this triangle, the element is not important, but the interaction among the elements is meaningful and shapes the exhibit's design (Mortensen, 2010).

On the contrary, Hillman’s study examined the design of hands-on interactive exhibits in science centers by synthesizing with The Contextual Model of Learning by Falk and Dierking and the pedagogical triangle by Aderson and Garrison. In this model, the triangle consists of an object, visitor, and designer. This model represented a synthesis of the contextual model of learning and pedagogical triangles in the interactive exhibit (Hillman, 2006). While comparing two similar studies, the exhibit label or text is part of the exhibit. In comparison, Mortensen (2010) clarified that labels are part of the medium (teacher role) and conceptual coherence, and Hillman (2006) explained text in the exhibit as a content deliverer (object role).

2.2.2 Labels for Interactive Exhibits

Exhibit label is an important part of the exhibit design for science centers. Exhibit label has different roles in science museums and centers in terms of guidance, scaffolding, instruction, and source of clarifying scientific content and building a communication bridge between visitor and exhibit. Visitors would be informed by the exhibit label about the exhibit or exhibit firsthand. Therefore, labels as a tool are important to construct scientific communication between visitors and exhibits (Kanel & Tamir, 1991). So the exhibit labels should be studied from different perspectives to design educational exhibit labels properly. In this realm, there have been few studies on labels for interactive exhibits in the literature.

Early studies were related to manifest design exhibit labels like aesthetic, font size, length, and type of text(Bitgood & Patterson, 1993; Wolf & Smith, 1993), and then design suggestions to exhibit labels (Bitgood, 1989; Serrell, 2015). In addition to that, the aesthetic design of labels affects visitors (Laçin-Şimşek & Öztürk, 2021). Laçin-

Şimşek and Öztürk (2021) argued that visitors mentioned how to use the interactive exhibit rather than what to learn from the interactive exhibit while asking about exhibits to them.

The labels for interactive exhibits were studied in terms of instructional purpose and impacts on visitors' behavior (Borun & Miller, 1980; Gutwill, 2006; Hohenstein & Tran, 2007; McManus, 1989). McManus (1989) studied the behavior of visitors in reading labels, so the conversation between visitors and the label content was found to parallel. In the study, the conversation between visitors was examined by text-echo, which means similar words from the labels' text in the conversation, and their similar words were found. Thus, visitors could be affected by labels' text. As a result of the study, the importance of labels in using the exhibits is emphasized. Another study showed the positive effect of labels in the exhibit on visitors' learning (Kanel & Tamir, 1991). They developed a new format that used different titles and added questions and illustrations to make visitors understand the exhibits easily. To construct meaningful learning, the questions included conceptual conflict. Thus, they summarized the format changes positively affected children's learning. The not only type of explanation affects cognitive and affective domain, but also the format of labels in terms of aesthetic and popular science writing style has affected visitors's learning (Kanel & Tamir, 1991).

Borun and Miller's studies were related to cognitive and affective gains (1980). This study investigated the effectiveness of explanatory labels in a science museum. They examined the effectiveness of labels in terms of label appearance, content, and length. They used four types of explanation as content: How It Works, Science Principles, Historical Information, and Everyday Applications. It is an interesting finding in this research because visitors chose scientific and technical explanations about the exhibit. However, the most effective learning occurred in visitors in historical and everyday application explanation types (Borun & Miller, 1980).

Borun and Adams's study (1992) found that, a label's style affected on whether or not an interactive exhibit remediates visitor's misconception about the concept. In the label called "Exploratorium style", there were how to operate the device, what visitors observe, and scientific explanations based on observation. Although such labels like "Exploratorium style" were more informative, they caused misconception because visitors only attended to do what was written in the label. Then, researchers changed the content of the exhibit label to operate the device, refer to why visitors use the device and offer the concept of the exhibit explicit explanation briefly so that labels turned hands-on into minds-on. This finding clearly shows that it is important to understand the role of the style of the label as a gap- bridge between visitor and exhibit. These studies show that the label for the interactive exhibit has an important role in visitor learning (Borun & Adams, 1992). In addition, there were similar studies about naïve knowledge and the exhibit design (Borun et al., 1993). They concluded that interactive exhibits with well-worded labels could change naïve concepts. Thus, misconceptions can be solved not only by changing the exhibit's object but also by adapting its label.

Previous studies show that the content and words in labels affect visitors' learning. There were found a few studies about the exhibit label content affects visitors understanding. The labels' content has emerged from the visitors' conversation (Crowley et al., 2001; Eberbach & Crowley, 2005). In the study, the conversation between parent-child was examined in an interactive exhibit, and three explanatory conversations were foundcausal, analogical, and principles (Crowley et al., 2001). All types of explanatory aimed to express the accepted scientific fact behind the exhibit. Then, the conversation between parent-child was examined in a botanical park, and a process explanation was also found in the previous study. As a result of the study, the explanation in the exhibit could be affected by branches of science because of their different nature (Eberbach & Crowley, 2005). Hall (2009) studied the effects of labels text on parent-child conversations. There were four labels in a specific interactive exhibit in principle, causal, analogical, and combination of all types. It was found that parents were made from labels while explaining to their children. It was found that the labels are sources of information about the exhibit for parents while explaining to their children. The labels provided conversation between parent and child and supported the exhibit's engagement. The combination of explanation types was found to positively affectheir learning (Hall, 2009, 2015).

According to Serrell (1988), exhibit labels should be designed to answer common questions, promote communation among visitors and staff, encourage observation, and engage in exhibit willingly. Therefore, an interactive exhibit label has a role in guidance, explanation, and interaction. Moreover, exhibit labels are established communication between writers and visitors (Bitgood, 1992a; Gutwill & Dancstep (née Dancu), 2017).

Beyond the different definitions of interactivity in science exhibits, visitors can participate actively in the exhibit physically and mentally, so texts should guide visitors on what and how to do an activity (Serrell, 2015). Serrell (20015) emphasized that informal science writing is different from label writing for interactive exhibits. That’s mean, a text would be excellent science writing but not a good text for interactive exhibit labels to link between context and visitor’s experience. Interactive exhibit labels should be not only instruction and explanation, but also she suggested that a label should be shorter and focus on the aim of the exhibit, and promote visitor’s exploration and thinking briefly (Serrell, 2015). In the book, a format of Exploratorium’s labels was given as an example of the development of interactive exhibit labels’ formation. The labels generally contain sections that are “What to do”, “What to Notice” for a visitor, as a question for a visitor “What’s going” on and “So what”, which is called a traditional exhibit label. The labels, such as Exploratorium, also have a title that attracts visitors’ attention and calls visitors to join the interactive opportunity. The title, like a tagline, is different from the information. Thus, there has been a logical and systematic sequence in the labels to follow in the traditional one.

Moreover, in Exploratorium’s example, exhibit labels generally include diagrams of how visitors engage the exhibit rather than photographs because of focused the aim and lack of noise. As a new approach, new labels have a title, tagline, and questions that align with the design of the interactive exhibit (Serrell, 2015). Thus, the exhibit's design and content can shapehe design of exhibit label(Borun & Adams, 1992; Serrell, 2015).

The EDGE project (Dancstep (née Dancu) & Sindorf, 2016) aims to find out the design of an exhibit that attracts girls’ attention more to science. For this purpose, researchers in Exploratorium studied randomly selected family groups with boys and girls between ages 8 and 13 with more than 300 exhibits within certain criteria in the exhibit design. As a part of exhibit design, the exhibit labels include drawings and images of a person. The drawing gives information on how to use the exhibit; that means what visitors should do in the exhibit. The image of a person is from a real-world context, that is, photo, models, illustrations or etc., related to using the exhibit, and/ or visitor’s reaction. In the EDGE project, researchers said that images of a person like photographs, drawing from real life context is a supportive role for girls to engage with the exhibit (Garcia-Luis & Dancstep (née Dancu), 2019); however, drawing is recommended rather than photographs from real- life because drawing is focused only one context and does not distract visitors’ attention (Serrell, 2015). Exhibit labels are not only informative text or drawings, but also they boost visitors’ social interaction collaboration and encourage discussion with others in the exhibit. Thus, the content of the exhibit labels is important to engage visitors effectively with the exhibit.

Several studies indicated that exhibit labels consisting of questions could enhance visitors’ engagement (Hirschi & Screven, 1988; Hohenstein & Tran, 2007); however, Gutwill (2006) mentioned that there was no significant difference in terms of the engaging time of visitors in an exhibit in a different type of questions. Hirschi and Screven’s study (1988) shows that there have been differences in visitor reading behavior in labels that consist of questions. In this study, questions were directed to the visitor to read the label so that the visitor could find the answer. Thus, finding an answer made visitors read the label carefully. In Gutwill's study, three types of the label were studied: suggestion, questions, and question and suggestions. Gutwill suggested that visitors mainly selected a mix of questions with suggestions about using exhibits. Also, the design of exhibit labels and questions used in the exhibit labels have been topic-specific because there are different variables to enhance visitors' engagement in the exhibit, like familiarity with the exhibit concept,ase of using the exhibit etc. (Gutwill, 2006). In this study, there was no found significant difference in visitor action and spent time, but visitors were more comfortable while reading questions and suggestion type. According to Hohenstein and Tran's study (2007), open-ended questions on the exhibit label would foster conversation and discussion between visitors about the exhibit's content, in addition to Hirschi and Screven's study. What's more, Gutwill and Dancstep (nee Dancu) studied the effects of using questions in exhibit labels to boost metacognition in science museums (Gutwill & Danscstep (nee Dancu), 2017). They (2017) found that exhibit- specific questions influenced metacognitive talk in terms of engaging time, but they also suggested that the effect of real-world questions is explored. According to these studies, it is concluded that questions used in exhibit labels can enhance visitors' learning and scientific literacy.

Conversation between visitors and the exhibit's design affects visitors' learning as a mediator. Interaction between labels and visitors depended on variables such as age and exhibit type (Borun & Dritsas, 1997). Informal science learning occurs in adults and children differently. In parent-child interaction in the interactive science exhibit, the parent behaved like guidance for a child. Hence, a parent or adult read more labels than a child, and the parent used the exhibit label to direct the child to use the exhibit or express the phenomena in the exhibit. Therefore, family label text should include attractive questions, simple and brief information rather than scientific explanation, and small parts as a chunks to ease understanding, which is more fun in the label than pure science sound (Borun & Dritsas, 1997). Labels are also essential tools for parents to engage the exhibit with their children, and so labels help parents how to guide their children (Hall, 2015)

According to previous studies, the role of the exhibit labels is summarized as providing guidance and instruction and explaining the phenomenon on the exhibit. Labels could be a mediator for effective learning (Hall, 2009), and scaffold for visitors (Wang & Yoon, 2013). In the light of studies on exhibit labels, there are some suggestions and recommendations.

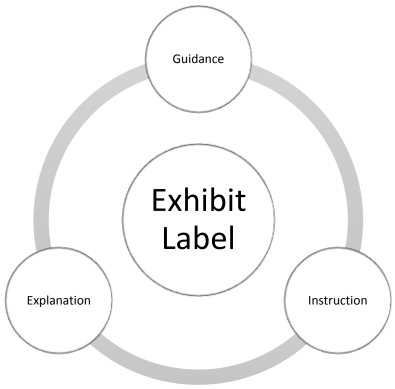

Figure 2.5. Role of exhibit label

Both Serrell (1983) and Bitgood (1989) stated deadly sins in exhibit labels that list common mistakes in exhibit labels.

1. Too long and wordy
2. Too technical for the intended readers
3. Boring, with inappropriate information
4. Badly edited, with mistakes in grammar, spelling, or syntax
5. Too small- tiny words crammed on a 3x5 card
6. Colored in a way that makes reading difficult or tiresome
7. Badly placed, causing neck, back, or eye strain in the viewer
8. Fails to grab the attention of the visitor

9. Codes are open to ambiguous interpretation
10. Is lost among the visiual noise of too many other labels and objects
11. Doesn’t adress visitor knowledge,interest, and misconceptions

When it is examined the lists of characteristics of exhibit labels, exhibit labels can consist in two parts: physical characteristics of the label like color, letter size, and meaning and structure of label like the voice of the writer, information etc. To engage visitors with exhibit, some techniques are used in exhibit labels. One technique is using questions to attract visitors’ attention (Gutwill & Dancstep (née Dancu), 2017).

2.3 Summary of Literature Review

In the literature review, learning in informal learning environment is focused in terms of environment and design of exhibit in a pedagogical approach. The study's purpose is to show variations of exhibit labels in science museums and science centers. Informal science learning and informal science environment were introduced for the purpose of visitors’ learning. Then, exhibits in science museums and science centers and the design of exhibits for science museums and science centers were introduced as a resource for learning in museums/ centers. When examining the literature review, learning in informal settings is complex and has varied outcomes, as mentioned in informal learning.

There were several studies in this approach in terms of social interaction and metacognitive learning. However, the studies might not be enough to draw a picture of the design of exhibit labels as well as guidance for exhibit label designers in both contents and ways of providing information. Also, as mentioned Gutwill’ s (2006) study, exhibit label is topic-specific, and so there should be studied with different approaches.

CHAPTER 3

METHODOLOGY

The purpose of this study was to explore the variations of labels used for the interactive exhibits in science centers and museums. More specifically, the aim of this study was to understand:

- The content of the labels used in the interactive science exhibits
- The way they guide visitor-exhibit interaction
- The way the scientific phenomenon is presented to the visitors

To figure out this aim, the research questions were formulated as follows:

1. What are the contents of labels used for interactive exhibits in science centers?
2. What are the variations in each content (e.g., directions, explanations, extensions) of labels across the field of science and science centers?

Content analysis, one of the qualitative research methods, was used to respond to the research questions.

3.1 Research Design

Qualitative research helps us gain more insight into the research problems with insufficient literature to express the phenomenon from data (Creswell, 2012). Content analysis is a suitable method to analyze text to answer the current research questions. Content analysis can be used for written materials like newspapers, textbooks, journal articles, and thesis to be analyzed in detail. Content analysis can show how to behave differently in the same phenomena, how to perceive the ideas from a document, and what to compare between works (Fraenkel et al., 2012). Content analysis is used as a research technique to make replicable and valid inferences that clearly show the relation of meaningful matters -texts, symbols, images, and sounds- in the context used (Krippendorff, 2004). Thus, content analysis helps to identify communications characteristics and messages that underline the meaningful matter. This study analyzed the text labels for interactive exhibits to identify educational messages and guiding styles.

The content analysis is most appropriate for the current research study. The labels for interactive exhibits consist of text and illustrations to inform and guide visitors' use and understanding of exhibits in science centers. In this study, the content of the labels to understand the existing elements in the interactive exhibit was examined.

Data collection and analysis were performed simultaneously. According to Creswell (2012), qualitative data analysis follows a simultaneous and back-and-forth process, from collecting to analyzing data. The researcher reads the collected data repeatedly to construct a deep understanding of the data. During the analyzing process, data interpretation depends on the researcher's perspective (Creswell, 2012).

