Teachers' Perception of Factors Delaying Evacuation of School Children

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Lärares Uppfattning av Faktorer som Fördröjer Evakuering av Skolbarn

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Abstract
The aim of this thesis is to study teachers' perception of children's ability to evacuate, thus learning about children's evacuation behavior. Questions of interest are teachers' perception of children's ability to evacuate, their behavior, if there are any misconceptions in the teachers' perception and how fire evacuation drills influence the teachers' perceptions. This was done through a questionnaire study where teachers of children of 6-12 years of age got to answer a questionnaire before and after an ordinary school fire evacuation drill. The results indicated that fire evacuation drills influence the teachers' perception of children's behavior and the teachers' sense of having control over the situation. More experience corresponded to less belief in the panic misconception among children during a fire evacuation. The teachers' answers qualitatively corresponded to the observations made during the fire evacuation drill. After the evacuation drill, the teachers could be assumed to have a perception of children's behavior which reasonably corresponded to reality.

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Sammanfattning

Inom modern brandskyddsdimensionering är det en lämpligt att använda metoden (RSET)/(ASET). Det innebär att man beräknar tiden det tar för de som uppehåller sig i en lokal att utrymma (RSET) och jämför med tiden som finns tillgänglig innan kritiska nivåer uppnåtts (ASET). Det här kräver att man har en god uppfattning om gångtider och hur den aktuella gruppen beter sig. Det finns en mängd faktorer som påverkar utrymningsprocessen, varav ålder är en.

Utrymning med barn är ett ämne som sällan studerats. Ämnet har dock blivit allt mer aktuellt på senare år och ett par undersökningar har gjorts främst på förskolor. Dessa har bland annat fokuserat på olika gånghastigheter, flöden och procedurer vid utrymning. Få studier har fokuserat på barns beteende. Denna studie syftar till att utöka kunskapen om hur barn i grundskolan beter sig vid ett brandscenario. Frågor som undersökningen skulle besvara handlade om hur lärare uppfattade barnens beteende, förmåga att utrymma, om det finns några missförstånd i lärarnas uppfattning om barnens beteende och hur brandövningar påverkar lärarnas uppfattning.

Studien bestod av en enkätundersökning där en grupp lärare för barn i åldrarna sex till tolv år fick svara på enkäter, en före och en efter en av skolans ordinarie brandövningar. Totalt samlades det in 22 enkäter före och 28 enkäter efter brandövningen. I enkäten studerades följande faktorer som antogs kunna påverka barns säkerhet vid utrymning.

- Barns reaktion på larm
- Barns tendens att bära med privata saker
- Lärarens kontroll över situationen
- Barns anknytning till plats
- Barns anknytning till person
- Hur brandövningar påverkar lärares uppfattning
- Barns tendens att leta efter branden
- Barns tendens att varna andra
- Missuppfattningar om panik bland barn
- Brandlarmets hörbarhet

Svaren från enkäterna varierade i flera av frågorna. Tendenser till liknande beteende som vuxna kunde ses. Svaren varierade även något på varje fråga vid enkäterna före och efter brandövningen. Faktorer som kan anses inverkat på spridda resultat är bland annat att lärarna svarade specifikt för brandövningen, antalet besvarade enkäter, stor variation mellan barnen, stor variation mellan barnens åldrar och hur lärarna styr barnen.

Med det underlag som idag finns om barns beteende vid brand går det inte avgöra med säkerhet om lärare har några missuppfattningar om barns förmåga att utrymma. Däremot tydde resultaten på att brandövningar påverkar lärarnas uppfattning av barnens beteende samt att lärarnas känsla av kontroll över situationen ökar. Vid ökad erfarenhet minskade tendensen i svaren för missuppfattningen om att panik kan utbryta bland barnen vid en brandutrymning. Lärarnas svar stämde väl överens med de observationer som gjordes och därmed antas lärarna ha god uppfattning av barnens beteende. Då få studier gjorts på ämnet bör dock ytterligare studier utföras för att kunna verifiera dessa resultat.

Summary

The RSET/ASET method is a commonly used method in modern fire protection engineering. This means to compare the Required Safe Egress Time with the Available Safe Egress Time. In order to calculate RSET, a good understanding of walking speeds and occupant behavior of the whole population spectrum is needed. There are several factors influencing the evacuation time, among which age is one.

The understanding of children's behavior in fire has not been object of several studies. A greater attention has been given to this topic during the last decade and research has been conducted, primarily on pre-schools. These studies have, for example, focused on data collection regarding walking speeds, flows and evacuation procedures with children. Nevertheless, few studies investigated children's behavior and even less studies have investigated the teachers' perception of children behavior. This is particularly important as children evacuation is often conducted with an assisted evacuation procedure. The present work aims to gain more information on teachers' perception regarding the behavior in fire among children in elementary schools. Questions of interest are teachers' perception of children's ability to evacuate, their behavior, if there are any misconceptions in the teachers' perception and how fire evacuation drills influence the teachers' perception.

This was done through a questionnaire study where teachers of children in ages six to twelve years got to answer a questionnaire. The same group of teachers was, a week later after a fire evacuation drill conducted by the school, asked the same questions. A total of 22 answered questionnaires before and 28 answered questionnaires after the drill were collected. In the questionnaire, the following factors regarding teachers' perception of children behavior were investigated:

- Children's reaction to an alarm
- Children's tendencies to bring personal belongings
- The teachers' perception of control over the situation
- Children's place affiliation
- Children's person affiliation
- Impact of fire evacuation drills on teachers' perception
- Children's tendencies to search for the fire
- Children's tendencies to warn others
- Panic misconception on children behavior
- Audibility of the alarm

The answers to the questionnaire differed in many of the questions. Tendencies of a behavior resembling adult behavior could be seen. The answers also slightly differed before and after the fire evacuation drill. There are many possible reasons for this, among which the low number of answered questionnaires and variations in the group are two possible reasons.

Given today's understanding of children behavior in fire it is not possible to determine if teachers have any misconceptions of children's ability to evacuate. However, the results indicated that experience of fire evacuation drills tend to influence the teachers' perception of children's behavior and the teachers' sense of having control over the situation raise. More experience meant somewhat less tendencies of the panic misconception among answers of how children would react to a fire evacuation.

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1 INTRODUCTION

In fire codes e.g. NFPA Life Safety Code 101 (NFPA, 2018), the most important aim is generally to save human lives. In order to design safe environments for occupants, Sime (2001) recommends the use of the occupant's required safe egress time (RSET) within the performance-based design approach. To guarantee the occupants safe egress in emergencies the occupant response shelter escape time (RSET) need to be compared to available safe escape time (ASET). All occupants are assumed safe if ASET exceed RSET. Both times are calculated in many ways, and the accuracy of calculation/simulations methods depends on the input data and theories they are based on.

In evacuation modelling, the need for a good understanding of human behavior is necessary to make correct assumptions for model calibration. To ensure this, there is an abundance of studies made on how people react and evacuate (Proulx, 2002). Still, there is little knowledge of how children react in different environments. Since children forego physical development as well as different stages of cognitive development (Piaget, 2008) their behavior could be different in emergency situations.

Teachers are educated in children's behavior and are generally the ones leading children during fire evacuations. Many teachers have experience of children's behavior when evacuating. Thus, their thoughts on children's behavior is of interest. Children may have different physical abilities than adults, which may have a negative effect on the evacuation time. For example, their short legs make it harder to walk stairs and some younger children need to be carried. Evacuation studies on children show differences in walking speed compared to adults but also depending on children familiarity with the evacuation route or not. When children are not familiar with the evacuation route, their curiosity may have a large impact on the walking speed as they look around instead of focus on the task. (Lárusdóttir & Dederichs, 2010)

Self-preservation capability among day-care occupants is defined as the ability of an occupant to evacuate a day-care occupancy without direct intervention by a staff member (NFPA, 2018). Approximately there were around 350-500 alarms of fires in Swedish schools, each year 2005-2015. In total, there were 4845 fires in schools during this time (MSB, 2016). Among building fires, this was the second most common fires during year 2015, next to fires in residences (MSB, 2016). In evacuation, age is one factor influencing the evacuation time (Proulx, 2001) as this impacts mobility and cognitive abilities. Children under 24 months are not considered to be able of self-preservation (NFPA 101). Considering questionnaire results into consideration Taciuc & Dederichs found that children 30-36 month old were able of self-preservation such as follow simple instructions, walk on horizontal surfaces without assistance and walk downstairs (Taciuc & Dederichs, 2013). Still, a large responsibility lays on the teachers in pre-schools and elementary schools as children rely on their actions and/or decisions (Taciuc & Dederichs, 2013). Understanding how children in different ages behave during fire evacuation could help more effective dimensioning and/or raise the safety for children.

A study of pre-school children, age four and five, the understanding of different fire alarms and the knowledge of evacuation signs, emergency telephone number and what to do in case of a fire, was investigated (Blom, 2018). In this study, Blom stated that the knowledge of the participating childen was overall lower than desired. Blom also stated that education of fire emergency

increase the childrens' knowledge and that repetition of this knowledge is a must to ensure that the remember (Blom, 2018).

Evacuation drills in Japanese nursery schools have shown different needs for safe evacuation of young children compared to adults (Furukawa et al., 2016). It was suggested that children might not have enough adults present at all times for a safe fire evacuation (Taciuc & Dederichs, 2013). This is possible in the morning or evening when parts of the staff are not present.

The pre-evacuation time is the time from when the alarm sounds until movement starts (Proulx & Fahy, 1997). Children are in different need of assistance during egress depending on their age. Small children might need to be carried or led by holding hands, while older children can perform self-rescue activities under adult supervision such as a command to evacuate (Taciuc & Dederichs, 2013). Less than 25% in ages zero to two years but over 85% among three to six years old children are able to descend stairs without assistance (Lárusdóttir et al, 2014). Hence the pre-evacuation time is dependent on a good organization during the evacuation of children. The need of knowing how children react is vital not only for fire safe building design but also for the training of the staff.

In an evacuation study of two children's amateur art centers in Moscow, it was concluded that 88.5% to 90.5% of the total evacuation time is due to the pre-evacuation time. This is typical for unannounced evacuation of buildings with children and adolescents. Much of the evacuation delay time in those tests was due to insufficient organization. The personnel, mostly teachers, were not able to fully control the situation. (Kholshevnikov, Samoshin, and Parfenenko, 2009)

1.1 Objectives and Purpose

This study aims to increase the understanding of the teachers' perceptions on children evacuation behavior and discuss how this can impact fire safety in elementary schools. Based on the teachers' perceptions this thesis aims to find behaviors among the children that have an impact on the evacuation time. In accordance with this, the study will look for any misconception teachers may have regarding children's capacity to evacuate and the impact of a fire drill on those.

Based on the results, recommendations on future research to increase the understanding of children behaviors and the teachers' perception of them will be given.

1.2 Research Questions

The research questions are presented below. They altogether try to find answers that would provide a better understanding of how teachers think children act in fire situations in the school and if experience changes the teachers' perception.

- Do teachers have any misconceptions regarding children's abilities to evacuate?
- What behaviors that teachers identify among children, could be negative in pre-evacuation time? Do this change after training?
- Are there any factors concerning teachers' experience that impact the misconceptions about children evacuation behavior?
- What impacts have fire drills on teachers' perception of children's abilities to evacuate?

1.3 Method

A literature study was performed on existing information on the impact of staff on evacuation behavior as well as children evacuation behavior, to get a theoretical base for the study. Literature of interest was on evacuation theories, human behavior and on questionnaire design. The literature used was found through online search engines as well as databases such as www.sciencedirect.com and www.scopus.com. Through search engines, papers were found in different institutions' databases. Examples of these are Danish Technical University, Lund University, Virginia University and International Association for Fire Safety Science. Books used were found in the public library or bought in an e-shop. Literature was also provided by the supervisor and from professors in earlier classes from the education. When searching for relevant publications, search words such as evacuation, evacuee behavior, children, school and pre-school and variants of those where used. If a publication refered to another study of interest, this was searched after. Publications of special interest was anything on children in fire evacuations and adult fire evacuation behavior. Publications on walking speeds and occupant flow were excluded, except studies of children walking speeds. Due to a shortage of publications of children in fire evacuations, even studies of walking speeds and such, were used for eventual observations of special behaviors among children evacuating.

A questionnaire study was the base of this thesis. The questions of the questionnaire were based on knowledge gathered from the literature studies. The questionnaire was limited to focus on known behaviors in similar environments and/or among children. This method was selected due to ethical and practical reasons. The conduction of experiments with underage people in Sweden would require an ethical approval before being conducted. Due to the limited time available for this thesis the latter was not possible. A questionnaire study is also a cost-effective way to study factors of interest and possibly collect a high number of responses. In this context, the main limitations include questionnaire fatigue and respondent bias. A low number of responses will however make it harder to spot small deviations and thus, to get accurate results.

In the present study, the teachers were divided to represent two different age groups. The younger group has children in classes F (preschool), 1 and 2. This means children in ages six to eight. The older group has children in classes 3 to 5 in ages nine to twelve. This is to see if there are any differences by age. The choice of groups is based on the findings by Lárusdóttir et al (2014) which stated that children react to the alarm before the teacher at the age of 9.

Contact with a school in Sweden was established to perform the questionnaire study in connection to one of the school's evacuation drills. The questionnaire was distributed two times to the teachers at one school, once before and once after a fire evacuation drill. The questionnaire included both open and close-ended (i.e. using a Likert Scale ranging from -2 to +2) statements (Oppenheim, 1992).

1.4 Limitations and Delimitations

The school normally conducts fire drills twice a year but did not conduct any drill during the last year before the drill. This could alter the results compared to a school that have had fire drills as planned.

Factors such as gender, cultural differences, ethnicity, social status and physical and/or psychological impairment are not included in this study. However, the socio-demographic area in which the school is placed can help understanding the social properties of the pupils/teachers in the school. Any comparisons with other similar studies would have to account for this issue. In this study, the following limitations and delimitations can be identified:

- The study includes the analysis of teachers to children in the ages range from six to twelve. The teachers are divided into two groups, a younger and an older group.
- Since the thesis is based on teachers' perceptions of children in assisted evacuation scenarios, the information of children's behavior when left unattended is not available.
- The study is limited to only one school during daytime and common activities during a school day.
- The evacuation drill was conducted at a time of the day when many children had recess.
- Due to the limitation to one school and working teachers at the time of the drill this study is limited to a small sample size.
- Gender, ethnicity, cultural differences, social class, physical or psychological impairments are not considered as personal factors of neither the teachers nor children.
- Only a limited set factors are considered in the study of children's behavior. Other factors that are not represented in this paper could possibly occur among children in schools.
- The impact of the ratio of children per teacher is not included as it was unclear who had responsibility for children at the time the fire drill started.

Based on the theories of Piaget (2008), different children undergo different development stages. This would mean that a consistent analysis would include children who have reached roughly the same development stage. However, this is a factor that is hard to estimate as development stages varies from child to child (Piaget, 2008). Thus, the group of children could behave different compared to a similar group and the answers from the teachers likewise. The composition of the group of children, teachers or both could have an impact on the answers.

A small sample size and the fact that the questionnaire was distributed in only one school may affect the results as this makes it difficult to detect small effect sizes. A larger sample size and questionnaires conducted in different schools would in a greater way reflect the national mean. However, a small sample size would show if any large differences occur (i.e. a large effect size). To see any differences, statistical testing for small sample size must be used. A small sample size is a cost-effective way to get an understanding of where more research would be needed. Thus, this study should be considered as an exploratory study of possible issues associated with teachers' perception of children.

The study is only focusing on regular activities during daytime in a school. In special activities or

in the start and end of the school day the teachers' responsibilities could be different and children might not act the same as during for example class. The fire training children have from school may make children act accordingly in the school environment. Children might act differently at places where they are present in larger or smaller numbers. Since evacuation behavior differs depending of the occupancy (Proulx, 2001) the study is not representative of any behaviors among children in environments that differ from the school environment.

1.5 Outline of the Thesis

Chapter one is an introduction of the basics of the thesis. Here the reader can find the background, objectives and limitations of the study as well as method and research questions. In chapter two some basic evacuation theories are presented as well as some basic psychology that might have an impact on children's abilities to evacuate. Further theories on the subject of each question are presented in the second part of this chapter. Chapter three is about the fire evacuation drill. First the premises and the school's routines of evacuation are presented. The second part contains an explanation of how the fire evacuation drill was executed. Chapter four describes the questionnaire with observations done by the author during the drill. After this the results of the questionnaire are presented. Chapter five contains a discussion of parameters that could influence the results. After the discussion, conclusions and suggestions of future research are presented.

2. EVACUATION THEORY

When studying children's evacuation behavior in schools, the starting point used in this work is to understand how people behave in similar situations. This chapter presents the theoretical base for the questionnaire. To understand children behavior, the starting point is to understand adult evacuation behavior in fire situations.

2.1 The Engineering Time-Line Model of Evacuation

The evacuation process can be divided into two major components, delay time and movement time. The pre-evacuation time is also called pre-movement time in the literature, but this could be misleading since there could be movement before deciding to start evacuating (Proulx, 2002). As the pre-evacuation time is part of the total evacuation time, this could lead to misconception. Thus, the pre-evacuation time are furthermore called delay time in this thesis.

The delay time is the time from when the alarm sounds until the movement towards an exit starts and the movement time is the time it takes to walk from the location point to the exit. The delay time is in turn divided into three different stages, perception, interpretation and action (Proulx, 2002). As in some cases it has been shown that 90 % of the evacuation time in pre-schools are due to delay time (Kholshevnikov, Samoshin, and Parfenenko, 2009), it is important to know what happens during this time. Figure 1 shows a scheme for evacuation time and the components of evacuation time.

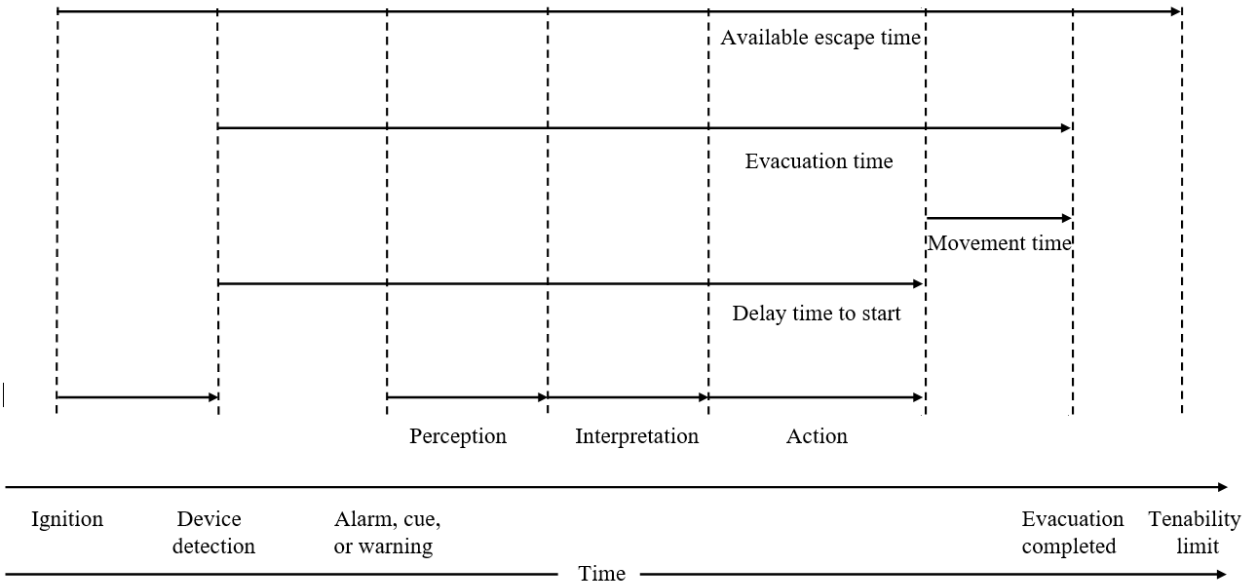


Figure 1: Scheme of evacuation time and its components (Proulx, 2002).

In this model, perception is the time it takes for occupants to perceive the fire signal. This could be an alarm signal, a fire cue or a warning from another person. Interpretation of the fire signal could take time as people often search for more fire clues before deciding on evacuating. When a decision is made to evacuate the occupants take different actions before starting to move (Proulx, 2002). Examples of actions people tend to do in different settings are getting dressed, finding

valuables, and notify others (Proulx, 2002). In Figure 2, a compilation of more examples of actions from a study by Bryan of an American population, mainly occupants of single family residential buildings, is listed. This shows that a person often makes more than one action before starting the movement time. The large part of occupants that took two or more actions before leaving the building further shows the importance of a good knowledge of the human behavior in fire emergencies (Bryan, 1977).

Actions	1st Action Percent	2nd Action Percent	3rd Action Percent
Notified others	15.0	9.6	5.8
Searched for fire	10.1	2.4	0.8
Called fire department	9.0	14.6	12.7
Got dressed	8.1	1.8	0.3
Left building	7.6	20.9	35.9
Got family	7.6	5.9	1.4
Fought fire	4.6	5.7	11.5
Got extinguisher	4.6	5.3	1.6
Left area	4.3	2.8	1.1
Woke up	3.1	0	0
Nothing	2.7	0	0
Had others call fire department	2.2	4.0	4.1
Got personal property	2.1	3.8	0.8
Went to fire area	2.1	1.0	0
Removed fuel	1.7	1.0	1.1
Enter building	1.6	0.8	1.1
Tried to exit	1.6	2.4	0.5
Went to fire alarm	1.6	1.8	1.1
Telephoned others—relatives	1.2	0.6	1.1
Tried to extinguish	1.2	1.8	1.9
Closed door to fire area	1.0	0.2	0.3
Pulled fire alarm	0.9	0.6	0.5
Turned off appliances	0.9	0.6	0.3
Check on pets	0.9	1.4	0.5
Await fire department arrival	0	1.0	3.6
Went to balcony	0.2	0.8	2.7
Removed by fire department	0	0	1.6
Open doors—windows	0.2	0.4	1.1
Other	3.9	8.8	6.6
$N = 29$	100.0	100.0	100.0

Figure 2: First, second and third action taken in fire emergency [from (Bryan, 1977)].

2.2 Evacuation of Children

Proulx's (2001) research on adults shows that many factors influence human behavior in fire incidents (Table 1). It is however not known how these factors influence children's evacuation but as seen in previous part these factors likely influence children's evacuation as well.

Not all actions taken by adults are compliable with today's view on children's capability to evacuate on their own (Larusdottir & Dederichs, 2010). Due to this only the actions that fit in a child's day at school are examined in this study. Actions during the delay time have been registered among children too. Examples on such actions are getting dressed, collect personal belongings and waiting for the adults (Lárusdóttir & Dederichs, 2011).

Evacuation of children also differs in other ways compared to evacuation of adults. One example of this is young children who sleep. Not only could it be hard to wake children sleeping at home (Bruck, 1999), an alarm when children were sleeping in pre-school could also generate confusion

(Taciuc & Dederichs, 2013) (Lárusdóttir et al, 2014). The process of getting children dressed is a routine that takes time. Depending on season and country there are different needs in clothing.

Table 1: Factors influencing human behavior in fire (Proulx, 2001).

Occupant Characteristics	**Building Characteristics**	**Fire Characteristics**
Profile • Gender • Age • Ability • Limitation	**Occupancy** • Residental (lowrise, midrise, highrise) • Office • Factory • Hospital • Hotel • Cinema • College and University • Shopping Centre	**Visual cues** • Flame • Smoke (colour, thickness) • Deflection of wall, ceiling, floor
Knowledge and Experience • Familiarity with the building • Past fire experience • Fire safety training • Other emergency training	**Architecture** • Number of floors • Floor area • Location of exits • Location of stairwells • Complexity of space/wayfinding	**Olfactory cues** • Smell of burning • Acrid smell
Condition at the Time of Event • Alone vs. with others • Active vs. passive • Alert • Under Drug – Alcohol – Medication	**Activities in the Building** • Working • Sleeping • Eating • Shopping • Watching a show, a play, a film etc.	**Audible cues** • Cracking • Broken glass • Object falling
Personality • Influenced by others • Leadership • Negative toward authority • Anxious	**Fire Safety Features** • Fire alarm signal (type, audibility, location, number of nuisance alarms) • Voice communication system • Fire safety plan • Trained staff • Refuge area	**Other cues** • Heat
Role • Visitor • Employee • Owner		

Kholshevnikov et al (2012) studied this in pre-school and noticed large differences in the time it takes to get children ready for evacuating depending on season. Small children are not expected of self-preservation i.e. when children are capable of walking unsupported and following simple instructions. Children need assistance and are not considered capable of understanding and following simple orders until the age of 30-36 month (Taciuc & Dederichs, 2013) (Lárusdóttir et al, 2014). Before this, staff needs to hold children's hands, carry them or in other means help children.

Fire evacuations in pre-school differs from other occupancies depending on the children´s stage of development. Both their abilities to move and their level of independence and decision-making capability results from their stage of development (Najmanová & Ronchi, 2017). These differences are linked to an increased need for an organized evacuation procedure. Observations showed that both children´s and staff members behaviors during fire evacuation drills are largely the same as their daily routine (Najmanová & Ronchi, 2017).

2.3 Children's Development

Children do not just differ from adults but as the child gets older this difference develops. This means there could be great differences between different ages but also between the individuals in an age group. The child's cognitive development is a never-ending process. Piaget's (2008) theory is the most influential theory on cognitive development. Most other theories of today either use it as a base or object to it (von Tetzchner, 2005). Today Piaget's theories are widely used in teachers' education.

Piaget's theory describes the child's intellectual development from infant to an abstract thinking adult. Due to this theory, the development process can be divided into four different stages.

- The sensorimotor (0 to1½-2)
- The preoperational (2 to 6-7)
- The concrete operational (7 to11-12)
- The formal operational stage. (>12 years)

The transition from one stage to another happens consecutively and it is the result of the child's interaction with the environment. In Piaget's theory, children's perception of objects and happenings are entirely constructed by the organism (Piaget, 2008). Thus, the child cannot connect a fire alarm with something bad before something scary happens in relation to the fire alarm or the child is old enough to learn to connect the alarm with a fire in some other way.

Piaget (2008) suggests that children at an age of six to seven enter the concrete operational stage. During this stage, the child starts to use logical or operational thought and leaves the egocentric world of the earlier years behind.

2.4 Theoretical Base for the Questionnaire

In order to study the delay time, researchers have used both fire evacuation drills and real-world case studies. Proulx has stated that some people believe fire drills are not a valid way to study the behavior of humans in fire emergencies. However, fire drills are perfectly representative for what a person would experience in a real fire incident where located away from the direct presence of the fire, especially so when the fire drill is unannounced. (Proulx, 2002)

After a thorough literature study on evacuation theories, ten different statements were developed for the questionnaire. All questions are based on theories of known behaviors in fire evacuation in different occupations. that may possibly be used to explain the teachers' perception of the behavior of children and their subsequent safety. Every subject in the following chapters, represents a statement in the questionnaire. In the beginning of each subject the resulting statements for the questionnaire are presented in cursive typing. The statements are first written in Swedish, as this was the language of the questionnaire, followed by a translation to English in brackets. Following are all the theories behind each one of the individual statements.

2.4.1 Statement 1: Response

In two unannounced evacuation drills of two children's amateur art centers in Moscow it was observed that children waited for an adult's instruction before starting to move. There were no attempts of self-rescue behavior among children in the kindergarten. This is explained with children's development as the part of the brain responsible for behavior, including taking reasonable decisions, grows in the age of 12 to 24 years. The lack of sufficient fire safety training is also mentioned as an explanation to this behavior. (Kholshevnikov, Samoshin, and Parfenenko, 2009)

The same behavior was observed by Lárusdóttir in Danish daycare centers where children did not react to an acoustic alarm signal. Instead they continued with their activities until interrupted by an adult notification. In one occasion the acoustic alarm was out of order and a strobe light was the only warning clue. In this case only a few of children noticed the alarm. In schools however, children from the age of nine reacted to the alarm before the teacher. (Lárusdóttir et al, 2014)

It has been noted that adults in different settings such as offices (Proulx, 2002), theatres (Frantzich, 2001), restaurants (Sime, 1992) and lecture halls (Sime & Kimura, 1988) may tend to continue the task at hand. This means continuing talking on the phone, listening, eating or continuing their current task. It has also been noted that people have a tendency to wait for their turn to pay when queuing in a store and that people tend to focus on their daily tasks until the expected leader announces an evacuation (Frantzich, 2001).

Among small children in ages zero to six years, daily routines are to be followed. Taciuc and Dederichs (2013) noted that children in a fire evacuation drill seemed surprised when they went outside without putting on shoes and jackets. Children in those ages tend to follow their daily routine. This meant they put on both shoes and jackets and checked the zipper before exiting. They also stopped in front of the door to wait for an adult. (Taciuc & Dederichs, 2013)

In elementary schools there are many cases similar to studies on adults. Children have adult supervision at all time and always expect instructions from a leader, the teacher. The most usual case would be in class when children focus is either on listening to the lecture and answering questions or on the task they are working with. The classes could be different, like physical education, but even here children either listen to the teacher or focus on their task.

In the canteen, we might have a similar case to the restaurants when children eat. This case can be similar to the occupants in the stores waiting on queues (in a restaurant they would wait to get the food and to turn away the dishes after eating). In order to have children evacuating on their

own, the response to fire cues such as an alarm is crucial. It is the first step of a self-rescue behavior. This statement aims to investigate if teachers think children react to the fire cues and if the alarm is an enough strong motivation for children to evacuate.

När larmet går fortsätter barnen med det de gjorde innan larmet tills en vuxen avbryter dem. (When the alarm sounds, children continue their current task until interrupted by an adult.)

2.4.2 Statement 2: Object Affiliation

Sime established the theory of affiliation when he stated that people tend to go for the familiar when put in a situation of potential entrapment (Sime, 1985). Sime studied how escapees tend to go to the familiar exit and that people tend to leave in the company they came. However, Sime thought it likely that other affiliative bonds could be present during fire evacuations and pointed out that this should be addressed in escape route designs (Sime, 1985).

Proulx have observed a tendency to collect valuables before evacuating buildings. This behavior was observed among occupants in both residential and in office buildings (Proulx & Fahy, 1997). To collect personal properties is also the second most usual reason for people who reenter after safely exiting a building (Bryan, 2002). In a Danish daycare center, it was noted that both children and adults brought personal belongings when evacuating (Lárusdóttir et al, 2014). To gather personal belongings could alter the safety of the occupant depending on the conditions.

A child might not have the same needs as an adult and thus the valuables in a child's eyes might be anything important for the child's daily life. In Danish daycare centers one small child refused to evacuate and had to be carried since the child wanted to bring a favorite hat (Lárusdóttir & Dederichs, 2011). In this statement, clothes are excluded since children often need to get dressed or at least put on shoes. If clothes were not to be excluded this could have altered the answer from the teachers. But this shows how small things can be very important for children.

När barnen utrymmer vill de bära med sig personliga ägodelar, bortsett från kläder. (When children evacuate, they want to bring personal belongings, except clothes.)

2.4.3 Statement 3: Teacher's Control

A leader of a group could have a positive impact on the evacuation time. This requires that the staff can make adequate decisions in the evacuation. Inappropriate staff behaviors or inability to initiate an evacuation can instead lead to longer evacuation time. The staff behavior in fire evacuation can be assumed to reflect the organizational fire training and the personal experience. Thus, the training should be specific to different occupancy type. (Samochine et al, 2005)

The teachers generally have the responsibilities for their respective class in the routines of evacuation in the school. It is considered that the evacuation time of school children depends on the teacher's actions and decisions (Kholshevnikov, Samoshin, and Parfenenko, 2009). Even if children are considered able of walking unassisted and follow simple instructions at the age of three, they are dependent on the teacher's decisions to the age of 10 (Taciuc & Dederichs, 2013) (Lárusdóttir et al, 2014).

This statement is about teachers' perception on their ability to lead children to safety. Fire training and knowledge is one thing that could influence a negative answer to this statement.

Other things that could yield a negative answer are if children are not listening or if the teacher cannot focus on the group. Children might not listen to the teacher of any reason, which would in turn inhibit the teachers focus on the behavior of the group. The teacher could also have a hard time focusing on the group if some individual needs much attention or assistance. This could in turn give a negative answer to the statement.

Young children have been noted to be easily distracted in fire evacuation drills. In daycare centers in Denmark (Lárusdóttir et al, 2014) children who saw an exciting toy could lose the focus at the task and go for the toy instead. Thus, children had to be carried or assisted in other means. A difference between the two age groups in this paper was noted. The older children did not need as much physical assistance and the majority only needed a verbal command to gather for evacuation (Lárusdóttir et al, 2014).

In a study of children's movement and behavior in fire evacuations it was stated that children have a lower level of independence and capabilities of decision-making, depending of their age (Najmanová & Ronchi, 2017). In a comparison of children aged three to four years and five to six years the younger children were in bigger need of assistance than the older ones. An example was that the instructions to the younger children were repeated many times and the younger children seemed to need more instructions (Najmanová & Ronchi, 2017). Similar difference in need of support have been observed among children six months to three years old and children aged three to six years (Lárusdóttir et al, 2014). Children are also in different needs of directions and assistance during movement, dependent on age and their behavioral development (Lárusdóttir et al, 2014) (Najmanová & Ronchi, 2017). Staff members seem more cautious with the younger children giving them more instructions and the older children were given more independency during fire evacuation drills (Najmanová & Ronchi, 2017). Children in fire evacuations seems dependent of an adult in motivating them to evacuate, their delay time activities, decision-making and behavioral patterns during egress. This shows a need for presence of an authority figure who provides children with both emotional security and help them evacuate safely (Najmanová & Ronchi, 2017).

Som lärare känner jag att jag har full kontroll under hela utrymningsprocessen. (As a teacher, I have full control during the whole evacuation process.)

2.4.4 Statement 4: Place Affiliation

The affiliative model describes how people tend to move towards the familiar. This means that instead of using the nearest safe exit in emergencies, people tend to use a familiar route more often than under normal circumstances. As Sime expressed in a paper on affiliation;

> "*Both the cognitive aspects of wayfinding and people's motivation to follow a particular route are likely to be important to a comprehensive understanding of escape behavior*" (Sime, 1985)

In the research on children evacuation behavior this comes to light once more as it is not known in which age evacuation theories of adults are fully applicable due to children's development. Place affiliation has been noted among adult occupants in many different settings. Data has shown that people in an emergency tend to use familiar routes (Sime, 1985). Occupants in a familiar environment find an exit route easier than occupants in an unfamiliar place (Frantzich,

2001). In both cases occupants tend to exit the same way they entered the building, but the tendency is greater among occupants in unfamiliar places (Frantzich, 2001).

The environment affects adult behavior. Similar tendencies have been studied among children too. In fire evacuation drills in Danish daycare centers it was noted that familiarity with the evacuation route leads to shorter evacuation times (Lárusdóttir & Dederichs, 2010). This is backed up with the same conclusions made by Murozaki and Ohnishi in their study on daycare centers in Japan (Murozaki & Ohnishi, 1985). Another observation (Lárusdóttir et al, 2014) was that when children were told to evacuate, some of them wanted to use same route as they were used to. This behavior was seen even if there was a door straight to the outside of the building.

To study teacher's perception of place affiliation among children, their evaluation of path when exiting a building was examined. Children's evacuation is generally dependent on the teacher's choices (Taciuc & Dederichs, 2013) (Lárusdóttir et al, 2014), thus children's exit choice can be assumed to be controlled by adults in most cases.

When using an external metallic staircase with see-through steps, used only for fire escape, Lárusdóttir found this to result in almost double movement time in comparison to a stair children use every day. Apart from hesitating to walk in the stair children showed big curiosity to this new environment and stopped in the middle of the stair to look around. (Lárusdóttir & Dederichs, 2010)

Teachers and experts in five countries in Europe and North America were asked about their opinion of children's behavior when using an unfamiliar escape route. In this study teachers were slightly positive that children would react the same way to an unfamiliar route as to a familiar route. 67% of the experts thought children would react different to an unfamiliar route. (Taciuc & Dederichs, 2013)

Vid utrymning har barnen en tendens att följa samma mönster som vanligt då de går ut ur lokalen. (When evacuating, children tend to follow the same pattern as when they usually exit the building.)

2.4.5 Statement 5: Person Affiliation

Person affiliation is like place affiliation, a confirmed behavioral aspect studied in many different settings (Sime, 1985; Sime & Kimura, 1988; Kimura & Sime, 1994). Humans are social and thinking beings. The individual behavior is affected by the people and social bonds in the group. In a report on a fire in Marquee Showbar (MSB), Sime noted a tendency to evacuate in the same group as occupants arrived in. It was also noted a tendency to rejoin with the group if separated (Sime, 1985).

The person affiliation also indicates that occupants are helping each other in fire evacuations. Even when people do not know each other, emerging small groups tend to form to evacuate together. In groups where occupants do not know each other it normally takes more time for groups to establish. This is because people do not want to make fools of themselves in taking the first step (Frantzich, 2001).

In daycare centers three examples of person affiliation can be found (Lárusdóttir et al, 2014). The first were parents who arrived with their child during the fire evacuation drill. When the alarm sounded the parents and their children evacuated together, separate from the rest of the group. Second were children with sibling in another part of the building. Some of the older children expressed a concern and asked for their siblings. Third example was in a daycare center where older children had their classroom near the younger children and evacuated along with the younger children. The older children assisted the younger ones and held their hands. In an elementary school a child with crutches got assisted by other pupils. This suggests that children, like adults, are most comfortable with the familiar. (Lárusdóttir et al, 2014)

In the same questionnaire mentioned for place affiliation (Taciuc & Dederichs, 2013), teachers and experts were asked if they think children would take instructions from unfamiliar adults such as other children's parents or firefighters. 70% of the teachers and 42% of the experts thought children would take orders from unfamiliar adults. In this case almost as many experts did not think children would listen to unfamiliar adults. (Taciuc & Dederichs, 2013)

Barnen tänker enbart på sig själva och riktar ingen fokus till sina vänner innan de kommit ut i säkerhet. (Children only think of their selves and does not focus on any other before they got to safety.)

2.4.6 Statement 6: Training

This statement is directly related to one of the research questions of this work. In Sweden fire drills are recommended as a part of an operation's preventive plan against fires (Arbetsmiljöverket, 2015). The school in this study have a plan to regularly run fire drills, to teach children how to correctly respond to a fire alarm. Here the teachers' perception on the usefulness of fire evacuation drills is researched. The teachers' opinion is also evaluated before and after the drill.

Some stress is considered to eventually affect any person involved in an emergency. This is for all occupants, regardless of sex, age, experience, training or cultural background. Performance under stress depends on the task demands, environmental conditions and the occupant. Under stress, decision-making is often characterized by a narrowing of attention and focus. A person under stress is unlikely to develop new solutions to the problem at hand. Thus, it is considered to be important with fire evacuation drills. (Proulx, 2002b)

Training can evolve children's understanding of the situation and children learn to connect the fire alarm with the evacuation behavior. But children could also learn to connect the alarm with practice. The way the training is done is also meaningful. Occupants might need to learn new exits or behaviors to be able to correctly apply the fire training in an emergency. This could be to teach children to get dressed outside or maybe use blankets instead.

Children, who has been to the fire department for fire education, have more knowledge of fire and fire evacuation related subjects. In a study (Blom, 2018) children who attended such education at the fire department this knowledge was significantly better among children that visited a fire station than children who did not. However, a difference was only detected in some matters. This could be due to the children forgetting over time since around six months had passed since the visit to a fire station. The study concluded that education is important but

repeating the knowledge is key (Blom, 2018).

Brandövningar har en positiv effekt på barns beteende vid brand. (Fire evacuation drills have a positive effect on children's behavior in fires.)

2.4.7 Statement 7: Search for Clues

Children may hide in case of a fire incident, especially in residential fires (Van Der Feyst et al, 2014). They might get scared from the smoke or feel guilt from possibly starting the fire (Van Der Feyst et al, 2014). This is one of the tasks included in the school routines of evacuation management. Administrative personnel search the premises for any child hiding or left behind for different reasons, such as being on the toilet when the alarm sounded.

Adults however often search for more clues once perceiving the fire alarm (Proulx, 2002; Bryan 2002). This could be flames, smoke, other evacuees or maybe the fire department arriving. Children are considered curious in new experiences (Lárusdóttir & Dederichs, 2010). This makes it plausible that children want to search for the fires when a fire alarm sound. A positive answer from the teachers would indicate that they perceive children as they search for clues while a very negative answer could indicate that children are perceived to hide. In any case, it could mean children could get in danger.

När larmet går vill majoriteten av barnen leta efter branden. (When the alarm sounds the majority of children want to search for the fire.)

2.4.8 Statement 8: Warning Others

According to a Lárusdóttir et al (Lárusdóttir et al, 2014) the task of activating the alarm is up to the adults. Small children can not be expected to know the cues of a fire. Hence, small children are not expected to react according to evacuation theories of adults. However, Lárusdóttir et al point out that small children are likely to contact an adult if they discover something odd. As children grow, they gain more knowledge and rational thinking. Thus, children are more and more likely to be able to interpret fire clues and warn an adult, even when no adult is in the room.

In a study (Blom, 2018), four and five year old children where individually interviewed. In one of the questions the children where asked what they think Is the most important thing to do if there is a fire. Of the children answering the question, a majority of 60 % said they would get out of the building. One child answered that the most important thing is to warn others. (Blom, 2018)

Majoriteten av barnen meddelar en vuxen ifall de misstänker att det brinner. (The majority of children contact an adult if they think there is a fire.)

2.4.9 Statement 9: Panic Misconception

Panic is a concept often associated with fires in media and statements from survivors (Fahy, Proulx and Aiman, 2012). In emergencies people and media often use panic as a synonym to being frightened, scared, nervous or anxious. To understand what the meaning of panic in the scientific community is, the word panic needs a definition.

- *A sudden and excessive feeling of alarm or fear, usually affecting a body of persons, originating in some real or supposed danger, vaguely apprehended, and leading to extravagant and injudicious efforts to secure safety* (Sime, 1980).
- *Panic is a collective flight based on a hysterical belief, a belief that a definite threat is present and that escape routes are closing* (Goldenson, 1984).
- *Panic is a reaction involving terror, confusion and irrational behavior, precipitated by a threatening situation.* (Goldenson,1984).
- *The word panic is often applied to a strictly individual, maladaptive reaction of flight, immobility, or disorganization stemming from intense fear* (Encyclopedia Britannica, 2015).

Another problem with the use of the word panic is that panic often is attributed to an occupant by an observer, when the person assumed panicking is of a totally different opinion (Sime, 1978). People under stress, anxiousness and fear often describe their emotional state and ability to respond to a problem as panic. Observers of how other people behave, who appear anxious, frightened or scared, tend to call their behavior panic if their actions do not seem like the most appropriate for the moment. (Fahy, Proulx and Aiman, 2012). Literature of human behavior usually describes panic as some sort of irrational behavior. Thorough research has shown that occupants rather behave rational, than irrational, and work together in emergencies (Drury Novelli and Clifford, 2013). The misconception of panic is often based on an observed behavior without a complete understanding of the occupants' situation. Occupants typically have a perfectly good explanation for their behavior (Fahy, Proulx and Aiman 2009). Panic rarely occurs in fire emergencies and is not a direct cause of crowd disaster (Fahy, Proulx and Aiman, 2012).

Children show no fear until eight to nine months old. Before this age, the child blinks as a reflex when an object gets close (von Tetzchner, 2005). No other defense mechanism, heightened pulse or other signs of fear are shown in situations when such behavior would be expected. Theories are that fear is both biological and cultural contingent (von Tetzchner, 2005). A child could for example learn to fear events it never shown fear of before. Children could also start fearing snakes at an age of three even if they never have seen a snake before (von Tetzchner, 2005). Fear among children is highly dependent on adults' reactions. If an adult shows fear, children could start fearing what the adult showed fear of. This way the child could learn to fear things of which it has no experience but not things it knows is safe. During development, a child goes through some different stages of fear and in the school years the child's fear is mainly of physical injuries (von Tetzchner, 2005).

Något barn i klassen blir oroligt och visar ett beteende som kan skada gruppen. Det okontrollerade beteendet överförs till majoriteten av klasskamraterna. (A child in the class gets really worried and show an irrational behavior that spreads among the majority of children.)

2.4.10 Statement 10: The Audibility of the Alarm

The audibility of the alarm is of high importance if people are expected to act on them. A good audibility is important for a short response time (Proulx & Fahy, 1997). If someone cannot hear the alarm that person must get warned or get cues of fire in another way. Observations have been done that show people often need more clues of a fire situation than just the sound of the alarm (Proulx & Sime 1991).

The audibility of the alarm is not the only important factor in motivating the occupants to evacuate. How familiar a person is with the sound of the alarm and what kind of alarm is also important for a person's reaction (Bayer & Rejnö, 1999). If people are believed to not respond as wanted on an alarm signal, this could be combined with a vocal message (Proulx & Sime 1991). In a study on sleeping children, it was concluded that a vocal message or a low pitch siren were the most effective methods to wake up children (Bruck et al, 2004).

In a thesis from 2018, Blom interviewed preschool children (4-5 year old) about their understanding of fire alarms. In the interviews the children got to listen to four different fire alarms and their task was to tell the interviewer what they thought it was. The majority of the children didn't associate any of the alarms with an alarm at all. The children associated the spoken alarm the least with any alarm and the common household fire alarm the most with an alarm (Blom 2018)

Brandlarmets hörbarhet är tillräcklig för att alla i gruppen skall uppfatta det. (The audibility of the alarm is enough for everyone to perceive.)

3 FIRE EVACUATION DRILL AT AN ELEMENTARY SCHOOL

The school in the study has a goal to perform at least two fire drills every year as part of their fire safety plan. In this chapter the reader will get an overview of the layout of the school and the routines of evacuation drills in the school.

3.1 School Premises and Organization

The school is in Varberg in southwest of Sweden. The choice of school was of practical reasons as the author of this thesis got contacts with staff at the school. Thus, an approval to do the questionnaire here was possible to get. When distributing the questionnaire, the teachers were promised full anonymity. As most of the teachers in the school participated, the name of the school isn't specified. Children who go to the current school come from one of the city's most segregated areas. However, the catchment area of the school changed a few years back to integrate areas where middleclass people live. Hence the older group are more segregated than the younger group. In the school there are around 400 children of ages six to twelve and about 50 personnel members. The school is an elementary school with classes from first to fifth grade and a pre-school for the youngest children. When in class, all children take off the shoes and jackets. These are kept in the hallways and children only wear shoes inside when in the canteen.

3.1.1 School Premises

The school premises consist of two different buildings. The main building, building A (Figure 3), is shaped like a capital H.

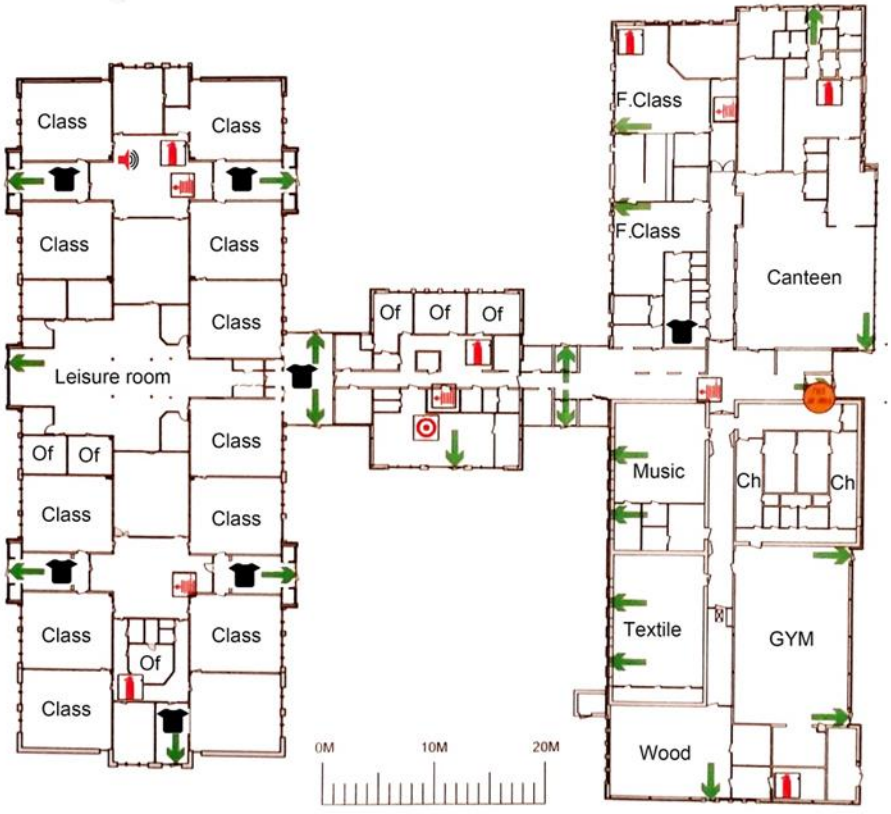


Figure 3: Evacuation plan with an overview of Building A.

Administrative personnel and teacher's staff room are placed in the middle of this building where the target icon is. Pre-school and classrooms for classes one and two are found in building A and classrooms for the older children in classes three to five are found in building B (Figure 4). In the west wing there are normal classrooms and leisure facilities for the youngest children. In the east wing of the building there are pre-school facilities, the canteen, esthetical and sports facilities. In building B there are classrooms for the older children. In the middle of this building there is a small school library.

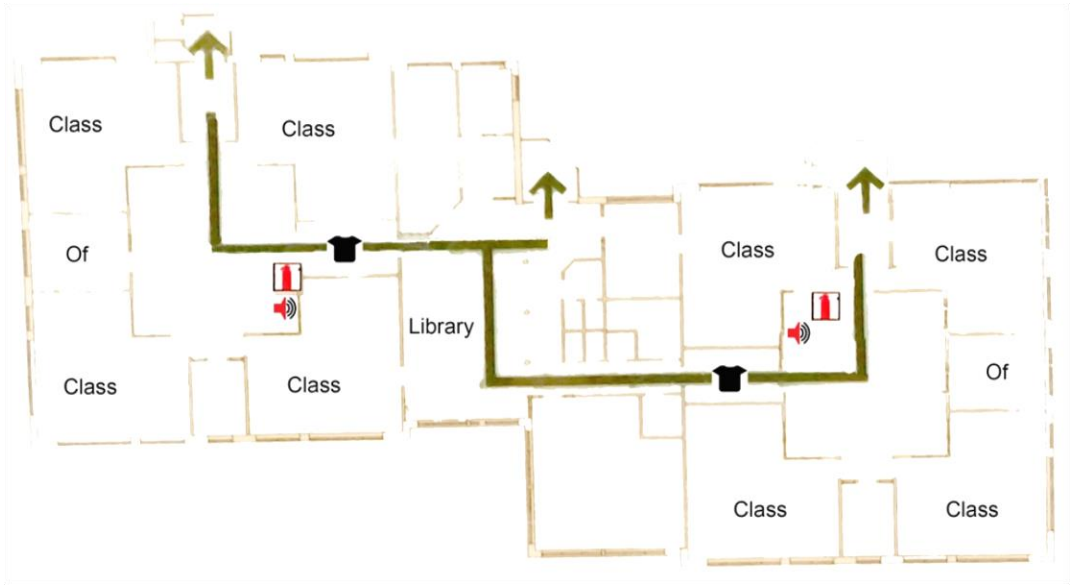


Figure 4: Evacuation plan with an overview of Building B

Generally, the entrances to classrooms are in each of the four corners in a square room. Direct access to the exits is available in the rooms connected to the classrooms of the older children. In the classes of the youngest children there are generally two exits, one to a central square room and one to a hallway where children hang their clothes. From the central square room there is access to the two hallways on the opposite sides of the building. From the hallways there is direct access to the schoolyard. The alarm sirens are placed in the central rooms close to the classrooms. The alarm consists of a high pitch siren.

3.1.2 Evacuation Routines

The personnel are divided into teachers and administrative personnel. The administrative are the principal, janitor, curator, cleaners and the canteen personnel. The administrative personnel have no assigned responsibilities for children. In case of an alarm, the administrative personnel gather at the office. All members of the administrative staff present at the drill are assigned an area in the school to walk past as they evacuate. The administrative personnel search the premises for anyone who did not evacuate and close all doors before evacuating to the assembly point for further orders. In case of a fire, the teaching personnel have responsibilities for the group of children each teacher is teaching at the moment. The teachers should be the last one leaving the room and assist children. In other activities such as break or lunch there are always teachers present to assist children. When evacuating to the assigned assembly points the teachers should

bring the class list and check that no child is missing. The place for observations was outside building A at the North-West assembly point (Figure 5).

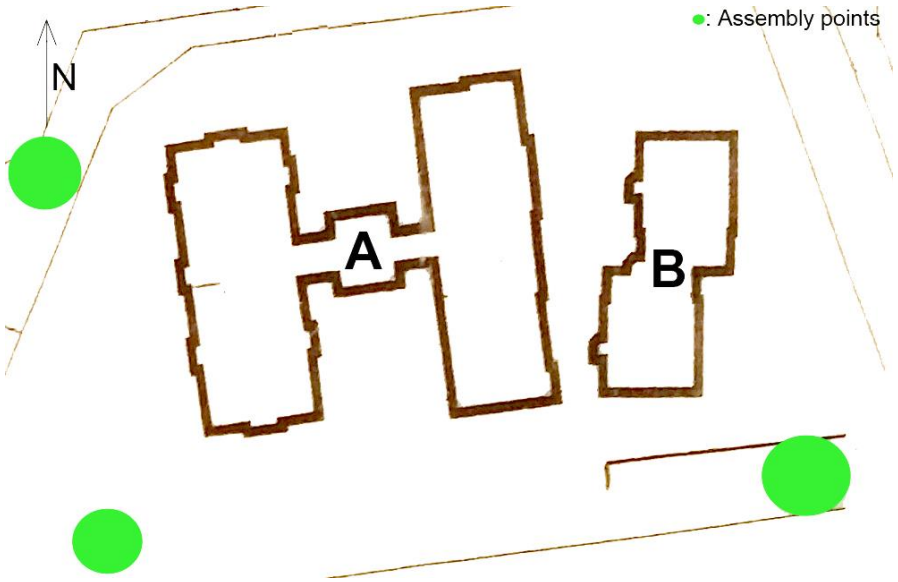


Figure 5: The school and assembly points.

3.2 Execution of the Fire Evacuation Drill

The fire drill started when all the youngest children in building B were on a break. This meant fewer adults per child as the teachers split the responsibility for children during breaks. It also meant children were dispersed at the moment the alarm sounded. About half the teachers were out with children as half the teachers had a coffee break.

Children in year three to five were in class. At this school, all children and staff knew about the drill in advance since some children are sensitive to alarms and must get special treatment (i.e. this was an announced fire drill). Parent's informed consent is obtained before the fire drill. In this fire drill, two children from a war zone participated with the parent's consent. After the evacuation drill, the teachers in every class had a discussion with children, talking about the evacuation and giving the children feedback of what had happened and why they evacuated.

3.2.1 Observations

The following observations were made by the author during the evacuation drill. No camera or other recording devices where used so these observations are restricted to the direct observations of the author. When the alarm sounded, the author was with one of the teachers in a classroom connecting to the exit closest to the mentioned assembly point. The two evacuated the building together and the teacher started to gather her class.

When the alarm sounded, people outdoors did not react at first. Everyone, both children and the staff, was continuing the activities they were carrying out at the moment of the drill. After the drill, it was noted that people outside did not hear the alarm since all alarm bells were placed inside. Thus, everyone outdoors, both children and teachers, did not hear the alarm but were alerted by the teachers coming from the staff room. This happened soon after the alarm went off since the teachers who came from the staff room went straight out and alerted the others before

going to their respective classroom to get the class list. After the drill ended, observations by the author were made in the class that assembled last.

One teacher was still in the classroom when the alarm sounded, and started searching all the nearby classrooms, toilets and other areas where a child might hide. After checking a room, the teacher closed the doors and went on to the next. During this time teachers came from the teacher's staff room to get the class list for the class for which they had responsibility before helping to gather children at the assembly point for this part of the school.

The teachers alerted all children but focused on the class they had responsibility for. Some had their children to walk in line by classes. The teacher who searched the classrooms before evacuating was the last adult among the teachers in this part of the school to exit the building. Children from this teacher's class were also the last ones to get to the assembly point. Since all the children already were outside in this part of the school, no observations of the preferred exiting route were made. Any children in this class listened to the other teachers and/or noticed what was going on. There were four children not listening and those were also the last children to get to the assembly point. These children were told by their teacher to come, time after time, but continued playing and showed no will to stop what they were doing. One of these children did not want to listen to anybody and in clear obstinacy stood and watched all others until someone went after him.

A few children went inside after being alerted. Some of them to get special clothes such as reflective vests and some seemed to go inside to investigate the situation. The three children that did not listen or react when children and teachers alarmed them went inside when most people already were at the assembly point. This makes it hard to believe they did not know what was going on. It is likely these children wanted to go get something or put something away. It could also be that they searched for more clues even if this is less likely since they went past at least two full classes on their way to the door. After the drill children said they went to listen for the alarm, but they also said they did not go in. Based on children's story they might have been searching for a cue on why everyone was gathering outside the schoolyard.

During the drill children warned each other and motivated each other to go to the assembly point. Children warning each other did so after being told what was happening. When asked of how children noticed the alarm children mainly said they heard it from a friend. Some heard it from a teacher, and some understood something happened when everybody was moving towards the assembly point. No one said they noticed the situation from hearing the alarm even if some of children said they heard the alarm, but that it was very weak.

After approximately six minutes everyone was gathered at the assembly point, some 10 meters from the schoolyard. Some children had brought the toys used during the break. Seemingly no child had brought anything else than toys they used during the break except from clothes.

After the fire evacuation drill the teachers had a meeting in each class. During this meeting children were asked how they felt when the drill started. In a first graders' class, around half children said they got a bit scared. In all, the children seemed very reasonable and had good knowledge of why it is important to evacuate due to a fire.

4 THE QUESTIONNAIRE

One research question in this project was if there will be any change in the teachers' perception of children behavior before and after a fire evacuation drill. To investigate this, a questionnaire was distributed both before and after a fire evacuation drill. In the questionnaire the lack of answer on a statement was interpreted as "do not know".

4.1 Distributing the Questionnaire

The questionnaire was distributed in two different ways before and after the drill, but all present teachers had a chance to answer both times. The before-drill questionnaire was distributed by email in the beginning of the week of the fire evacuation drill. At the day of the drill 22 teachers had completed the before-drill questionnaire. After the drill some more of the fire evacuation drill questionnaires were delivered but had to be discarded since they were delivered after the drill and thus the answers could be influenced from the experiences from the drill. Of the 22 answered questionnaires, 12 were from teachers teaching the age group of six to eight years.

On the day of the fire evacuation drill, questionnaires were distributed after the drill, to all teachers present. The first distribution was hand to hand in the teacher's staff room. Since not all teachers had their lunch in that location the questionnaire was distributed to the last teachers by hand to all teachers in the classrooms and teacher's offices. Some teachers were not present during the fire evacuation drill and did not experience this drill firsthand. These teachers are excluded in the questionnaire since their possible change of opinion would not be based on children's behavior in firsthand, but from what they were told about the evacuation from children or adults. After the drill a total of 31 questionnaires was answered and collected. A few questionnaires were collected where no age of children was given and thus were excluded from the results after tracking most of the answers. In total 28 of the questionnaires after the drill could be used, where 18 of the questionnaires were from teachers teaching the age group of six to eight years.

4.2 Results from the Questionnaire

The different distribution methods lead to a different number of answers before and after the fire evacuation drill. In this section, the results of the questionnaire are presented. Results from the questionnaire are processed with Wilcoxon rank sum test in five separate studies. First all the answers from before the fire evacuation drill were compared with all answers after the drill [1]. This was performed to study eventual differences in the answers. Answers were also analyzed considering different age groups where the younger age group [2] and the older age group [3] where analyzed for differences in answers before and after the drill. Last a comparison of answers before the fire evacuation drill were done between answers from the younger age group and the older age group [4]. The same comparison was done with answers after the fire evacuation drill [5] to examine any difference in answers in the two age groups. The latest analyses should be considered as exploratory given the limited sample size.

To study the results from the questionnaire one must first analyze the test samples from the questionnaire answers. The factors that influence the knowledge of dependency the most in this case are identified to be anonymity, different amount of answers and the fact that the questionnaire was performed in one school. To understand the choice of method, the work and thoughts that lead to the result a short discussion around these factors follows.

Responses were anonymous; this makes it not possible to understand if the teachers that answered the questionnaire are the same in the answers before and after. The answers before and after, based on the previous statement, could be from two fully different groups. The amount of answers after the fire evacuation drill however indicate that at least some of the teachers answered the questionnaire both before and after which would make the populations dependent. For most cases teachers have responsibilities for one class but some teachers such as music, gym class, woodwork and other classes such as Swedish as second language or parental tongue. In the comparison between answers about children in different age groups the population therefore should be completely different and thus independent.

The choice of method is also influenced by the different number of answers and pairing problems. Some teachers did not participate in the questionnaire after the fire evacuation drill due to reasons such as vacations or no contact with children during the drill. This means direct pairings are missing as at least some of the teachers answered either only before or after the fire evacuation drill. Teachers were promised complete anonymity, and no kind of identification numbers were used on the questionnaire form. Thus, there is no way to track and/or pair the answers. The different number of answers in the studied groups also made any pairing hard as some answers could not be paired due to this. This means that no method using paired values were found suitable for the statistical significance tests. The sample sizes made it impossible to assume a normal distribution without testing. Thus, the choice was to use a nonparametric test.

Wilcoxon rank sum test was the chosen statistical test to evaluate if any differences could be spotted among the answers of the questionnaire. The Wilcoxon rank sum test allows for different number of observations in two different samples. Another strength in this case is that the data does not need to be quantitative. However, the Wilcoxon rank sum test make the assumption of samples drawn from independent populations. A significance level of $\alpha = 0{,}05$ were chosen as acceptable proof for eventual differences.

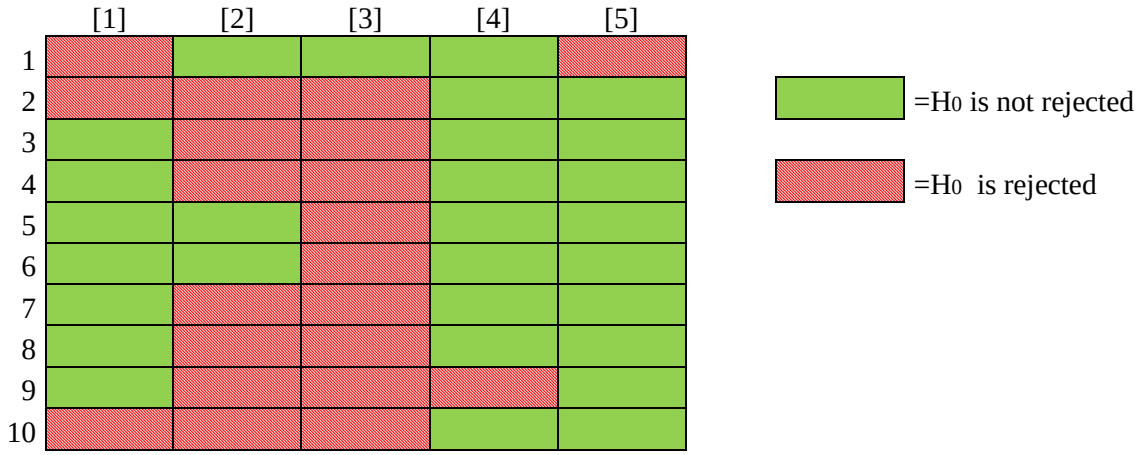
Testing results are reported in Appendix C. However, in cases with different sample sizes and when a difference in the P-value was detected, the P-value from the smaller of the two populations was used for comparison with α. As a final step in those calculations the test statistic value (z-value) were corrected with the norm.dist function from excel. The P-value was doubled for a two-sided test. If $P<\alpha$ then H_0 was rejected, which means there are a significant difference.

Descriptive statistics were also calculated. For the max, min, median, 25^{th} percentile and 75^{th} percentile, the function percentlie.inc were used. The inter quartile range (IQR) were calculated for use in the calculations of outliers. A point beyond an inner fence on either side is considered a mild outlier. A point beyond an outer fence is considered an extreme outlier. Any data points above the outlier+ or below the outlier- values are interpreted as outliers when making the boxplots. The corresponding values of any outliers are shown as dots in the charts.

With a significance level of $\alpha = 0{,}05$ the null hypothesis could be rejected in 40% of the significance tests. Table 2 shows the five different ([1]–[5]) tests done on the answers in each statement (1–10). Every striped field symbolizes a case where a significant difference was found in answers of the two various test samples. The fields without a pattern represents all cases where

no significant difference could be proven with the conditions given.

Table 2: Chart of rejected null hypothesis with a significance level of α = 0,05 for all 10 statements with different combinations of populations [1]-[5]. Where [1] is comparison of all the answers before and after the drill, [2] and [3] are answers of the younger respectively the older age group before and after the drill. Last the younger age group compared with the older age group was made before [4] and after [5] the drill.



4.2.1 Statement 1: When the Alarm Sounds, Children Continue Their Current Task Until Interrupted by an Adult.

In statement one, most teachers thought children would not continue with their task until interrupted by an adult. Half of the teachers totally disagreed to the claim that children continue with their tasks until interrupted by an adult and 18 % disagreed a bit, 18 % of the teachers agreed to the claim.

After the fire evacuation drill the teachers answered a bit different depending on which age group they represented, 69 % of the teachers in the younger age group were positive while 58 % of the teachers in the elder age group were negative to the claim. All teachers outdoors answered positive or do not know on this statement. One teacher commented that there were some children who were so absorbed in what they were doing so they did not respond to what happened.
In the box chart (Figure 6) a few outliers could be spotted. These outliers could influence the means that are marked with x:es in the different distributions. Since the Wilcoxon rank sum test uses means to test for differences which makes it less sensitive to outlier data points. The teachers were mostly negative to the claim before the fire evacuation drill with both negative values of both medians and means (see Table 3). Teachers for the younger age group were more positive to the claim than teachers for the older age group and teachers in total. The results of the Wilcoxon test are a bit inconclusive both with answers from the younger and the older age group. To represent the result the P-value from the smaller sample sizes were used and this showed no difference in answers before and after. The P-values from the larger sample sizes, however, showed a significant difference. After the fire evacuation drill the medians and means were a bit more positive. The inter quartile range got greater, thus there was greater spread in the answers after the drill. In the answers before and after in the total population and between the answers from teachers for the different age groups a significant difference in answers were found.

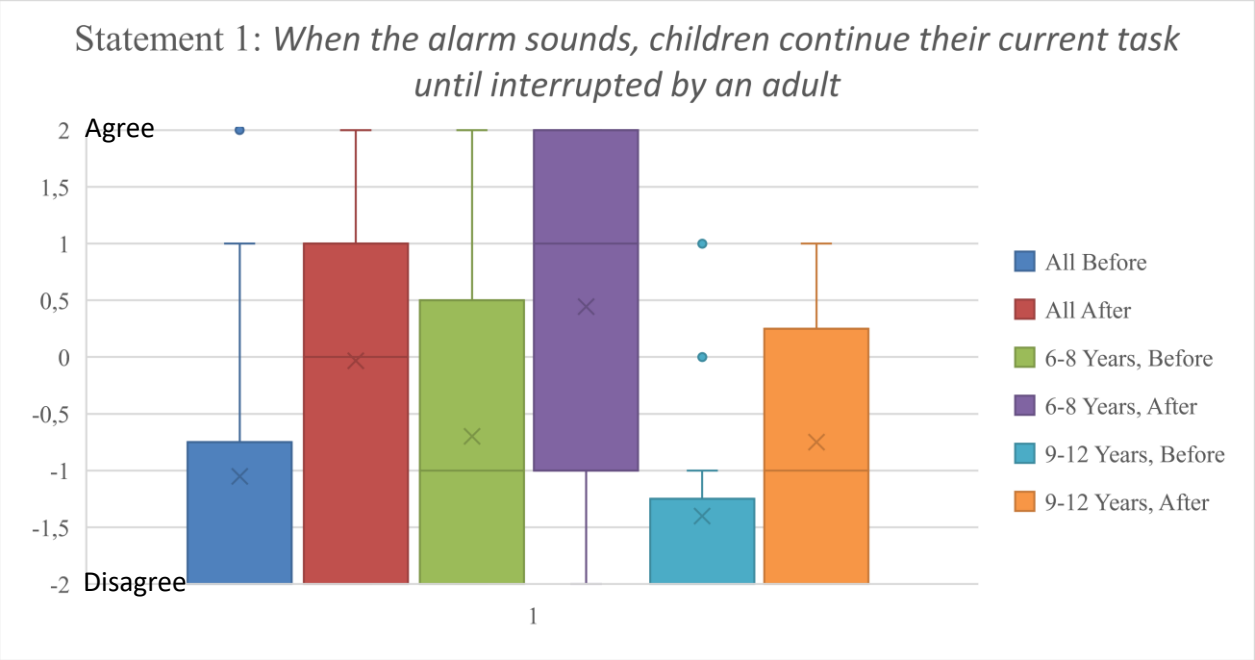


Figure 6: The teachers' answers on response before and after the fire evacuation drill.

Table 3: Descriptive statistics of answers on response.

	Total population before drill	**Total population after drill**	**Ages 6-8 before drill**	**Ages 6-8 after drill**	**Ages 9-12 before drill**	**Ages 9-12 after drill**
Minimum	-2	-2	-2	-2	-2	-2
Q1	-2	-2	-2	-1	-2	-2
Median	-2	0	-1	1	-2	-1
Q3	-0,75	1	0,5	2	-1,25	0,25
Maximum	2	2	2	2	1	1
Mean	-1,05	-0,03	-0,7	0,44	-1,4	-0,75
Range	4	4	4	4	3	3
IQR	1,25	3	2,5	3	0,75	2,25
Outlier +	1,13	5,5	4,25	6,5	-0,13	3,63
Outlier -	-3,88	-6,5	-5,75	-5,5	-3,13	-5,38

4.2.2 Statement 2: When Children Evacuate, They Want to Bring Personal Belongings, Except Clothes.

In the statement if children bring personal belongings 59 % of the teachers thought children would do so. Only 13.6 % was however very positive to this. A total of 27 % did not think children bring personal belongings when evacuating, where 4.5 % were highly negative to this claim. After the drill a majority of 64.5 % answered that children do not bring personal belongings. A total of 48.3 % strongly disagreed with the claim, 19.4 % answered that children

bring personal belongings and 6.4 % were highly positive to this. One teacher commented that some children went inside to gather balls and similar things. Even children from other classes were seen by this teacher that went inside to gather different items.