Due to covid 19, the data in this study were collected in two years. After each collected data, the analysis process was repeated and developed with new data. First, the data were collected and made available for analysis. The researcher reviewed these data, and units were determined before the analysis. These units were determined as title, phrase, sentence, question, and paragraph. These determined units were coded according to their meanings. Codes with similar meanings were brought together to form the categories. The codes in each category were separated according to their similarities and differences, and sub-categories were also formed during this process. Data was repeatedly reviewed during and after the generation of each category and subcategory. Although the formation of categories and sub-categories depends on the nature of data, it was supported by the opinion of colleagues interested in this subject and by the literature. The research design and the process are represented in Figure 3.1. The steps of the research design were detailed in the following sections.

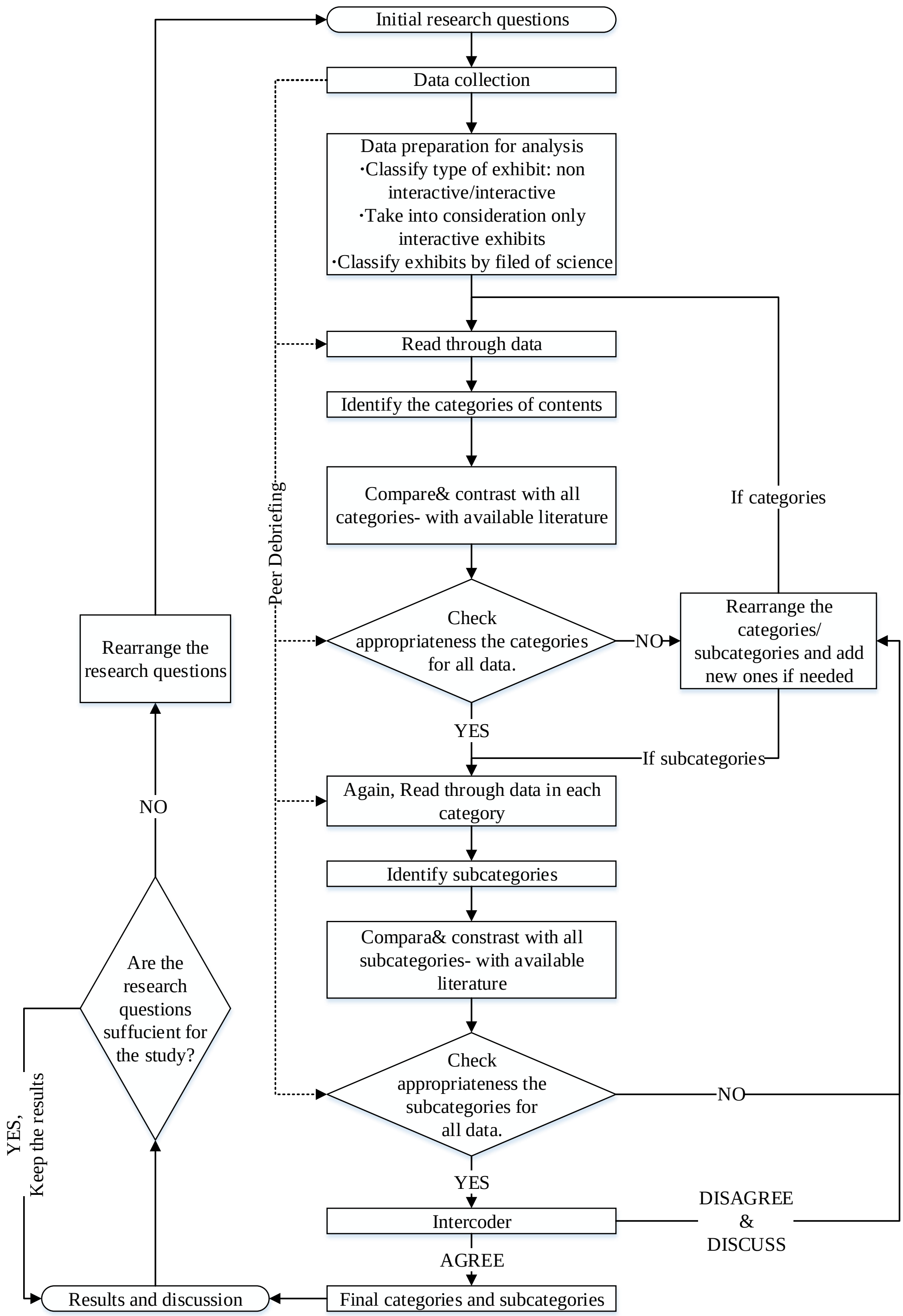

Figure 3.1. Research design process

3.2 Sampling

In this study, the labels for the interactive exhibit were analyzed in the science centers; therefore, the science centers were grouped according to financial supporters in Turkey (*TÜBİTAK Bilim Merkezleri*, n.d.-b). There were found twenty-two science centers with interactive science exhibits and systematic labels. TUBİTAK established six science centers, the municipality established thirteen science centers, and the different universities established three science centers in Turkey.

Due to the Covid-19 pandemic, science centers were closed sometimes; thus, samples were collected from open and permitted science centers at different times. In this research, convenience sampling was used as a method to select science centers. Convenience sampling is described as a method of selecting a random or systematic non-random sample that is extremely hard (Fraenkel et al., 2012). Because of COVID-19, samples were chosen from accessible and permitted science centers following financial supporters.

The sampling techniques include some stages in Figure 3.2. Science centers were divided into three groups in accordance with financial support, and then data were obtained from each group. Finally, the labels were chosen from interactive exhibits. The data for this study was collected from six science centers' exhibit labels, and interactive exhibits' labels were chosen for the analysis. Science centers were divided into three groups: three supported by TUBİTAK, two supported by the municipality, and one supported by the university that influenced the design of labels for the interactive exhibit. These labels belong to a permanent exhibit at science centers. There were found 417 interactive exhibits in the field of science: physics (n=279), life science (n=39), earth science (n= 32), space science (n=22), technology (n=19), math (n=15) and chemistry (n=11) in selected six science centers.

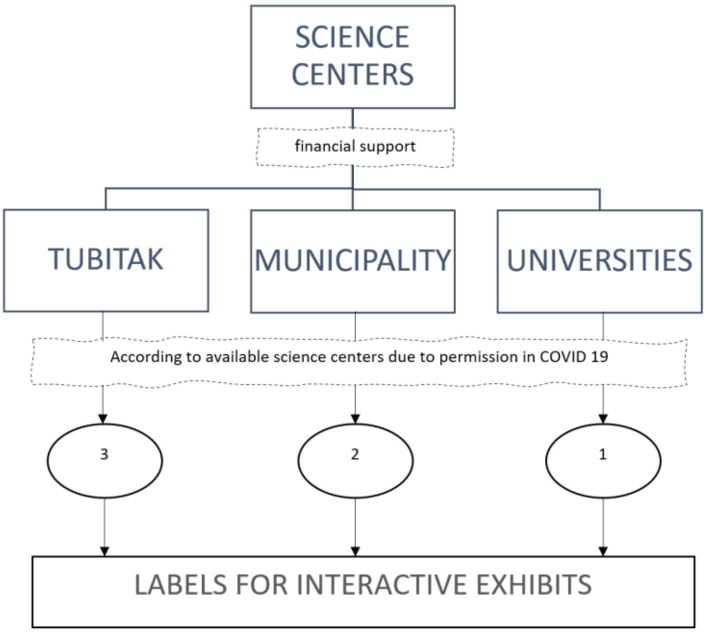

Figure 3.2. Sampling Techniques

3.3 Data Collection

In this research, the data were documented and ready in science centers. The researcher collected the data from science centers by taking photographs. However, science centers were closed during the research because of the Covid- 19 pandemic. Therefore, data were collected when science centers were opened during the period of them between 2020-2022.

The photographs were categorized considering interactive science exhibit and field of science. The categories were determined in accordance with categorization in science centers from the researcher’s notes and the researcher’s understanding. The field of science were physics, life science, earth science, space science, technology, math, and chemistry in selected six science centers.

3.4 Data Analysis

As mentioned in the research design, there were mainly two parts of this study the content of the labels for an interactive exhibit and ways of educational massage conveyed. First, the unit of analysis was determined for the analysis. The units ranged from titles, phrases, paragraphs, sentences, and questions to illustrations with or without explanation included in the interactive exhibit labels. These units were coded according to the messages and the way the messages were provided. The manifest coding was used.

An iterative data analysis was performed in a series of stages, as shown in Figure 3.1. The collection of data and analysis of data was conducted simultaneously. All data were examined repeatedly, and the final version was reached based on the related literature, peer debriefing, and intercoding agreements. The data were coded several times, and the codes were compared repeatedly. Similar codes referred to the same teaching purpose for the units of labels' text were gathered under the same categories. Then, each main category found in the labels for the interactive exhibit was examined repeatedly, and subcategories were determined in accordance with the ways of providing information in each category. In addition, the main categories and their subcategories were searched in the literature and discussed with peers. It was the general process in the research; on the other hand, data analysis was carried out in three stages.

The first stage of the data analysis was to identify the content of labels for the interactive exhibit, which is the type of information presented to visitors related to the exhibit. While analyzing this study, the obtained data were read and classified according to similar contents. The information with difference purposes was separated, and the information presented to the visitor with a similar purpose was brought together. Then, the main categories were formed. As a result of this classification, the types of information included in the label emerged.

In the second stage of the analysis, the focus of attention was shifted to the way the contents were represented to visitors. The similarities and differences within each category were revealed. Then, sub-categories were created in order to bring together similar ways. It defined and clarified the categories and their sub-categories with the nature of the labels for interactive exhibits. While doing these analyses, the classification used in the literature, such as analogical text and refutation text, were also used.

The final stage of data analysis was to check the consistency between categories and subcategories. While repeated categories and subcategories were removed, similar categories and subcategories were brought together. The data were reviewed in accordance with the last version of the main categories and their subcategories.

3.5 Researcher Role and Profile

The role of the researcher is vital in the nature of qualitative research. In this study, the research questions are answered using qualitative research methodology, and it is emphasized that researchers' role in qualitative research is immersed in their research (Fraenkel, Wallen, & Hyun, 2011). In this research, the researcher interacts with labels to interpret.

The researcher has been in the science center voluntarily during her undergraduate education. Before this study, she also worked designing interactive exhibits for science centers for a year as a content writer and preparing the written text in labels and signage of the interactive exhibit. During the research, she continued her master's study in Science Education at Middle East Technical University and has worked as a research assistant in the Mathematics and Science Education department.

The researcher's prior knowledge, assumptions, and positions are essential to interpretive data in this research. Therefore, the analysis of data has resulted from the researcher's interpretations of the work that is limited by the researcher's understanding of the literature review and background. The researcher did not manipulate the label writers or was not manipulated by writers. The research findings that will represent later in Chapter 4 were based on the researcher's understanding.

3.6 Trustworthiness

The nature of this study is qualitative research. Qualitative and quantitative research has different validity and reliability issues and techniques because of the nature of the research design (Fraenkel et al., 2012). Lincoln and Guba (1986) examined credibility and transferability concerning trustworthiness. From data collection to data analysis, the trustworthiness issue was taken into consideration throughout the current research

3.6.1 Credibility

There are several techniques for determining whether the study's findings correspond to the reality of the situation. According to Lincoln and Guba (1986), the research design should be appropriate to enhance a study's credibility, and the credibility of findings should be approved. In this perspective, peer debriefing and intercoder agreement were used.

3.6.1.1 Peer Debriefing

Peer debriefing is "obtaining an individual outside of the study to review and evaluate the report" (Fraenkel et al., 2012). In this research, the researcher examined the data independently. During the analysis, the researcher shared and expressed the categories and subcategories with two Ph.D. students in science education. Until agreement with categories and subcategories, the findings were discussed with Ph.D. students. Thanks to peer briefing, biases in the interpretation of data were eliminated, and the description of categories and subcategories created was made more transparent.

3.6.2 Transferability

The goal of this study was not to form a guideline that could be exactly replicated in other science centers to find the same outcomes. The purpose of this study was to show variations in labels for interactive science exhibits at science centers. According to Lincoln and Guba's perspective (1986), if explanatory interpretation is included in the findings, others who wish to apply some parts of the findings may judge match level or familiarity.

The collection of data and analysis of data were explained detailed. Findings in the current research were expressed with examples from the labels for the interactive exhibit, and each example was explained. In other words, in this study, the elements of the labels for an interactive exhibit and their subcategories were informed by researchers, which is relevant to the design of the exhibit and the design of the labels for interactive exhibits. Thus, the transferability of the study is applicable to the extensive study of informal science learning and the design of interactive exhibits at science centers.

3.6.3 Dependability and Confirmability

Dependability is defined as the consistency and stability of the result, and confirmability is defined as the objectivity of the result in the study (Lincoln & Guba, 1985). Dependability provides consistency between obtained data and the result of data following the purpose of the research. On the other hand, confirmability indicates that data results are supported by data rather than researcher bias. Therefore, this study explained data collection, analysis, and results in detail. Also, the researcher's role and profile were explained to eliminate the researcher's biases. In addition, the advisor had a role in examining the analysis process and checking the consistency between the data and results of this study.

3.6.3.1 Intercoder Agreement

Intercoder, interrater, and agreement refer to the consistency and stability of responses to various data by multiple coders. After creating the categories and subcategories, the researcher shared and explained the findings from the study to a Ph.D. student in science education as an intercoder. The data were selected in 10% of exhibits in each science center. As a result of the intercoder, 95% agreement was agreed upon when compared with the researcher.

3.7 Limitation of the Study

The study is limited to the researcher's perceptions and understanding of the nature of the data. This study is limited to labels obtained from selected science centers. Exhibit labels in different science centers may also have a different design that affects the content. Also, different science centers may have a different exhibits, which can also affect on variations in labels. This study is limited to the labels collected from selected science centers within a certain period. The data were collected between June 2020 and May 2022, and the researcher once visited the selected science centers and took photographs and field notes. The labels in science centers may be renewed after being collected. Moreover, the exhibit in science centers may be changed or renewed after this date.

CHAPTER 4

RESULTS

In this chapter, data analysis and interpretation in the light of the research question were represented. The purpose of the study was to elicit and identify the contents of interactive exhibit labels in science centers. According to the research questions, the analysis of data and results were divided into three main parts. The study was focused on analyzing content of the labels and ways of providing informations. Firstly, the content in the label focusing on the interaction between visitors and exhibits was described and categorized. Secondly, the way the explanations were constructed about the scientific phenomena in the labels was analyzed. Finally, the extensions in the labels for interactive exhibits was explained and categories.

The data sources were obtained from science centers by taking photographs of labels and the corresponding interactive exhibits. The obtained data were analyzed by the content analysis approach that was explained in the Methodology Chapter. The content of the exhibit labels usually includes titles, texts, and images. However, in this current study, the labels for interactive exhibits were analyzed by manifest content, so it was determined which contents were provided in the labels. Then, these contents were interpreted according to their purpose. The categories and subcategories emerging from the analysis were represented in Figure 4.1. In the following sections, I will detail these categories.

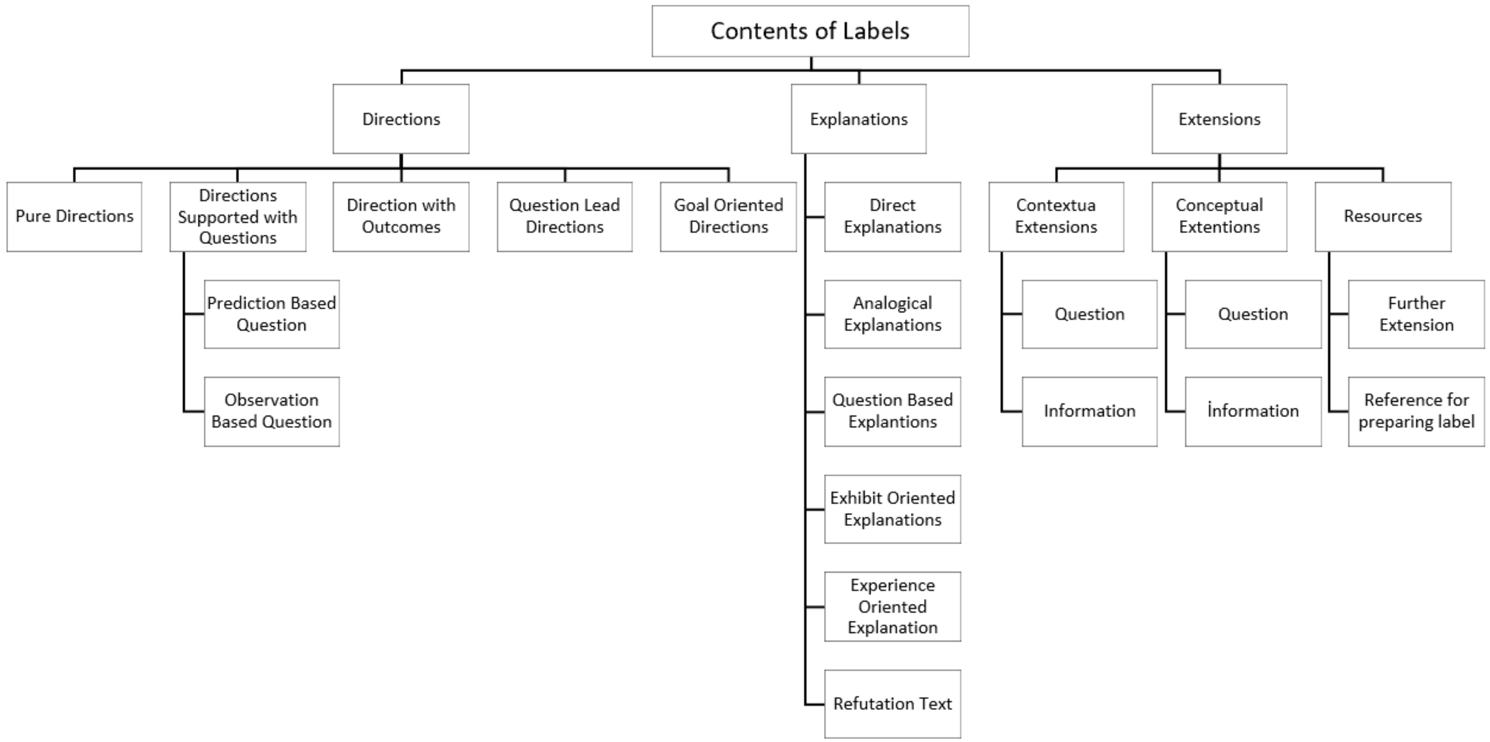

Figure 4.1. Contents of labels for interactive exhibit

4.1 Directions: How to Interact with Interactive Exhibits

One of the major parts of content common in all exhibits is the directions. This category refers to the content of labels giving visitors information about how to interact with the corresponding exhibit. When the directions provided by the labels are analyzed, there emerge some variations among them according to the way the directions were presented. These variations were categorized as pure direction, direction supported with question(s), direction supported with outcomes, question(s) lead directions, and goal-oriented directions. The types of directions provided by the labels were presented in Figure 4.2.

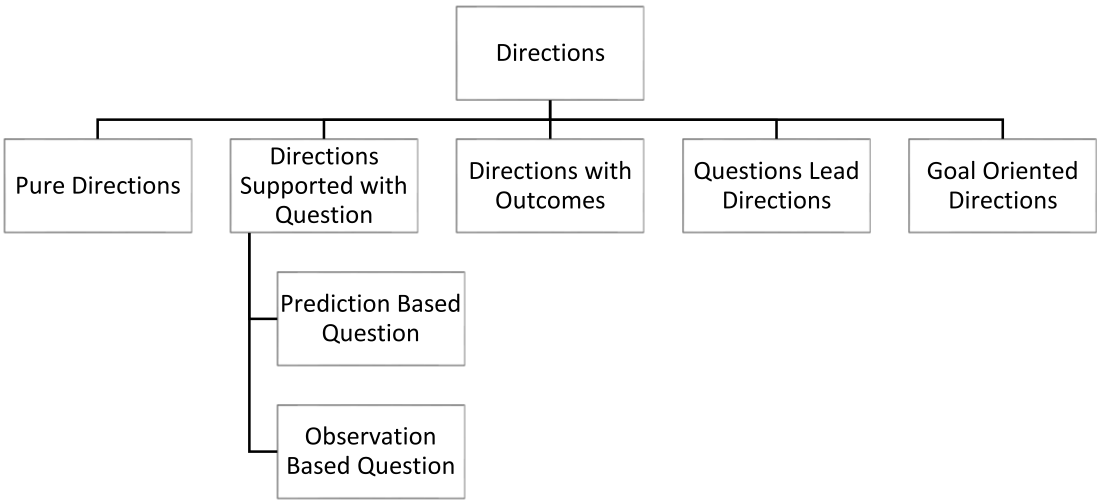

Figure 4.2. Type of directions provided by the labels

4.1.1 Pure Directions

Pure direction refers to the directions given explicitly to visitors in a cookbook manner. Directions are given in a step-by-step procedure like a cookbook without giving any other information or questions related to the exhibit

In the pure direction, the information was about what to do with the exhibit. There were command sentences such as *push the button* or *pull the string*. The sentences generally were short and clear. The content of interaction with the interactive exhibit was like the user manual of the exhibit for visitors. Several examples from the analysis of data are as follows.

Example 1:

- Try to pull the metal ball
- Then, push the red button

In this example, the direction was clear. There was a heavy metal ball. When pushing the red button, the air blew under the metal ball. There were commands for visitors to engage with the exhibit,

Example 2:

- Stand on the platform with your arms outstretched
- Have someone start you spinning slowly
- While spinning, pull your arms in against your body.

The direction in the example was clear and step by step procedure for the visitor. The text was related to how to use the exhibit, like a user manual.

Example 3:

- Pull both discs together at the same point
- Release free both discs at the same time and point

Also, visitors could follow the procedure to play with the interactive exhibit in this example. The text included how to manipulate the exhibit.

Example 4:

- Close the valve by turning the lever to the right
- Start the engine by turning the wheel and observe the change in the needle

- Observe the change by placing your hand on the copper coils

Like previous examples, there were step-by-step procedures for the exhibit and how to manipulate the exhibit. As seen in the examples, the direction was clear and step-by-step procedures for visitors. The text included direct guidance for visitors to use the exhibit. Visitors could find what to manipulate in the exhibit. Also, if the exhibit had some digital parts to observe change, like a voltameter or a thermometer, the information directs the visitors.

4.1.2 Directions Supported with Questions

Direction is given step-by-step procedure on how to use the exhibit and asking question(s) to visitors about the exhibit. Questions are usually aimed at predicting or observing the outcome of a direction. In the directions supported with a question, the text seems to speak with visitors and support visitors to engage with the exhibit effectively.

Due to the meaning of the questions, the direction supported with the question was divided into two categories: Prediction Based Question and Observation Based Question. Several examples from the analysis of data are as follow.

4.1.2.1 Directions with Prediction Based Questions

Directions with prediction-based questions refer to asking the result of given directions before using the exhibit. Prediction questions are generally open-ended, like *what you think* or *will happen*. Before questions, the text includes how to manipulate in the exhibit. Prediction questions provide visitors to think about possible outcomes of the exhibit. Even though the text starts with pure directions, it continues with prediction questions.

Example 1:

- Release two discs simultaneously with the same mass and radius from the same height. Which discs do you think will win the race? Why?

In the example, the question was related to prediction. Before visitors try the exhibit, the question on the label could make them think about the possible results of the exhibit and their reasons.

Example 2:

- Red, blue and green lights shine on the wall.
- What color do you think your shadow will be? Try!

In this example, there were two different questions. The first question was related to the concept of color. The second question is related to prediction before using the exhibit.

Example 3:

- How do you think the balls hung on ropes of different lengths move in the exhibit? Do they move together or separately from each other?

In this example, there was a question. The question asked predictions about the movement of the pendulums with different lengths of rope. Before using the exhibit, the question prompted visitors to think about the possible motion of the pendulums when released simultaneously and in position.

4.1.2.2 Directions with Observation Based Question

Directions observation-based questions refer to paying attention to the outcomes of given directions after using the exhibit. Observation questions can be close-ended or open-ended, like *what happen, do you notice, or do you observe*. Before questions, the text includes what and how to manipulate the exhibit. Observation questions provide visitors to look at the outcomes of the exhibit, and experience with the exhibit. Even though the text starts with step-by-step directions, it continues with observation questions.

Example 1:

- Release the first ball in the exhibit. What happens?
- Release the second ball in the exhibit. What happens?

This exhibit had two tiny metal balls with different masses and a timer. The direction was about how to use the balls in the exhibit. After each step, questions direct visitors to observe the exhibit's physical response.

Example 2:

- Follow steps 1, 2, and 3 to draw a sand picture in the figure
- Watch the pattern appear- be patient; it takes a little time
- Next time, try moving the slider up or down, or changing the spot where you let go
- What happens to the pattern?

In this example, the pendulum was suspended by two ropes, and these ropes were connected with a sliding piece at one point. The pendulum had a container where visitors could put sand. The direction was given step by step using illustrations for visitors. After manipulating the exhibit, the question "*What happens to the pattern?*" was related to observing the exhibit changes.

Example 3:

- Position the see-saw in the center, on the pivot point.
- Lift and slide the weight to one end.
- Push the other end of the see-saw down to raise the weight.

- Now lift and slide the weight towards the pivot point and try again. Do you notice the difference?

In the example, there were steps for visitors and questions asked at the end of the directions. The question made visitors aware of different experiences in each step, related to observation and comparing each step experience.

Example 4:

- Sit on one of the chairs
- Pull the rope to lift yourself upwards
- Try them all; which one is easiest?

In these examples, directions were guidance on how to use the exhibit. Questions differed from others because they made visitors compare the experiences with the exhibit.

Example 5:

- Hold a lens in front of the lamp. Move it slowly toward the screen until a clear image appears there. What do you notice about the images?
- Hold one of the paddles in front of the lamp and move it toward the screen. What kind of images can you make? Do different paddles make different kinds of images?
- Raise the small screen. What happens to the images you make when you move the screen closer to the lamp?

There was direactions, and then questions about results of these directions. In this example, the text was made of direction- question. After each manipulation in the exhibit, the visitors were asked about observations, so visitors were made to pay attention observing the system.

4.1.3 Direction with Outcomes

Direction is given explicitly in labels, and the exhibit's results and observations are written directly before using an exhibit. Direction with outcomes is like a fortune teller. Therefore, visitors know what to observe before using an exhibit. The text includes questions or statements to explain the outcomes of the exhibit. These statements and questions consist of observation and experience with the exhibit. Some tag questions (e.g., *don't you?*) were found asking for confirmation about the experience.

Example 1:

- Shown in the figure, try to look at the exhibit from green approvable angle. Try to touch the object that you see above the exhibit
- Now, try to look at different angles and touch the object you see. You cannot touch the object you see, can you? The object you see looks like very reel, but it is not there.

In the example, there were directions about using the exhibit, and what visitors experienced in the exhibit were given directly. The direction was clear, and step-by-step how visitors use the exhibit. Before trying, visitors knew what to experience with the exhibit.

Example 2:

- Combine and close the two hemispheres properly in the exhibit; there is no gap between them.
- Plug the vacuum hose into the system shown in the figure. (Be careful, the vacuum hose and valve are parallel and perpendicular, as shown in the red circle. The valve should be open in this case.)
- Push the red button on the exhibit

- Run the system for 10 seconds, then turn the valve vertical to horizontal shown in the green cycle figure. The valve should be closed in this case.
- Push the red button again, and remove the vacuum hose from the system. Then, try to separate the hemispheres by holding their arms. You do not separate them, don’t you?
- Turn the valve hose into vertical, and try to separate them. You notice that hemispheres are separated easily, don’t you?
- Thank you for closed the system shown in the figure after you tried the exhibit.

In the example, the direction was directly written step-by-step for using the interactive exhibits; however, experiences with the interactive exhibit were also written and asked explicitly after the directions. The meaning of such statements related to the visitor’s experience was an agreement with the observation and experience with an interactive exhibit. That means the label guided how and what to do with an interactive exhibit first, indicating the situation to be observed. Thus, the label helped visitors know what actually to observe before using the exhibit. Questions were simple and confirmed the experience.

Example 3:

- Turn it by holding the handle on the right side of the assembly as seen in the picture. As you continue to nail the handle, examine the movement of the metal pipes.
- Notice that the wave image formed when the metal pipes in the 1st part shown in the picture move up and down, move to the right (or left), and that the wave image that occurs when the metal pipes in the 2nd part of the picture move up and down in the same direction as the pipes.

In this example, the direction was given directly as the others. However, the phenomenon that visitors had to observe was explained in detail. The label's expression included where visitors look at parts of the exhibit specifically and how visitors interpret the exhibit's movement.

4.1.4 Question Lead Directions

Question lead directions refer to the direction given as a question. Direction starts with an engaging question. These questions concern the interactive exhibit's phenomenon, context, concept, and procedure.

In this type of label, the questions directed the usage purpose of the exhibit. Questions were varied in terms of possible prior knowledge and using exhibit. Questions were like, " *why did you do something?, can you do something?, or how does it work?*". Questions could be followed by pure directions or suggestions about using the exhibit. Several examples from the analysis of data are as follow.

Example 1:

- Although we cannot ride a bike slowly because of unbalancing, why do we ride a bike fast?
- Sit down turn table, and then take the wheel turned faster by your friend. Now, try to turn the faster wheel right or left. What do you observe?

In the example, it started with an interesting question from daily life. The purpose of the question was like a bridge between visitor, concept, and exhibit. Then, a suggestion for visitors was written on how to use the exhibit to answer the question. In addition, the visitor could make inferences about how to use the exhibit thanks to questions. Visitors could turn the wheel in the exhibit slow and fast.

Example 2:

- Can you see all of the stars?
- Turn mechanism using lever to see different sky views
- Move the telescope through the different areas

- How does light pollution affect your vision of the sky?

In this example, it also started with a question called a yes/ no question, but the meaning of the question provided for visitors to think about the concept of observing stars in daily life. Then, a direction was given on how to use the exhibit. The question was linked between daily life experiences and the exhibit. Thus, the question gave a clue for visitors using the telescope and thinking about their prior experience.