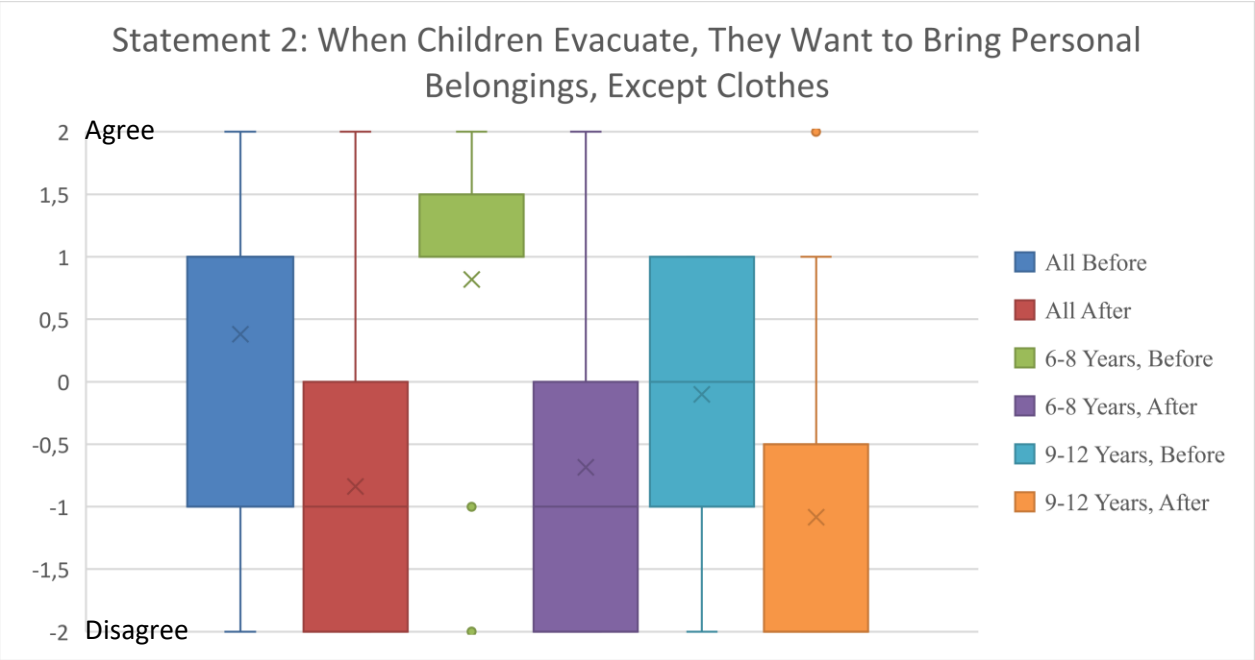


Figure 7: The teachers' answers on personal belongings before and after the fire evacuation drill.

Table 4: Descriptive statistics of answers on personal belongings.

	Total population before drill	**Total population after drill**	**Ages 6-8 before drill**	**Ages 6-8 after drill**	**Ages 9-12 before drill**	**Ages 9-12 after drill**
Minimum	-2	-2	-2	-2	-2	-2
Q1	-1	-2	1	-2	-1	-2
Median	1	-1	1	-1	0	-2
Q3	1	0	1,5	0	1	-0,5
Maximum	2	2	2	2	1	2
Mean	0,38	-0,84	0,82	-0,68	-0,1	-1,08
Range	4	4	4	4	3	4
IQR	2	2	0,5	2	2	1,5
Outlier +	4	3	2,25	3	4	1,75
Outlier -	-4	-5	0,25	-5	-4	-4,25

In the answers before the fire evacuation drill among teachers for the younger age group two teachers answered negative to the claim that children want to bring personal belongings when evacuating. These two answers were treated as outliers in the box chart (Figure 7) and influenced

the mean enough for it to be lower than quartile 1. The trend that could be seen were that the medians (Table 4) were positive or neutral before the drill, but after the drill the medians were negative. The null hypothesis could be rejected in both the tests of the total population as well as the tests of the individual age groups. With 10 % significance level, a difference also could be spotted in the test before the drill with different age groups.

4.2.3 Statement 3: As a Teacher, I Have Full Control During the Whole Evacuation Process.

When asking the teachers about their control in evacuation scenarios 54.5 % answered they felt they had control during the process. Before the fire evacuation drill 27.2 % answered they had full control and 36.3 % of the teachers felt they did not have control during the whole process. After the drill 48.3 % answered they had control and 35.5 % felt they had full control as 19.4 % still did not feel they had control.

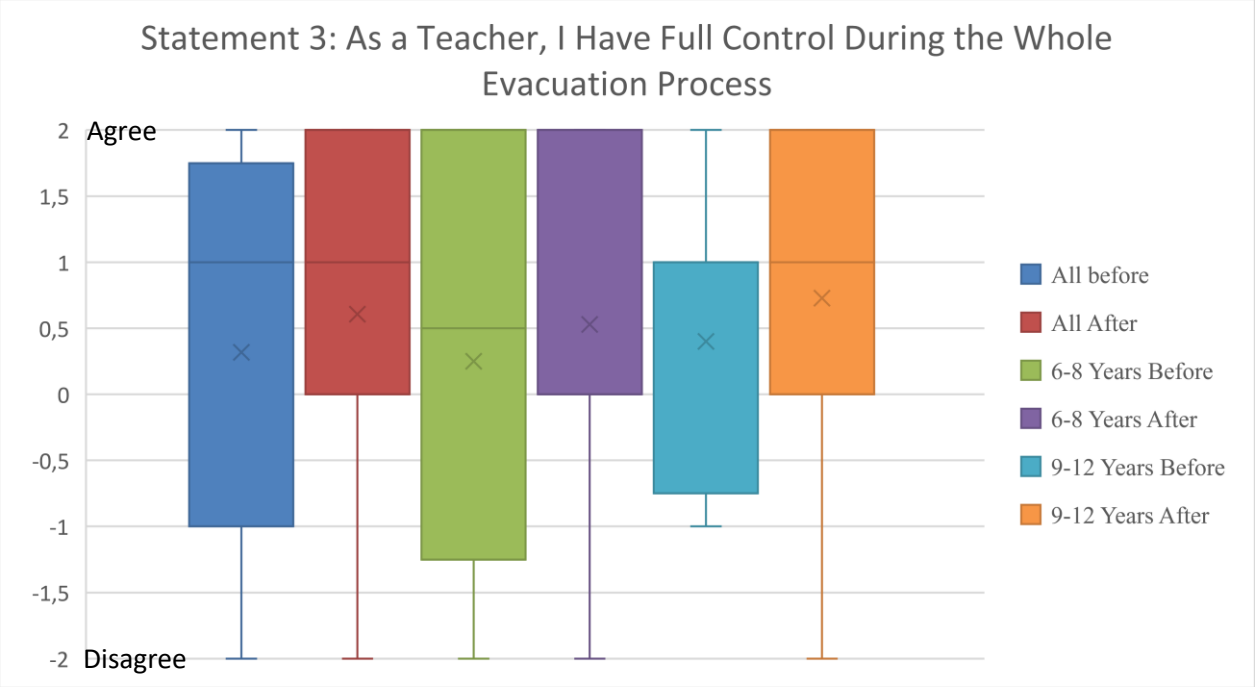


Figure 8: The teachers' answers on their control before and after the fire evacuation drill.

All three teachers who answered they had no control in the process of evacuation, commented that they had little or no experience with fire evacuation. An interesting note was that most teachers who felt control also answered that children would be calm in statement 9. Another interesting note was two teachers of the younger age group, who answered they had full control, but they thought children would panic.

The teachers' answers had a large spread as shown in the boxplot over the distributions (Figure 8). This could also be studied through the inter quartile range (Table 5). Even so, the answers were mostly positive as all values for medians and means were positive, except the median before the fire evacuation drill among teachers for the younger age group.

Table 5: Descriptive statistics of answers on teachers' control.

	Total population before drill	Total population after drill	Ages 6-8 before drill	Ages 6-8 after drill	Ages 9-12 before drill	Ages 9-12 after drill
Minimum	-2	-2	-2	-2	-1	-2
Q1	-1	0	-1,25	0	-0,75	0
Median	1	1	0,5	0	1	1
Q3	1,75	2	2	2	1	2
Maximum	2	2	2	2	2	2
Mean	0,32	0,61	0,25	0,53	0,4	0,73
Range	4	4	4	4	3	4
IQR	2,75	2	3,25	2	1,75	2
Outlier +	5,88	5	6,88	5	3,63	5
Outlier -	-5,13	-3	-6,13	-3	-3,38	-3

A difference in answers before and after the fire evacuation drill could be seen both among teachers in the younger and the older age group. The teachers got more positive to the claim after the drill. However, in the younger age group the median were lower after the fire evacuation drill than before. The majority of the teachers in this group answered positive and a quarter of them answered neutral.

4.2.4 Statement 4: When Evacuating, Children Tend to Follow the Same Pattern as When They Usually Exit the Building.

In the statement if children tend to follow the same pattern during evacuation as normal egress, 22.7 % (Figure 9) were neither negative nor positive to the claim. Before the fire evacuation drill, 27.3 % were a little positive and a total of 40.9 % were positive to the claim that children follow the same pattern and 31.8 % were negative to the claim.

After the drill, 29 % were positive to the claim, 41.9 % were negative and did not think children follow the same pattern and 19.4 % did not know. Teachers in the younger group could have harder to answer this since children were outside. Among the teachers of the elder group 50 % did not think children follow the same pattern as in normal egress and 16.7 % answered children follow the same pattern when evacuating. One teacher commented that some children can be hard to get outside at break time but probably not in emergencies.

The teachers were in total neutral to the claim before the drill, though teachers of the older age group were slightly positive to the claim. After the fire evacuation drill answers (Table 6) were a bit more negative to the claim and in both the younger and the older age group there were a statistically significant difference in the teachers' answers. With $\alpha = 0,10$ differences could be seen between the answers referring to the two different age groups before the drill.

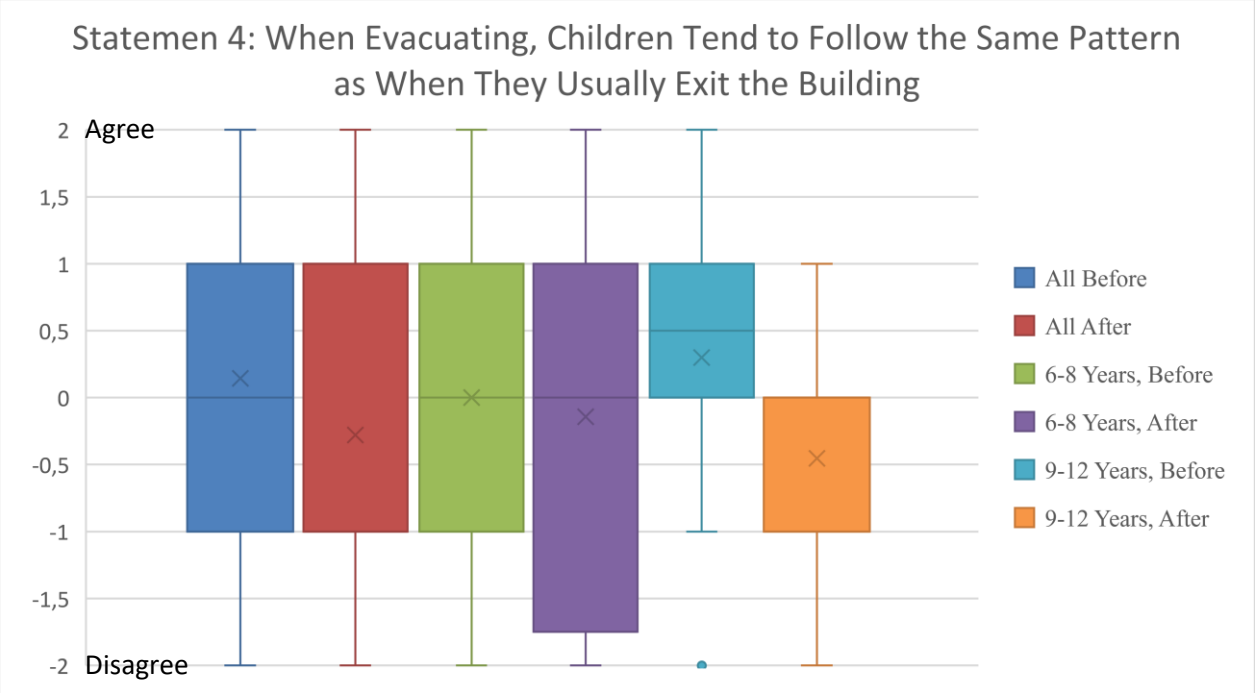


Figure 9: The teachers' answers on place affiliation before and after the fire evacuation drill.

Table 6: Descriptive statistics of answers on place affiliation.

	Total population before drill	**Total population after drill**	**Ages 6-8 before drill**	**Ages 6-8 after drill**	**Ages 9-12 before drill**	**Ages 9-12 after drill**
Minimum	-2	-2	-2	-2	-2	-2
Q1	-1	-1	-1	-1,75	0	-1
Median	0	-1	0	0	0,5	-1
Q3	1	1	1	1	1	0
Maximum	2	2	2	2	2	1
Mean	0,14	-0,28	0	-0,14	0,3	-0,45
Range	4	4	4	4	4	3
IQR	2	2	2	2,75	1	1
Outlier +	4	4	4	5,13	2,5	1,5
Outlier -	-4	-4	-4	-5,88	-1,5	-2,5

4.2.5 Statement 5: Children Only Think of Their Selves and Does not Focus on Any Other Before They Got to Safety.

Before the fire evacuation drill 50 % of the teachers were neither negative nor positive to the claim that children only think of themselves in an emergency. Among teachers, 27.2 % thought children only think of themselves until in safety while 18.1 % thought they think of others all the time. After the drill, 45.2 % answered that children think of others while 25.8 % answered they do not and 19.4 % answered neither negative nor positive to the claim. A comment from a teacher was; “Some children took the responsibility of warning others. One teacher commented “do not know since I did not evacuate” referring to being outside when the alarm went off.

The distributions before the fire evacuation drill were a bit positive (Figure 10) in the total population and among teachers in the older age group. The teachers in the younger age group were slightly negative to the claim before the drill. Both in total and in the younger age group the medians (Table 7) were neutral. After the drill all the medians and means got more negative. Only in the answers from the teachers of the older age group a statistically significant difference could be seen. With $\alpha = 0{,}10$ there were differences in the answers before and after the fire evacuation drill among teachers from the younger age group and between the two age groups before the drill.

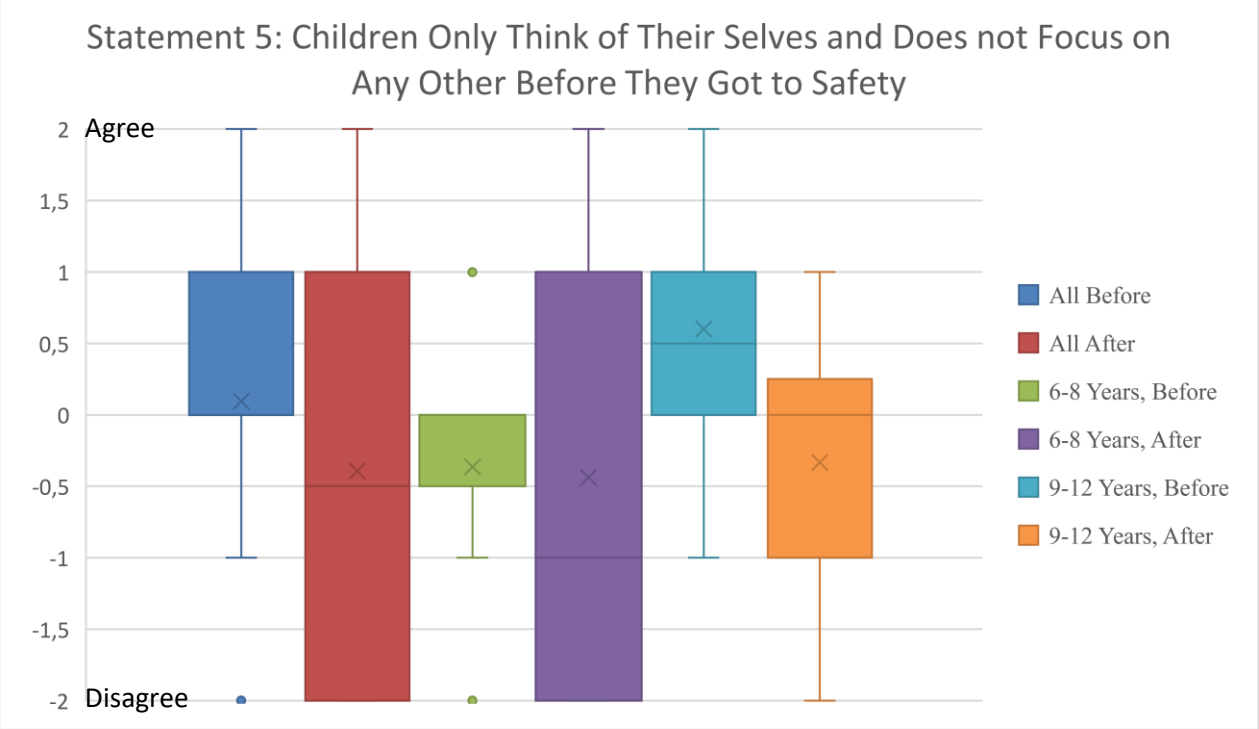


Figure10: The teachers' answers on person affiliation before and after the fire evacuation drill.

Table 7: Descriptive statistics of answers on person affiliation.

	Total population before drill	**Total population after drill**	**Ages 6-8 before drill**	**Ages 6-8 after drill**	**Ages 9-12 before drill**	**Ages 9-12 after drill**
Minimum	-2	-2	-2	-2	-1	-2
Q1	0	-2	-0,5	-2	0	-1
Median	0	-0,5	0	-1	0,5	0
Q3	1	1	0	1	1	0,25
Maximum	2	2	1	2	2	1
Mean	0,1	-0,39	-0,36	-0,44	0,6	-0,33
Range	4	4	3	4	3	3
IQR	1	3	0,5	3	1	1,25
Outlier +	2,5	5,5	0,75	5,5	2,5	2,13
Outlier -	-1,5	-6,5	-1,25	-6,5	-1,5	-2,88

4.2.6 Statement 6: Fire Evacuation Drills Have a Positive Effect on Children's Behavior in Fires.

Before the drill, 59.1 % (Figure 11) thought that fire evacuation drills are good for children's safety in case of a fire. Out of the 21 answers, one teacher, or 4,5 %, was negative to this claim.

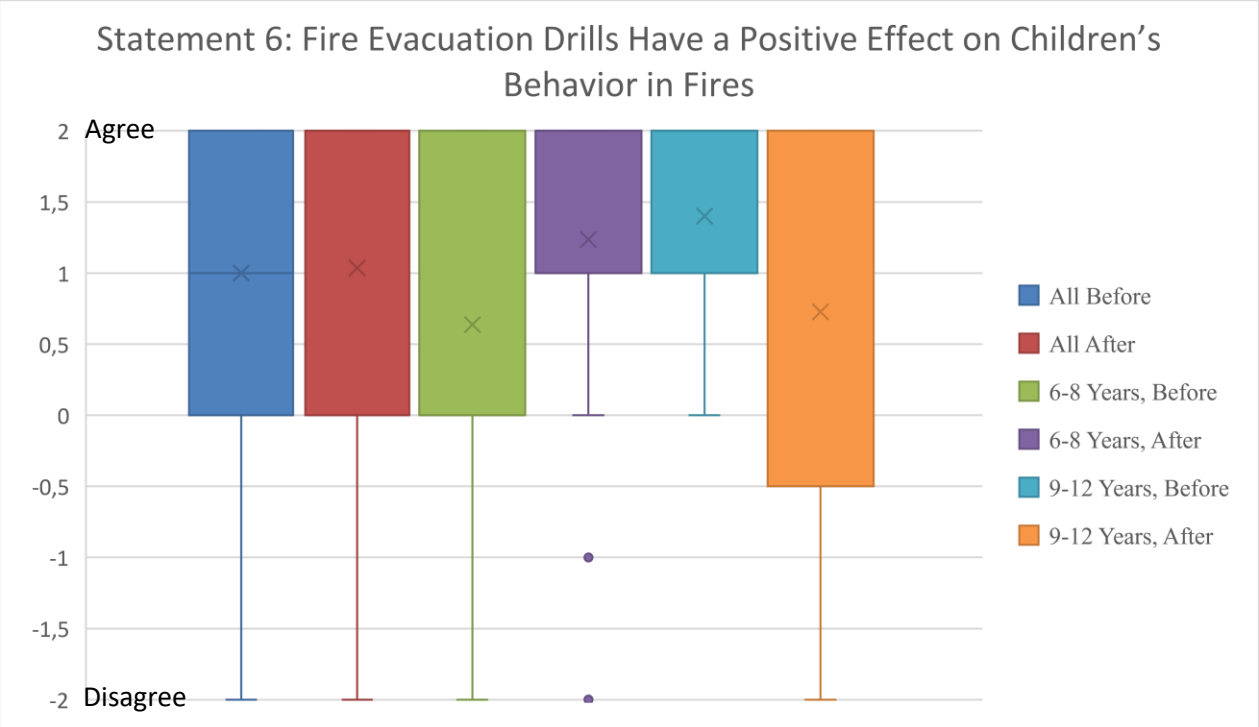


Figure 11: The teachers' answers on fire evacuation drills before and after the fire evacuation drill.

After the fire evacuation drill, 61.3 % were positive that fire evacuation drills are good for children's safety. A total of 54.8 % was very positive to this. Four teachers out of 28 were negative to the claim. The same teacher who did not evacuate in statement 5 answered "do not know" and commented "if there is an evacuation drill, yes". Since this teacher did not choose a number in the scale this answer is not included in the calculations for differences. Medians raised to a higher value or stayed high after the drill in all groups of teachers (Table 8). Thus, the teachers were positive to the claim both before and after. However, a difference in the distributions only appeared in the answers from teachers of the older age group.

Table 8: Descriptive statistics of answers on fire evacuation drills.

	Total population before drill	**Total population after drill**	**Ages 6-8 before drill**	**Ages 6-8 after drill**	**Ages 9-12 before drill**	**Ages 9-12 after drill**
Minimum	-2	-2	-2	-2	0	-2
Q1	0	0	0	1	1	-0,5
Median	1	2	0	2	2	2
Q3	2	2	2	2	2	2
Maximum	2	2	2	2	2	2
Mean	1	1,04	0,64	1,24	1,4	0,73
Range	4	4	4	4	2	4
IQR	2	2	2	1	1	2,5
Outlier +	5	5	5	3,5	3,5	5,75
Outlier -	-3	-3	-3	-0,5	-0,5	-4,25

4.2.7 Statement 7: When the Alarm Sounds the Majority of Children Want to Search for the Fire.

A total of 50 % of respondents strongly disagreed to the claim that children wanted to search for the fire, and a total of 68.2 % (Figure 12) were negative to this before the drill. Only 13.6 % were positive to this and thought children would search for the fire. After the drill, 67.7 % were strongly against the claim and 12.9 % was partly against this. A total of 9.6 % thought children would search for the fire. One teacher commented that children did not want to search for the fire, but they wanted to listen to the alarm.

Most of the teachers were negative to the claim that children want to search for the fire both before and after the fire evacuation drill. After the drill there was a lower (Table 9) mean in the answers in total and in both age groups. The median, however, did not change other than in among answers about the younger age group. In the older age group and among answers in total, the majority were strongly against the claim already before the fire evacuation drill. Thus, the median could not get any lower. In the statistical test, a significant difference was detected in the answers before and after the fire evacuation in both age groups.

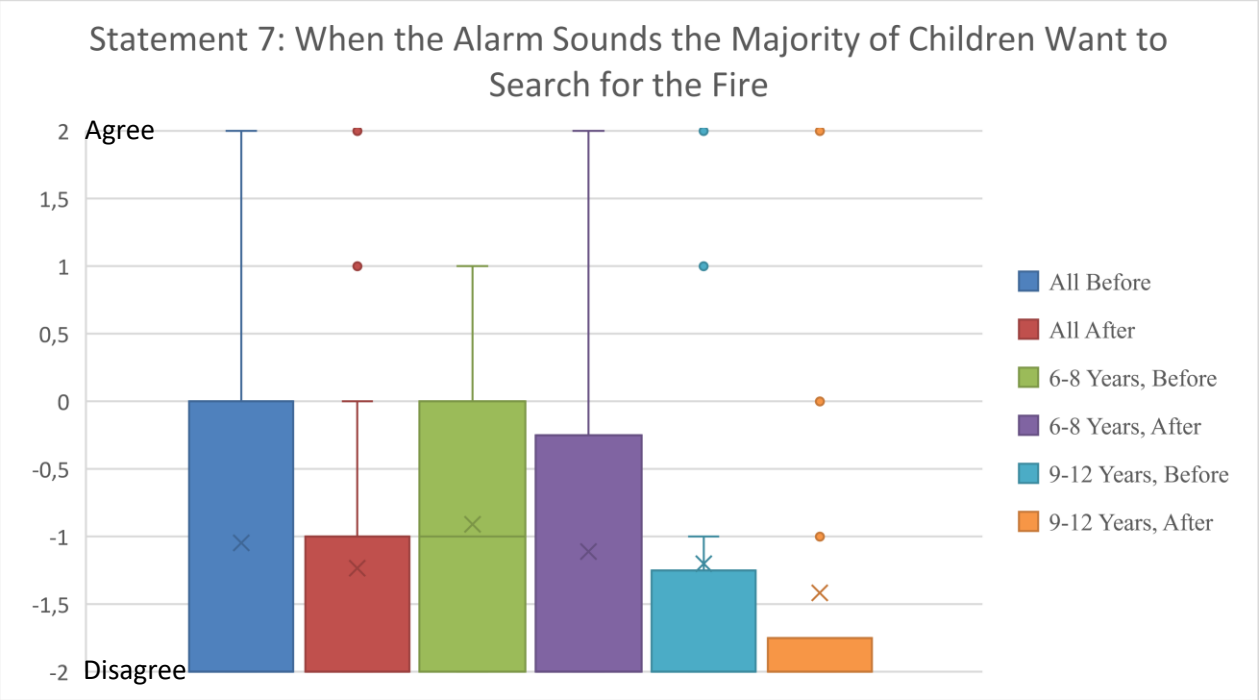


Figure 12: The teachers' answers on searching for clues before and after the fire evacuation drill.

Table 9: Descriptive statistics of answers on searching for clues.

	Total population before drill	**Total population after drill**	**Ages 6-8 before drill**	**Ages 6-8 after drill**	**Ages 9-12 before drill**	**Ages 9-12 after drill**
Minimum	-2	-2	-2	-2	-2	-2
Q1	-2	-2	-2	-2	-2	-2
Median	-2	-2	-1	-2	-2	-2
Q3	0	-1	0	-0,25	-1,25	-1,75
Maximum	2	2	1	2	2	2
Mean	-1,05	-1,23	-0,91	-1,11	-1,2	-1,42
Range	4	4	3	4	4	4
IQR	2	1	2	1,75	0,75	0,25
Outlier +	3	0,5	3	2,38	-0,13	-1,38
Outlier -	-5	-3,5	-5	-4,63	-3,13	-2,38

4.2.8 Statement 8: The Majority of Children Contact an Adult if They Think There is a Fire.

Before the fire evacuation drill (Figure 13), 63.6 % answered that they fully agree that the majority of children would warn an adult when they suspect a fire and 4.5 % did not believe so. After the drill 48.4 % fully agreed to the claim that children would warn an adult and 9.7 % slightly agreed. Among teachers, 12.9 % totally disagreed to the claim and did not think children

would warn an adult and 29 % said they were neither negative nor positive to the claim.

In the comments, one teacher thought children would warn. Since it was a drill and the teacher were not in the same spot as children, this teacher totally disagreed that children would warn an adult. Someone also commented that it depends from school to school. In some schools, children often knock on the teacher staff room but in this school, it never happens.

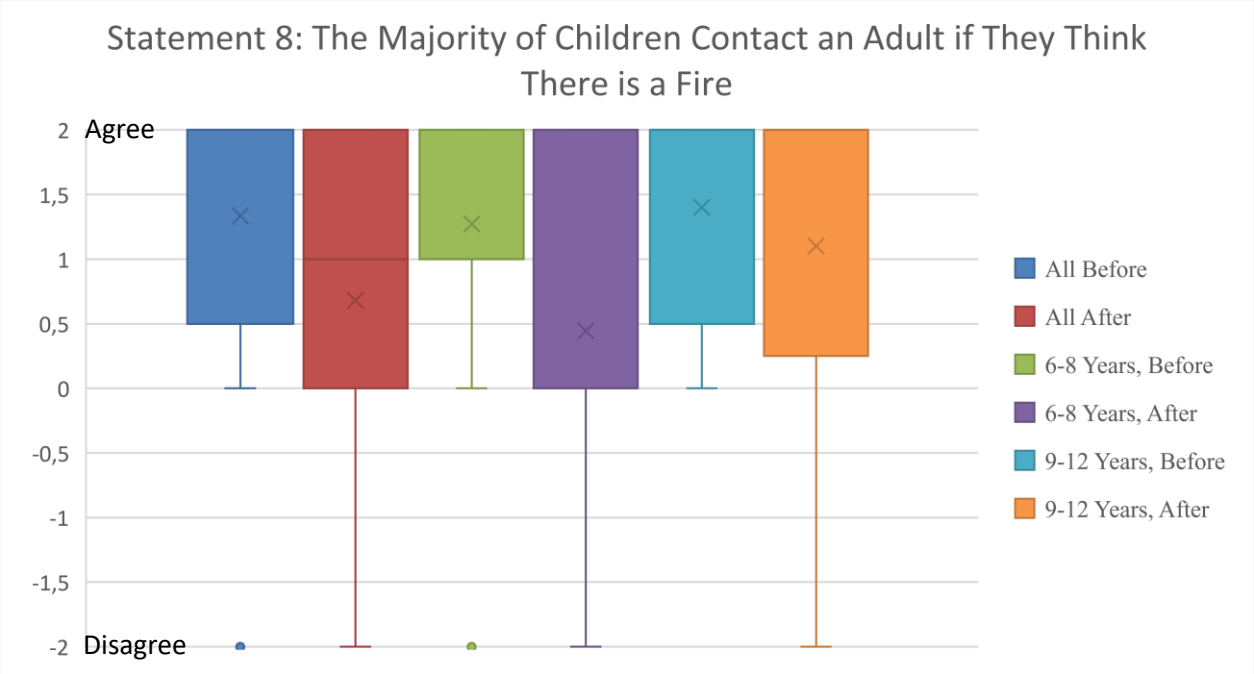


Figure13: The teachers' answers on warning others before and after the fire evacuation drill.

Table 10: Descriptive statistics of answers on contacting adults.

	Total population before drill	**Total population after drill**	**Ages 6-8 before drill**	**Ages 6-8 after drill**	**Ages 9-12 before drill**	**Ages 9-12 after drill**
Minimum	-2	-2	-2	-2	0	-2
Q1	1	0	1	0	0,5	0,25
Median	2	1	2	0	2	2
Q3	2	2	2	2	2	2
Maximum	2	2	2	2	2	2
Mean	1,33	0,68	1,27	0,44	1,4	1,1
Range	4	4	4	4	2	4
IQR	1	2	1	2	1,5	1,75
Outlier +	3,5	5	3,5	5	4,25	4,63
Outlier -	-0,5	-3	-0,5	-3	-1,75	-2,38

The teachers were very positive to the claim that children would contact an adult in case of fire both before and after the fire evacuation drill. After the drill the teachers were a bit less positive to the claim and the significance tests showed this as well in both age groups but not in total. The significance test for the younger age group were a bit ambiguous and the results from the larger sample did not detect any difference in the answers when the results from the smaller sample showed a significant difference. Concerning the mean and median (Table 10) the largest changes were in the younger age group.

4.2.9 Statement 9: A Child in The Class Gets Really Worried and Show an Irrational Behavior That Spreads Among the Majority of Children.

Teachers who answered they did not feel they have control answered that children panic more often than teacher who felt control. Half of the teachers were negative to the claim that children would panic when asked before the drill (Figure 14). Among teachers, 27.3 % thought children would panic and 13.6 % fully concurred to that one child would get afraid and trigger mass panic. All that answered positive on this claim where teachers of the younger age group.

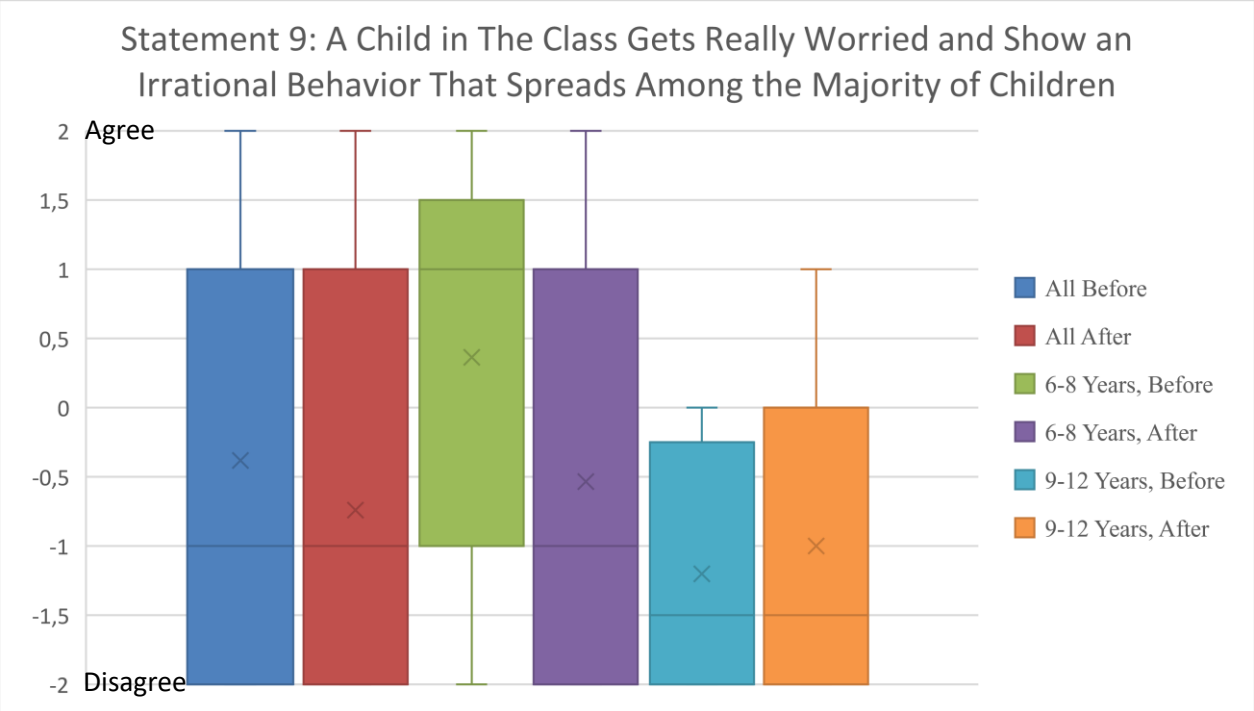


Figure 14: The teachers' answers on panic before and after the fire evacuation drill.

After the drill 54.8 % of the teachers did not think children would panic and 25.8 % thought children would panic. In general, the teachers with older children were more negative to this claim than teachers of the younger age group. One child got so worried that the child wanted to go home to the parents. Another teacher had a child that would not listen. This scared the classmates and could possibly lead to a situation that is less manageable for the teacher.

Before the fire evacuation drill, teachers from the younger age group were relatively positive to the claim with both a slightly positive mean (Table 11) and a positive median. The teachers from the older age group were quite negative to the claim. This difference could be seen in the statistical significance testing. After the fire evacuation drill the teachers from the younger group were more negative to the claim and teachers from the older age group were more positive and no difference among the answers from the two groups could be seen. In the two age groups a statistically significant difference was found in answers from before and after the fire evacuation drill. No difference could be seen in the total population.

Table 11: Descriptive statistics of answers on panic.

	Total population before drill	**Total population after drill**	**Ages 6-8 before drill**	**Ages 6-8 after drill**	**Ages 9-12 before drill**	**Ages 9-12 after drill**
Minimum	-2	-2	-2	-2	-2	-2
Q1	-2	-2	-1	-2	-2	-2
Median	-1	-1	1	-1	-1,5	-1,5
Q3	1	1	1,5	1	-0,25	0
Maximum	2	2	2	2	0	1
Mean	-0,38	-0,74	0,36	-0,53	-1,2	-1
Range	4	4	4	4	2	3
IQR	3	3	2,5	3	1,75	2
Outlier +	5,5	5,5	5,25	5,5	2,38	3
Outlier -	-6,5	-6,5	-4,75	-6,5	-4,63	-5

4.2.10 Statement 10: The Audibility of The Alarm is Enough for Everyone to Hear.

Half of the teachers answered that they thought the audibility of the alarm was very good before the drill (Figure 15). A total of 59.1 % thought the audibility was good or very good.
After the fire evacuation drill 67.7 % thought the audibility of the alarm was very bad, 6.5 % thought it was slightly bad and 16.1 % of the teachers thought the audibility was very good. After the drill, many teachers commented that the alarm did not sound outside. Even teachers that were inside at the moment when the alarm sounded answered that the audibility was very bad with the comment that people outside did not hear the alarm. Someone in building B wrote that the alarm initially did not sound at all in that part of the school and they got a warning from someone of the administrative personnel and one wrote the alarm sounded after 10 minutes. One teacher who was in a classroom in building A wrote that the audibility was bad both outside and in the classroom.