Example 3:

- How does magnetism work?
- Unplug the electrical wires if they are connected.
- Move the rod left and right
- Now plug in the electrical wires, what happens to the rod?
- Try to move the rod left and right now, is there a difference?
- Swap the plugs of the electrical wires, what happens now?

As seen in the example, there were different questions about the exhibit. When examining the example, it was closed to inquiry-based instruction. The first question was related to the concept of the exhibit, and it gave some ideas about the exhibit. When reading the question on the label, the exhibit's topic was clear to be magnetism in science; however, the topic given in the question was too general to understand what to do in the exhibit. Then, there are many suggestions for manipulating the exhibit and questions about observations.

Example 4:

- Do you prefer the long rope or the short one when you want to ride on a swing? Why?
- Turn the lever indicated by the arrow in the picture, then lift the board and quickly release the board back. After a while, observe what happens in the movement of the balls suspended on ropes of different lengths.

- Do the balls move together or different from each other? So, what do you think the movements of the balls?

In the example, at the beginning of the label, there was a question linked with a daily life example. The question prompted visitors to observe the difference between long and short ropes, even though there was a direction. In the exhibit, there were pendulums with different lengths of rope.

4.1.5 Goal Oriented Directions

Goal-oriented direction refers to the goal given to visitors to achieve using the exhibit. The labels contain hints or directions about the object in the exhibit.

In the goal-oriented direction, a statement explained the task to a visitor. Generally, there were words such as *create* and *make*. The content of interaction with the interactive exhibit was achieving or reaching something. Several examples from the analysis of data are as follow.

Example 1:

- Choose the angle and height that will land the ball in the target
- Adjust the angle of the ramp using the crank wheel.
- Release the ball from your chosen height
- Observe where the ball lands
- Missed? Check the screen to help you figure out why

In this example, visitors had a goal to hit the ball toward the target, so they chose the angle and height to hit the target. There were some hints using the exhibit, and hitting the target.

Example 2:

- Create a system that illuminates a light brightly or dimly.

In this exhibit, there were some electric circuit elements. There were hints of what the elements are and how elements are connected. However, there were not found hints about goals. Visitors were expected to create a defined system and follow the hints on connecting the electric circuit elements.

Example 3:

- Make a hovercraft with a variable fan speed.

Similar to the previous example, there were electric circuit elements to construct a mini- hovercraft. The interactive exhibit included brief information about electric circuit elements. To reach the goal, visitors must think about a goal, and they have to find their own solution for these tasks by using the given elements in the exhibit.

4.1.6 Types of Directions Across Science Centers and Fields of Science

In this section, the ways of providing directions were examined in labels for interactive exhibits. Directions: how to interact with the exhibit refer to engaging with the exhibit. It was found that there were more than one type of direction in labels. These were a pure direction, direction supported with a question, direction with outcomes, question lead direction, and goal-oriented direction. Even though labels had one type of directions, some had more than one style.

Figure 4.3 showed that pure directions (45%) were the most used directions found in the labels. The second most common interaction with exhibit style was directions supported with questions (28%). The other interaction with exhibit styles in labels were directions with outcomes (26%), question lead directions (17%), and goal-oriented directions (8%). Question lead directions and goal-oriented direction were found the least in labels. In addition, the direction supported with question was divided into two groups: Prediction Based Question and Observation Based Question. In this category, direction supported with questions included observation questions (89%), and a few prediction questions (22%).

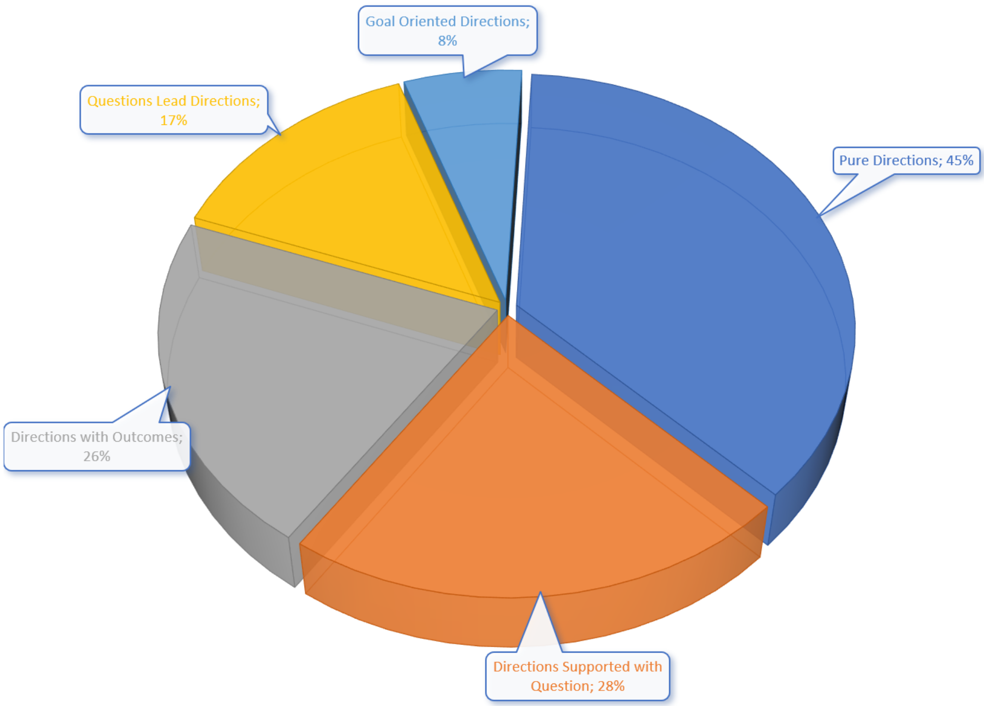

Figure 4.3. Distribution of directions used in labels

Figure 4.9 showed the frequency distribution of directions found in field of science. The frequency distribution varied among the field of science, even though the same direction styles were used. Pure directions were the most used in physics (40%), life science (49%), earth science (44%), space science (41%), technology (63%), and chemistry (45%); however, goal-oriented directions were the most used in math (60%). In addition, there were not found directions with outcomes in math and goal-oriented directions in life science. Each field of science had different ways of providing interactions between visitors and exhibits in Figure 4.9.

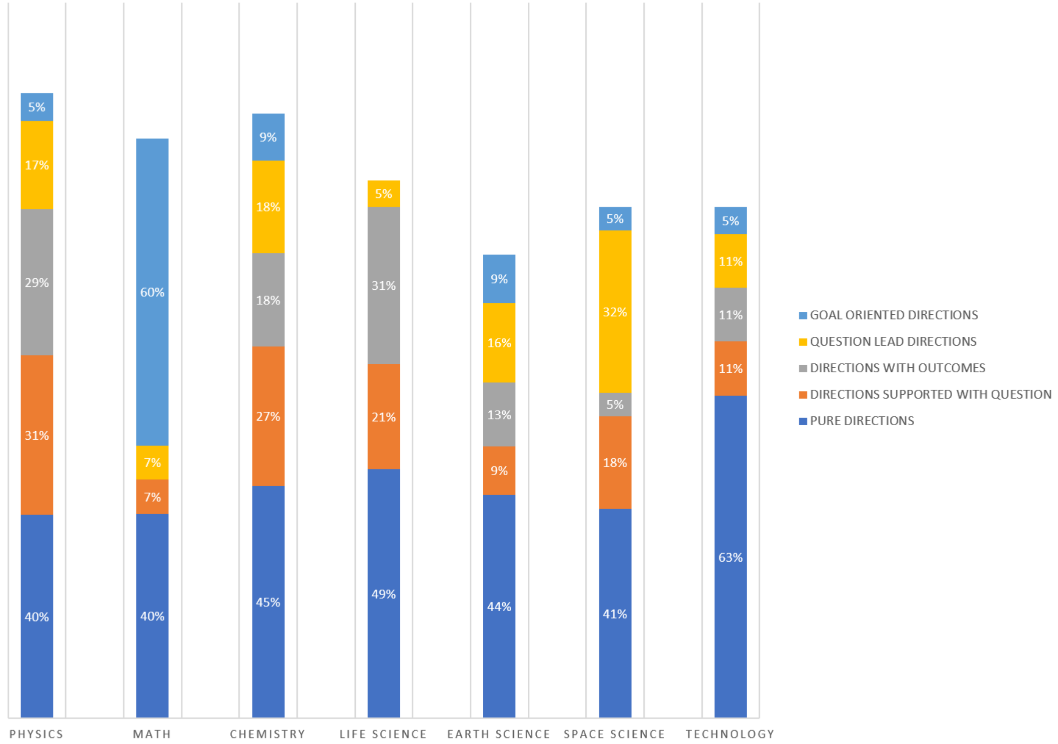

Figure 4.4. Distribution of directions used in field of science

The Table 4.1 and Figure 4.5 showed the frequency distribution of directions found in science centers. Even though science centers used the same interaction with exhibit styles, their frequency distribution was found to be different in all of them. The most found interaction with exhibit style in labels for the interactive exhibit was varied among science centers. Pure direction was the most used in T3 (61%), M1 (58%), T1 (51%), and T2 (42%). On the other hand, the question to interact with exhibit was the most used in M2 (59%), and direction with the result of the exhibit was the most used in U1 (55%). Besides that, goal-oriented direction was the least used in T2(10%), T1(10%), M2 (9%), M1(3%), and T3(3%). Direction with the exhibit result was also used in M2 (9%), and question to interact with the exhibit was the least used in U1 (3%). Each science center had different ways of providing interaction between visitors and exhibits in Table 4.1 and Figure 4.9.

Table 4.1. Distribution of directions used in science centers

	U1	M1	M2	T1	T2	T3
Pure Directions	24%	58%	30%	51%	42%	61%
Directions Supported with Question	19%	30%	39%	27%	33%	22%
Directions with Outcomes	55%	9%	9%	11%	38%	21%
Questions Lead Directions	3%	6%	59%	27%	13%	9%
Goal Oriented Directions	10%	3%	9%	10%	10%	3%

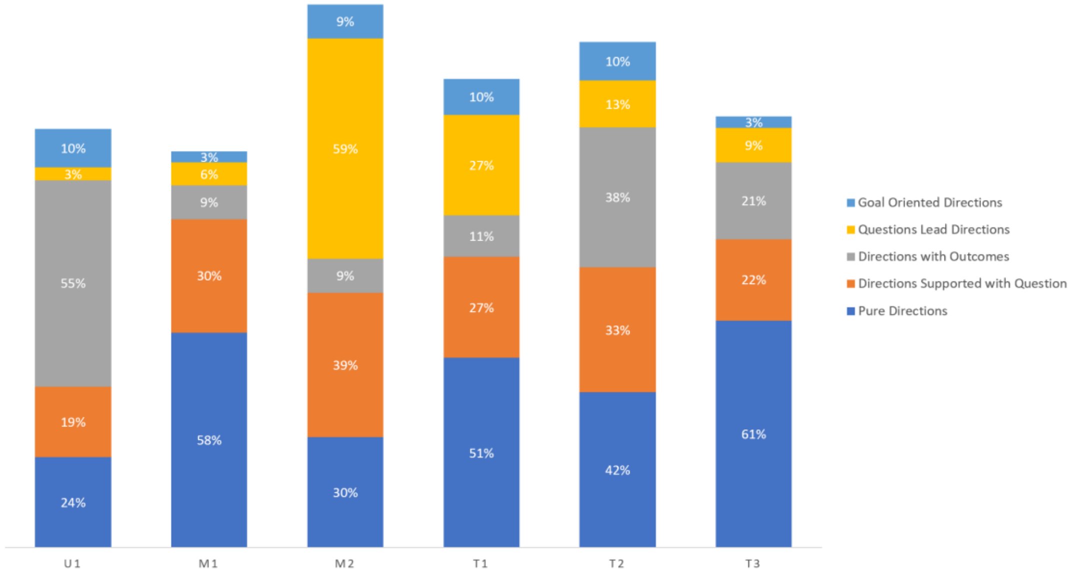

Figure 4.5. Distribution of directions used in science centers

4.2 Explanations

One of the major parts of content common in all exhibits is the explanations. This category refers to the content of labels giving visitors information about the phenomena corresponding exhibit. When the explanations provided by the labels are analyzed, there emerge some variations among them according to the way the explanations were presented. These variations were categorized as direct explanations, analogical explanations, question-based explanations, exhibit-oriented explanations, experience-oriented explanations, and refutation text-based explanations. The types of explanations provided by the labels were presented in Figure 4.6.

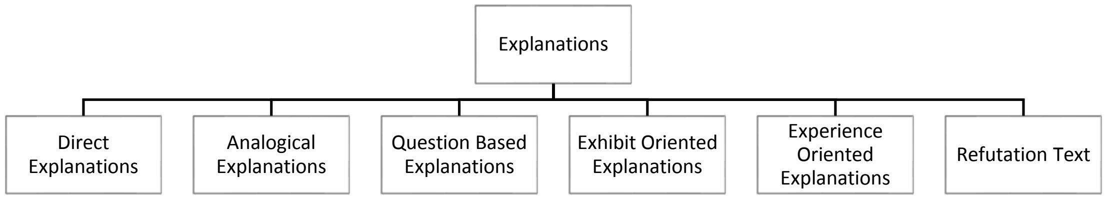

Figure 4.6. Types of explanations provided by the labels

4.2.1 Direct Explanations

Direct explanation refers to explaining the phenomena in exhibits. Direct explanation includes scientific phenomena which are not directly observable. It includes scientific facts and principles, rules, and definitions corresponding to the phenomena in the exhibit.

In direct explanation, the text in the label was what scientific principles are in the exhibit. The sentence included like, "*according to this principle*, or *the electron hits…, the definition of…*". The content of the explanation was like a textbook.

Example 1:

> According to Bernoulli's principles, the pressure of a fluid decreases if its velocity increases. For this reason, the pressure of the fluid, like air, whose velocity increases along the direction of the blower, will decrease. Because the low velocity of the air in the surrounding has a greater pressure, it pushes the ball towards where the low air pressure is. Therefore, the ball displaces when the direction of the blower is changed. If we apply a force on the ball, we encounter resistance due to this pressure. If we don't take it out of the direction of the fluid, if we remove the applied force, the ball will return to its original position.

In this example, the explanation included the scientific principle. The phenomenon in the exhibit was not observed directly by visitors because visitors probably cannot sense relationships between fluid velocity and fluid pressure. The text consisted of information about phenomena, and experience in the exhibit was explained in terms of scientific fact.

Example 2:

> Both liquids and gases have viscosities. Viscosity is the degree to which a fluid resists flow under an applied force. The lower the liquid flow rate, the higher the viscosity.

This example included a definition of the scientific term and the causal relationship between two variables. The text clarified the viscosities in fluids.

Example 3:

> The x-ray machine sends a high-speed electron beam against a metal plate. This cause the metal to radiate energy in the form of x-rays. These rays can easily penetrate soft tissue, such as skin, muscle and the internal organs. A photographic film placed behind the subject is exposed by the penetrating rays, causing it to darken when developed. But x-rays are scattered by more dense tissue, like bone, and by metals. Light shadows are left on the film where the x-rays did not penetrate. Each shade of grey left on the film represents a different density of tissue.

In this example, how the x-rays machine works is explained step by step. The text included detailed information and was supported with scientific facts about the x-ray. These were not observable things.

4.2.2 Analogical Explanations

An analogical explanation refers to an explanation of new and challenging concepts. Analogical explanations are to transfer abstract concepts into concrete. Generally, the texts use analogy explanations to make the situation understandable to the visitors by simplifying the actual situation.

There was a target concept explained using a similar concept or context. In this explanation, the text included the words "*behave like, similar t.*". The phenomenon was explained by comparing similarities between actual and simulated situations. Several examples from the analysis of data are as follow.

Example 1:

> Gravity Whirlpool in Space
>
> The balls in this model behave like objects falling into a black hole.
>
> As the balls orbit the center of the cone, they lose energy through friction with the cone's surface.
>
> Objects orbiting a black hole in space would also lose energy through friction with the dust and gas surrounding the black hole and would eventually spiral into the black hole. Once an object is swallowed by a black hole it adds its mass to the black hole and is gone forever.
>
> A black hole is black because of its enormously powerful gravity field, so strong that even light can escape it.

The concept was too abstract to understand easily in this example, and the exhibit simulated Blackhole. The exhibit was likened to a black hole, and a ball was likened to an object falling on Blackhole. In this example, two contexts were compared in terms of similarity, and the Blackhole is explained by using the similarities of these things.

Example 2:

> When you rotated the turbulent sphere, you saw patterns within the sphere similar to those observed in the atmosphere. In fact, the movement of our earth's atmosphere is similar to the movement of the medium of the turbulent sphere. Winds that occurred in the atmosphere due to pressure differences interact with the rotating Earth and create complex flow patterns.

In this example, the exhibit was to show how air turbulence happens. The target concept was atmospheric circulation which is explained by the motion of sand and liquid under rotational motion. Therefore, the sand and liquid were likened to the atmosphere of Earth. It was an analogy between two different situations.

Example 3:

> While turning the lever, you observed two different types of propagation of mechanical waves.
>
> In transverse waves, the oscillating motion of the particles in the medium is perpendicular to the wave's propagation direction. Like in the 1st part shown in the picture, when the metal pipes move up and down, the wave moves to the right (or left).

In the example, the motion of particles in a medium is likened to the motion of the metal pipes, and the phenomena in the exhibit are expressed by using concrete things. The situation in the interactive exhibit is connected with the similarity of the propagation of mechanical waves.

4.2.3 Question(s) Based Explanations

Question-based explanation refers to the questions leading the explanation. The sequence of the labels is a question-answer about the exhibit.

The text started with a question and followed the answer in the question-based explanation. Questions were related to experience with the exhibit like "*why doesn't…, how it works, did you..?"*. The content of the explanation was not direct but followed question-answer.

Example 1:

> Why doesn't the ball fall?
>
> There is a jet of air streaming out of the blower. This air jet does two things:
>
> First, it pushes the ball up. But the farther the ball gets from the blower, the least push there is. Gravity pulls the ball down towards the blower and the air jet pushes it back up. That's why the ball "bounces".
>
> Second, the air pressure in the jet is lowered because the air is moving. So when you tap the ball partially out of the air stream, the higher pressure of the surrounding still air pushes it back into the jet. Moving the cone simply shifts the low pressure area, causing the ball to follow.
>
> Why does moving air have a lower pressure than still air?
>
> The more energy that goes into motion, the less energy there is for pressure. Thus the higher the speed of the air, the lower its pressure. This is called Bernoulli's Principle.

In the example, there were found two questions. The first question was the result of the interactive exhibit, and the second was about the scientific concept. The text answers these questions step by step. So, the explanation was based on the topic of the questions.

Example 2:

> Is a straight line the fastest path from top to bottom? The ramps start and end at the same heights but have different curves.
>
> Each ball converts the energy stored in its high starting position into motion. All four balls have the same amount of potential energy, but how this energy is converted depends on the slope of ramp.

The example started with a question. The subject of the question was related to concepts and observation of the exhibit. The question did not serve only to enter the concept but also to engage the scientific explanation. There were different shaped paths, and the motion of the ball was observed in these paths. The question was related to the result of experience with the exhibit. Then, the explanation gives information about the exhibit briefly.

Example 3:

> How do caves form?
>
> Rainwater drains through cracks in the limestone. Acids in the water dissolve the rock. As the rock wears away, it leaves behind caves, sinkholes and underground streams. The flowing acidic water makes the opening larger over time.

Example 4:

> How does solar power work?

> Solar panels are made of thin sheets of silicon crystals. The silicon absorbs light bumps silicon electrons away from their atoms. The free electrons flow along a circuit to produce electricity.

The way of explanation had the same style in these two examples, 3 and 4, from different exhibits and content because labels included how things work-questions and answers for such questions. Such an explanation was about the working principle or the formation. The explanation part was related to these questions.

Example 5:

> What’s going on?
>
> Did you get a strange feeling when you jiggled your right hand and it didn’t seem to move?
>
> This strange feeling comes from a mismatch between what you see and what you feel. Experiments like this one may help us understand other situations in which one’s body boundaries seem to change, as in phantom limb or out of body experience.

Example 5 had questions and explanations. The first question was too general to specify the concept, and the question’s role was to start a new part of the label. The second question directed the intended experience with the interactive exhibit and asked about the intended experience with the interactive exhibit gained. The explanation aimed to answer the second question in the label.

Example 6:

> A person can easily communicate with whomever they want, wherever they are in the world.

> In the setup, when you pick up the phone and press one of the buttons, another phone rings in a far country. The other person picks up the phone and you immediately hear their voice.
>
> So, how do voices get to the other side during speaking via phone?
>
> When you pick up the phone, the electrical circuit is turned off. This allows you to hear the dial tone. The number you dial is transferred to the computer. The numbers tell the computer where to make the connection. Communication cables and satellite networks that usually run underground connect your phone and the other part's phone. The phone starts ringing, and you start talking.

Similar to examples 3 and 4, the question directed how communication occurred between countries via phone. The text answered this question.

4.2.4 Exhibit Oriented Explanations

Exhibit-oriented explanation refers to the explanation depending on the outcome of the exhibit. The explanation depends on observation and process in the exhibit rather than scientific fact.

The exhibit-oriented explanation text explained the concepts and context of the interactive exhibit based on observations. Such text generally included expressions like "*when you turn/ push…... then it happen….*" based on visitors' observations from the exhibit.

Example 1:

> The image of the spring is made by a big curved concave mirror. Light from the real spring bounces off the mirror to form the image you see.

> When you shine the flashlight at the image of the spring, the light reflects from the mirror and lights up the real spring. Because the real spring is lit up, its reflected image is lit up, too.

As seen in the example, the working process of the interactive exhibit was expressed briefly. Information given in the text is related to what happens in the exhibit and how the exhibit works. The process in the interactive exhibit was explained in detail.

Example 2:

> These balls each swing back and forth at slightly different rates, determined by the length of the strings.
>
> Each ball completes a set number of swings in 30 seconds from the longest (15 swings) to the shortest (24 swings).
>
> The balls start out swinging together, then move out of phase. But just when it seems random another pattern emerges. In 30 seconds, when each ball has completed its set number of swings the balls are all back together again.

In this example, the text consisted of what happens in the interactive exhibit. When reading the text, it was clear how balls with different strings swing. The text explained the observation from the interactive exhibit and clarified the observable motion of these balls with different lengths of string.

Example 3:

> When you turn the handle on the wheel in the experimental setup, the gas is sent to the copper pipes. When you compress the gas, it starts to heat up. When you release the valve, the gas cools again.

In the example, the text consisted of the interactive exhibit's working process after manipulating the parts. The text informed what to change in the exhibit and how the device works. After visitors manipulated the exhibit, the text explained the working principle of the exhibit.

Example 4:

> When the vacuum and bell ring button are pressed at the same time, the air starts to be evacuated from the glass and the sound decreases over time. When the air is completely evacuated, no sound is heard.

In the example, the texts consisted of the interactive exhibit's working process. The explanation included a connection between the steps observed in the exhibit and the working principle of the exhibit.

4.2.5 Experience Based Explanations

Experience-based explanation refers to the explanation depending on visitors' prior knowledge and everyday experience. The phenomena in the exhibit can be expressed with familiar content.

In experience-based explanation, the explanation starts to recall prior knowledge or experience. The words such as "we know and when we do…happens..." were generally included. The content of the explanation was to connect daily life experience or prior knowledge with the phenomena in the exhibit.

Example 1:

> We know that we need to apply a force to move a stationary object or to stop a moving object. The heavier the object, the harder it will be to stop or move it. Putting the shot is more difficult than catching a soccer ball.

In this example, the prior knowledge was given to clarify the interactive exhibit with "*We know*….". The text explained the content in the interactive exhibit by using prior knowledge. Also, difficulty moving or stopping heavy objects as a possible experience from daily life was used to clarify the content in the exhibit. Prior knowledge was used to clarify the science behind the interactive exhibit.

Example 2:

> We slowed down when we came round the curve on roads because this effect can throw you off the road if you go fast at a sharp curve. For this reason, velodrome tracks with an inclination angle of up to 43 degrees are built to increase road handling in a bicycle or car races. The purpose of the slopes of the runways is to form the centrifugal force during the turn in the direction of the ground. Thus, as the friction force of the vehicle with the ground increases, the road handling will also increase.

The daily life experience was used in this example to express the phenomena. Turning a curve on the road with a car was used as an experience from daily life, and the explanation was based on this situation.

Example 3:

> Sound reflection is the phenomenon of sound waves hitting a hard surface and returning.
>
> - When we shout on the side of a mountain, our voice hits the mountain and comes back.
> - The echo of the sound when we clapped in an empty room
> - The echo of our voice when we shout in the gym

In this example, the concept of the echo in sound was explained with daily life examples. These were possible visitors' experiences from daily life, and the observed phenomena and daily life examples were connected. The concept of echo in sound was expressed with some examples from daily life.

4.2.6 Refutation Text Based Explanations

Refutation text refers to a text refuting the misconception and explaining accepted scientific facts. The refutation text includes misconceptions and refutes the misinterpretation of accepted scientific knowledge (Guzzetti, 2000; Tippett, 2010).

In the refutation text, the text included common misconceptions about phenomena in the exhibit. Then, the information was to explain accepted scientific facts. Generally, the sentences included such as *".... was refuted,* and *.... look like but ....".* Several examples from the analysis of data are as follow.

Example 1:

> The famous philosopher Aristotle's hypothesis, accepted until the 17th century, when objects dropped from the same height would fall to the ground before, was refuted by the famous Italian physicist Galileo Galilei, who lived in this century. Galileo hypothesized that objects dropped from the same height and affected by an equal amount of air friction would fall to the ground simultaneously. As a matter of fact, in 1971, the astronauts of Apollo 15 showed that objects of different weights fell to the ground at the same time by dropping a hammer and a feather from the same height on the Moon, where there was no air friction, and proved Galilei's rightness.

In this example, the misconception about falling objects was expressed clearly with the historical development. It explained why heavy objects do not fall to the ground, a common misconception. Then, the text included accepted scientific information in the context of the interactive exhibit.

Example 2:

> Constellations look like two-dimensional shapes from Earth, but they are not flat at all.

> The stars in a constellation look as if they are grouped on a layer, like an image drawn on paper. But some stars are actually much closer to Earth than others.
>
> The closest star in the Big Dipper is almost 78 light- years away. The farthest is about 124 light- years away.

In this example, the information started with misinterpreting observation. Even though the stars appear to be in the same position as Earth, their positions relative to Earth are different. The misconception can be explained by using the example of the distance of the stars in the same constellation.

Example 3:

> Despite Galileo Galileo's claim that "all objects fall at the same time regardless of their mass", this exhibit shows that rolling round objects do not fall at the same time even with the same weight. We see that the rate of acceleration (angular acceleration) of rolling bodies depends not only on the mass but also on the distribution of mass on the body.

This example is slightly different from previous examples. The misconception in one of the concepts can cause misinterpretation in a different concept, and the motion of a falling object and a rolling object were compared.

4.2.7 Types of Explanation Across Science Centers and Field of Science

In this section, the ways of providing explanations were examined in labels for interactive exhibits. When the explanation of phenomena in the interactive exhibit was examined, it was found that there were more than one explanation type. These were the direct explanation, analogical explanation, question-based explanation, exhibit-oriented explanation, experience-oriented explanation, and refutation text-based explanation. Even though labels had one explanation style, some of them had more than one explanation style. The distribution of explanation style was represented over collected data in Figure 4.7 and the field of science in Figure. In addition, the distribution of explanation styles was represented across science centers in Figure 4.14.

Figure 4.13 showed that direct explanations (70%) were the most explanation found in the label. The second most common explanation style was exhibit-oriented explanations (45%). The other explanation styles in labels were question-based explanations (16%), experience-oriented explanations (16%), analogical explanations (7%), and refutation text-based explanations (1%). The least refutation text-based explanation (1%) was found in examined labels.

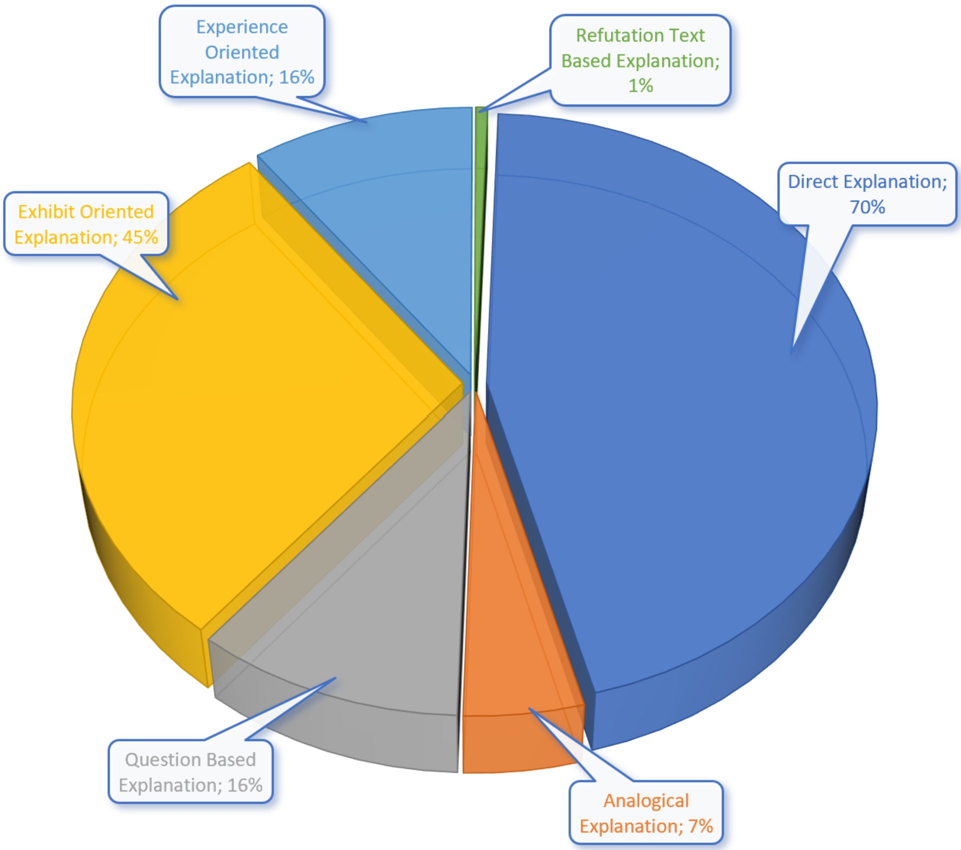

Figure 4.7. Distribution of explanation used in labels

The Figure 4.8 showed the distribution of explanations across the field of science. The most used explanation was direct explanation across the field of science. Even though all fields of science used the most direct explanation, the variation of other explanations differed. The refutation text-based explanation was found only in physics and space science. On the other hand, the analogical explanation in chemistry and the experience-based explanation in math and chemistry were not found in the sample.