In the answers from the total population and the teachers from each of the two age groups significant differences were shown in the significance test. The largest differences could be seen among teachers from the younger age group where the median went from the maximum value before the drill to the minimum value after the drill (Table 12). A smaller, but similar difference could be seen among teachers in the older age group.

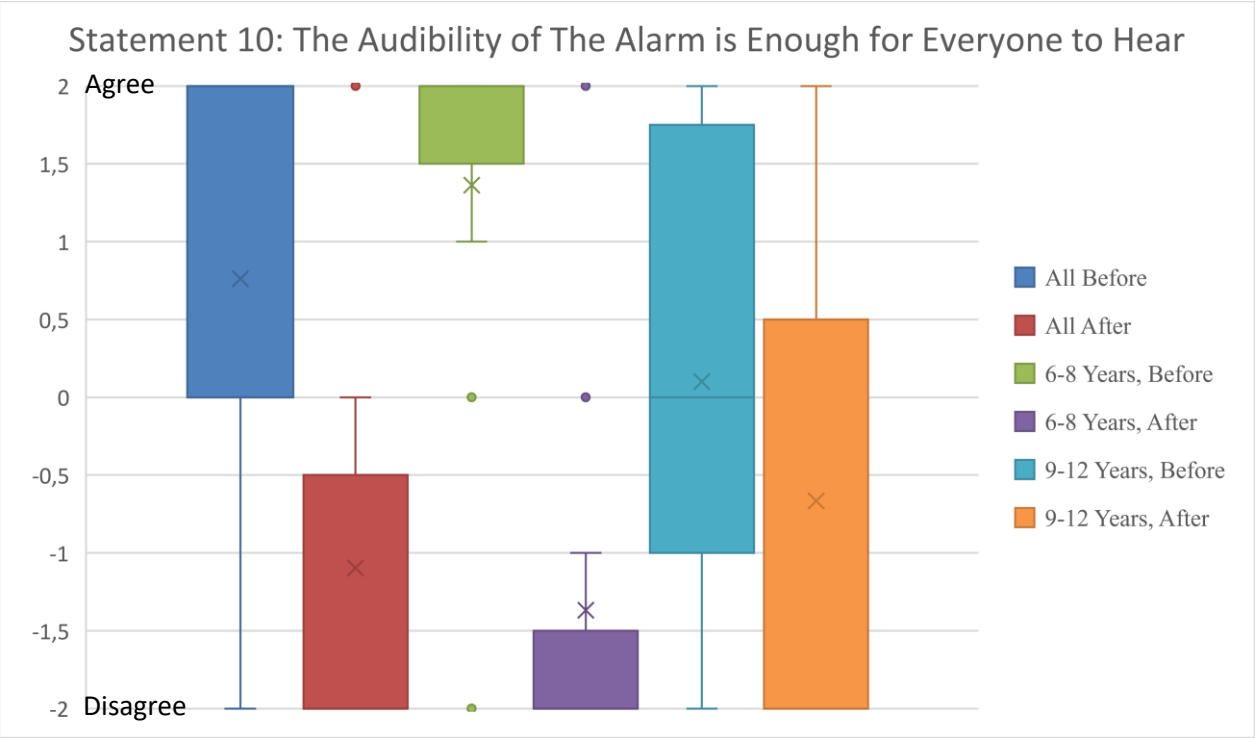


Figure 15: The teachers' answers on the audibility of the alarm before and after the fire evacuation drill.

Table 12: Descriptive statistics of answers on the alarm audibility.

	Total population before drill	**Total population after drill**	**Ages 6-8 before drill**	**Ages 6-8 after drill**	**Ages 9-12 before drill**	**Ages 9-12 after drill**
Minimum	-2	-2	-2	-2	-2	-2
Q1	0	-2	1,5	-2	-1	-2
Median	2	-2	2	-2	0	-2
Q3	2	-0,5	2	-1,5	1,75	0,5
Maximum	2	2	2	2	2	2
Mean	0,76	-1,1	1,36	-1,37	0,1	-0,67
Range	4	4	4	4	4	4
IQR	2	1,5	0,5	0,5	2,75	2,5
Outlier +	5	1,75	2,75	-0,75	5,88	4,25
Outlier -	-3	-4,25	0,75	-2,75	-5,13	-5,75

4.2.11 Comments and Observations From the Teachers

The author of this thesis observed the fire emergency drill and followed one class after the drill. During the distribution and collecting of the questionnaire the author also talked directly to most of the teachers. In this chapter the observations made by the author are presented. The teachers also had a choice to comment in the questionnaire. Those comments are also included here.

Many teachers seemed relatively insecure about the routines with the fire evacuation drill in the school. One teacher wrote that routines and responsibility was unclear since the alarm sounded when everyone had a break, and either was outside checking children or on a break. Since no other adult could be seen inside, this teacher searched the premises. The teacher noted that some children tend to go inside and hide during breaks when they do not want to be outside. All doors inside were open so the teacher meant there could be children anywhere inside in this section of the school.

Another teacher did not have information on what to do if there was any child missing. Teachers also seemed hesitant of how long they were supposed to wait at the assembly point. They did not know if they are supposed to go inside when the alarm stops or wait for someone to tell them.

When talking with the teachers, those with little or no experience felt less control in fire evacuations and thought children would panic with greater tendency. The lack of experience was seen among teachers that were new to the profession, school and among those who never had experienced a fire drill with the actual class they were teaching. One teacher noted would prefer a fire evacuation drill in the beginning of the semester. Especially in autumn as this is when some teachers could get new classes and since new children starts at the school.

One teacher with long experience had taught children to gather in a row every time they go to gym class, lunch or similar activities outside the classroom. This teacher said this helped a lot when evacuating since children were used to a certain pattern that could be used in fire evacuations too.

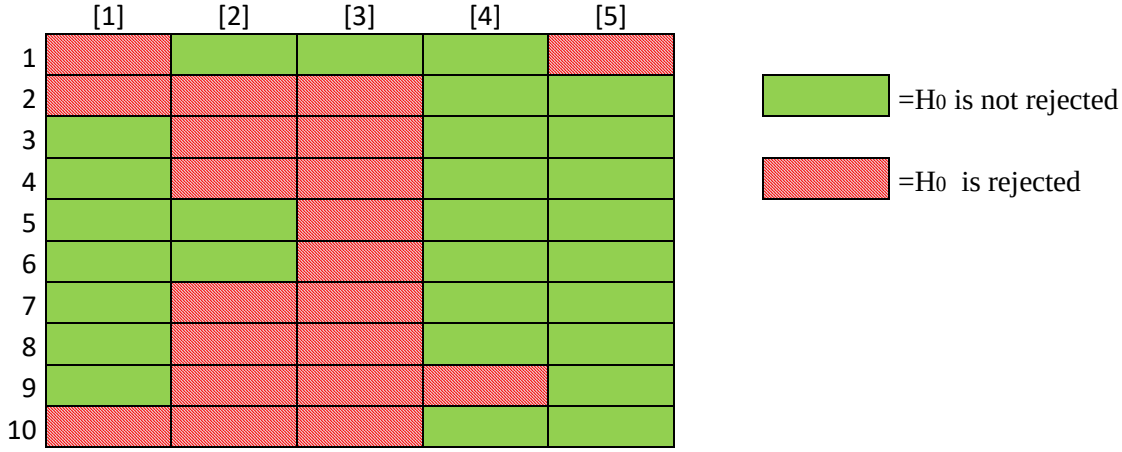
5 DISCUSSION

Answers from the teachers differ significantly in some of the statements. Due to this and the small sample size it is hard to make bold conclusions even if tendencies in teachers' perception of children's behavior might be observed in some statements. There are many reasons to why the answers could differ. Human behavior in fire emergencies vary with many factors and are a complex process, even when some factors are disregarded. Evacuation behavior among children is in no means less complex to study. In a school, children have a role as pupils, but this role could vary in its meaning depending on children's schedule. Children might not act the same in class as on a break. As children are monitored by adults, they always have an assigned leader. Thus, children's actions may depend only on the adult's actions and decisions. This could mean that what looks like differing behaviors among children might be due to the teachers' personalities and experience.

The fact that children in elementary school are in the middle of their cognitive development means that children's behavior could vary a lot among the different ages represented. Even among children who are year cohorts, the behavior and grade of cognitive development could vary a lot. This cognitive development is individual and since it could differ almost a whole year between children in each class as children start school in autumn, the year they turn 7.

As the fire emergency drill in the school provided a new situation for many teachers this could be a reason for changing answers before and after the drill. It was clear from the questionnaire that many teachers answered specific for the drill in the questionnaire after the fire evacuation drill. Also, many of the teachers had talked to each other and answered for example that the audibility of the alarm was bad with the comment that people outdoors did not hear it, when they themselves was indoors. Since the fire evacuation drill differed from what the teachers were used to, this could be the single greatest factor influencing differences in the teachers' answers before and after.

Table 13: Chart of rejected null hypothesis with a significance level of $\alpha = 0{,}05$ for all 10 statements with different combinations of populations [1]-[5]. Where [1] is comparison of all the answers before and after the drill, [2] and [3] are answers of the younger respectively the older age group before and after the drill. Last the younger age group compared with the older age group was made before [4] and after [5] the drill.



7 out of 10 significance tests in the younger age group and 9 out of 10 significance tests in the older age group showed significant differences from answers before and after. However, the results could be very different from time to time in a small sample size as the population of the group is from one school. A different population from another school might not have the same perception of children's behaviors.

Teachers have different degree of fire training and many of the teachers might not react on typical behaviors that exists among evacuating adults. This could in theory mean that the answers are not representative for children's behavior. However, teachers work all day with children and have development and behavioral theories in their education. Thus, the teachers' answers as a group should give an indication of children's behavior during fire evacuation.

5.1 Statement 1: When the Alarm Sounds, Children Continue Their Current Task Until Interrupted by an Adult.

The resulting answers could be an effect of the fire evacuation drill during break time. Since children outside did not hear the alarm, everyone outside were warned by an adult. However, the teachers in building B, where the older children are, did not hear the alarm either and occupants in this building were warned by the administrative personnel. Thus, the same results should be seen in the older as in the younger age group if this was the dominating cause in initiating egress.

An interesting factor is that answers after the fire evacuation drill, from the younger and the older age group, were different. Since neither the younger nor the older age group heard the alarm, the different results were not expected. The different environments could be a reason for this. Children might be harder to stop playing to evacuate or gather than to get to start an evacuation when in class. This could also be an effect of a single event during the drill that changed the teachers' minds. Only one teacher commented that some children did not notice anything around them and had to be fetched by another teacher. The author observed these children as well and some other children outside who kept on playing even when told by their teacher to gather at the reassembly point. One child was clearly defying the teacher's orders as one group of children from the younger age group might been too absorbed in their play to notice what happened around them.

Statistical significance in the tests from the individual age groups is observed. It could as well be that the different sample sizes match each other in the distributions but the larger one has more sample points and thus a clearer distribution than the smaller one. The difference shown here could not be seen in other statements except the statement of panic (statement 9). This could be due to the distribution of the age groups. Children develop at different paces and the two age groups could be too close to each other's in ages and development to see differences in the two age groups with such a small data sample. Meaning there could be differences in other statements too. However, there are too large differences in the surroundings in this statement to make this

assumption without further investigation.

The fact that teachers thought that children will stop their tasks is interesting. This is the opposite of what studies of adults' behavior in similar situations show. This could be due to differences in children's and adults' behaviors, but it could as well be misconception among the teachers. The change in answers among teachers in the younger age group could be a result of the different environment where teachers never practiced fire evacuations drills before. The change was positive in both age groups, even if not significantly more positive this could show that children behave more similar to adults than the answers from before the drill showed.

5.2 Statement 2: When Children Evacuate, They Want to Bring Personal Belongings, Except Clothes.

There was no evacuation from the building for the pupils in the younger age group, as they had playtime and already were outside. This could be a large factor that influenced the answers and even what some teachers highlighted. This could be a reason for teachers answering that children do not bring personal items when evacuating. After the fire evacuation drill the teachers might have seen children with personal items but these items could have been brought outside for playtime and not during an evacuation. Or the teachers might have answered negative to the claim only because of thinking they did not evacuate and thus the interpretation from the teachers could be that no personal items could have been brought even if collected after the alarm was noticed.

Another reason could be that children brought toys, but these toys could have been school property. If so, the statement for personal items would not be correct. Maybe the answers would be different if the statement were phrased in another way. This could also be a result from children being led by the teachers who might consciously or subconsciously direct children from such behavior.

5.3 Statement 3: As a Teacher, I Have Full Control During the Whole Evacuation Process.

In the statement of the teachers' control over the situation in an evacuation the results were scattered both before and after. After the drill teachers were however more positive and felt they had more control. This could show the importance of experience of fire evacuation drills for the teachers' knowledge of children and the routines. As the teachers' confidence went up their perception of children's tendency to panic went down. This would be normal as panic would mean the teacher lose control. But lost control does not mean panic.

The teachers' direct children during the fire evacuation drill. This might alter children's behavior. Children left alone in fire evacuation scenarios might behave in a different way if not directed by adults. This means that the results seen in this paper could be altered behaviors among children due to the teachers' directions and their control of children.

The answers were mainly positive before the fire evacuation drill but after the drill an even more

positive change could be seen in the answers. This could be a hint that fire evacuation drills are good for the teachers to maintain proper training and confidence of what to do in case of emergency. This could also be a result from children getting the right training to get more self-reliant in this kind of situation.

5.4 Statement 4: When Evacuating, Children Tend to Follow the Same Pattern as When They Usually Exit the Building.

Before the fire evacuation drill, most of the teachers answered between -1 and +1 with a median of +1. This could be explained as half or at least some children follow the same pattern when evacuating as they normally do. This could also mean children follow the same pattern to a certain degree. It could be stated that teachers do not think all children follow the same pattern to a full extent. After the drill, the answers differed a lot and not much could be read from the results. Among the teachers of the older group the answers tended to be a bit more negative after the drill than before. In the younger age group, the answers differed more. This could be explained with children being outdoors and thus it was hard for the teachers to answer this statement. The number of teachers that did not answer this statement after the fire evacuation drill indicates this could be the factor making a difference in answers from before and after.

When entering the building, children normally take off their coats and shoes. These are stored in each child's personal dress rack outside the classroom. Children do not use shoes indoors, except in the areas around the dining hall and in the corridors in direct proximity to the diner and the reception. During a fire emergency drill, it is thus natural for children to get dressed and go out through the closest door. The closest door should be the same door as children entered the building as no shoes are allowed indoors. This could make it hard for teachers to decide if children tend to follow the same pattern or not. The result from the teachers' answers could show that children are very flexible in their choice of their way out. The answers could also show that children are more flexible and not as bound to habits as adults might be.

The answers from teachers of the older age group changed to more negative to the statement. These children were still having class or in the cantina. The answers could show that that children did not shower after gym class or left their food at the table. Another possible explanation would be if children left everything in place instead of cleaning their desk before leaving class or similar deviations from the normal pattern.

Another factor that influence the results is that children are led by the teacher. This could alter children's egress pattern as they follow the teachers' commands. A teacher could answer negative to this if children follows given orders as they in that case would follow orders and not the same pattern as when they usually leave the building. Following orders would not be the same pattern as an ordinary exit as children would be directed to evacuate with a certain order in the group.

5.5 Statement 5: Children Only Think of Their Selves and Does not Focus on Any Other Before They Got to Safety.

The results from the statement of person affiliation could be explained similar to the place affiliation. Here most teachers answered but the answers among the teachers differed much after the fire evacuation drill. This could be explained with children being outdoors and thus teachers could interpret this as they already were safe when they started warning each other. However, children should not be considered safe until the teacher checked that everyone from the class are at the assembly point. Children could hide indoors or go inside when left unattended.

Children could have different social bonds. They are a part of the larger group as a classmate. The class is cared for by the teacher who tries to keep order and lead the group orderly to safety. In this group children might feel less need to warn the group as they the fact that there was no evacuation from the building for the pupils in the younger age group as they had playtime and already were outside trust the teacher to lead the group. Children also could have closer friends. This could be children in the same class or in different classes. Such friendships could mean children keep together during the egress or checks on each other when outside if in different classes. Another social bond among children is siblings. If siblings are in different ages, one marker could be if children ask about their sibling. The answers from the teachers show that children not only think of themselves, but it does not show which social bonds are important in evacuation of children.

5.6 Statement 6: Fire Evacuation Drills Have a Positive Effect on Children's Behavior in Fires.

Common belief implies that fire emergency drills are important for children as they learn what the fire alarm signal means and how to react to it. The layout of the drills could however have an impact on children's and the teachers' ability to safely evacuate in every situation. The fact that some teacher did not think it was a fire evacuation drill could be because it was something out of the ordinary. Some teachers and children seemed a bit confused by the timing of the drill. This could that well-planned fire evacuation drills are important for the organization. It is important to have strong routines and to practice those, but it is also important to practice on the different situations that could occur at a school. In fire evacuation drills it could be important to practice different exits, different settings and to evacuate without getting dressed indoors before exiting to minimize the risk of confusion in case this is needed in a fire scenario. However good and well-trained routines could provide easier decisions and could mean shorter evacuation times. The teachers were positive that fire evacuation drills are good for children's safety in case of a real fire incident.

The effects of fire evacuation drills are often discussed. No studies are done that focus on positive and negative effects on the behaviors of individuals training. A child who never heard the fire alarm bell would likely not know what this meant or how to react to a ringing bell. Depending on the age, an instructive alarm message might be enough to initiate the correct reaction even if the child never practiced fire evacuation. Fire evacuation drills could have a negative effect as

children might think it is another drill when a real emergency occur.

5.7 Statement 7: When the Alarm Sounds the Majority of Children Want to Search for the Fire.

A negative result could be interpreted as teachers think children tend to hide in case of fire in schools. This could be due to the school's routines. When the fire alarm sounds some of the teachers always search the schools' premises in case there are any children left. As no children were reported as hiding, this should not be the case in this study. The routines of searching the school for children, could be a cause from thinking that children would hide in cases like this.

One teacher pointed out that children searched for clues. It could be that children left alone search for clues but as they are supervised by the teachers all the time the teachers' leadership and orders make the search for clues unnecessary.

The alarm did not sound outside or in the part of the school with the older children. This might have altered the resulting answers after the fire evacuation drill. Some children went to listen for the alarm even if they already had been told to gather at the assembly point. This would not be necessary if the alarm sounded outside. As the alarm did not sound it could be natural to check what is happening, hearing this could be enough clues for children to get to safety.

5.8 Statement 8: The Majority of Children Contact an Adult if They Think There is a Fire.

Less positive answers after the drill might be connected to the teachers' negative view on the younger children's response in statement 1. Lárusdóttir & Dederichs (2011) noted that children start responding before the teacher when 9 years old. If the teachers think children will not respond to a fire it would be hard for them to warn an adult. The result could be interpreted as the teachers think most children would warn an adult. However, a teacher pointed out that they might warn the teacher if they are in the same room but otherwise this teacher was negative to children warning an adult. This could of course differ from school to school as the social environment differs. In this school children never knock on the teachers' staff room while it is usual in some other schools. Psychology research has shown that children in this age are more afraid of physical injuries and that social discomfort starts growing when the child is a teenager. This could mean that children in elementary school are more prone to warn an adult and each other as they are not as afraid to make fools of themselves.

5.9 Statement 9: A Child in The Class Gets Really Worried and Show an Irrational Behavior That Spreads Among the Majority of Children.

Adults rarely panic in fire emergencies but not much is known about children in this field. It would be reasonable to assume that children in schools seldom panic since children behavior may be in line with the ones of adults, thus they interpret them and decide accordingly on how to act in a situation they are not used to. If the teachers are trained and behave rationally, children would probably do the same.

All children knew there was an upcoming fire evacuation drill. Thus, these results are limited in terms of what could happen in a real fire evacuation. There is no evidence that children would act irrational and trigger mass panic if really frightened or if they do not understand the teachers' directions. At the moment, these are speculations, and the results show that children as a group act calm and rational.

There is a difference in answers in the two age groups before the fire evacuation drill. This difference could be that the younger children could have higher tendencies to worry when something strange happens. One reason this was not seen in the answers after the alarm could be that children were outside. Thus, there were no alarm or egress that could worry children. The only thing that really could worry children was the strange happening of gathering at the assembly point.

5.10 Statement 10: The Audibility of The Alarm is Enough for Everyone to Hear.

The statement about the audibility of the fire alarm shows how much any person could learn from a fire evacuation drill. Before the drill, teachers thought the alarm signal would have good audibility while they learned the alarm does not sound outside in the evacuation drill. Now it resulted in some confusion but in a fire incident, the outcome could be very different.

Hearing the alarm could make a difference in many of the statements. Hearing the alarm could trigger a different or quicker response.

5.11 Methodolical Issues

During this thesis the school principal did all the planning of the fire evacuation drill. As the statements in the questionnaire mainly focused on different activities indoors, it could have altered the answers in some cases. For example, since no one outside heard any alarm, everyone outside were warned by other teachers coming from the teacher's lounge. A fire evacuation drill with a scenario that is new to everyone could mean larger differences in answers than what is true. Since many of the statements was from examples of how adults behave in different settings, the questionnaire probably would have been designed differently to fit the actual drill better.

The principal also handled the distribution of the questionnaire before the drill with information of the study to the teachers. Some teachers had missed this or waited with it to prioritize other chores. If the author would have distributed the questionnaires by hand this could have generated in more answers. The different number of answers before and after the drill could be a cause of both showing bigger differences and not showing differences that might be. The way the questionnaire was distributed made it impossible to tie any answers before and after to each other. If it would have been possible to compare the answers before and after the drill on an individual level, a more qualitative analysis could have been performed.

The study was limited to the teachers in one school. It is likely that some of the teachers have

spoken about the statements with each other before answering. This could have altered the answers and hidden any probable differences.

6. FUTURE RESEARCH

This study mainly focuses on understanding the teachers' perception on children behavior and subsequently discuss how known behaviors among adults can be translated into children's behavior in similar situations. In the school and similar surroundings, children are monitored by adults. However, there is no guarantee that children, under all time, are under direct supervision. To only rely on the teacher to get a larger group of children to safety without knowledge of children's behavior in fire evacuation may lead to some issues. This means there could be situations where children play a large role in their own safety. This is particularly important in case of assisted evacuation procedures. Further research should be done on children's behavior to understand how children react in fire emergencies and how those different among age groups. This is crucial for the understanding of children's abilities to evacuate but also for a more effective fire protection engineering in buildings. Further research should include children's development to understand if and if so, at which ages certain behaviors occur.

It is common to think that children hide in fire scenarios in their home. Observations of this behavior, among adults, have not been recorded in any material found for this paper. Thus, it is sound to believe that there could be other behaviors that differ among children and adults. Both if there are small or large differences should be further researched to understand how children react in fire evacuation scenarios.

6.1 Statement 1: When the Alarm Sounds, Children Continue Their Current Task Until Interrupted by an Adult.

In this statement the results from the answers show a significant difference between answers in the two age groups. There are factors such as surroundings, insufficient data and the age groups being quite similar. This makes it hard to state that there are differences due to children's ages. However, there are similarities in the two cases which might show differences in fire evacuation of children in different ages.

Due to the answers, teachers think that children tend to react on the fire alarm. This means the teachers think children will stop what they are doing but it does not mean children start evacuating before the teachers initiates the egress. These negative answers compared with answers about children's tendencies to search for clues, could show that children are more prone than adults to start evacuating with the fire alarm as only cue. How children react to the fire alarm in different surroundings needs more research.

6.2 Statement 2: When Children Evacuate, They Want to Bring Personal Belongings, Except Clothes.

Children, six months to six years old, have been observed to be upset over leaving personal items behind. The teachers believed a similar object affiliation could occur when they answered before the fire evacuation drill. As this also is seen among adults it is sound to believe there is some level of object affiliation. A study that would be interesting is how strong this affiliation is in different ages. As three children was observed to go inside to bring something it would also be interesting to study if and in that case in what extent children would go back to collect personal items.

6.3 Statement 3: As a Teacher, I Have Full Control During the Whole Evacuation Process.

As discussed in statement 1, there were some children who would not listen to the teachers' orders. In this study this fraction of children was small but is this true for all ages? There are several stages in a child's development, and some are more turbulent than others. Although most children seemed to follow the teachers' directions this behavior could be fatal in the wrong situation. Do children in general defy their teachers or their leaders in other surroundings or is this a seldom observed behavior? This might be interesting to study even in higher ages in the school, if rebellious teenagers might have a similar behavior. Are there ages when the child is more prone to defy parents or leaders in the group in case of emergency?

6.4 Statement 4: When Evacuating, Children Tend to Follow the Same Pattern as When They Usually Exit the Building.

Children's habits and flexibility to new situations might not be the same as for adults. Adults may have more learned patterns they follow in their day to day life than children have. On another level children might feel more secure with set patterns. Answers from teachers imply there are not any large differences in evacuation pattern among children and adults. Thus, a study of this would be of lesser interest with the present knowledge of children's behavior in fire evacuations. This might not be of interest at all in surroundings where children are monitored by adults. Further research, as suggested in this paper, could however indicate a need for further studies of children's choice of exit during egress. A study of interest could be how large influence the teachers' directions are on children's evacuation pattern.

6.5 Statement 5: Children Only Think of Their Selves and Does not Focus on Any Other Before They Got to Safety.

Some children did not show any interest of that their classmates were gathering in the classes, at the assembly point. They either defied their teacher or went with the other children they were playing with when alarmed. This imply that there could be different social bonds playing part in a child's process of fire evacuation. If there are any, and in that case which social bonds make the biggest impact on children's fire evacuation, among children in different situations and surroundings could be an interesting to study. Such a study could investigate if a child is dependent on adults and/or in what degree an adult can help a group of children.

6.6 Statement 6: Fire Evacuation Drills Have a Positive Effect on Children's Behavior in Fires.

It is hard to know the positive effects of fire evacuation drills and a study of any actual gain would have to be extensive. One way to do this might be to study a group of children and follow them over a longer time. However, the question of the gain from fire evacuation drills is not bound to age but a question in need of an answer for all types of surroundings and ages. This could help to plan more effective drills and preventive organizational measures.

6.7 Statement 7: When the Alarm Sounds the Majority of Children Want to Search for the Fire.

It is not uncommon to think children would want to hide in a real fire scenario. This might be true in residential situations, but does this apply for all environments that children occupy? The majority of the teachers answered that children in school environment does not search for clues of a fire when they hear the fire alarm. As stated in the discussion, children's behavior could be different in other situations and if they are left without direct supervision. This could be due to a

different behavior among children compared to adults, or the different social bonds in schools, and should be further investigated.

6.8 Statement 8: The Majority of Children Contact an Adult if They Think There is a Fire.

Warning others is an important part of safe evacuation. In Sweden, basic fire education teaches to alert others in case of a fire. Since warning others could shorten the evacuation time it is an important subject. However, if children constantly are supervised by adults with proper knowledge and routines this is of minor importance to study. If further studies enable fire safety dimensioning with bigger responsibilities for children, this must be researched further.

6.9 Statement 9: A Child in The Class Gets Really Worried and Show an Irrational Behavior That Spreads Among the Majority of Children.

In the answers and in theoretical studies both show that it could be a possibility for younger children to panic if there are a fire. This could as well be a misconception as the answers changed after the drill. Studies show a raised discomfort when not familiar with people or surroundings. Discomfort is however not the same as panic. Questionnaire studies have been made of the recommended adult/child ratio. Furthers studies of this could be of interest as adult's possibilities to handle a critical situation could have an influence on how they react, and thus how children react.

6.10 Statement 10: The Audibility of The Alarm is Enough for Everyone to Hear.

Many studies are done on fire alarms in different surroundings. An alarm with lucidity is proven to greatly shorten reaction times. How different alarms influences children's reactions is however not studied. As more studies are done on children's behavior in fire evacuation scenarios, the effect of different alarm types could be useful to be researched.

6.11 Proposed Questions for Further Studies

The following questions are general and clasp more than one of the statements from the questionnaire. These five questions are a proposed start for further studies.

- Are children always in need of an adult leader or at what age could children be considered self-depending during evacuations?
- How do children of different ages act in fire evacuation with minimal interference from adults?
- How do children react to clues such as fire alarms, smoke and fire?
- Are there any behaviors among children, in fire evacuations, that are not observed among adults?
- Do children's behavior differ due to age and surroundings?

7. CONCLUSION

The results of this research show that fire evacuation drills might alter the teachers' perception of children's abilities to evacuate. This is however not enough to make a conclusion of any misconceptions among teachers, but fire training has an impact on the teachers' perception of children. This could be since the teachers and children got new experience in a fire evacuation drill and that teachers' answers are specific to the drill. There are no answers from the teachers that in large deviate from the observations done during the fire evacuation drill. Thus, there is no reason to assume any misconception of children's ability to evacuate.

The greatest change in answers was seen in a teacher who never attended a fire evacuation drill with children. Generally, teachers with less experience felt they had less control and tended to answer that children could panic. Experience could be expressed either lack of fire emergency training in general or lack of fire emergency training with the group they have responsibility for. Teachers with many years of experience seemed more confident in their abilities to control the situation and that children would listen to them. Experience with children in fire situations give a better understanding of their evacuation behavior and perceptions, such as losing control or children panicking, change.

Teachers felt they were in control, which might make the search for clues and affiliation theories less valid than among adults. Children get instructions from teachers and might not need more clues to start egress, but some children still tend to use the same pattern or mind their friends. The person affiliation could even help the teacher to keep the group together as children encourage their friends to evacuate and come with the group. In the answers, getting personal belongings were the thing most teachers thought children would participate in. This changed radically after the drill. Among the younger children, the factor that would influence the delay time most negative would be perception of the alarm as a motivation to evacuate.

8 BIBLIOGRAPHY

Arbetsmiljöverket, 2015, Utrymning, [ONLINE] Available at: https://www.av.se/inomhusmiljo/lokaler-och-arbetsutrymme/utrymning/, [Accessed 10 April 2018].

Bayer, K., Rejnö, T., (1999) "Utrymningslarm Optimering genom fullskaleförsök", Lunds Tekniska Högskola, Brandteknik, Lund. http://lup.lub.lu.se/student-papers/record/1767237,

Blom, J., (2018) "*Förskolebarns kunskaper om brand och utrymning",* Lunds Tekniska Högskola, Brandteknik, Lund. https://lup.lub.lu.se/student-papers/search/publication/8964428

Bruck D., (1999) "Non-awakening in children in response to a smoke detector alarm", Fire Safety Journal; 32, 369-376.

Bruck, D., Reid, S., Kouzma, J. and Ball, M., (2004) "The effectiveness of different alarms in waking sleeping children", *Proceedings of the Third Human Behavior in Fire Conference*, Belfast, 1-3 October. London: Interscience Communications, pp. 279-290.

Bryan, J.L., (1977) "Smoke as a Determinant of Human Behavior in Fire Situations", University of Maryland, College Park.

Bryan, J.L., (2002) "Behavioral Response to Fire and Smoke", chapter 3-12, pages 3-315–3-341. In The SFPE Handbook of Fire Protection Engineering. Society of Fire Protection Engineers, Bethesda, MD, third edition.

Fahy, R., Proulx, G. & Aiman, L. (2009). 'Panic' and human behavior in fire. *Proceedings of the 4th International Symposium on Human Behavior in Fire*, Cambridge, UK, 387–399.

Fahy, R.F., Proulx, G., Aiman, L., (2012) "Panic or not in fire: Clarifying the misconception", Fire and materials, Fire mater, 36:328-338.

Frantzich, H., (2001) "Tid för utrymning vid brand". SRV Rapport P21-365/01, Statens räddningsverk, Karlstad.

Furukawa, Y, Sano, T, Tsuchiya, S, Fujii, K, Satoh, T, Hatakeyama, Y & Hasemi, Y 2016, "Evacuation safety strategy for nursery school children based on the survey of the evacuation behavior drill fire safety planning for nursery school Part.l", *Journal of Environmental Engineering (Japan)*, vol. 81, no. 728, pp. 845-853. https://doi.org/10.3130/aije.81.845

Drury, John, David Novelli, and Clifford Stott. "Representing crowd behavior in emergency planning guidance:'mass panic'or collective resilience?." *Resilience* 1.1 (2013): 18-37

Goldenson, R.M. (ed.), (1984) "Longman Dictionary of Psychology and Psychiatry", Longman: New York.

Kholshevnikov, V.V., Samoshin, D.A. and Parfenenko, A.P., (2009) "Pre-School and School

Children Building Evacuation", Proceedings of the Fourth International Symposium on Human Behavior in Fire 2009, Robinson College, Cambridge, UK.

Kholshevnikov, V.V., Samoshin, D.A., Parfenenko, A.P., and Belosokhov, I.P., (2012) "Study of children evacuation from pre-school education institutions", *Fire and Materials*, 36:349–366.

Kimura, M., Sime, J. D., (1994) "Exit choice behavior during the evacuation of two lecture theatres". Fire Safety Science - Proceedings of the 2nd International Symposium, Tokyo, Japan, pp. 541-550.

Lárusdóttir, A. R., & Dederichs, A. S., (2010) "Evacuation of Children: Movement on Stairs and on Horizontal Plane". *Fire Technology, 48.*

Lárusdóttir A.R., Dederichs A.S, (2011) "A Step Towards Including Children's Evacuation Parameters and Behavior in Fire Safe Building Design". *Fire Safety Science* 10: 187-195. 10.3801/IAFSS.FSS.10-187.

Lárusdóttir, A.R., Dederichs, A., and Nilsson, D., (2014) "Evacuation of Children: Focusing on daycare centers and elementary schools" Technical University of Denmark, Department of Civil Engineering. (BYG Rapport R-295).

Murozaki, Y., Ohnishi, K., (1985) A Study of Fire Safety and Evacuation Planning for Pre-Schools and daycare centers. Memoirs of the Faculty of Engineering Kobe University, 32:99-109.

Najmanová, H., Ronchi, E. An Experimental Data-Set on Pre-school Children Evacuation. *Fire Technol* **53,** 1509–1533 (2017). https://doi.org/10.1007/s10694-016-0643-x

National Fire Protection Association. Nfpa 101 - life safety code, 2018.

Oppenheim, A.N., (1992) "Questionnaire design, interviewing and attitude measurement, new edition". Continuum, London & New York.

Piaget, J., (2008) "Barnets själsliga utveckling", Lars Sjögren (Translation), Norstedts Akademiska Förlag, Falun.

Proulx, G., Fahy, R.F., (1997) "The Time Delay to Start Evacuation: Review of Five Case Studies", Proceedings of the Fifth International Symposium on Fire Safety Science, Melbourne, Australia, pp. 783-794.

Proulx, G., (2001) "Occupant Behavior and Evacuation", Proceedings of the 9th International Fire Symposium, Munich, pp. 219-232.

Proulx, G., (2002) "Movement of People: The Evacuation Timing", chapter 3-13, pages 3-341 – 3-366. In The SFPE Handbook of Fire Protection Engineering. Society of Fire Protection Engineers, Bethesda, MD, third edition.

Proulx, G., (2002b), “Cool under fire”. Fire Protection Engineering, No 16, pp. 33-35. NRCC-45404

Samochine, D.A., Boyce, K. and Shields, T.J., (2005) “An Investigation Into Staff Behavior In Unannounced Evacuations Of Retail Stores - Implications For Training And Fire Safety Engineering”. *Fire Safety Science* 8: 519-530. doi:10.3801/IAFSS.FSS.8-519.

Sime, J.D., (1978) “The Concept of Panic – Brief Appraisal”, Conference on Behavior in Fires, National Bureau of Standards: Washington DC.

Sime, J.D., (1980) “The Concept of Panic”, Canter D. (ed.), Fires and human behavior, John Wiley & Sons, Chichester, UK, pp.63-81.

Sime, J.D., (1985) “Movement Towards The Familiar: Person and Place Affiliation in a Fire Entrapment Setting”. Environment and Behavior, 17:6, 697-724.

Sime J.D., Kimura M., (1988) “The timing of escape: Exit choice behavior in fires and building evacuation”. Safety in the Built Environment, Ed J Sime, E & F.N Spon, London.

Sime, J.D., (1992) “Human Behavior in Fires Summary Report”, Research Report No. 44. Central Fire Brigades Advisory Council, Joint Committee on Fire Research, Home Office, London.

Sime, J.D., (2001) “An Occupant Response Shelter Escape Time (ORSET) Model”, Safety Science, 38, 109-125.

Taciuc, A., Dederichs, S.A., (2013) Determining Self-Preservation Capability in Pre-School Children, Fire Protection Research Foundation, Denmark.

Van Der Feyst, M., Wissner, E., Petruzzi, J., (2014) ”Residental Fire Rescue” PennWell Corporation, Oklahoma, USA, ISBN: 9781593703226.

von Tetzchner, S., (2005) ”Utvecklingspsykologi. Barn- och ungdomsåren”, Lund: Studentlitteratur.

Encyclopedia Britannica, 2015-04-26,
http://www.britannica.com/EBchecked/topic/441284/panic,

Appendix A: The Questionnaire

Denna enkät syftar till att undersöka hur lärare uppfattar barns beteende vid brand. Ditt medverkande i denna enkät är helt anonymt och inga personuppgifter samlas in. I tillägg kommer INGA uppgifter som kan knytas skolan eller den enskilda individen publiceras i den slutliga rapporten.

Var uppehöll du dig när utrymningslarmet startade?

☐Klassrum ☐Matsal ☐ Personalrum ☐Annat:_____

Hur många barn hade du ansvar för då utrymningslarmet startade

☐ <10 ☐ 10-19 ☐ 20-29 ☐ >30

Vilken ålder på barnen är bäst representativ för gruppen du ansvarade för då utrymningslarmet startade? _____

Nedan ges ett antal påståenden. Svara i vilken grad du anser att varje påstående stämmer. -2 betyder att du inte alls håller med om påståendet och +2 betyder instämmer helt med påståendet.

1.	När larmet går fortsätter barnen med det de gjorde innan larmet tills en vuxen avbryter dem.	☐ ☐ ☐ ☐ ☐-2 -1 0 +1 +2
2.	När barnen utrymmer vill de bära med sig personliga ägodelar, bortsett från kläder.	☐ ☐ ☐ ☐ ☐-2 -1 0 +1 +2
3.	Som lärare känner jag att jag har full kontroll under hela utrymningsprocessen.	☐ ☐ ☐ ☐ ☐-2 -1 0 +1 +2
4.	Vid utrymning har barnen en tendens att följa samma mönster som vanligt då de går ut ur lokalen.	☐ ☐ ☐ ☐ ☐-2 -1 0 +1 +2
5.	Barnen tänker enbart på sig själva och riktar ingen fokus till sina vänner innan de kommit ut i säkerhet.	☐ ☐ ☐ ☐ ☐-2 -1 0 +1 +2
6.	Brandövningar har en positiv effekt på barns beteende vid brand.	☐ ☐ ☐ ☐ ☐-2 -1 0 +1 +2
7.	När larmet går vill majoriteten av barnen leta efter branden.	☐ ☐ ☐ ☐ ☐-2 -1 0 +1 +2
8.	Majoriteten av barnen meddelar en vuxen ifall de misstänker att det brinner.	☐ ☐ ☐ ☐ ☐-2 -1 0 +1 +2

VÄND SIDA =>

9. Något barn i klassen blir oroligt och visar ett beteende som kan skada gruppen. Det okontrollerade beteendet överförs till majoriteten av klasskamraterna.

☐ ☐ ☐ ☐ ☐-2
-1 0 +1 +2

10. Brandlarmets hörbarhet är tillräcklig för att alla i gruppen skall uppfatta det.

☐ ☐ ☐ ☐ ☐-2
-1 0 +1 +2

11. Har du några kommentarer angående utrymning med barn kan du skriva dem här.

_____
_____
_____
_____
_____
_____

STORT TACK FÖR DIN MEDVERKAN!

The questionnaire, translated to English

This questionnaire aims to examine teachers perceptions of children's behaviors in case of a fire. Your participation is anonymous and no personal information is gathered. In addition, there will be NO information will be published in the final report, that can be connected to the school or individuals.

Var uppehöll du dig när utrymningslarmet startade?

☐Class ☐Canteen ☐ Staff room ☐Other:_____

How many children was under your supervision when the fire alarm sounded?

☐ <10 ☐ 10-19 ☐ 20-29 ☐ >30

What age, best represent the group of your responsibility during the fire evacuation drill?

_____

Below is a number of different statements. Answer in what grade you agree with the different statements- -2 means you don't agree at all and +2 means you fully agree to the statement.

1.	When the alarm sounds, children continue their current task until interrupted by an adult. .	☐ ☐ ☐ ☐ ☐-2 -1 0 +1 +2
2.	When children evacuate, they want to bring personal belongings, except clothes.	☐ ☐ ☐ ☐ ☐-2 -1 0 +1 +2
3.	As a teacher, I have full control during the whole evacuation process.	☐ ☐ ☐ ☐ ☐-2 -1 0 +1 +2
4.	When evacuating, children tend to follow the same pattern as when they usually exit the building.	☐ ☐ ☐ ☐ ☐-2 -1 0 +1 +2
5.	Children only think of their selves and does not focus on any other before they got to safety.	☐ ☐ ☐ ☐ ☐-2 -1 0 +1 +2
6.	Fire evacuation drills have a positive effect on children's behavior in fires.	☐ ☐ ☐ ☐ ☐-2 -1 0 +1 +2
7.	When the alarm sounds the majority of children want to search for the fire.	☐ ☐ ☐ ☐ ☐-2 -1 0 +1 +2
8.	The majority of children contact an adult if they think there is a fire.	☐ ☐ ☐ ☐ ☐-2 -1 0 +1 +2

TURN PAGE =>

9. A child in the class gets really worried and show an irrational behavior that spreads among the majority of children. ☐ ☐ ☐ ☐ ☐-2
-1 0 +1 +2

10. The audibility of the alarm is enough for everyone to percieve. ☐ ☐ ☐ ☐ ☐-2
-1 0 +1 +2

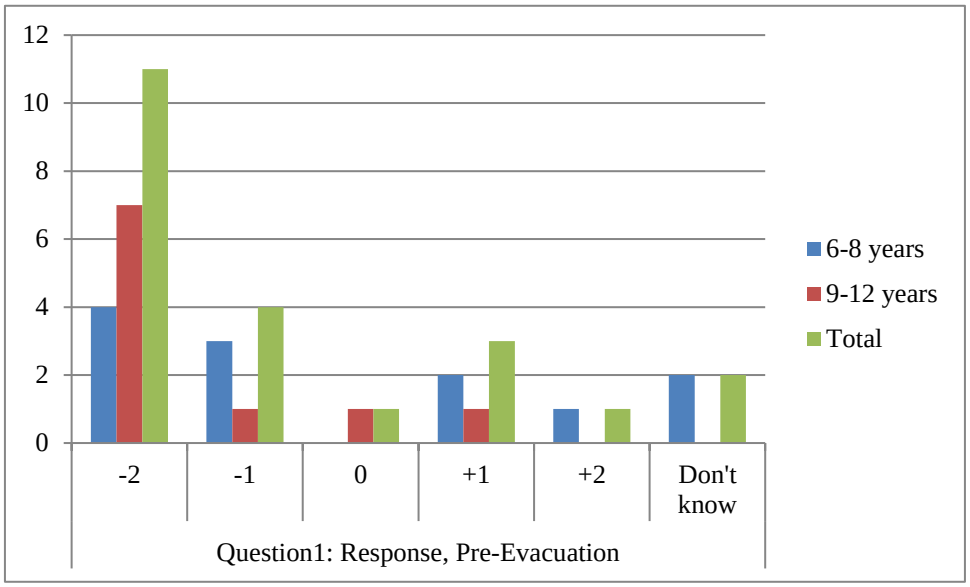
11. Any comments on evacuation of children can be added below.

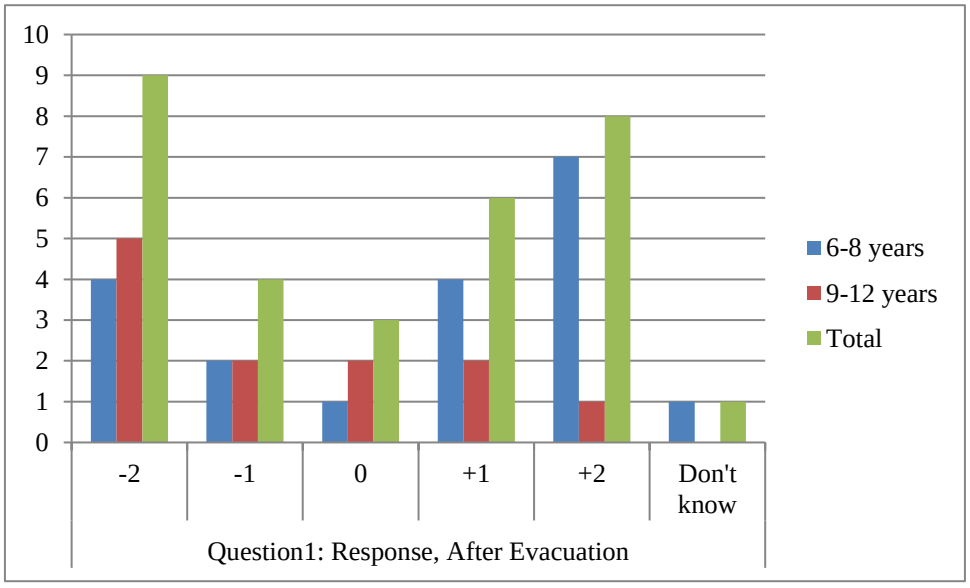
_____
_____
_____
_____
_____
_____

THANK YOU VERY MUCH FOR YOUR PARTICIPATION!

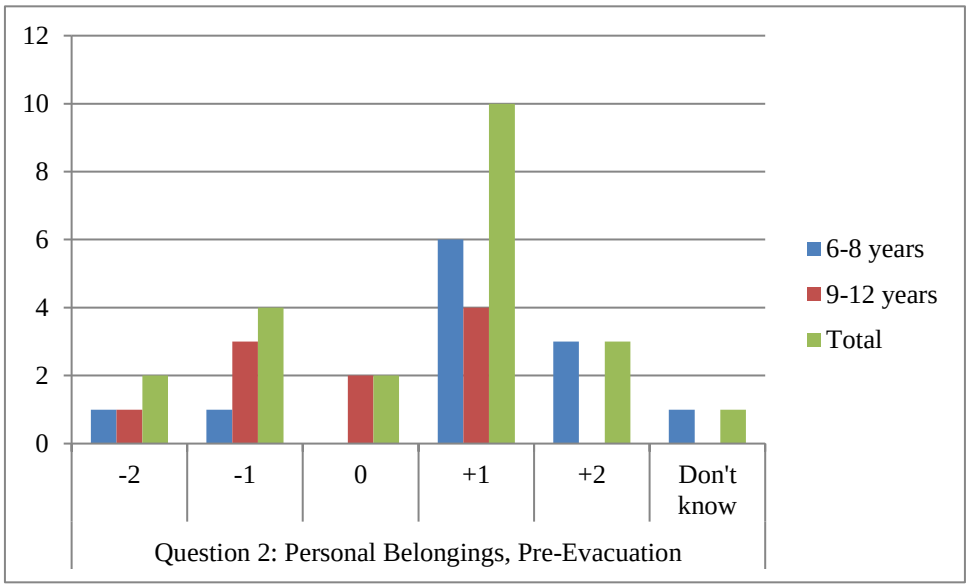
Appendix B: Charts of Answers Among Teachers Before And After the Fire Evacuation Drill.

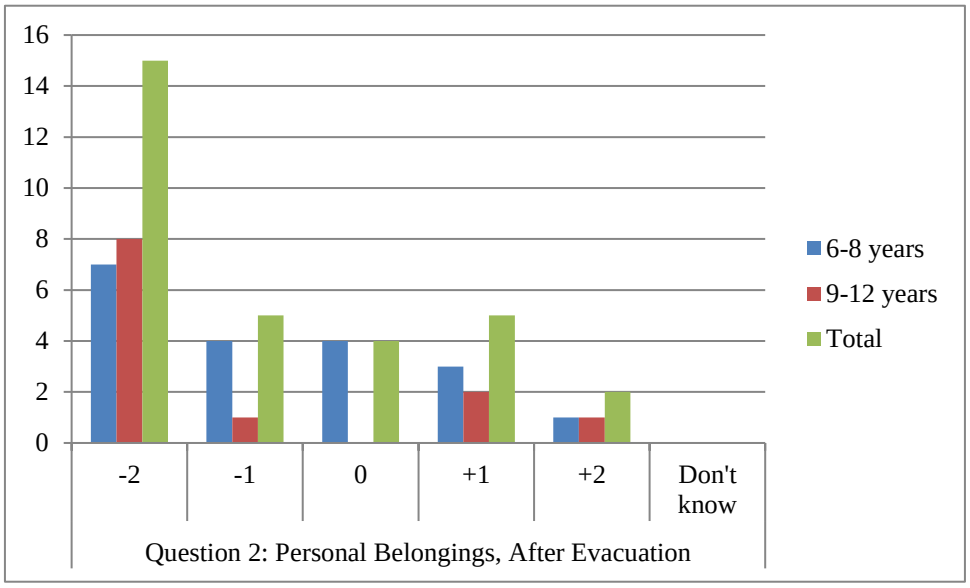
Question 1: When the alarm sounds, children continue their current task until interrupted by an adult.



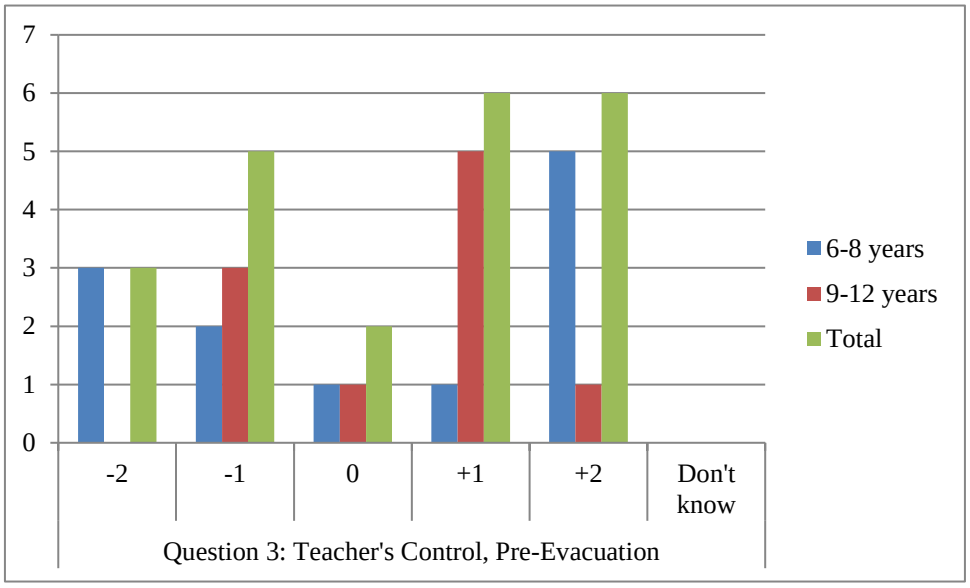


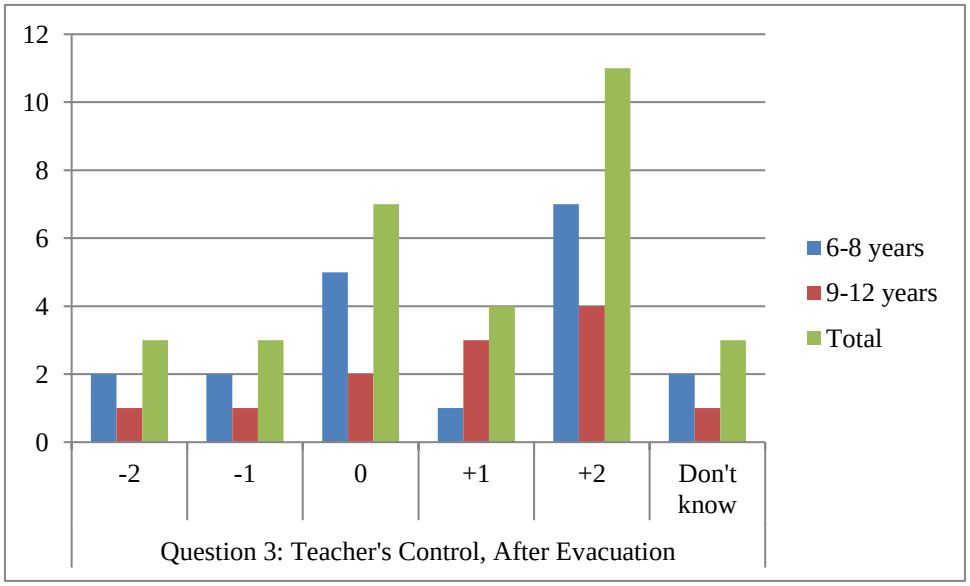
Question 2: When children evacuate, they want to bring personal belongings, except clothes.



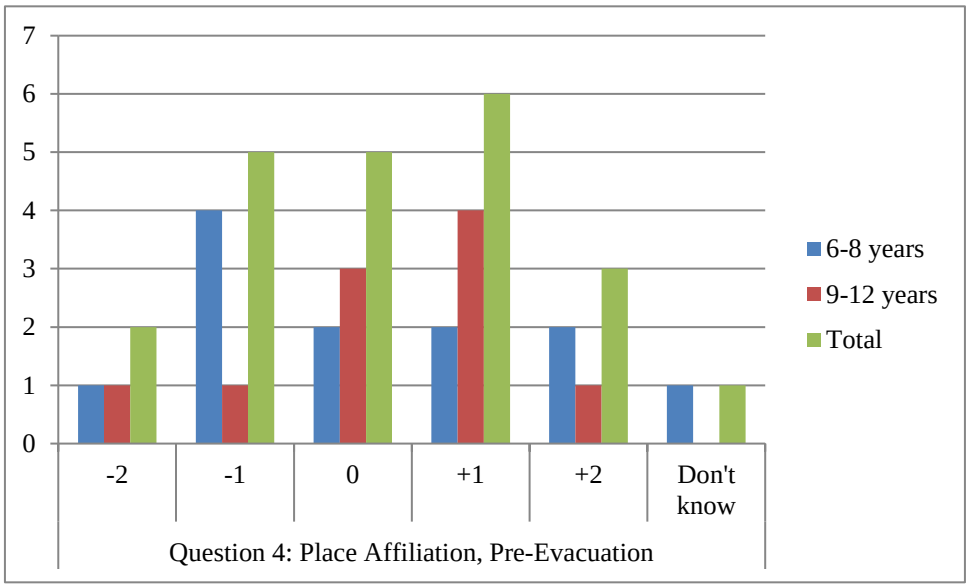


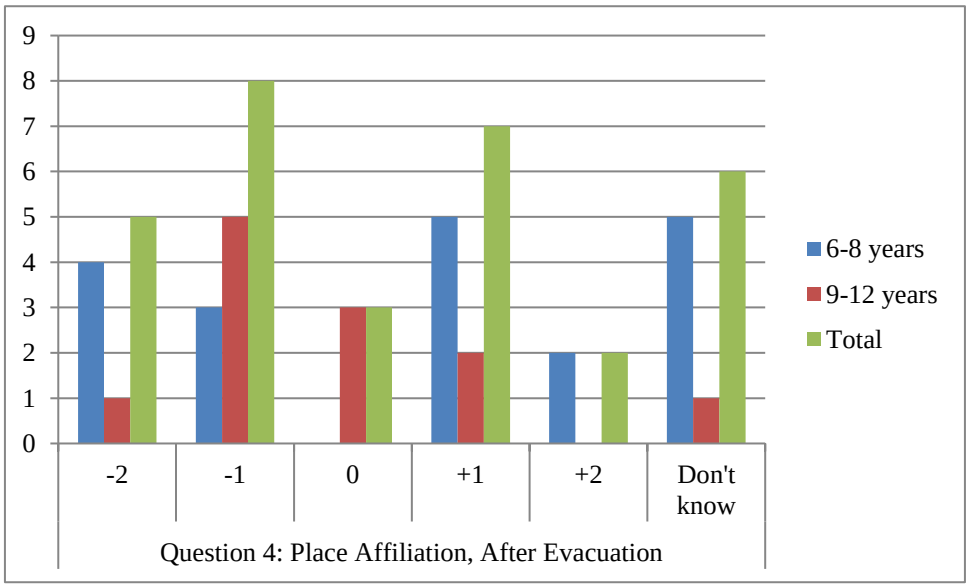
Question 3: As a teacher, I have full control during the whole evacuation process.



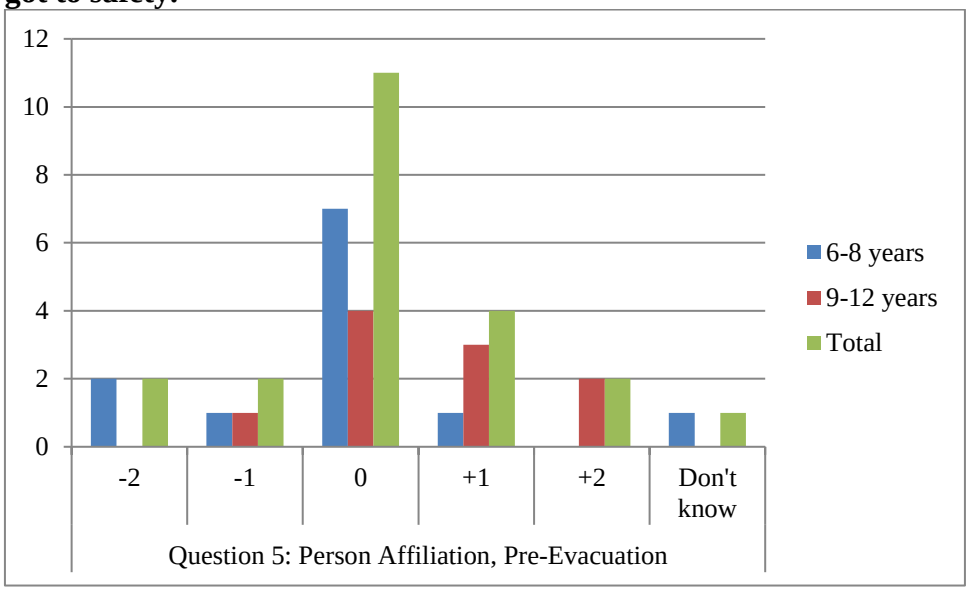


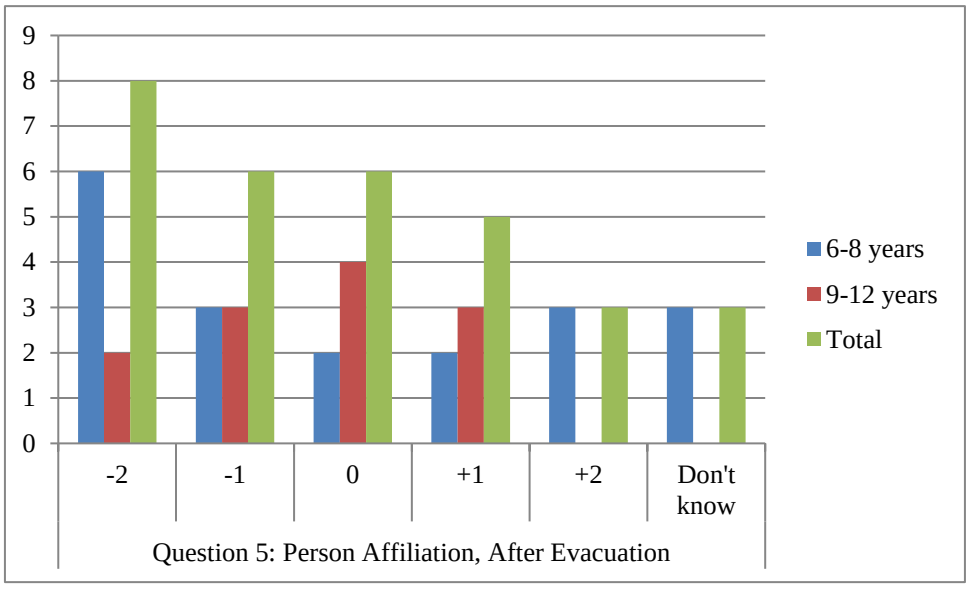
Question 4: When evacuating, children tend to follow the same pattern as when they usually exit the building.



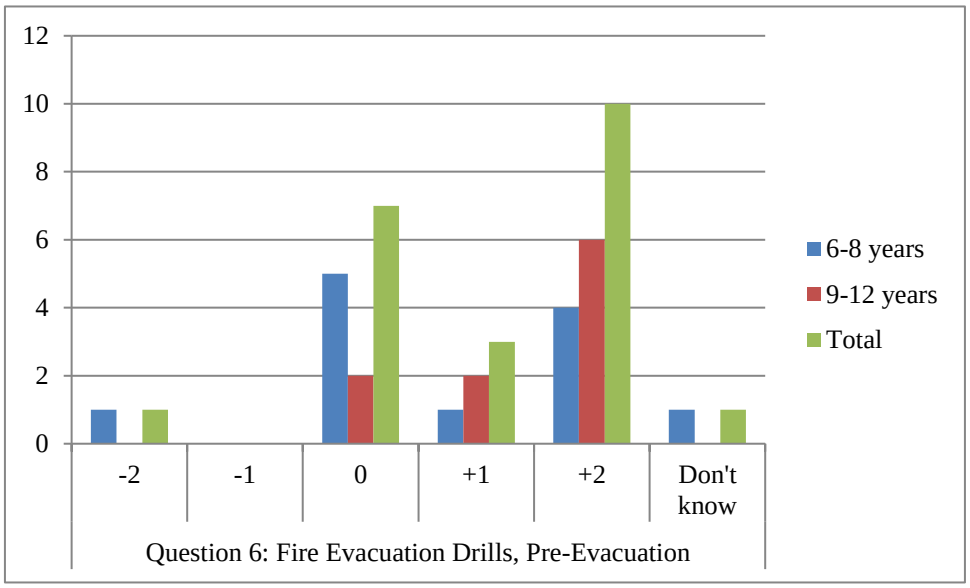


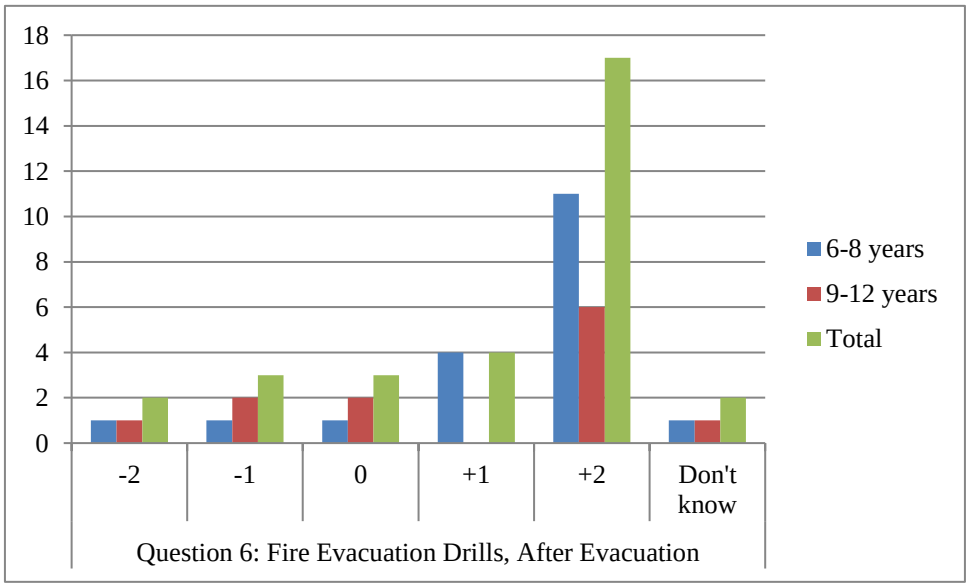
Question 5: Children only think of their selves and does not focus on any other before they got to safety.



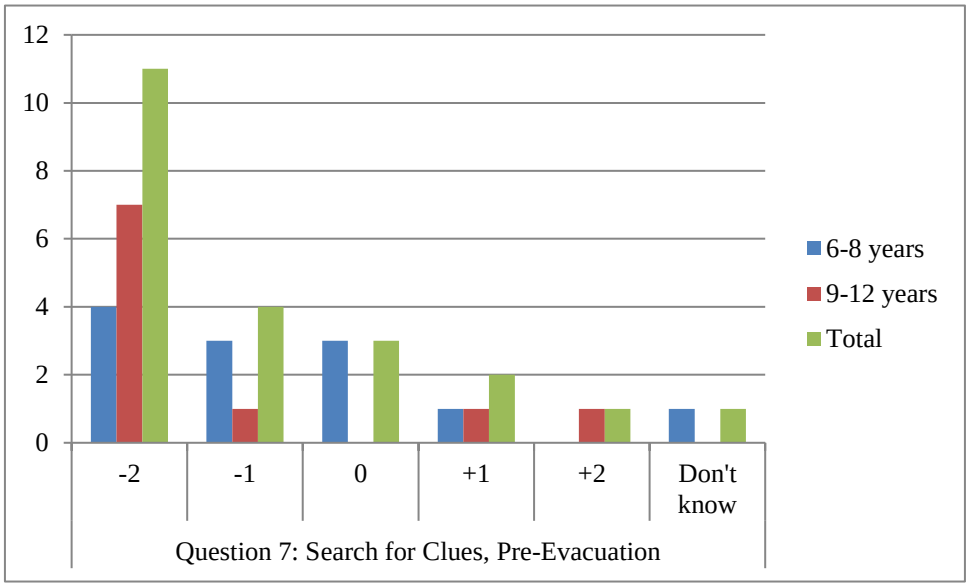


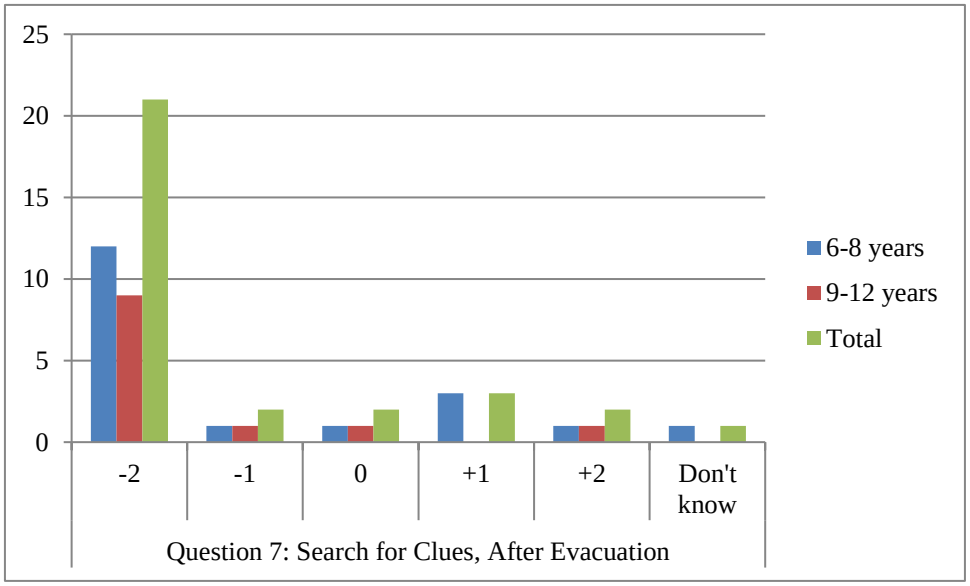
Question 6: Fire evacuation drills have a positive effect on children's behavior in fires.



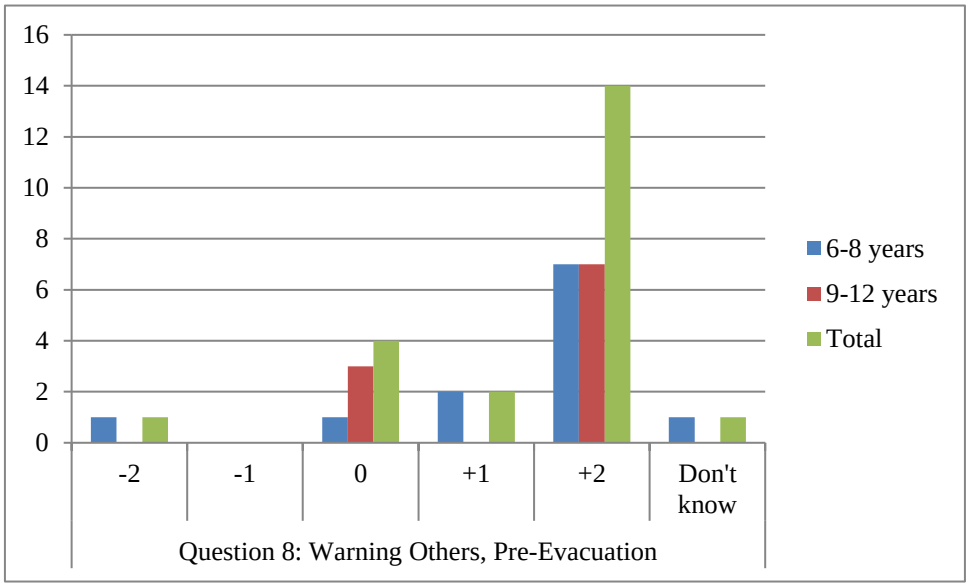


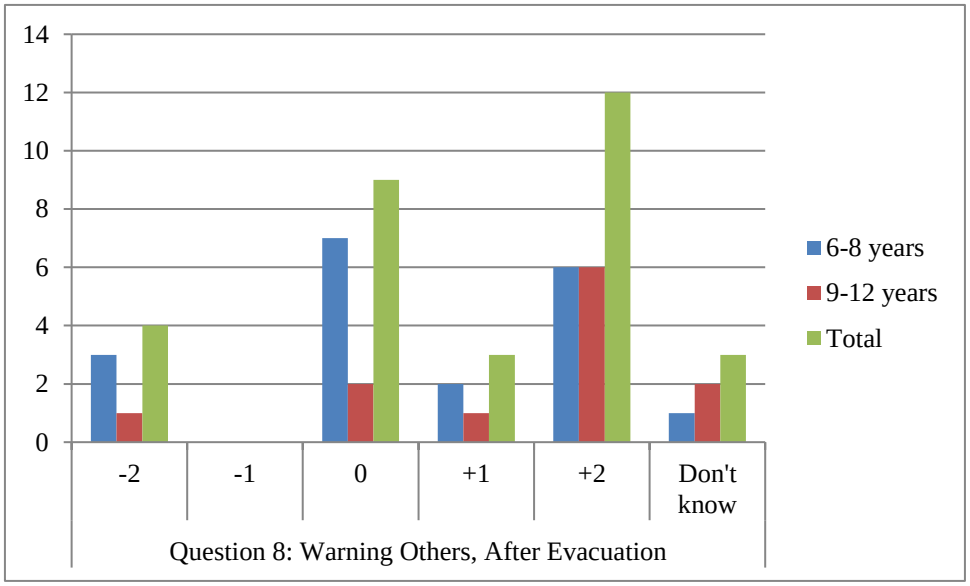
Question 7: When the alarm sounds the majority of children want to search for the fire.