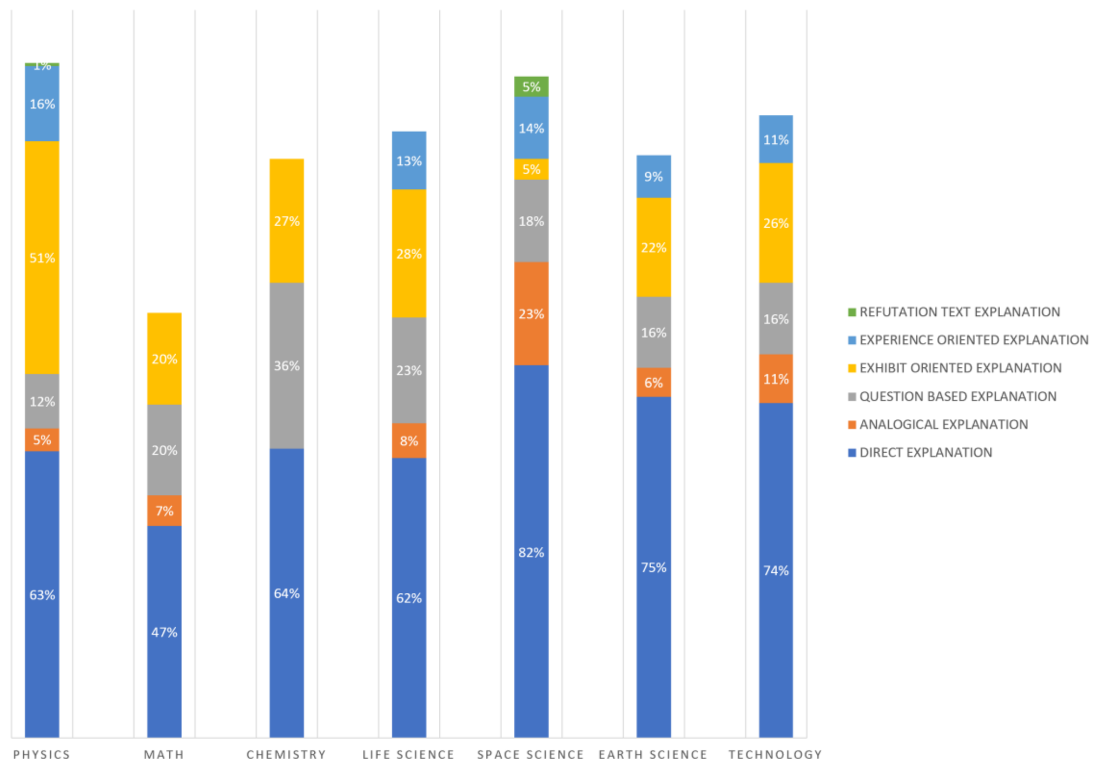

Figure 4.8. Distribution of explanation used in field of science

The Figure 4.9 and Table 4.4 showed the distribution of explanations found in science centers. The most found explanation was direct explanation in selected science centers. The second most found explanation was exhibit-oriented explanations in U1 (62%), M2 (50%), T2(32%), and T3(34%), and question-based explanations in M1 (39%) and T1 (14%). The refutation text-based explanations were not found in M1, M2, T2, and T3 science centers. Except for direct explanation, the distribution in explanation styles differed across science centers.

Table 4.2. Distribution of explanations used in science centers

	U1	M1	M2	T1	T2	T3
Direct Explanation	71%	42%	55%	62%	40%	46%
Analogical Explanation	5%	6%	2%	7%	8%	2%
Question Based Explanation	7%	39%	24%	14%	4%	9%
Exhibit Oriented Explanation	62%	36%	50%	7%	32%	34%
Experience Oriented Explanation	18%	6%	2%	9%	15%	10%
Refutation Text Based Explanation	4%			1%		

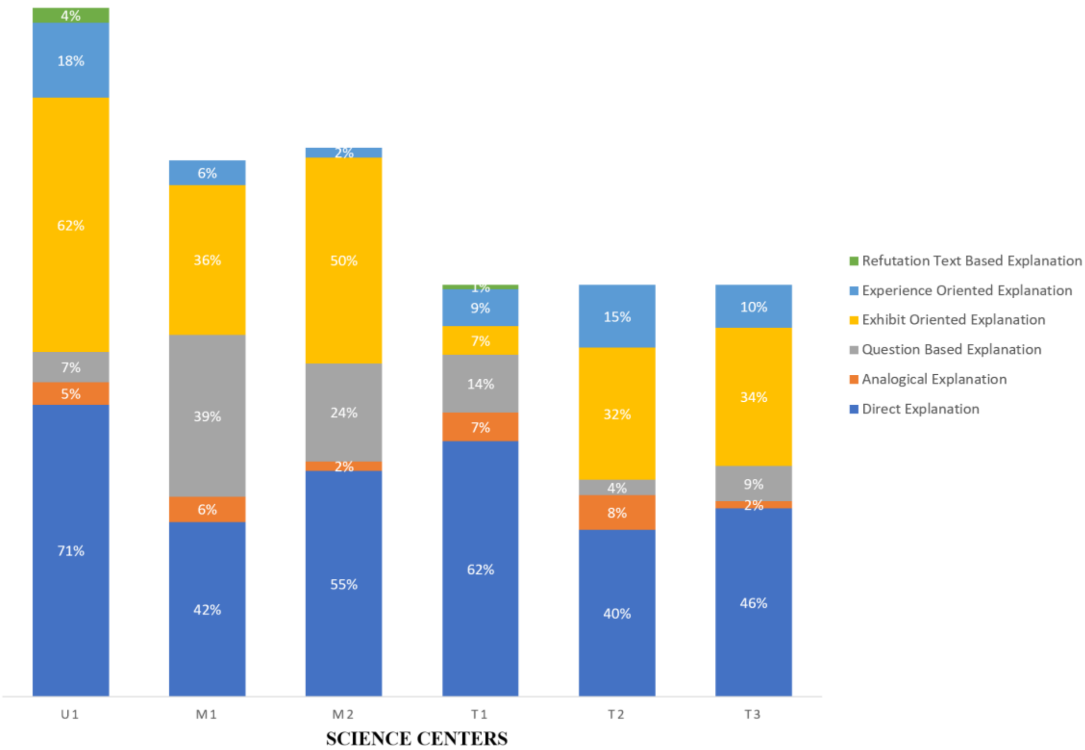

Figure 4.9. Distribution of explanation used in science centers

4.3 Extensions

One of the major parts of content common in the exhibits is the extension. This category refers to the content of labels giving visitors extra information or thought-provoking questions about the corresponding exhibit. When the extensions provided by the labels are analyzed, some variations emerge among them according to how the extensions were presented. These variations were categorized into three broad categories: contextual, conceptual, and resources. The types of extensions provided by the labels were presented in Figure 4.10.

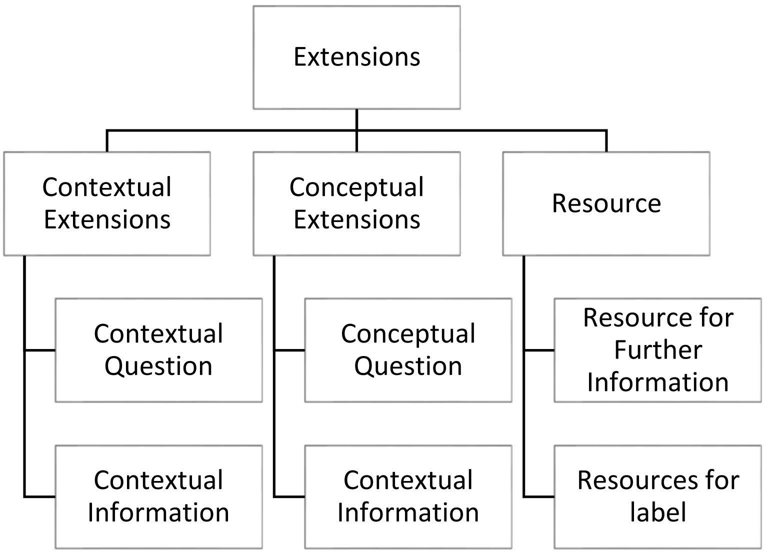

Figure 4.10. Type of extensions provided by the labels

4.3.1 Contextual Extensions

The contextual extension refers to an application in a new situation. The contextual extension is given in the form of questions and information. Questions make visitors think about the new situation by applying the concepts learned from the exhibit. Information is about the application of the concept into new situations related to the exhibit. Several examples from the analysis of data are as follows.

4.3.1.1 Question Based Contextual Extension

Question-based contextual extension refers to asking questions considering the applications. Questions are generally the new situation that different from the context of the exhibit.

Questions were generally open-ended to search the new context in accordance with applying the concept. Some of them were yes/no questions related to possible prior experience. Both forms of questions were based on thinking about new situations, experiences, and other fields of application. There were some hints in the label, such "*search"* or *"now your turn"*.

Example 1:

> How do you think an airplane with 400 tons of fuel takes off? How do the wing structure and other aircraft characteristics relate to the exhibit?

In this example, these questions were a new situation for visitors. In the exhibit, visitors could experience the Bernoulli principle with a ball and a blower and observe the ball's motion under flowing air. The questions were related to the concept of the interactive exhibit, so the question provided visitors with to link application of the concept to airplane as a new context. These questions were found at the end of the label.

Example 2:

> Have you ever thought why helicopter has two propellers? Or have you seen a helicopter that has one propeller before?

In this example, it was a question for visitors to think about their previous experiences. These questions were directly related to visitors. The exhibit context and the question context were different from each other. However, the concept in the exhibit was related to the concept in these questions, and the question included new context.

Example 3:

> Do you prefer the long or short rope swing when you want to ride a swing? Why?

This example is at the label's beginning and is a context different from the interactive exhibit. Visitors could not experience the context of the question. However, the exhibit was made of pendulums with different lengths of rope, so the observation in the exhibit would be transferred into a swing example. The underlying concept in both situations was the same. Visitors cannot experience the exhibit question, but visitors can observe the concept. Therefore, the question was related to a new context with daily life examples, and it provided visitors extend the topic of the interactive exhibit into a new one.

Example 4:

> Are there any other fields of application you can think of?

In this example, the question directly asked about daily life examples from the exhibit's concept. Although the form of the question was a yes/ no question, the question’s purpose was for the visitor to think of another context or daily life example, and it could prompt the visitor mentally beyond the context of the exhibit.

4.3.1.2 Direct Information Based Contextual Extension

Direct information contextual extension refers to the information given explicitly to visitors. The information is about new situations or new applications of the science behind the exhibit. The information includes an explanation of examples from daily life or application on daily life. In addition, some examples are about health and environmental issues.

Direct information-based contextual extensions were generally what the new context is and how it works. Some of them were applications to daily life. Several examples from the analysis of data are as follow.

Example1:

> Breathing in harmful substances from the environment can cause lung damage, which can lead to diseases like lung cancer. A substance that can cause cancer is called a carcinogenic.

In this example, the exhibit's concept was related to the respiration system and how the lung mechanism works in the human body, considering a smoker and a non-smoker. The information was related to the health of the lung system, not the working principle. Even though one of the harmful substances is also cigarettes, additional information about harmful substances from the environment was noticed.

Example 2:

> Bats find their way when the sound they make hits something and comes back. Radar and sonar systems have been found thanks to this feature in animals. With radar, police control the speed of vehicles on the highway. Sonar devices on ships detect the distance from the surface. The sound reflection feature is used in determining submarines' direction, the sunken ships' location, and mapping in oceans.

The examples in this exhibit were examples of different contexts explained by the same concept in nature and their technological applications in daily life. The examples from nature were animal life and its technical application.

4.3.2 Conceptual Extensions

The conceptual extension refers to the detailed explanation or inquiry about the concepts. The conceptual extension is given in the form of questions and information. Questions make visitors think about the concept deeply or inquire about other affecting variables corresponding to the exhibit's concept. Information is about related concepts or affecting variables. Several examples from the analysis of data are as follows.

4.3.2.1 Question Based Conceptual Extension

Question-based conceptual extension refers to asking questions considering the concept of the exhibit. Questions are generally to think about the concept deeply or other affecting variables on the concept in the exhibit. Questions were generally open-ended to search for the concept. Also, there were some questions for visitors to find out the affecting variables. There were some hints in the label such "*search*" or *"now*

Example 1:

> Do you think the radiometer will rotate in every type of light? Is the speed of rotating propellers affected by sunlight, blue light, red light etc.?

In the exhibit, a bulb was used as a light source, and other types of light asked in the question were not found. The question prompted the visitor to consider how different types of light affect the system. So, the question provided a different perspective on the concept.

Example 2:

> How can you determine the poles of a magnet in which N and S pole are not labeled like the black ring magnet in the exhibit?

In this example, the question tried to inquire about the concept of the magnetic pole. There was more than one black ring magnet in the exhibit. While exploring the nature of magnets and interaction among magnets in the exhibit, the question directed visitors to inquire magnetic poles concept detailed in different shapes of magnet.

Example 3:

> If you had an opportunity to do the same system on the moon, what do you think the oscillations of the balls would be?

In the example, the question was related to another possible affecting variable on the system. Visitors cannot experience the variable in the question. Also, the question was different from previous ones, and it was not explicitly asked about the affecting variable in the concept. In the question, another variable that could affect the system was asked using a different context, so visitors should find the variable by understanding the question. The question was at the end of the label and had the title "Now You Search".

4.3.2.2 Direct Information Based Conceptual Extension

Direct information-based conceptual extension consists of information about concepts in the interactive exhibit. The information in the labels is historical information about the concept and additional information clarifying the concept in the interactive exhibit. Moreover, the information can express a new concept to clarify the concepts in the interactive exhibit. There were generally found additional concepts and historical-based information in the labels.

Example 1:

> In space, we measure distance in light-year because km is much too small to be useful. One light year is about 9,500,000,000,000 km!

In the example, there was an additional concept to clarify the topic in the exhibit. The exhibit's content was constellations, and an additional statement in the box gave distance measurement in space and why light-year is used as distance measurement in space.

Example 2:

> X-ray radiation can be harmful.
>
> Repeated exposure can cause damage to body tissues. To minimize this danger, new, more efficient equipment that requires less radiation to produce a good image, and lead shields are now used routinely.

There was also some helpful information for visitors in the interactive exhibit labels. The exhibit explains how x-ray radiation forms the image and offers an experience of how human tissues are determined in the image. The information emphasized the damage of radiation to the human body. The information warned visitors about possible harm to their health. There was useful knowledge that affects visitor’s life.

Example 3:

> Lasers are a monochromatic, single wavelength, intense, powerful beam of light. The laser was invented by Theodore Maiman in 1960.
>
> The word “LASER” has passed into our language from first letter of “Light Amplification by Stimulated Emission of Radiation”.

In this example, there was found conceptual and historical information about Laser. This information was given under “Did you know?” and they were additional information about the concept of Laser and its historical background.

4.3.3 Resource

The resources as an extension refer to the reference given to visitors for further information or for preparing the labels. Resources are a website or textbooks to find more information about the exhibit. Resources were divided into references for further information and for preparing the label. The information was not written directly on the label. Thus, visitors can look at further references if they want to learn more.

4.3.3.1 Resource for Further Information

Resource for further information consists of additional information related to the interactive exhibit, and there is a direction to a web site in the labels. This information is not written on the label; if visitors want to learn the information, they can look at it themselves from other sources. These sources are like a suggestion for visitors.

Example 1:

> For mathematical model, you can visit the following webpage http://bit.ly/2HG6T71

At the end of the explanation in the label, a webpage showed what happened in the exhibit using a mathematical model. Visitors who want to understand the system from a mathematical point of view can learn by visiting the webpage.

4.3.3.2 Resource for Preparing Label

The resource for preparing labels is generally a reference list in the labels. Reference sources are commonly used for gathering background information on a topic and finding the facts about a topic. They provide brief and authoritative overviews of a subject and essential information in a simple and organized direction (Reference ResourcesResearch Like a Librarian, n.d.). There were found reference lists in some of the labels under *Reference* title, which content writers probably use the reference to prepare the labels. Written references in the labels can allow visitors to look at these sources individually.

Example 1: Web Site

http://www.energyquest.ca.gov/story/chapter04.html

In the example, web site included more information about electricity and energy. The information in the link also covered the exhibit label and beyond the exhibit as a concept. This link was given as a reference, so the text in the label's content was formed by using the information in this reference. Besides that, visitors can find more information about the concept in the exhibit from the link.

Example 2: Textbook Reference

Serway, R. A. Physics for Scientists and Engineers 4th Edition, Saunders College Publishing, 649-741.

In the example, the textbook was given as a reference. The textbook was a scientific book, and there was found conceptual information. There was found information beyond the concept in the interactive exhibit.

Example 3: Textbook Reference

Hipschman, R. (1983). Exploratorium Cookbook III. San Francisco, CA: Explotarium.

In the example, the textbook was also given as a reference. In Exploratorium Cookbook, there was information about many scientific exhibits and examples from labels for interactive exhibits; this reference was quite different from the previous one.

4.3.4 Types of Extension Across Science Centers and Field of Science

In this section, the ways of providing extension were examined in labels. Extension was related to further information for visitors. It was found that there was more than one extension. These were contextual, conceptual, and resources. Even though labels had one extension type, some had more than one type.

The Figure 4.11 showed that the contextual extension (47%) was the most found in label text for interactive exhibits. The second most common was conceptual extension (41%). There were found the least resources (23%) in examined labels. The question structure in conceptual extension (56%) and contextual extension (56%) was found more than information formation. Besides that, resources were found in two subcategories: reference for further information and reference for preparing the label. Reference for further information (13%) was found more than preparing labels (88%). Overall, contextual extension in question structure was the most used among labels.

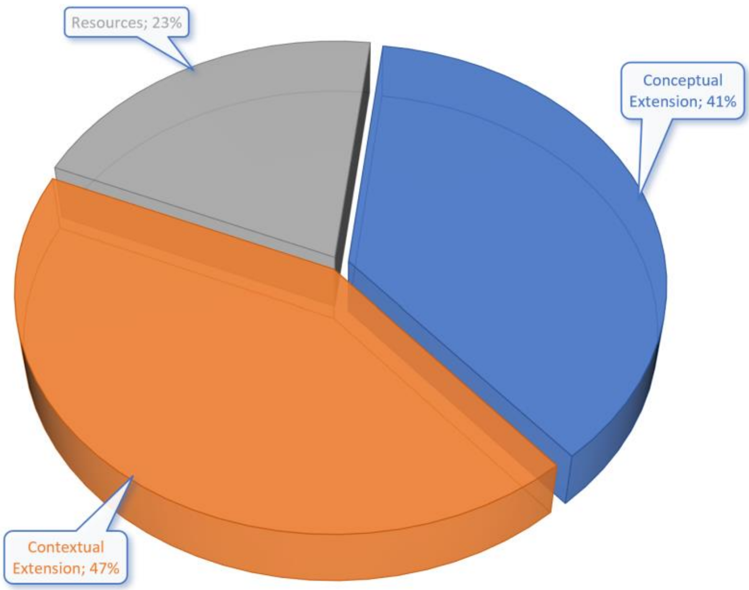

Figure 4.11. Distribution of extension used in labels

Figure 4.12 showed the distribution of extension types found in the field of science. The variation of extension types varied across the field of science. The conceptual extension was not found in chemistry. Also, the resources were not found in Earth science, technology, and chemistry.

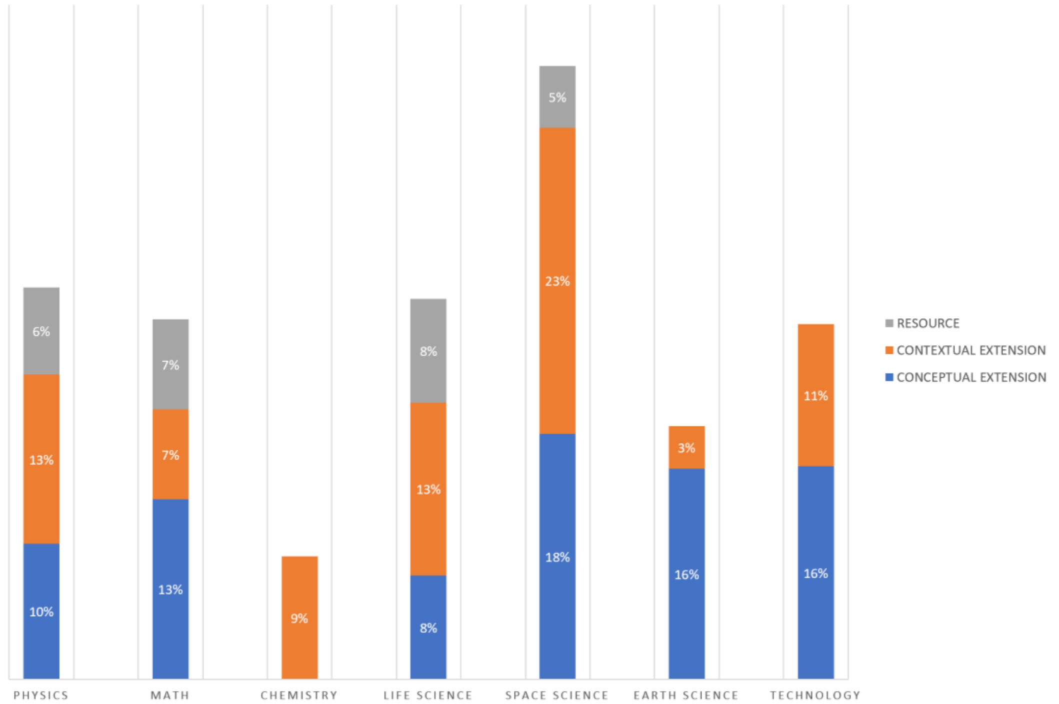

Figure 4.12. Distribution of extension used in field of science

The Figure 4.13 and Table 4.3 showed frequency distribution of extension type found in science centers. The most found in labels for interactive exhibits was a contextual extension in selected science centers. Although the contextual extension was found the most in T2 (100%), M1 (71%), M2 (66%), and T3 (60%), conceptual extension in T1 (72%) and resource in U1 (76%) were the most found. There were not found resource in M2, T1,T2 and T3. Thus, the extension types distribution were different among science centers.

Table 4.3. Distribution of extension used in science centers

	U1	M1	M2	T1	T2	T3
Conceptual Extension	14%	13%	50%	72%	33%	50%
Contextual Extension	14%	75%	66%	33%	100%	60%
Resources	76%	25%				

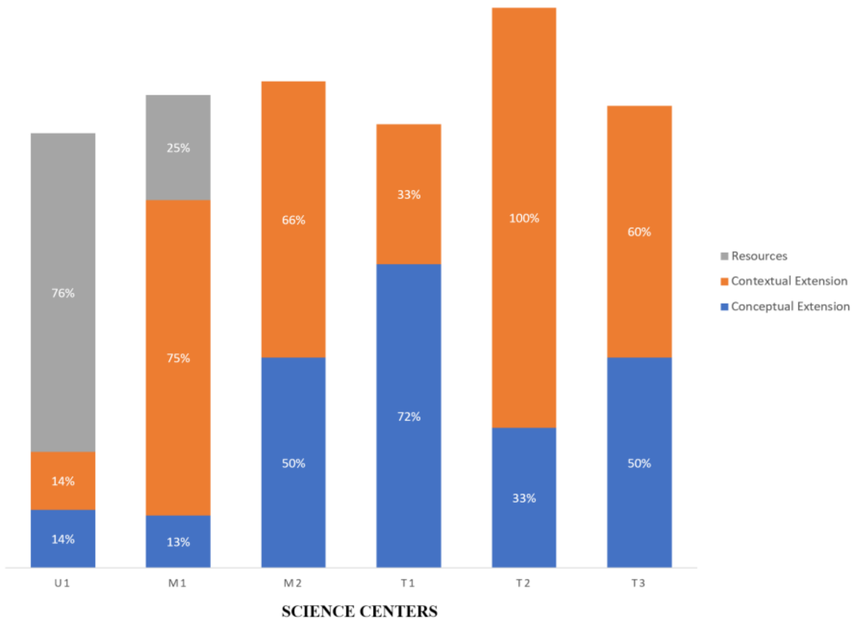

Figure 4.13. Distribution of extension used in science centers

Figures 4.14 and Table 4.4 show the frequency distribution of extentions' structures found in science centers. The most found labels for interactive exhibits varied in selected science centers. The reference for preparing labels was found the most in U1 (69%); the other types and structures were distributed uniformly. The contextual extension in question structure was seen the most in T2 (100%), M1 (63%), and T3 (60%). The conceptual extension in information structure was found the most in T1 (72%). There were no found reference for further information and preparing labels M2, T1,T2, and T3. The contextual extension and conceptual in information structure were not found in M2. The contextual extension in question structure was not found in T1, T2, and T3. the conceptual extension in question structure was not found in T1 and T2. As a result of the findings, the extension's distribution of types and structures varied among science centers.

Table 4.4. Distribution of extension subcategories used in Science Centers

	U1	M1	M2	T1	T2	T3
Reference for Preparing Label	69%	13%				
Reference for Further Information	7%	13%				
Contextual Extension- Information	7%	63%		33%	100%	60%
Contexual Extension- Question	7%	13%	66%			
Conceptual Extension- Information	7%	13%		72%	33%	30%
Conceptual Extension- Question	7%	13%	50%			20%

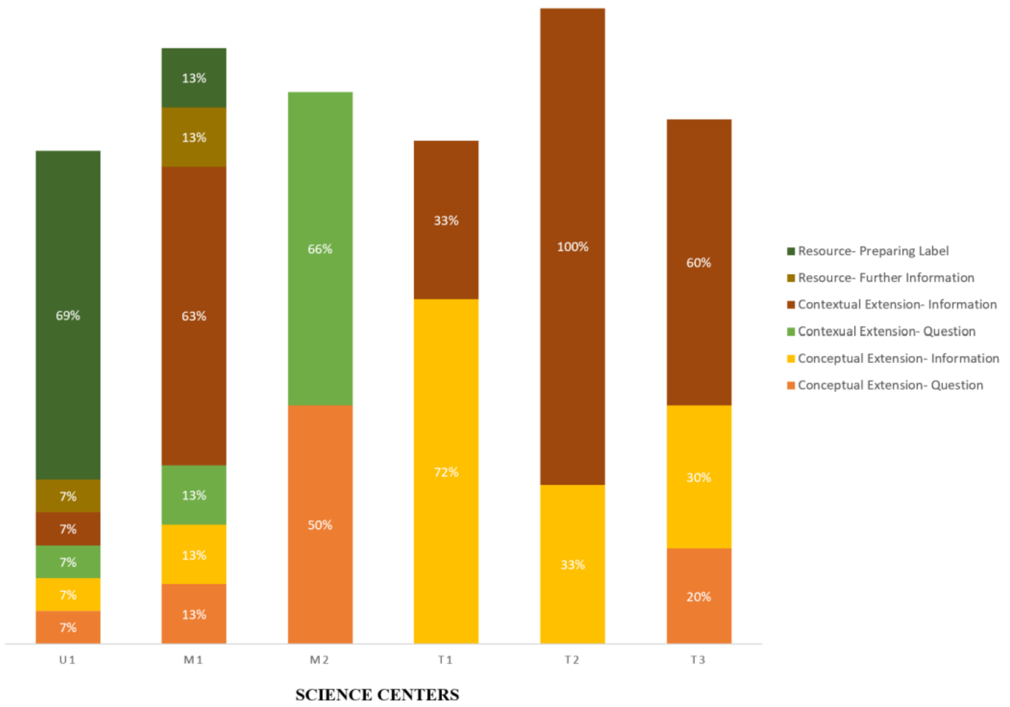

Figure 4.14. Distribution of extensions used in science centers

4.4 Distribution of Content of Labels Across Science Centers and Field of Science

In this section, the distributions of the content in the labels examined were presented. In Figure 4.15, the content of the labels was found directions, explanations, and extensions. As a result of the analysis of data, it was found that the content of labels generally included directions (94%) and an explanation about a phenomenon in the exhibit (92%). Moreover, a few extensions (25%) were found in the content of the labels for an interactive exhibit.