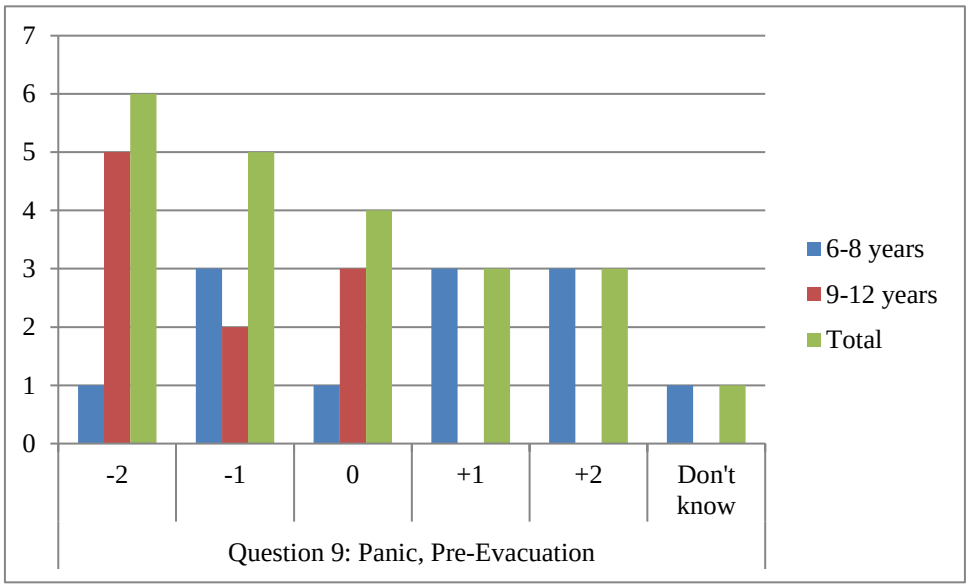


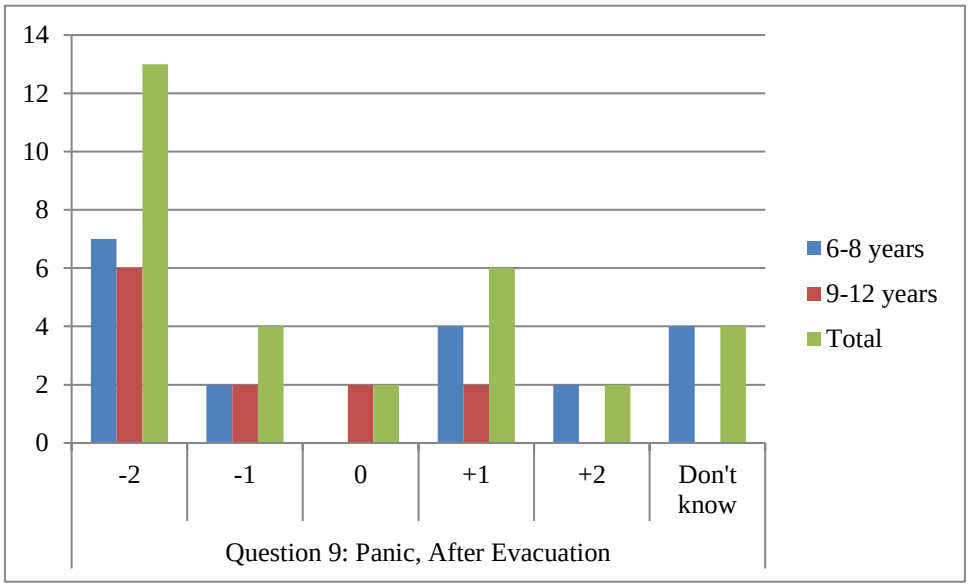
Question 8: The majority of children contact an adult if they think there is a fire.



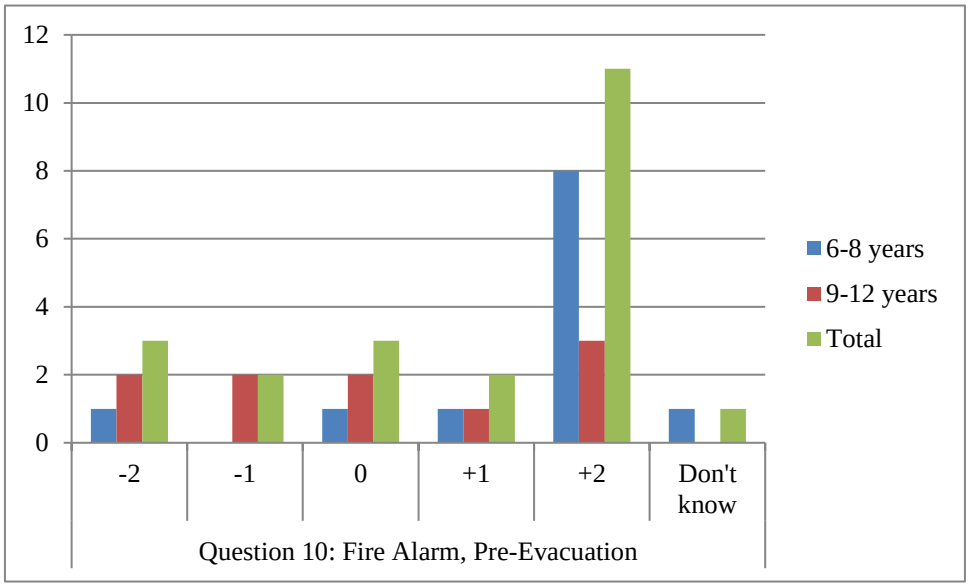


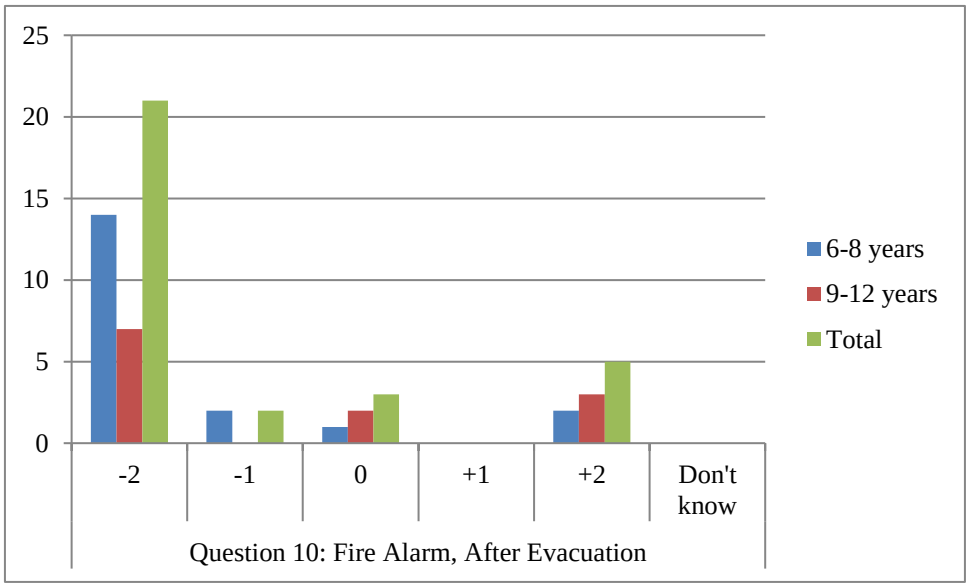
Question 9: A child in the class gets really worried and show an irrational behavior that spreads among the majority of children.





Question 10: The audibility of the alarm is enough for everyone to hear.





Appendix C: Calculations, Wilcoxon Rank Sum Tests in Five Different Tests on All Ten Questions.

Wilcoxon Rank sum test

$$\mu_R = \frac{n_1(n_1 + n_2 + 1)}{2}$$

$$\sigma_R = \sqrt{\frac{n_1 n_2(n_1 + n_2 + 1)}{12}}$$

$$z = \frac{R - \mu_R}{\sigma_R}$$

$H_0 = The\ answers\ before\ and\ after\ the\ drill\ are\ the\ same.$
$H_1 = There\ are\ a\ difference\ in\ answers\ before\ and\ after\ the\ drill.$

Question 1: When the alarm sounds, children continue their current task until interrupted by an adult.

All teachers [1]

Q1.[1]	**Before**	**After**
n	20	30
Sum of ranks	403	872
Mean/Expectation	510	765
Std.Deviation	50,49752469	50,49752469
Test Statistic	-2,118915742	2,118915742
P-value	0,034097588	0,034097588

Teachers of the younger age group [2]

Q1.[2]	**Before drill**	**After drill**
n	10	18
Sum of ranks	176	441
Mean/Expectation	145	261
Std.Deviation	20,85665361	20,85665361
Test Statistic	1,486336235	8,630339427
P-value	0,137190207	0

Teachers of the older age group [3]

Q1.[3]	**Before drill**	**After drill**
n	10	12
Sum of ranks	131,5	216
Mean/Expectation	115	138
Std.Deviation	15,16575089	15,16575089
Test Statistic	1,087977781	5,143167692
P-value	0,276604916	2,70144E-07

Teachers of both age groups, before [4]

Q1.[4]	**6-8 Years**	**9-12 Years**
n	10	10
Sum of ranks	120,5	89,5
Mean/Expectation	105	105
Std.Deviation	13,22875656	13,22875656
Test Statistic	1,171689866	-1,171689866
P-value	0,241321593	0,241321593

Teachers of both age groups, after [5]

Q1.[5]	**6-8 Years**	**9-12 Years**
n	18	12
Sum of ranks	327	138
Mean/Expectation	279	186
Std.Deviation	23,62202362	23,62202362
Test Statistic	2,032002032	-2,032002032
P-value	0,04215345	0,04215345

[1] = Tests performed on the total population, all answers before and after.
[2]+[3] = Tests performed on answers before and after in the specific age groups.
[4]+[5] = Tests performed on differences between the two age groups.

Question 2:When children evacuate, they want to bring personal belongings, except clothes.

All teachers [1]

Q2.[1]	**Before drill**	**After drill**
n	21	31
Sum of ranks	715	663
Mean/Expectation	556,5	821,5
Std.Deviation	53,62135769	53,62135769
Test Statistic	2,955911727	-2,955911727
P-value	0,003117463	1,996882537

Teachers of the younger age group [2]

Q2.[2]	**Before drill**	**After drill**
n	11	19
Sum of ranks	314	299,5
Mean/Expectation	170,5	294,5
Std.Deviation	23,23610696	23,23610696
Test Statistic	6,175733321	0,215182346
P-value	6,58571E-10	0,829625155

Teachers of the older age group [3]

Q2.[3]	**Before drill**	**After drill**
n	10	12
Sum of ranks	244	183,5
Mean/Expectation	115	138
Std.Deviation	15,16575089	15,16575089
Test Statistic	8,506008107	3,000181154
P-value	0	0,002698191

Teachers of both age groups, before [4]

Q2.[4]	6-8 Years	9-12 Years
n	11	10
Sum of ranks	147	84
Mean/Expectation	121	110
Std.Deviation	14,20093894	14,20093894
Test Statistic	1,830864855	-1,830864855
P-value	0,067120717	0,067120717

Teachers of both age groups, after [5]

Q2.[5]	**6-8 Years**	**9-12 Years**
n	19	12
Sum of ranks	329,5	166,5
Mean/Expectation	304	192
Std.Deviation	24,65765601	24,65765601
Test Statistic	1,03416156	-1,03416156
P-value	0,301060641	0,301060641

[1] = Tests performed on the total population, all answers before and after.
[2]+[3] = Tests performed on answers before and after in the specific age groups.
[4]+[5] = Tests performed on differences between the two age groups.

Question 3: As a teacher, I have full control during the whole evacuation process.

All teachers [1]

Q3.[1]	**Before drill**	**After drill**
n	22	28
Sum of ranks	524	751
Mean/Expectation	561	714
Std.Deviation	51,16639522	51,16639522
Test Statistic	-0,723130872	0,723130872
P-value	0,469599484	0,469599484

Teachers of the younger age group [2]

Q3.[2]	**Before drill**	**After drill**
n	12	17
Sum of ranks	231	358
Mean/Expectation	180	255
Std.Deviation	22,58317958	22,58317958
Test Statistic	2,258317958	4,560916661
P-value	0,023925843	5,09308E-06

Teachers of the older age group [3]

Q3.[3]	**Before drill**	**After drill**
n	10	11
Sum of ranks	172,5	219,5
Mean/Expectation	110	121
Std.Deviation	14,20093894	14,20093894
Test Statistic	4,401117439	6,936161084
P-value	1,07695E-05	4,029E-12

Teachers of both age groups, before [4]

Q3.[4]	**6-8 Years**	**9-12 Years**
n	12	10
Sum of ranks	138,5	114,5
Mean/Expectation	138	115
Std.Deviation	15,16575089	15,16575089
Test Statistic	0,032969024	-0,032969024
P-value	0,97369929	0,97369929

Teachers of both age groups, after [5]

Q3.[5]	**6-8 Years**	**9-12 Years**
n	17	11
Sum of ranks	240,5	165,5
Mean/Expectation	246,5	159,5
Std.Deviation	21,2583317	21,2583317
Test Statistic	-0,28224228	0,28224228
P-value	0,777757741	0,777757741

[1] = Tests performed on the total population, all answers before and after.
[2]+[3] = Tests performed on answers before and after in the specific age groups.
[4]+[5] = Tests performed on differences between the two age groups.

Question 4: When evacuating, children tend to follow the same pattern as when they usually exit the building.

All teachers [1]

Q4.[1]	**Before drill**	**After drill**
n	21	25
Sum of ranks	542,5	538,5
Mean/Expectation	493,5	587,5
Std.Deviation	45,34589287	45,34589287
Test Statistic	1,080582979	-1,080582979
P-value	0,279882657	0,279882657

Teachers of the younger age group [2]

Q4.[2]	**Before drill**	**After drill**
N	11	14
Sum of ranks	195,5	236,5
Mean/Expectation	143	182
Std.Deviation	18,26654501	18,26654501
Test Statistic	2,874106733	2,983596513
P-value	0,00405172	0,002848822

Teachers of the older age group [3]

Q4.[3]	**Before drill**	**After drill**
n	10	11
Sum of ranks	208	167
Mean/Expectation	110	121
Std.Deviation	14,20093894	14,20093894
Test Statistic	6,900952144	3,239222435
P-value	5,16542E-12	0,001198561

Teachers of both age groups, before [4]

Q4.[4]	**6-8 Years**	**9-12 Years**
n	11	10
Sum of ranks	112,5	118,5
Mean/Expectation	121	110
Std.Deviation	14,20093894	14,20093894
Test Statistic	-0,598551972	0,598551972
P-value	0,549471692	0,549471692

Teachers of both age groups, after [5]

Q4.[5]	**6-8 Years**	**9-12 Years**
n	14	11
Sum of ranks	189,5	135,5
Mean/Expectation	182	143
Std.Deviation	18,26654501	18,26654501
Test Statistic	0,410586676	-0,410586676
P-value	0,681375635	0,681375635

[1] = Tests performed on the total population, all answers before and after.
[2]+[3] = Tests performed on answers before and after in the specific age groups.
[4]+[5] = Tests performed on differences between the two age groups.

Question 5: Children only think of their selves and does not focus on any other before they got to safety.

All teachers [1]

Q5.[1]	**Before drill**	**After drill**
n	21	28
Sum of ranks	591	634
Mean/Expectation	525	700
Std.Deviation	49,49747468	49,49747468
Test Statistic	1,333401359	-1,333401359
P-value	0,182400127	0,182400127

Teachers of the younger age group [2]

Q5.[2]	**Before drill**	**After drill**
n	11	16
Sum of ranks	189,5	264
Mean/Expectation	154	224
Std.Deviation	20,2649122	20,2649122
Test Statistic	1,751796388	1,973855085
P-value	0,079808826	0,048398223

Teachers of the older age group [3]

Q5.[3]	**Before drill**	**After drill**
n	10	12
Sum of ranks	248	214
Mean/Expectation	115	138
Std.Deviation	15,16575089	15,16575089
Test Statistic	8,769760296	5,011291598
P-value	0	5,40659E-07

Teachers of both age groups, before [4]

Q5.[4]	**6-8 Years**	**9-12 Years**
n	11	10
Sum of ranks	94	137
Mean/Expectation	121	110
Std.Deviation	14,20093894	14,20093894
Test Statistic	-1,901282734	1,901282734
P-value	0,057264989	0,057264989

Teachers of both age groups, after [5]

Q5.[5]	**6-8 Years**	**9-12 Years**
n	16	12
Sum	223,5	182,5
Mean	232	174
Std.Deviation	21,54065923	21,54065923
Test Statistic	-0,394602594	0,394602594
P-value	0,693136199	0,693136199

[1] = Tests performed on the total population, all answers before and after.
[2]+[3] = Tests performed on answers before and after in the specific age groups.
[4]+[5] = Tests performed on differences between the two age groups.

Question 6: Fire evacuation drills have a positive effect on children's behavior in fires.

All teachers [1]

Q6.[1]	**Before drill**	**After drill**
n	21	28
Sum of ranks	507,5	717,5
Mean/Expectation	525	700
Std.Deviation	49,49747468	49,49747468
Test Statistic	-0,353553391	0,353553391
P-value	0,72367361	0,72367361

Teachers of the younger age group [2]

Q6.[2]	**Before drill**	**After drill**
n	11	17
Sum of ranks	168	357
Mean/Expectation	159,5	246,5
Std.Deviation	21,2583317	21,2583317
Test Statistic	0,399843229	5,197961983
P-value	0,689271988	2,01485E-07

Teachers of the older age group [3]

Q6.[3]	**Before drill**	**After drill**
n	10	11
Sum of ranks	190	172,5
Mean/Expectation	110	121
Std.Deviation	14,20093894	14,20093894
Test Statistic	5,633430322	3,62652077
P-value	1,7666E-08	0,000287266

Teachers of both age groups, before [4]

Q6.[4]	**6-8 Years**	**9-12 Years**
n	11	10
Sum of ranks	102	129
Mean/Expectation	121	110
Std.Deviation	14,20093894	14,20093894
Test Statistic	-1,337939701	1,337939701
P-value	0,180916094	0,180916094

Teachers of both age groups, after [5]

Q6.[5]	**6-8 Years**	**9-12 Years**
n	17	11
Sum of ranks	259,5	146,5
Mean/Expectation	246,5	159,5
Std.Deviation	21,2583317	21,2583317
Test Statistic	0,611524939	-0,611524939
P-value	0,540852113	0,540852113

[1] = Tests performed on the total population, all answers before and after.
[2]+[3] = Tests performed on answers before and after in the specific age groups.
[4]+[5] = Tests performed on differences between the two age groups.

Question 7: When the alarm sounds the majority of children want to search for the fire.

All teachers [1]

Q7.[1]	**Before drill**	**After drill**
n	21	30
Sum of ranks	588,5	737,5
Mean/Expectation	546	780
Std.Deviation	52,24940191	52,24940191
Test Statistic	0,81340644	-0,81340644
P-value	0,415985068	0,415985068

Teachers of the younger age group [2]

Q7.[2]	**Before drill**	**After drill**
n	11	18
Sum of ranks	252,5	344
Mean/Expectation	165	270
Std.Deviation	22,24859546	22,24859546
Test Statistic	3,932832531	3,326052655
P-value	8,39507E-05	0,000880853

Teachers of the older age group [3]

Q7.[3]	**Before drill**	**After drill**
n	10	12
Sum of ranks	196,5	224,5
Mean/Expectation	115	138
Std.Deviation	15,16575089	15,16575089
Test Statistic	5,373950858	5,703641095
P-value	7,70299E-08	1,17275E-08

Teachers of both age groups, before [4]

Q7.[4]	**6-8 Years**	**9-12 Years**
n	11	10
Sum of ranks	135	96
Mean/Expectation	121	110
Std.Deviation	14,20093894	14,20093894
Test Statistic	0,985850306	-0,985850306
P-value	0,324206575	0,324206575

Teachers of both age groups, after [5]

Q7.[5]	**6-8 Years**	**9-12 Years**
n	18	12
Sum of ranks	289,5	175,5
Mean/Expectation	279	186
Std.Deviation	23,62202362	23,62202362
Test Statistic	0,444500445	-0,444500445
P-value	0,656680808	0,656680808

[1] = Tests performed on the total population, all answers before and after.
[2]+[3] = Tests performed on answers before and after in the specific age groups.
[4]+[5] = Tests performed on differences between the two age groups.

Question 8: The majority of children contact an adult if they think there is a fire.

All teachers [1]

Q8.[1]	**Before drill**	**After drill**
n	21	28
Sum of ranks	604	621
Mean/Expectation	525	700
Std.Deviation	49,49747468	49,49747468
Test Statistic	1,59604102	-1,59604102
P-value	0,110479635	0,110479635

Teachers of the younger age group [2]

Q8.[2]	**Before drill**	**After drill**
n	11	18
Sum of ranks	254	289,5
Mean/Expectation	165	270
Std.Deviation	22,24859546	22,24859546
Test Statistic	4,000252517	0,876459821
P-value	6,32749E-05	0,38078011

Teachers of the older age group [3]

Q8.[3]	**Before drill**	**After drill**
n	10	10
Sum of ranks	199,5	184,5
Mean/Expectation	105	105
Std.Deviation	13,22875656	13,22875656
Test Statistic	7,14352854	6,009635121
P-value	9,09717E-13	1,85941E-09

Teachers of both age groups, before [4]

Q8.[4]	**6-8 Years**	**9-12 Years**
n	11	10
Sum of ranks	119	112
Mean/Expectation	121	110
Std.Deviation	14,20093894	14,20093894
Test Statistic	-0,140835758	0,140835758
P-value	0,887999694	0,887999694

Teachers of both age groups, after [5]

Q8.[5]	**6-8 Years**	**9-12 Years**
n	18	10
Sum of ranks	235,5	170,5
Mean/Expectation	261	145
Std.Deviation	20,85665361	20,85665361
Test Statistic	-1,222631419	1,222631419
P-value	0,221468941	0,221468941

[1] = Tests performed on the total population, all answers before and after.
[2]+[3] = Tests performed on answers before and after in the specific age groups.
[4]+[5] = Tests performed on differences between the two age groups.

Question 9: A child in the class gets really worried and show an irrational behavior that spreads among the majority of children.

All teachers [1]

Q9.[1]	**Before drill**	**After drill**
n	21	27
Sum of ranks	561	615
Mean/Expectation	514,5	661,5
Std.Deviation	48,1170448	48,1170448
Test Statistic	0,966393514	-0,966393514
P-value	0,333847308	0,333847308

Teachers of the younger age group [2]

Q9.[2]	**Before drill**	**After drill**
n	11	15
Sum of ranks	266,5	263
Mean/Expectation	148,5	202,5
Std.Deviation	19,26784887	19,26784887
Test Statistic	6,124191694	3,139945741
P-value	9,11451E-10	0,001689791

Teachers of the older age group [3]

Q9.[3]	**Before drill**	**After drill**
n	10	12
Sum of ranks	171,5	218
Mean/Expectation	115	138
Std.Deviation	15,16575089	15,16575089
Test Statistic	3,725499675	5,275043787
P-value	0,000194929	1,32724E-07

Teachers of both age groups, before [4]

Q9.[4]	**6-8 Years**	**9-12 Years**
n	11	10
Sum of ranks	155	76
Mean/Expectation	121	110
Std.Deviation	14,20093894	14,20093894
Test Statistic	2,394207887	-2,394207887
P-value	0,016656305	0,016656305

Teachers of both age groups, after [5]

Q9.[5]	**6-8 Years**	**9-12 Years**
n	15	12
Sum of ranks	223	155
Mean/Expectation	210	168
Std.Deviation	20,49390153	20,49390153
Test Statistic	0,634335047	-0,634335047
P-value	0,525862189	0,525862189

[1] = Tests performed on the total population, all answers before and after.
[2]+[3] = Tests performed on answers before and after in the specific age groups.
[4]+[5] = Tests performed on differences between the two age groups.

Question 10: The audibility of the alarm is enough for everyone to hear.

All teachers [1]

Q10.[1]	**Before drill**	**After drill**
N	21	31
Sum of ranks	745,5	632,5
Mean/Expectation	556,5	821,5
Std.Deviation	53,62135769	53,62135769
Test Statistic	3,52471493	-3,52471493
P-value	0,000423939	0,000423939

Teachers of the younger age group [2]

Q10.[2]	**Before drill**	**After drill**
n	11	19
Sum of ranks	331	256,5
Mean/Expectation	170,5	294,5
Std.Deviation	23,23610696	23,23610696
Test Statistic	6,907353296	-1,635385827
P-value	4,93783E-12	1,898031808

Teachers of the older age group [3]

Q10.[3]	**Before drill**	**After drill**
n	10	12
Sum of ranks	240,5	222,5
Mean/Expectation	115	138
Std.Deviation	15,16575089	15,16575089
Test Statistic	8,275224941	5,571765
P-value	2,22045E-16	2,52171E-08

Teachers of both age groups, before [4]

Q10.[4]	**6-8 Years**	**9-12 Years**
N	11	10
Sum of ranks	146,5	84,5
Mean/Expectation	121	110
Std.Deviation	14,20093894	14,20093894
Test Statistic	1,795655915	-1,795655915
P-value	0,072549257	0,072549257

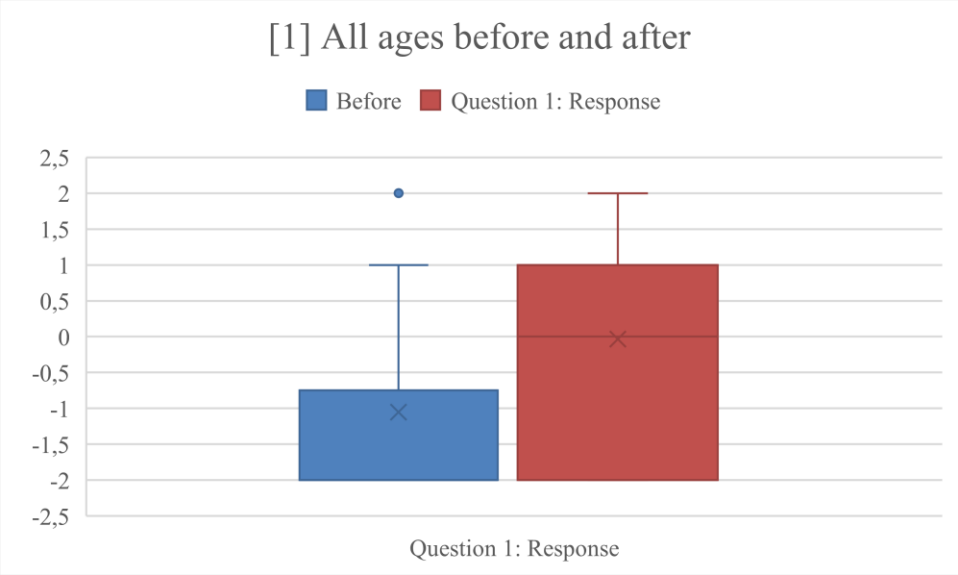
Teachers of both age groups, after [5]

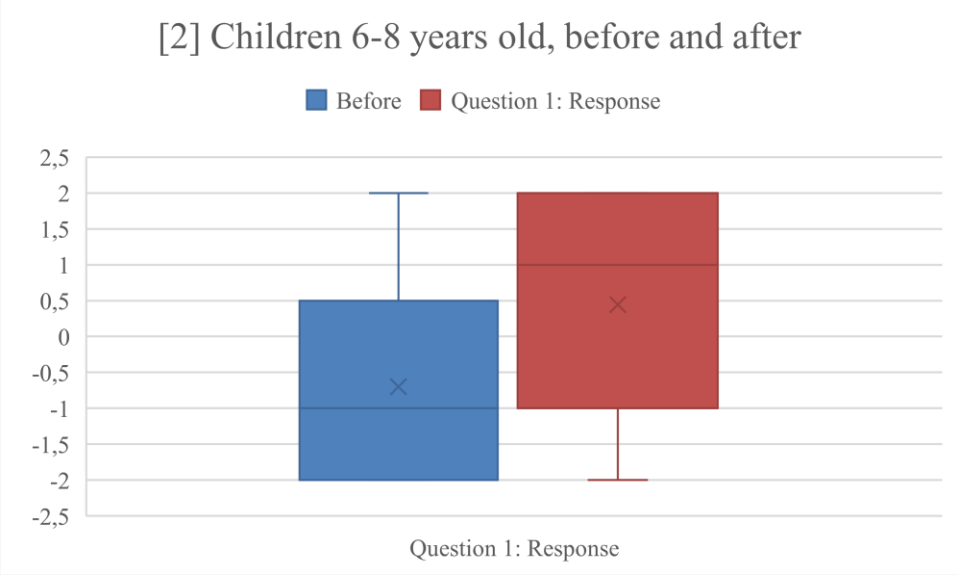
Q10.[5]	**6-8 Years**	**9-12 Years**
n	19	12
Sum of ranks	282	214
Mean/Expectation	304	192
Std.Deviation	24,65765601	24,65765601
Test Statistic	-0,892217816	0,892217816
P-value	0,372276195	0,372276195

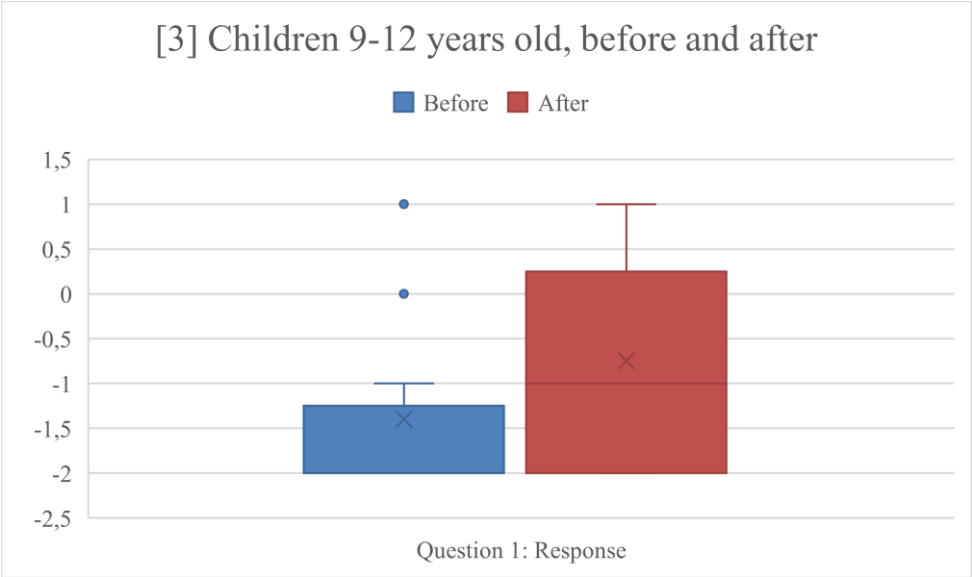
[1] = Tests performed on the total population, all answers before and after.
[2]+[3] = Tests performed on answers before and after in the specific age groups.
[4]+[5] = Tests performed on differences between the two age groups.

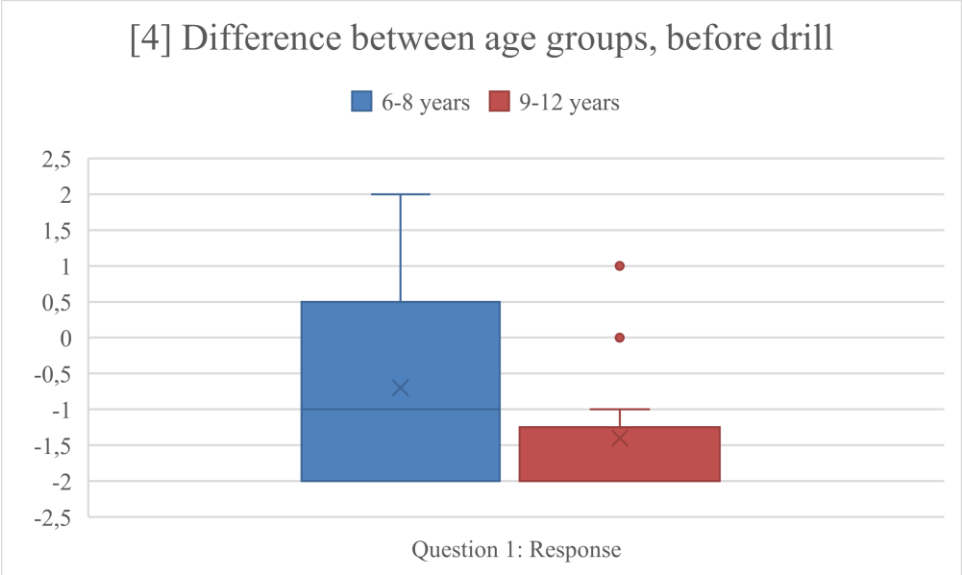
Appendix D: Charts on Differences Between Teachers' Answers in All Questions and Five Different Tests.

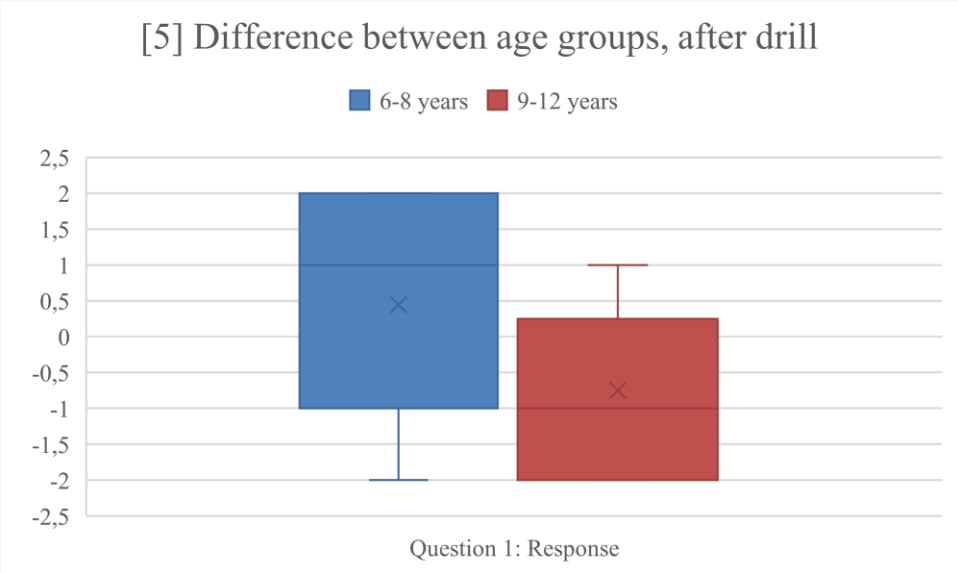
Question 1: When the alarm sounds, children continue their current task until interrupted by an adult.