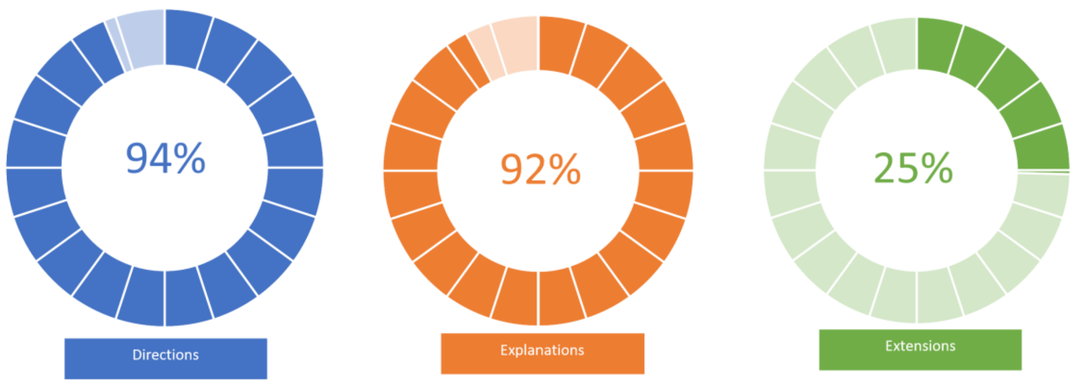

Figure 4.15. Distribution of the contents used in labels

According to findings in the study, different sequences among the content of labels for interactive exhibits were found. The content in labels was generally separated by a title, and some of them were separated with boxes. For example, while there were directions under the title of *Try* or *Predict* or *Let's Explore*, there were explanations about phenomena in the exhibit under the title *What's going on*. Also, the extension was under the title of *Search* or *Now Your Turn*. However, these titles were not used in all science centers. Some science centers used only titles on labels, and some used general titles and boxes.

Some science centers used a printed single label, but some used more than one printed label on the exhibit. Using more than one printed label was coded as not applicable because of blur in sequence. Therefore, there was not found one sequence in labels. There were found general labels for the description of more than one exhibit in some science centers have been found. In that case, a general label is also used for explanation coded as labels for more than one exhibit. As a result of the analysis of data, the sequence of the most used content in labels was directions- explanation (50%) in Figure 4.27.

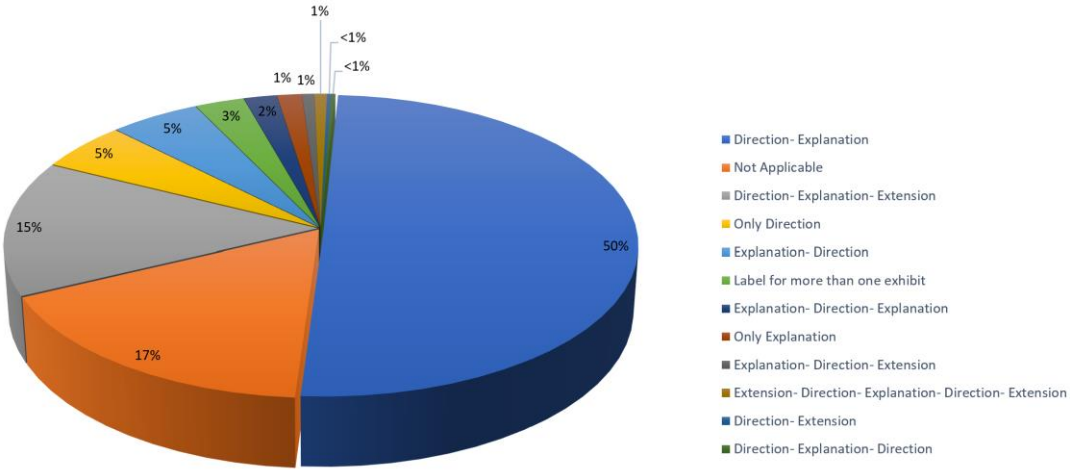

Figure 4.16. Distribution of content sequence used in labels

The labels texts included directions and explanations in all selected science centers between 84% and 96%. However, the extension rate in labels varied across science centers. The extension in labels at M2 (86%) and U1 (50%) was found more than T1 (24%) and M1 (23%), but the extension was found the least in T3 (10%) and T2 (3%). As a result of the finding, the distribution of content over science centers was illustrated in Figure 4.17.

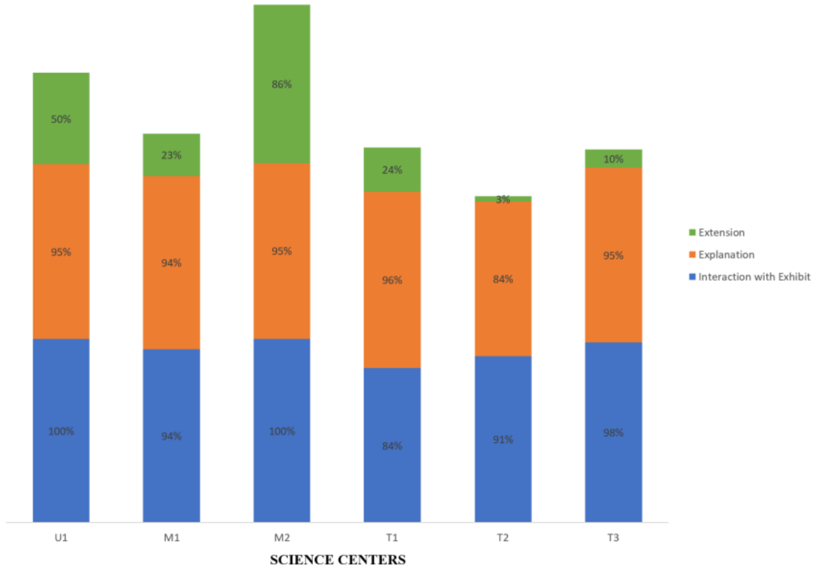

Figure 4.17. Distribution of content variations in science centers

The content of interactive exhibit labels varied in the field of science in Figure 4.18. There were found 417 interactive exhibits related to physics (n=279), life science (n=39), earth science (n= 32), space science (n=22), technology (n=19), math (n=15) and chemistry (n=11).

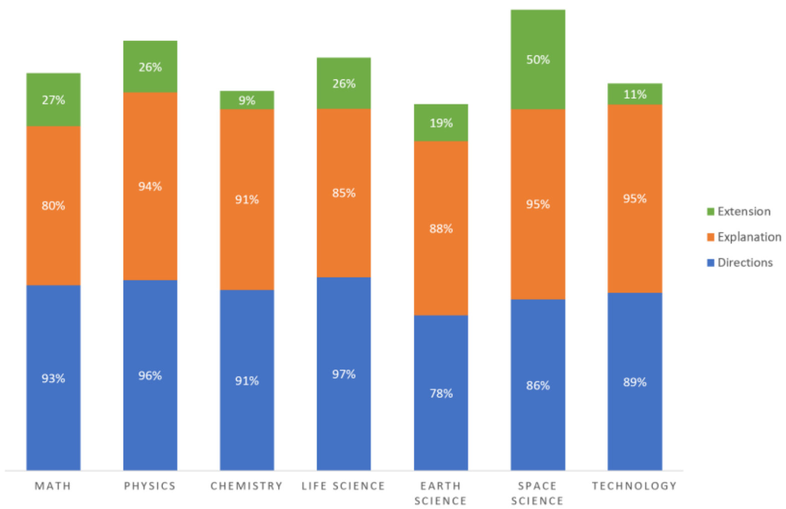

Figure 4.18. Distribution of content used in field of science

CHAPTER 5

DISCUSSION, IMPLICATION AND RECOMMENDATION FOR FURTHER STUDIES, AND CONCLUSION

This chapter includes discussion, implications, recommendations for further study, and conclusion.

5.1 Discussion

Understanding educational goals in science centers has evolved to require visitors to have a meaningful interaction with the exhibit rather than increasing their knowledge (Humphrey et al., 2005). The general trend in science centers has shifted from planned discovery to inquiry-based learning. So, exhibit design should provide open-ended discoveries and include less instruction and explanation in the labels (Humphrey et al., 2005). One of the exhibit objects is exhibit labels. The exhibit labels mediate (Hall, 2015) and scaffold visitors' learning (Wang & Yoon, 2013). Labels are one of the elements that facilitate visitors' discovery (Borun et al., 1993; Hall, 2015). Thus, labels are essential in facilitating communication between visitors and exhibits.

There are a few previous studies corresponding to labels' content. The labels' contents are limited in terms of description. So, previous studies have not been sufficient to give us a picture of the content in labels. Serrell (2015) explained that labels for interactive exhibits include directions and explanations. Some labels had questions and suggestions (Humphrey et al., 2005). In the current study, label content was found to parallel previous studies. However, extensions were found in this study, including questions for visitors to think or search about the exhibit. Extensions guide visitors to search for further information or learn more about the exhibit. In addition, labels' sequence follows directions, explanations, and some labels follow questions and suggestions (Humphrey et al., 2005; Serrell, 2015). However, while the content is given in a definite sequence in the literature, it has been revealed that the sequence of these contents has changed in the study across science centers and the field of science.

Even though the nature of labels is planned and structured instruction, the ways of providing information could be varied to engage and inform visitors about the exhibit. In the current study, the content of labels for the interactive exhibit was examined in terms of ways of providing information beyond the description of labels' contents as in the previous study. Although similar content was found parallel to previous studies, there were different variations in ways of providing the content. The fact that there would be different ways of providing information shows the richness of the learning environment.

McManus stated that visitors benefit from labels during using the exhibit (McManus, 1989). One of the major parts of content is directions. Different variations of directions were found in the study. These findings are similar to the available literature. There were pure directions, directions supported with questions, directions with outcomes, question lead directions, and goal-oriented directions in the study. Directions that include questions and goals are more visitor-centered than others. Gutwill (2006) suggested that one strategy for encouraging visitor-driven investigation is to use questions rather than statements in labels. Questions in labels also contribute to visitors' learning discussion among them (Hohenstein & Tran, 2007). In addition, Borun et al. (1993) argued that visitors are information receivers because labels are more instructive and appropriate for learning by reading. Therefore, using questions are essential to engage visitor actively with the exhibit. However, these limited studies in the available literature are related to content rather than ways of providing directions. Different strategies would affect visitors with different learning styles (Borun et al., 1993).

One of the other major parts of content is explanations. Borun and Miller' study showed that explanatory labels affected visitors' cognitive gain. Also, they have argued that unlabeled exhibits could cause misconceptions in children because of answering their questions incorrectly by adults. For this purpose, they used labels that include how it works, scientific principles, relevant historical information, and everyday applications. Although the visitors' preferred exhibits' scientific facts and working principles, the study indicated that visitors gained more knowledge from the historical and everyday applications (Borun & Miller, 1980). From a different perspective, label explanations were studied in conversation among visitors. The explanatory conversation between visitors was classified (Crowley et al., 2001; Eberbach & Crowley, 2005). Depending on these previous studies, Hall (2009) examined dialogues between parent and child in different explanations in labels to show the effectiveness of labels explanations. These studies cannot reflect differences in explanations. In the current study, there were found different variations in explanations. These findings are similar to the available literature, but the ways of explanations are different. Unlike previous studies, experience-oriented explanations and refutation text-based explanations were found in labels.

Another content of labels found in the study is extensions. Serrell (2015) explained labels' content and described the "*so what*" section as extended content. However, extensions found in this study refer to information for visitors to think about the phenomenon before leaving exhibits. In addition to historical information and daily life applications, interesting questions were found about relevant concepts or contexts of exhibits. Extensions can provide visitors to transfer knowledge effectively. Extensions are mentioned in a few studies as a part of explanations (Borun & Miller, 1980; Humphrey et al., 2005), and extensions were not explicitly found in previous literature. However, since both structure and educational message in labels are found to be different, extensions were examined as another major content of labels. There were found different variations in extensions.

5.2 Implication and Recommendation for Further Study

The study aimed to investigate content and ways of providing information in labels. Labels are written materials that inform visitors about exhibits. Labels included directions, explanations, and extensions. Variations in labels' content were found in terms of ways of providing information. This study has shown a picture of labels' content and used strategies in science centers. The variation in labels might represent the variety of learning strategies in science centers.

Directions: how to interact with the interactive exhibit was related to how to use the exhibit and how visitors interact with the exhibit. The different variations were found in directions across science centers and the field of science. It was divided into five subcategories: pure direction, directions supported with questions, directions with the outcome, questions lead directions, and goal-oriented directions. As a result of the analysis, pure directions were found more than others among labels. Pure directions are close to expository teaching because of the cookbook manner. However, Gutwill (2006) argued that visitors preferred questions on labels while playing exhibits. Questions can be used as directions that support the transitions from planned discovery to inquiry-based instruction in science centers. In creating an effective learning environment in science centers, visitors may be able to inquire about concepts in exhibits through questions. Exhibit designers and museum educators can be use more *directions with questions*, *question lead directions,* and *goal-oriented directions* in labels. These directions are more close to inquiry-based learning.

One of the contents found in the labels for interactive exhibits was explanations. Labels have an instructive role in the interactive exhibit, including explanations about exhibits. The different variations were found in explanations across science centers and the field of science. It was divided into six subcategories: direct explanations, analogical explanations, question-based explanations, exhibit-oriented explanations, experience-oriented explanations, and refutation text-based explanations. As a result of the analysis, direct explanations were found more than others. Since the study is not about effects on visitors, it is not concluded effective ways of explanations for visitors. However, Hall (2015) has argued that labels should be designed for a wide range of visitors. A label should consist of open-ended questions, analogies, and accepted scientific facts to be a practical learning experience in visitors' agenda (Hall, 2009, 2015). In addition, visitors preferred more historical information and everyday experience in labels (Borun & Miller, 1980). Thus, exhibit designers and museum educators can use different explanations in labels. They can use analogical explanations, exhibit-oriented explanations, experience-oriented explanations, refutation text-based explanations, and question-based explanations to affect visitors' cognitive gains in accordance with the exhibits' nature.

Extensions refer to further information for visitors to search for or to learn more about the exhibit. The different variations were found in the ways of providing extension in the labels: contextual extension, conceptual extentions, and resources. Extensions were found in different forms: questions, information, and references. As a result of the analysis, there were found the least extension part in labels. However, it can be helpful to support effective learning and increase visitors' curiosity. Thus, exhibit designers and museum educators can add extensions to labels.

Labels are one of the powerful learning tools in science centers. They are like a guide for visitors to discover science themselves. This study has shown what labels are and how labels convey educational messages to visitors. For effective learning environments for students, teachers should be arranged and well-planned before going to informal settings (Kanlı & Yavaş, 2021; Şentürk, 2015). Teachers can use labels as learning tools for their students during the visit. While encouraging students' discoveries, teachers can inform their students where they can find information about exhibits.

Labels should be designed as facilitating learning tools for a wide range of visitors. This study would be a preliminary step for further studies about visitor-exhibit interaction. Besides, labels can be integrated by using technology to convey information to visitors. In order to be more effective labels, experimental research should be done with visitors. The effect of different content and ways of providing information found in this study on visitors should be investigated.

5.3 Conclusion

In this study, exhibit labels in science centers were examined by content analysis. This study aimed to investigate variations of labels in science centers. For this purpose, data were collected from six science centers in Turkey. Labels were examined in terms of content and the ways of providing this content. There were found variations in these contents in terms of purpose and providing of information.

Labels content was found directions, explanations, and extensions. Directions varied across labels, science centers, and fields of science. Pure directions were found more than others. Explanations varied across labels, science centers, and fields of science. Direct explanations were found more than others. Extensions, least found the content in labels, varied across labels, science centers, and the field of science. Contextual extensions were found more than others. Thus, there was found more direct instruction in science centers. Available labels were found to be more museum's authority-based labels, even though there were found different variations in label content from museum's authority to visitor-centered. This study has shown the picture of label content in science centers.

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