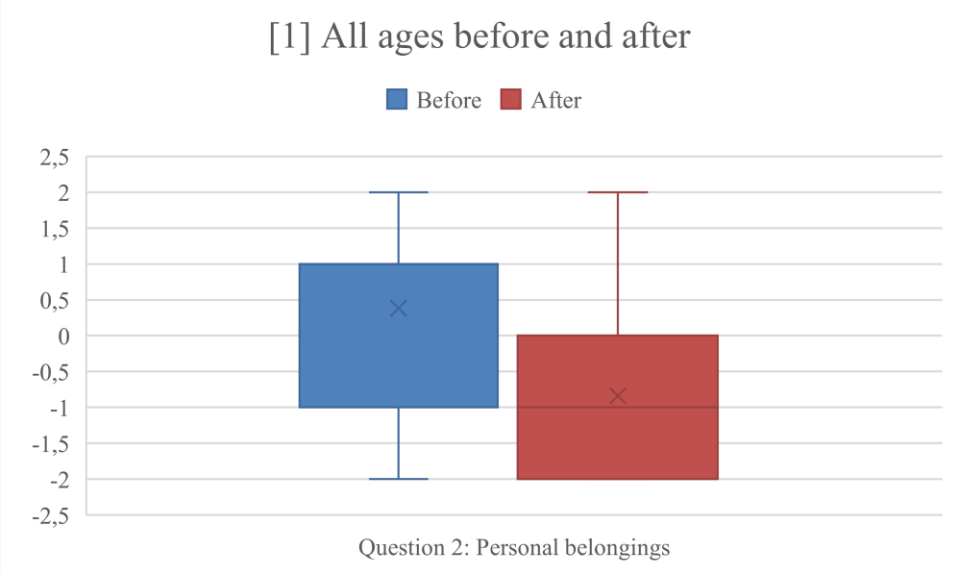


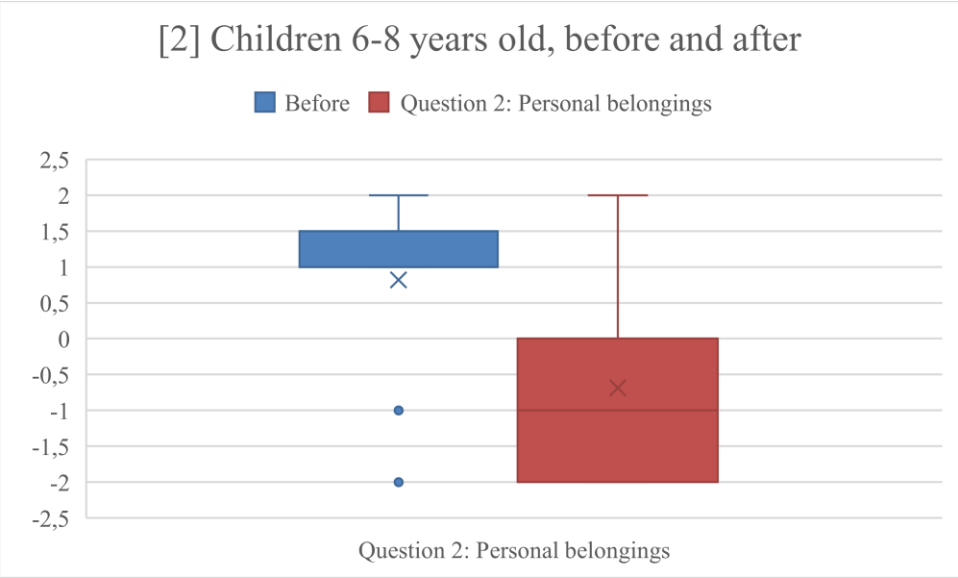

[3] Children 9-12 years old, before and after
Before
After
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 1: Response

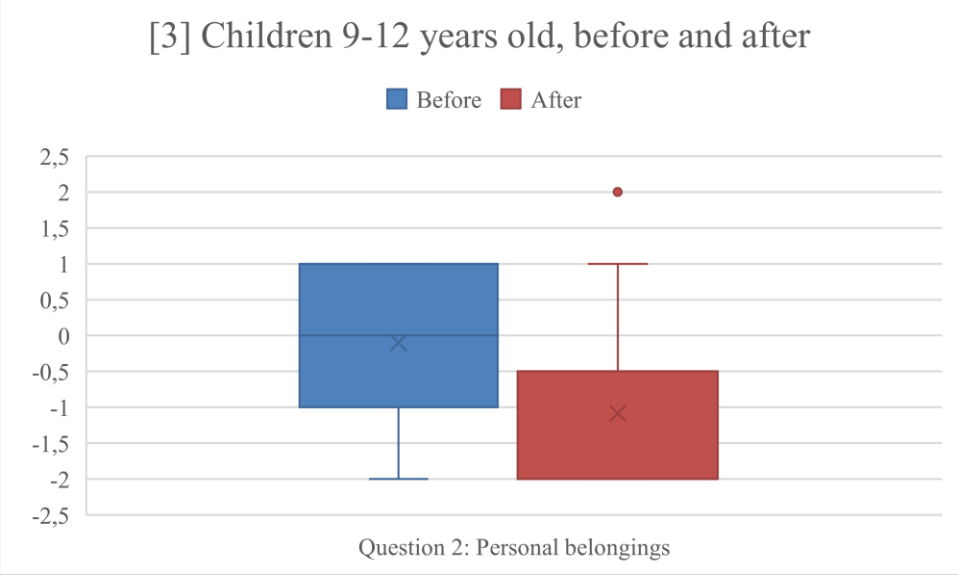

[4] Difference between age groups, before drill
6-8 years
9-12 years
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 1: Response

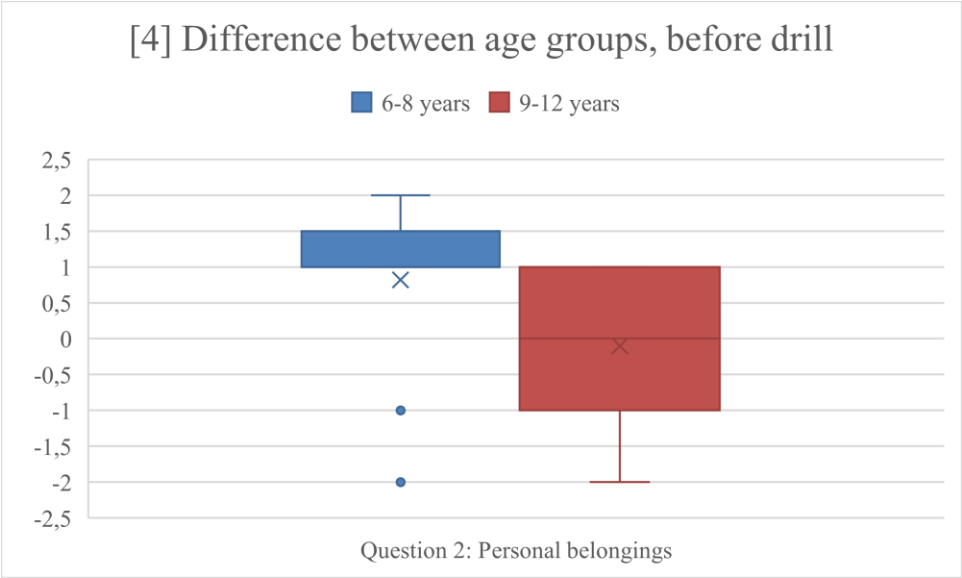


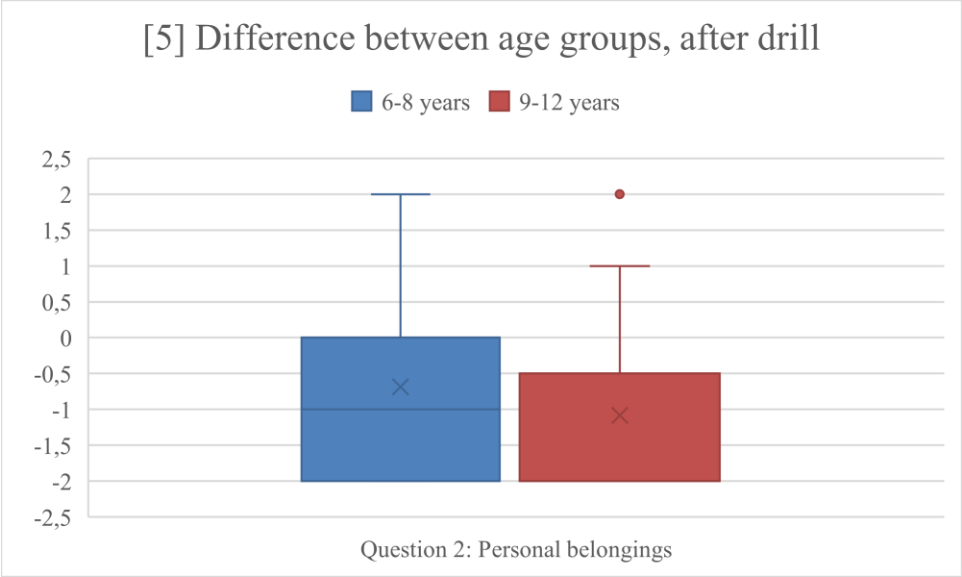
Question 2: When children evacuate, they want to bring personal belongings, except clothes.



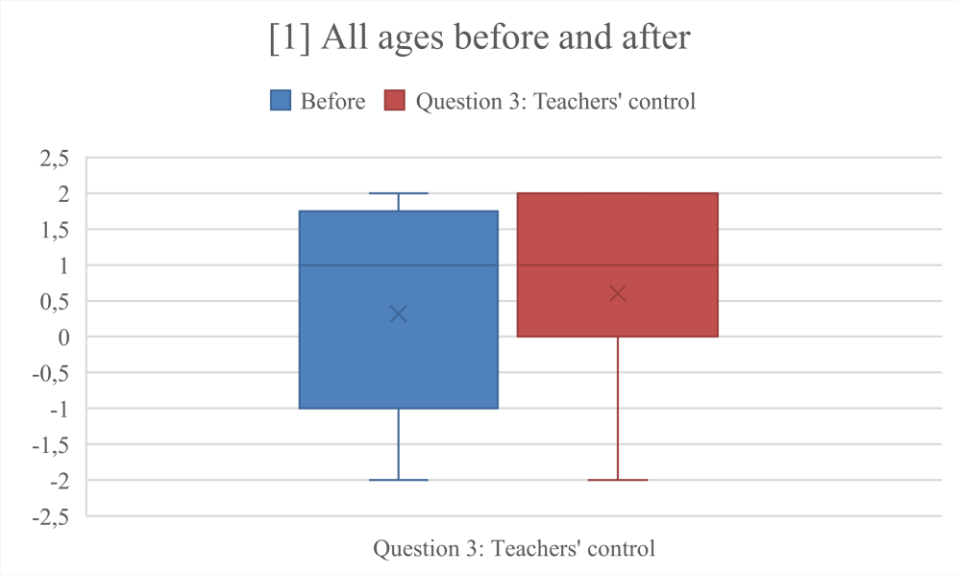

[2] Children 6-8 years old, before and after
Before
Question 2: Personal belongings
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 2: Personal belongings

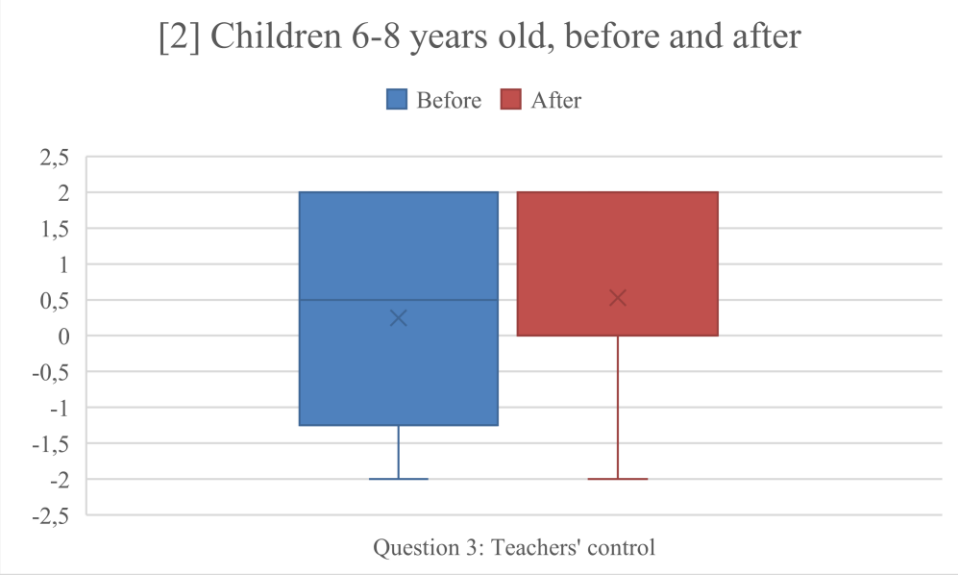

[3] Children 9-12 years old, before and after
Before
After
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 2: Personal belongings

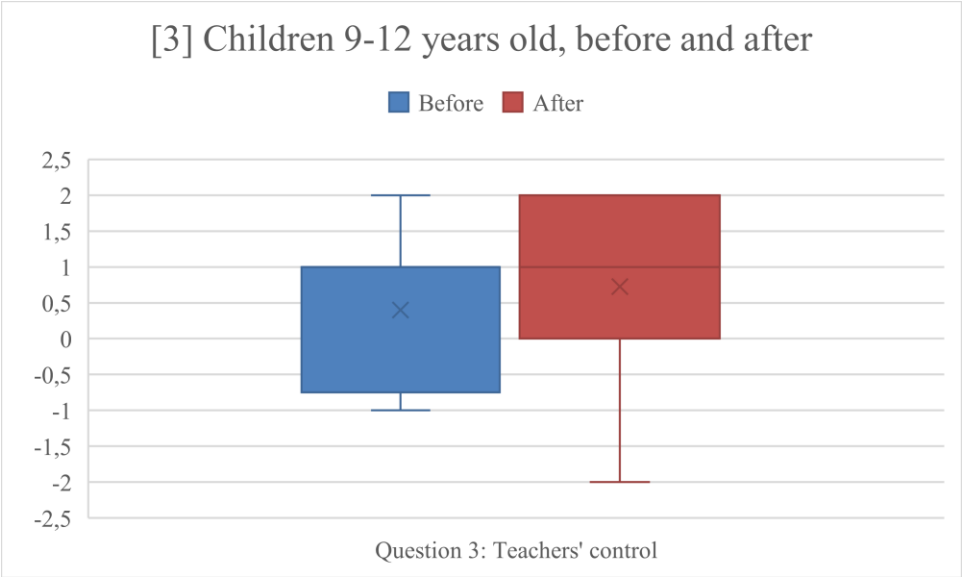

[4] Difference between age groups, before drill
6-8 years
9-12 years
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 2: Personal belongings

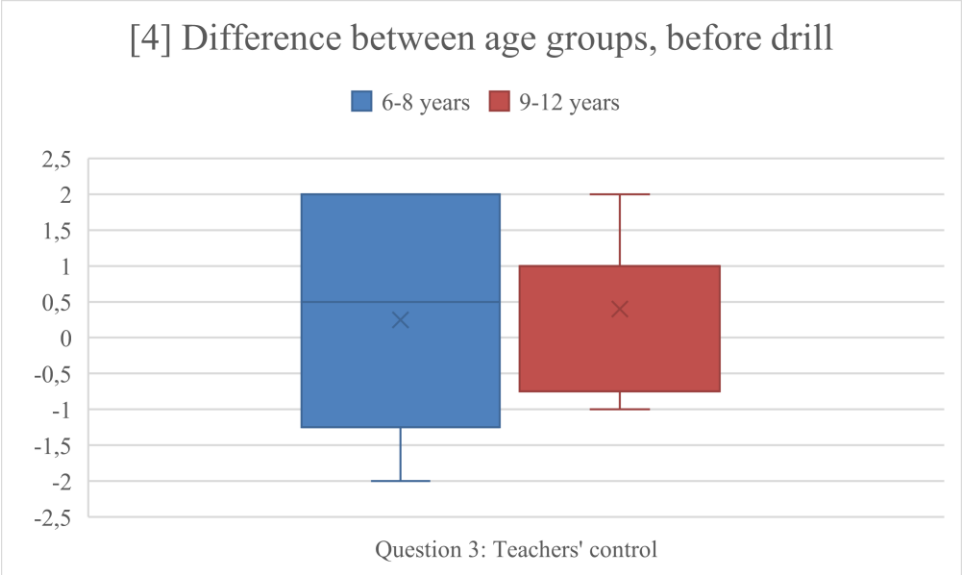

[5] Difference between age groups, after drill
6-8 years
9-12 years
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 2: Personal belongings

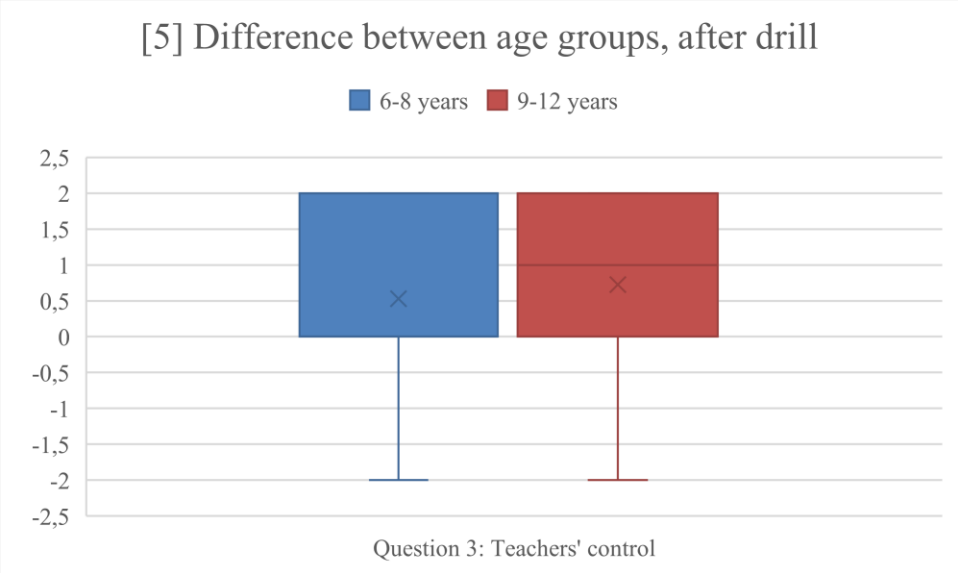
Question 3: As a teacher, I have full control during the whole evacuation process.



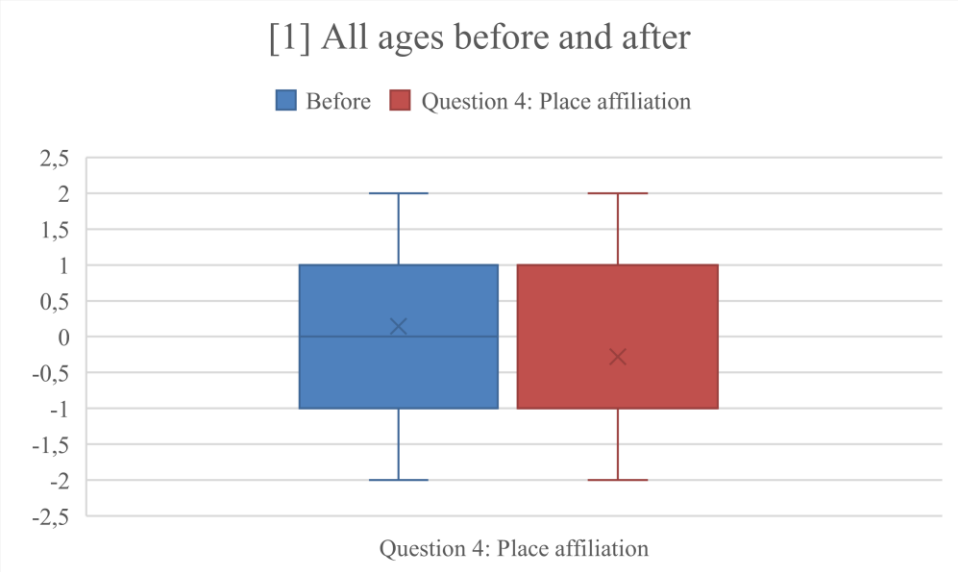


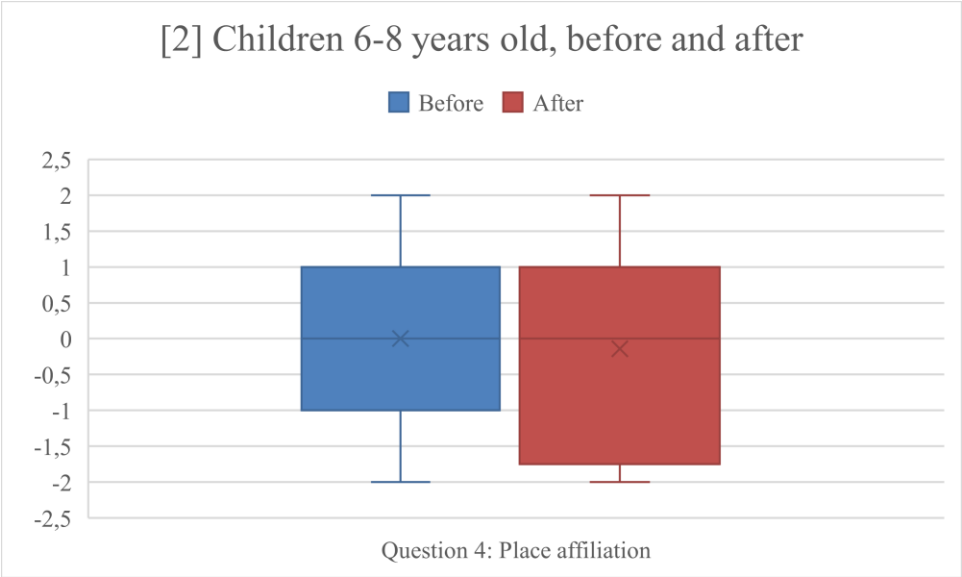

[3] Children 9-12 years old, before and after
Before
After
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 3: Teachers' control

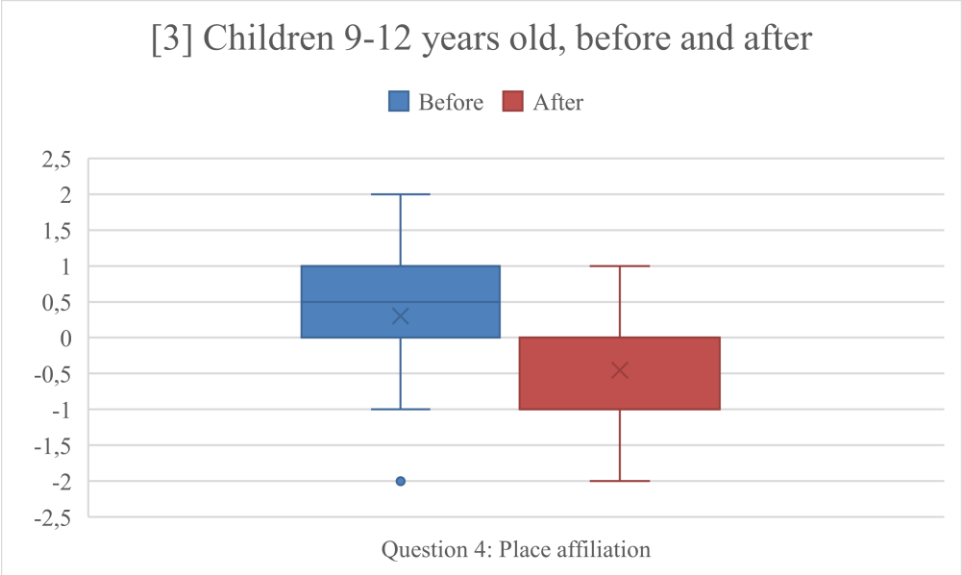

[4] Difference between age groups, before drill
6-8 years
9-12 years
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 3: Teachers' control

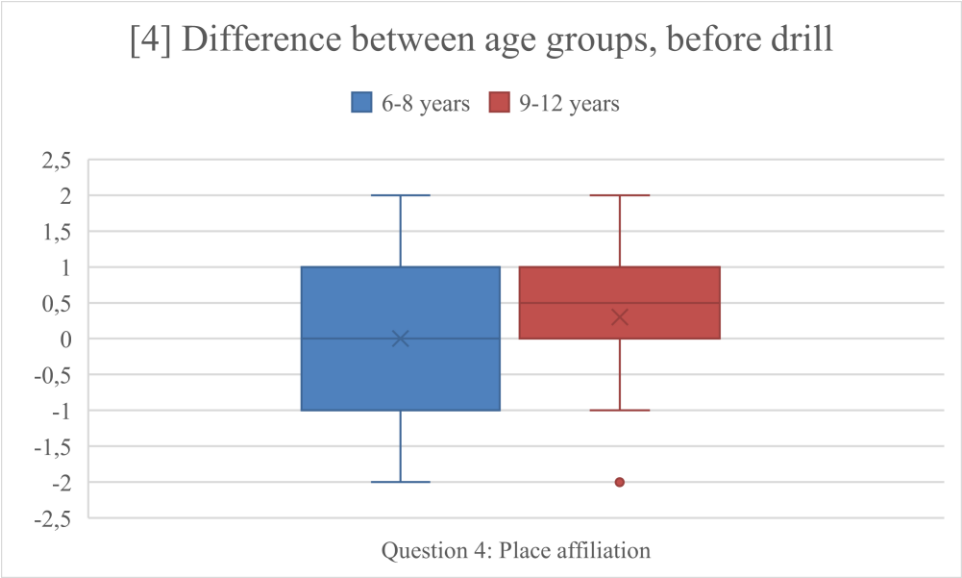


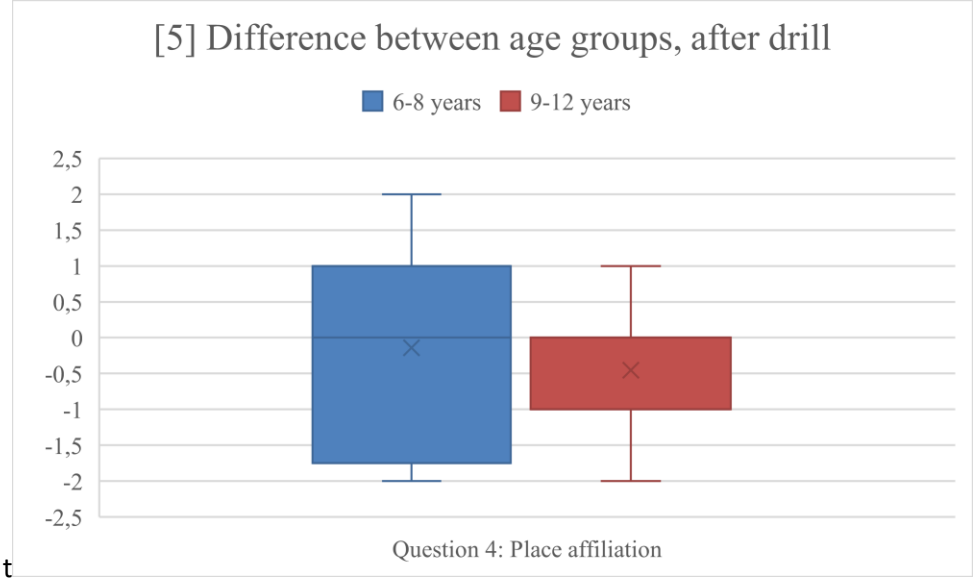
Question 4: When evacuating, children tend to follow the same pattern as when they usually exit the building.




[2] Children 6-8 years old, before and after
Before
After
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 4: Place affiliation

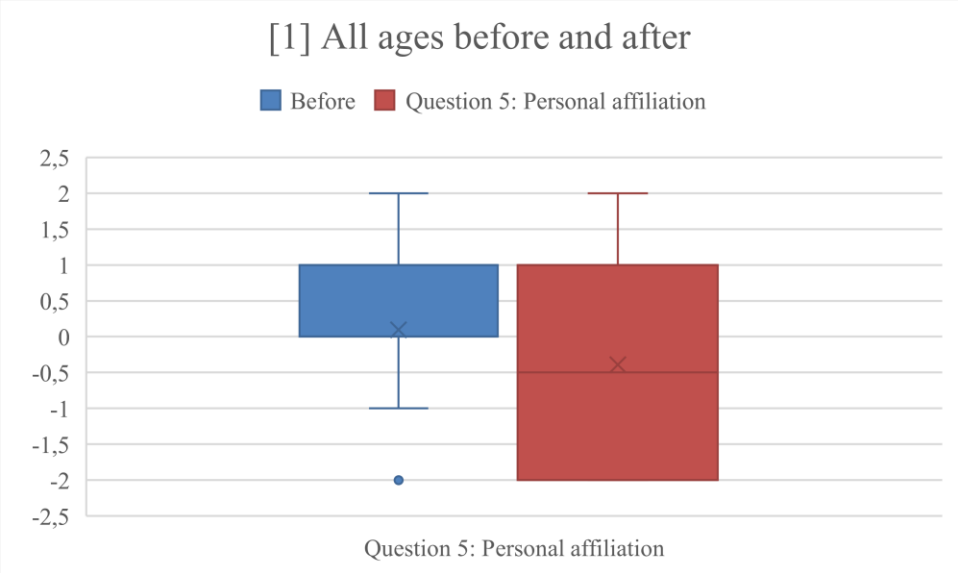

[3] Children 9-12 years old, before and after
Before
After
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 4: Place affiliation

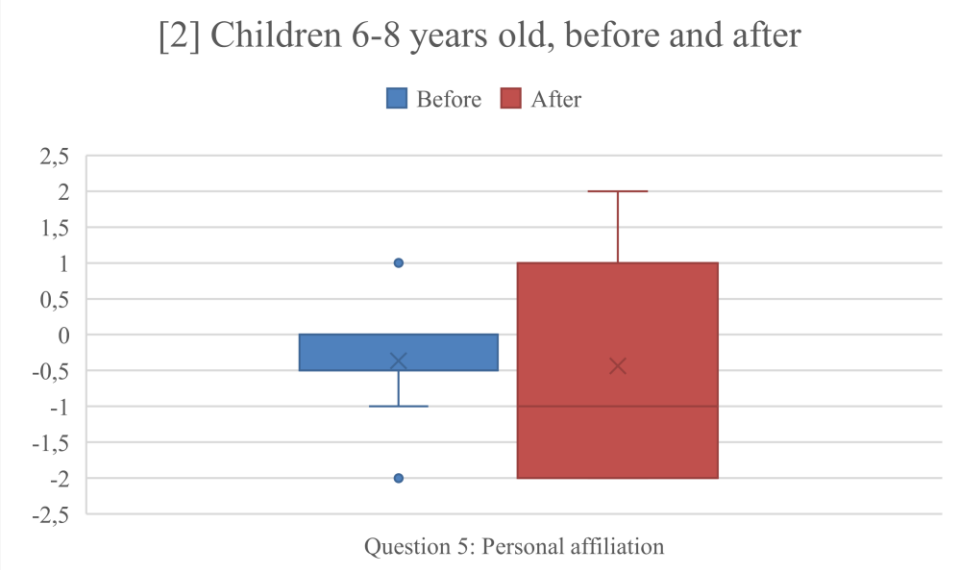

[4] Difference between age groups, before drill
6-8 years
9-12 years
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 4: Place affiliation

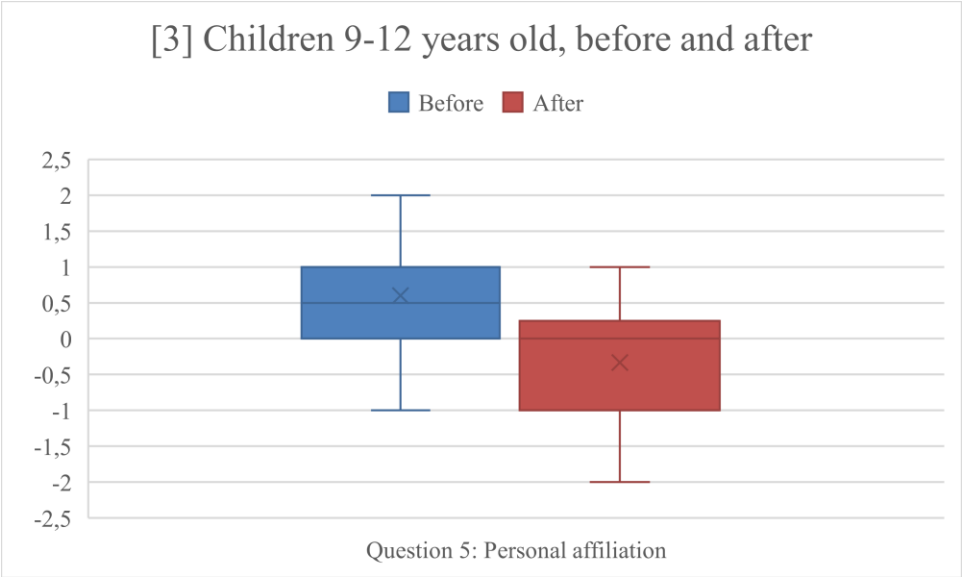

[5] Difference between age groups, after drill
6-8 years
9-12 years
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 4: Place affiliation

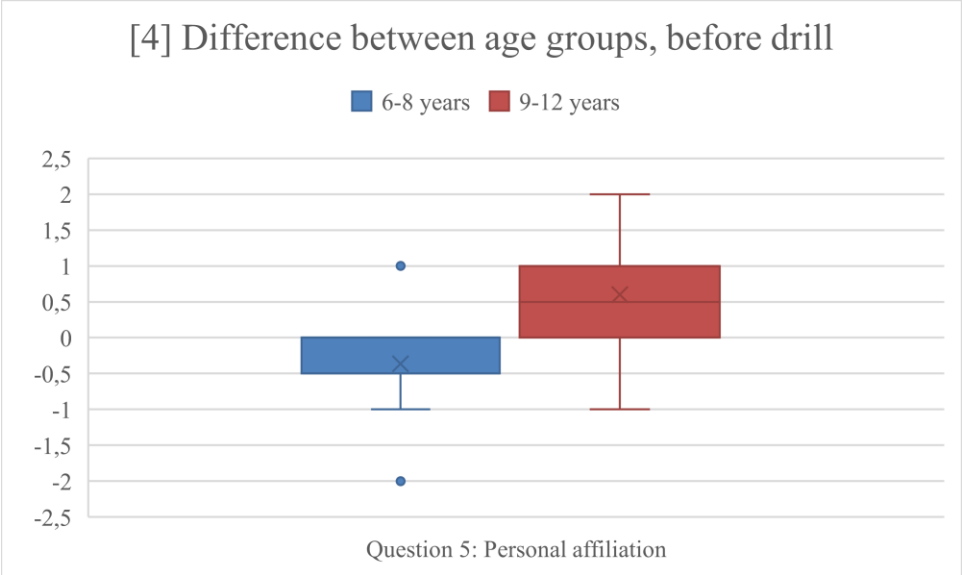
t

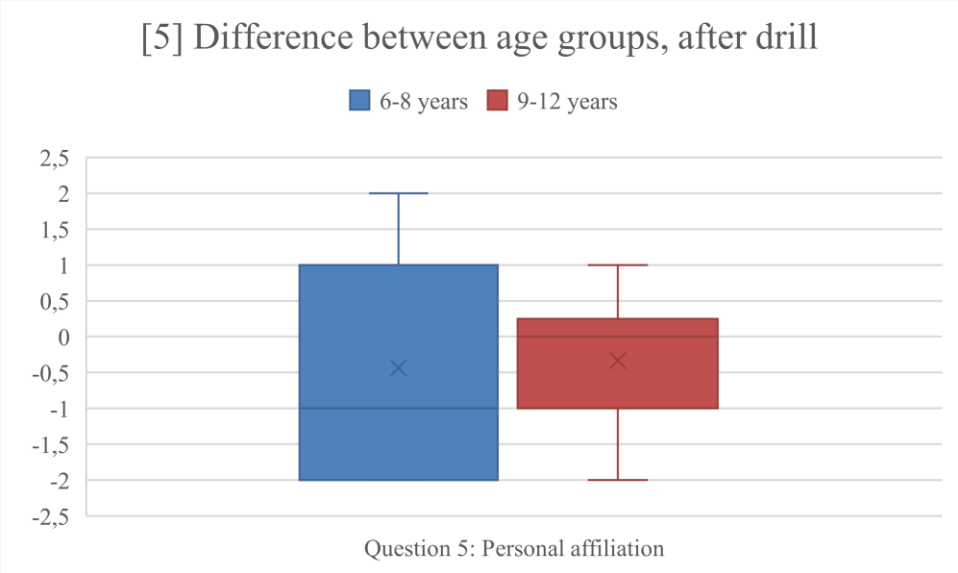
Question 5: Children only think of their selves and does not focus on any other before they got to safety.



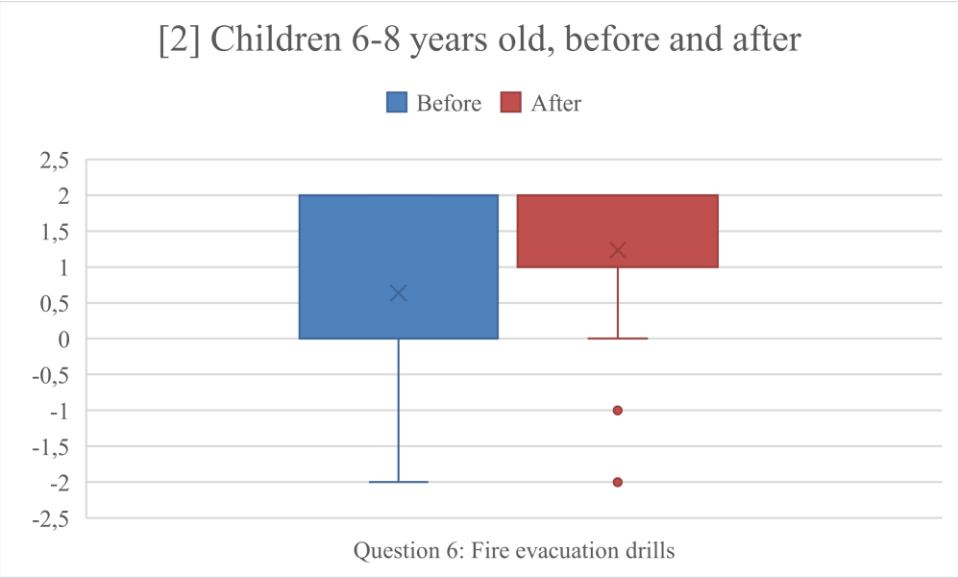


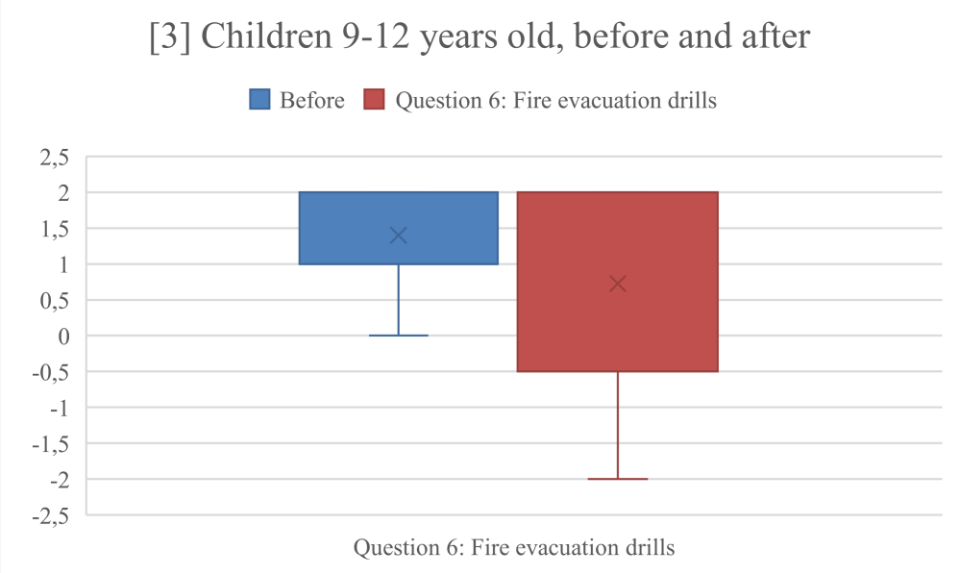

[3] Children 9-12 years old, before and after
Before
After
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 5: Personal affiliation


[4] Difference between age groups, before drill
6-8 years
9-12 years
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 5: Personal affiliation

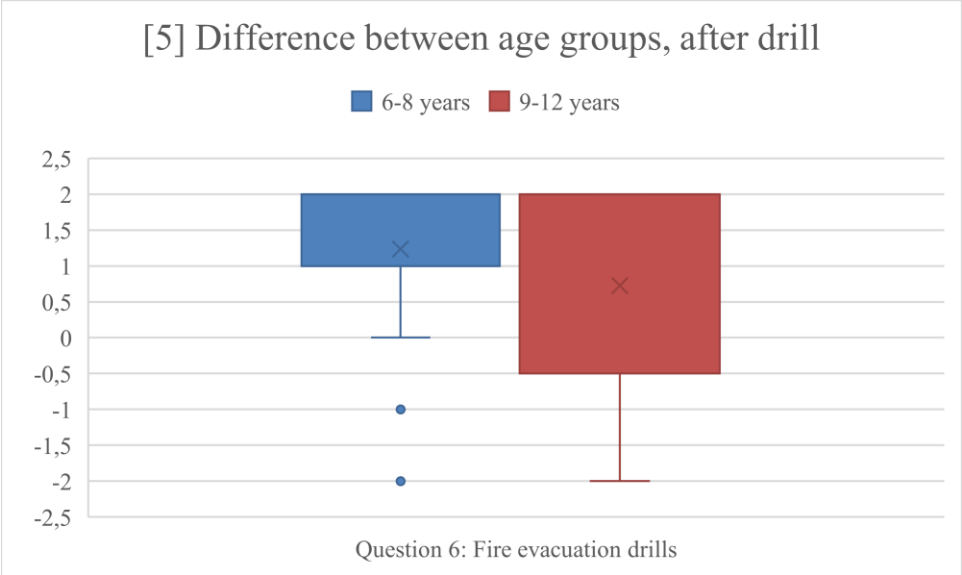


Question 6: Fire evacuation drills have a positive effect on children's behavior in fires.

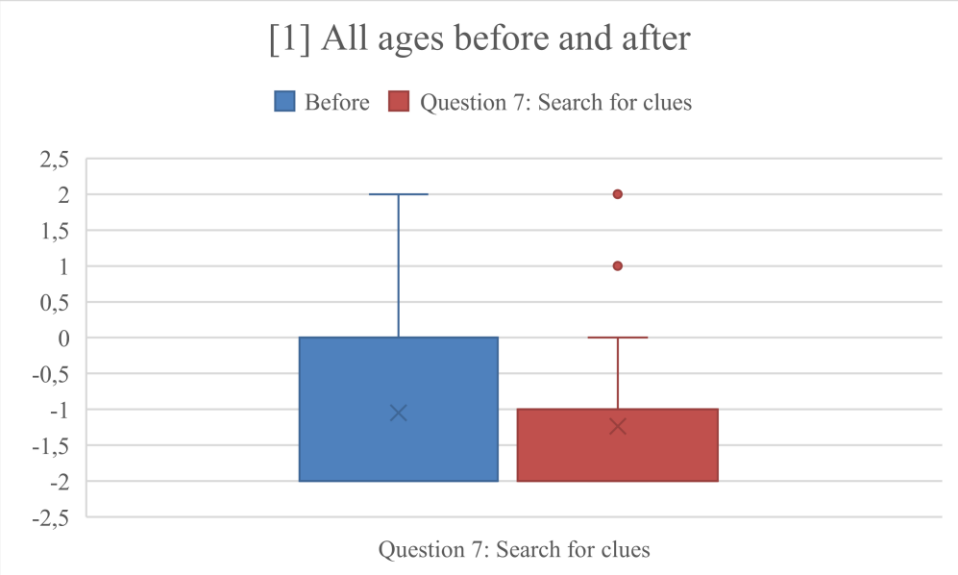

[2] Children 6-8 years old, before and after
Before
After
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 6: Fire evacuation drills

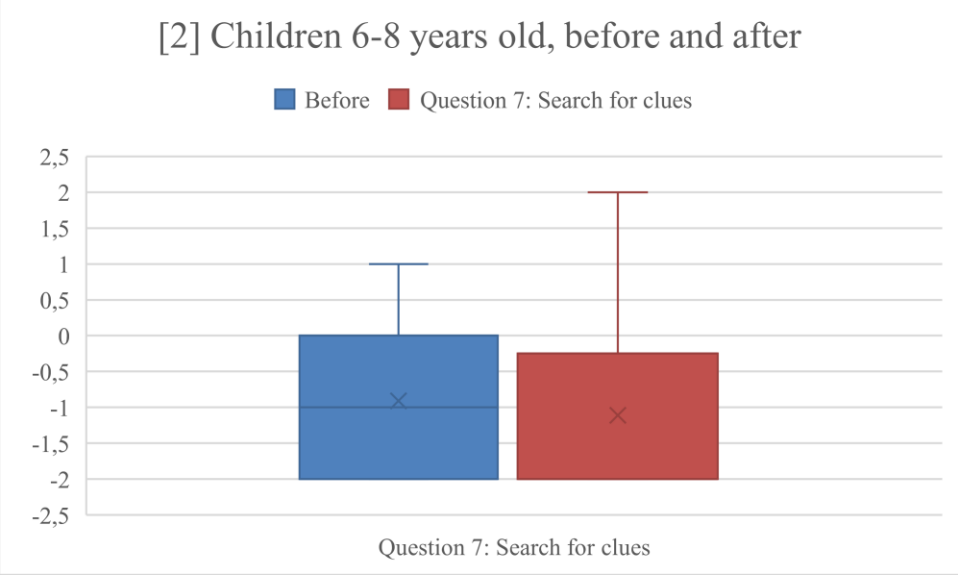

[3] Children 9-12 years old, before and after
Before
Question 6: Fire evacuation drills
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 6: Fire evacuation drills

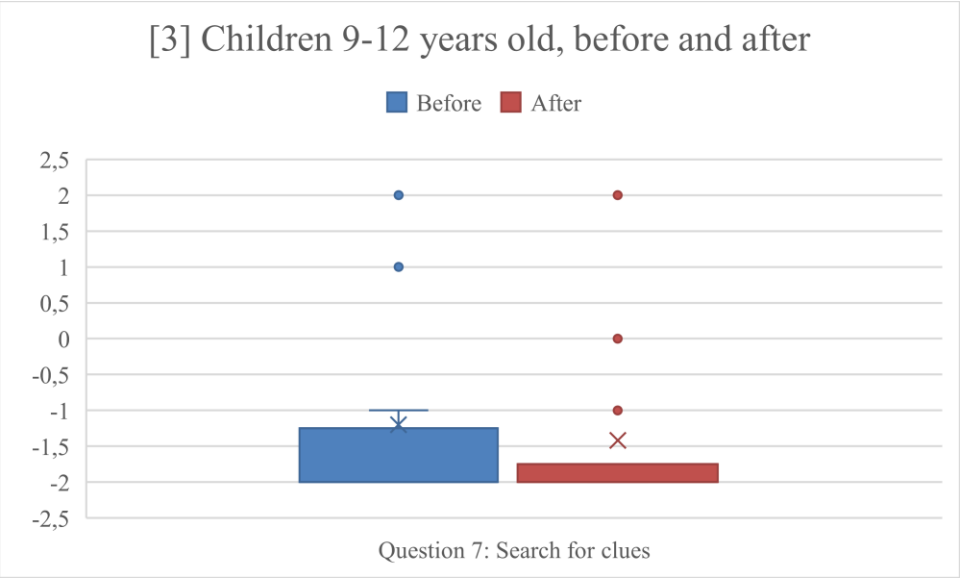

[4] Difference between age groups, before drill
6-8 years
9-12 years
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 6: Fire evacuation drills

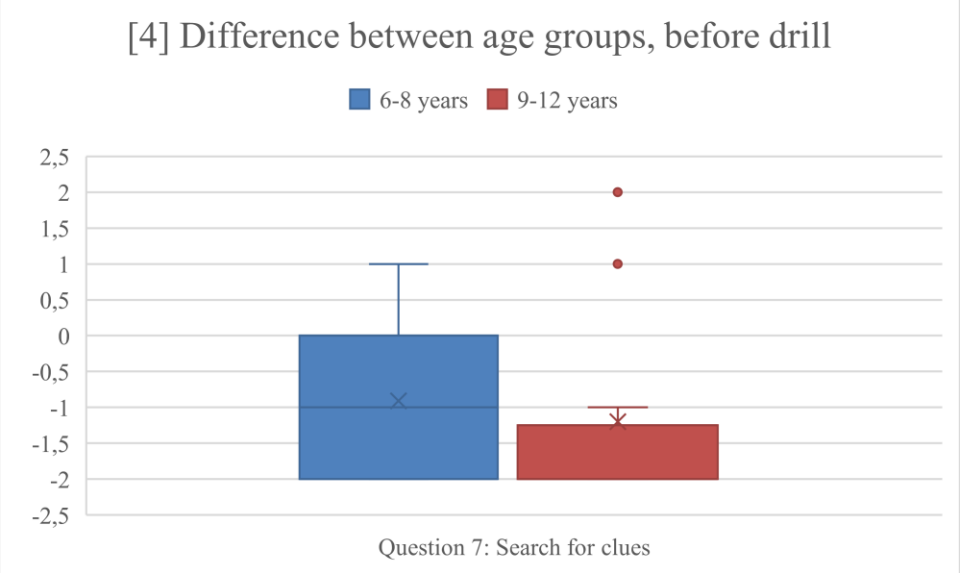

[5] Difference between age groups, after drill
6-8 years
9-12 years
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 6: Fire evacuation drills

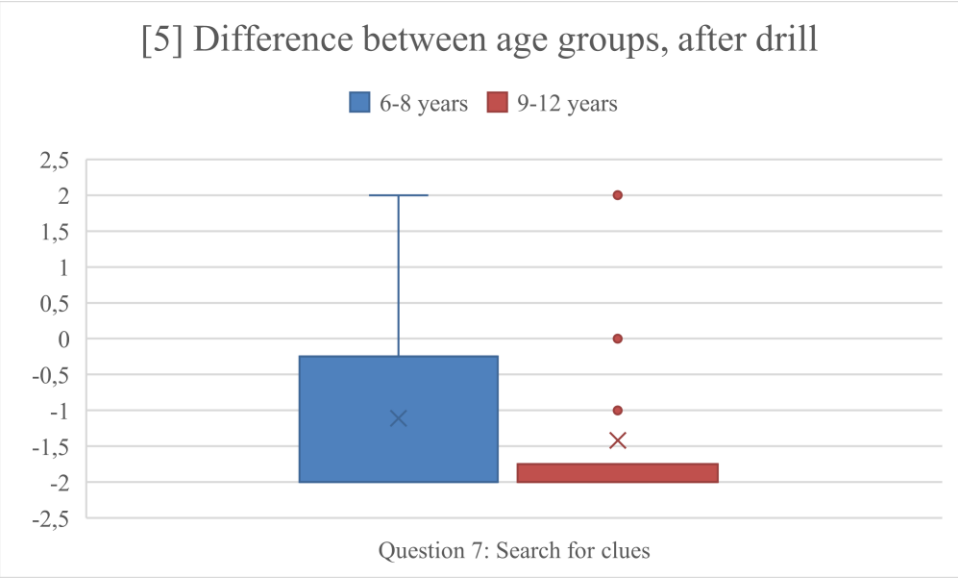
Question 7: When the alarm sounds the majority of children want to search for the fire.



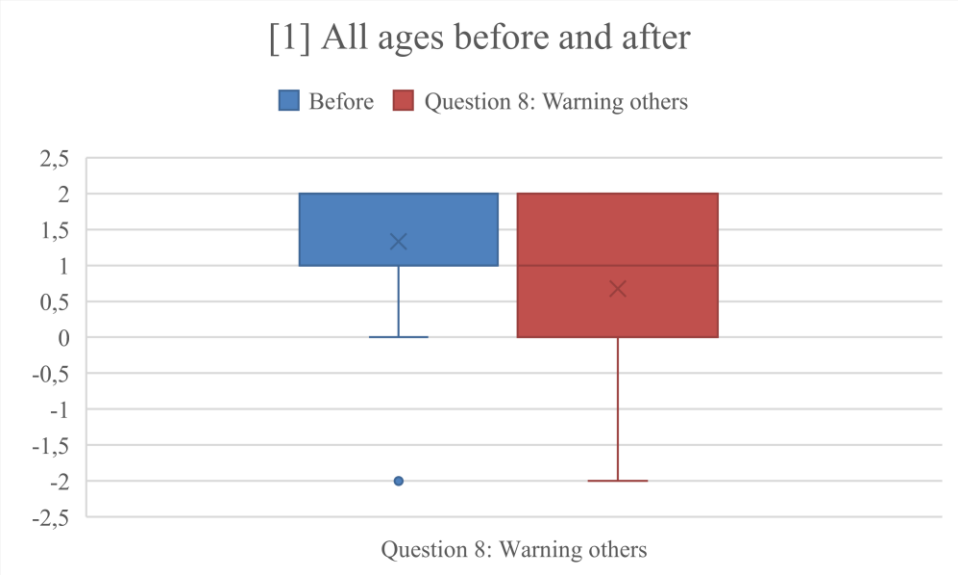


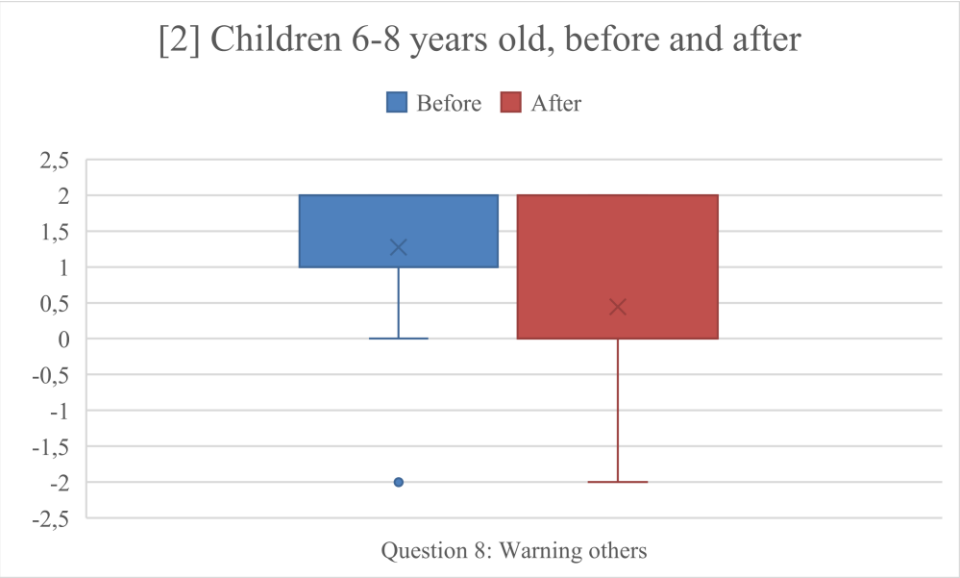

[3] Children 9-12 years old, before and after
Before
After
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 7: Search for clues

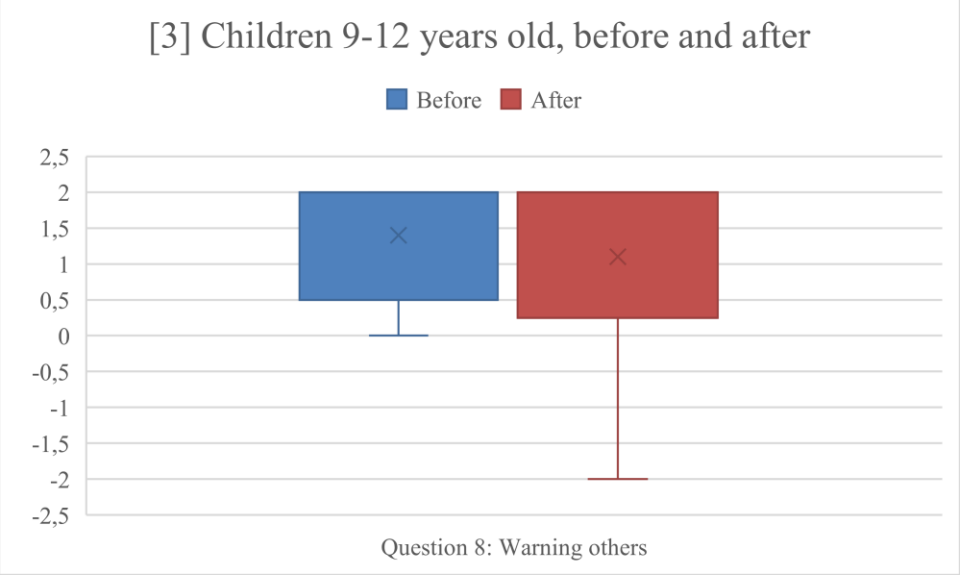

[4] Difference between age groups, before drill
6-8 years
9-12 years
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 7: Search for clues

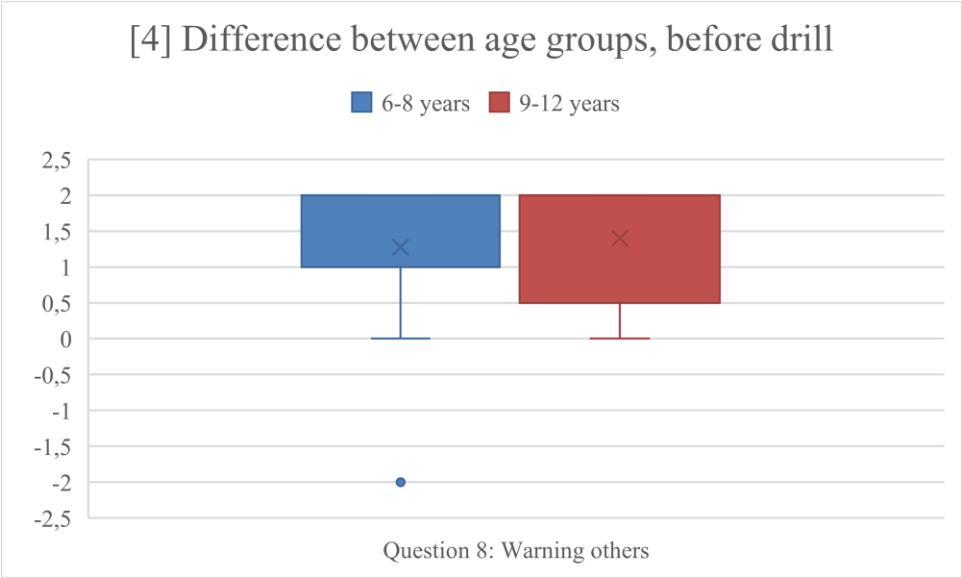


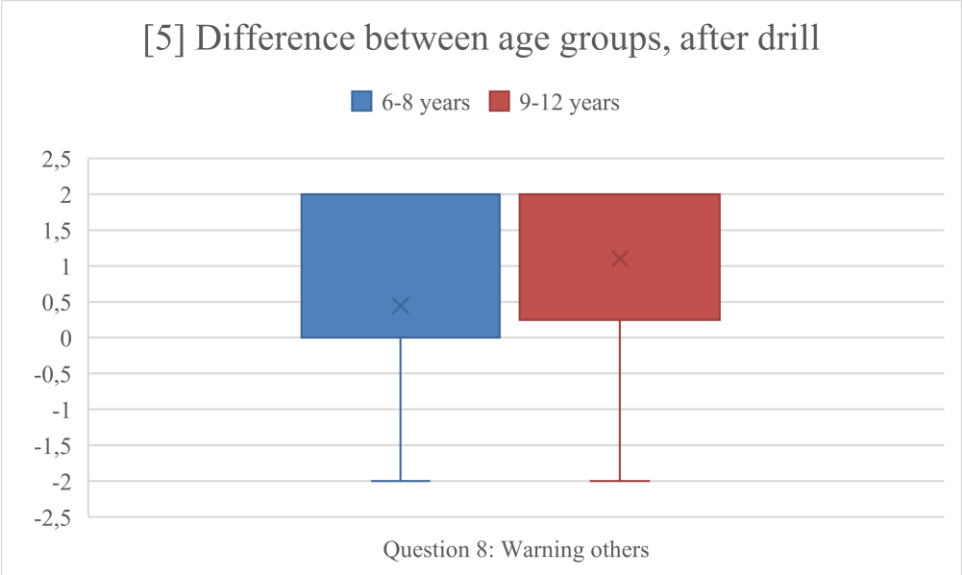
Question 8: The majority of children contact an adult if they think there is a fire.



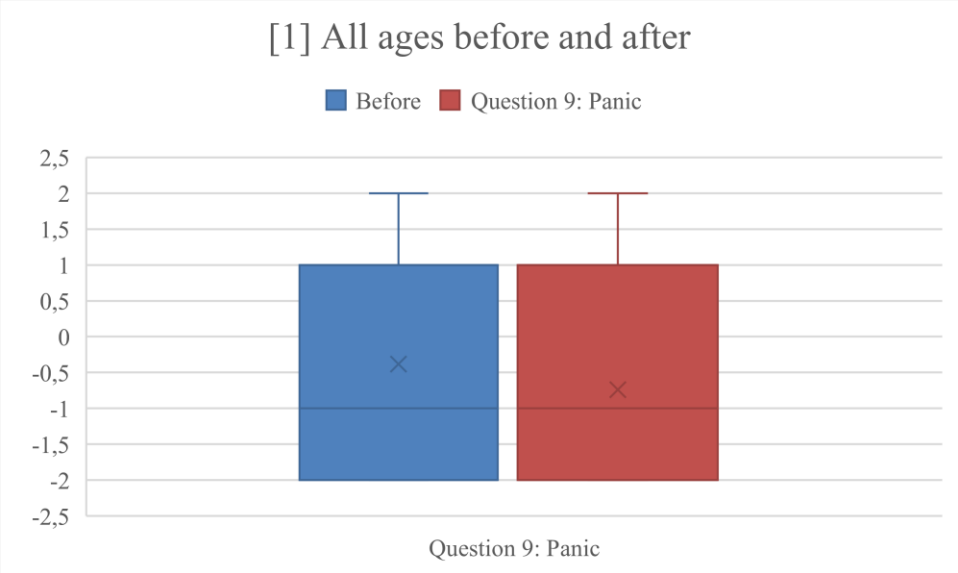

[2] Children 6-8 years old, before and after
Before
After
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 8: Warning others

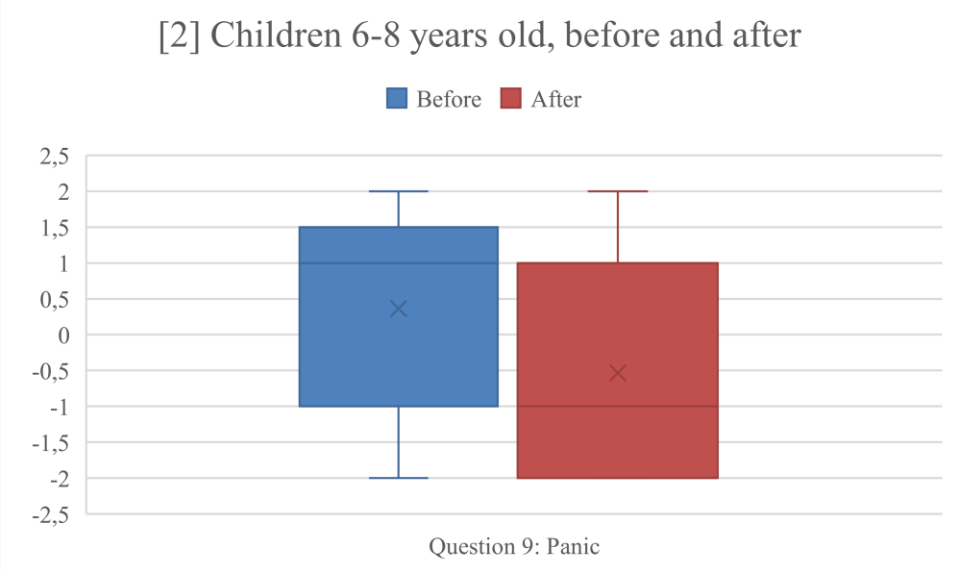

[3] Children 9-12 years old, before and after
Before
After
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 8: Warning others

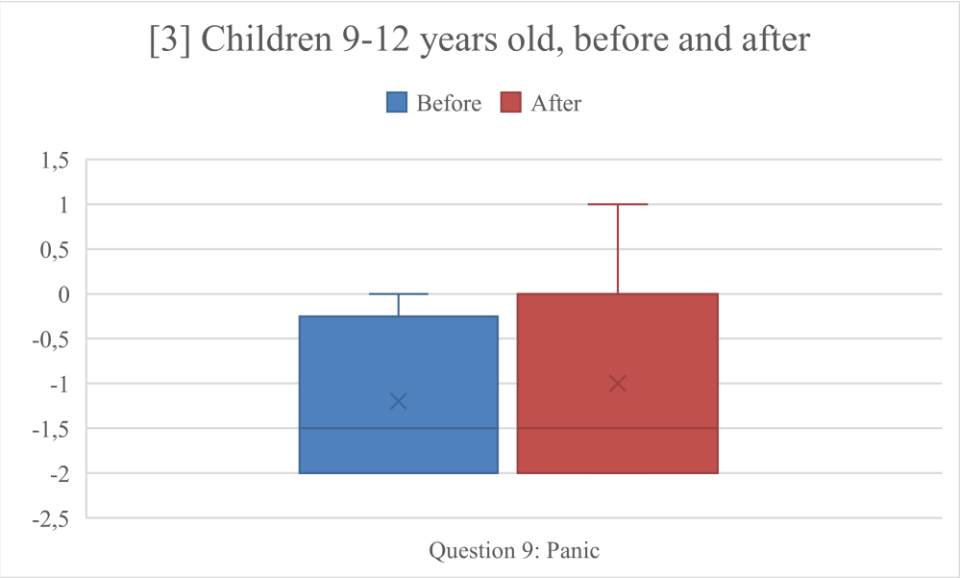

[4] Difference between age groups, before drill
6-8 years
9-12 years
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 8: Warning others

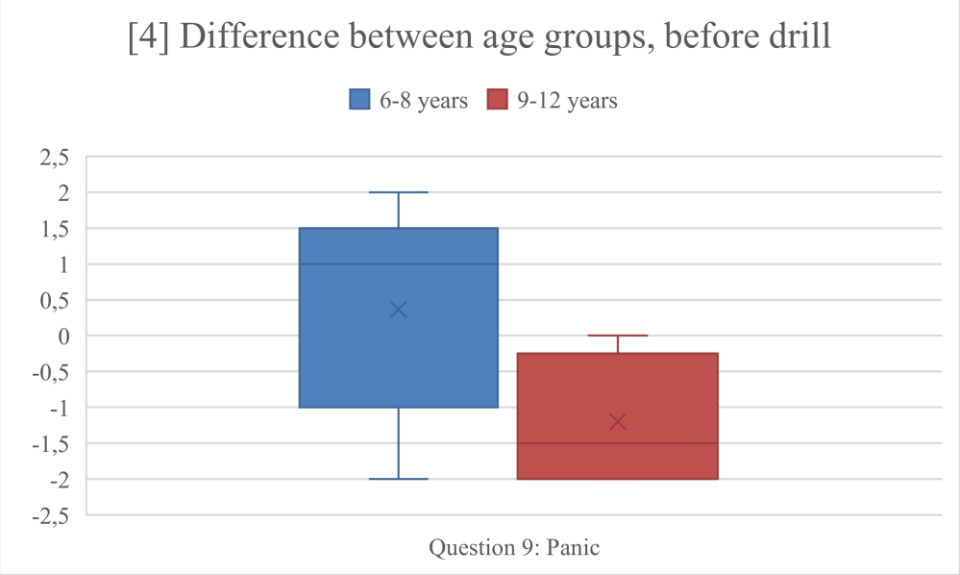

[5] Difference between age groups, after drill
6-8 years
9-12 years
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 8: Warning others

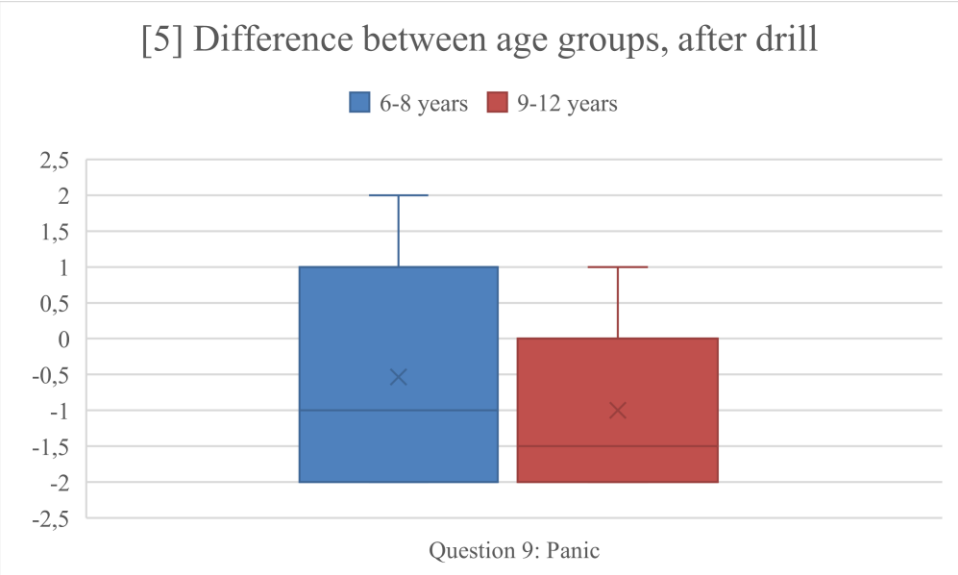
Question 9: A child in the class gets really worried and show an irrational behavior that spreads among the majority of children.



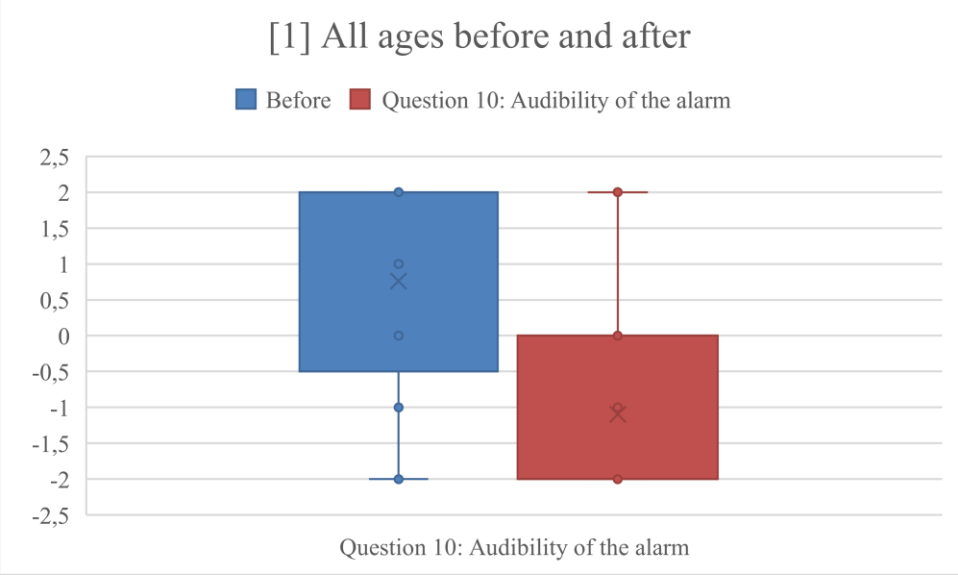


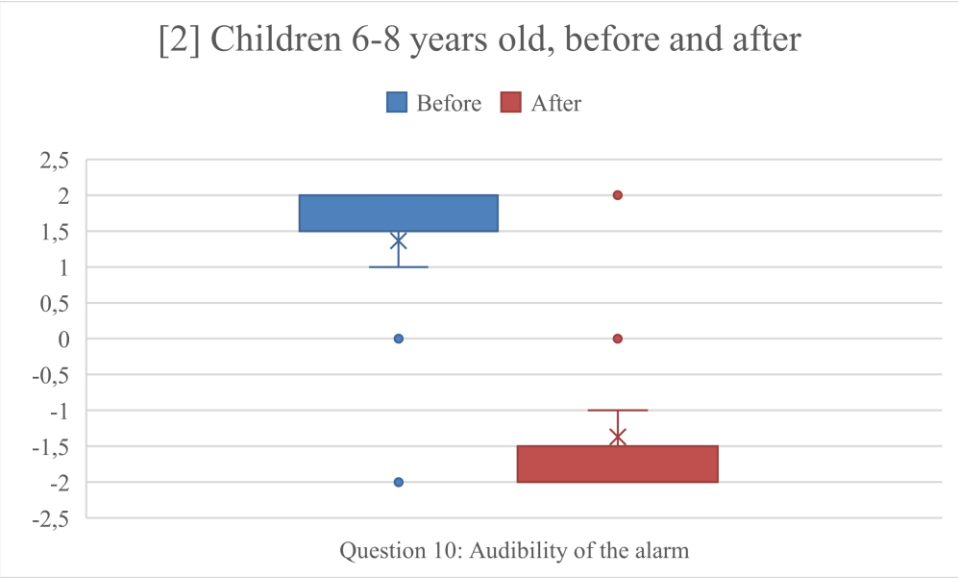

[3] Children 9-12 years old, before and after
Before
After
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 9: Panic

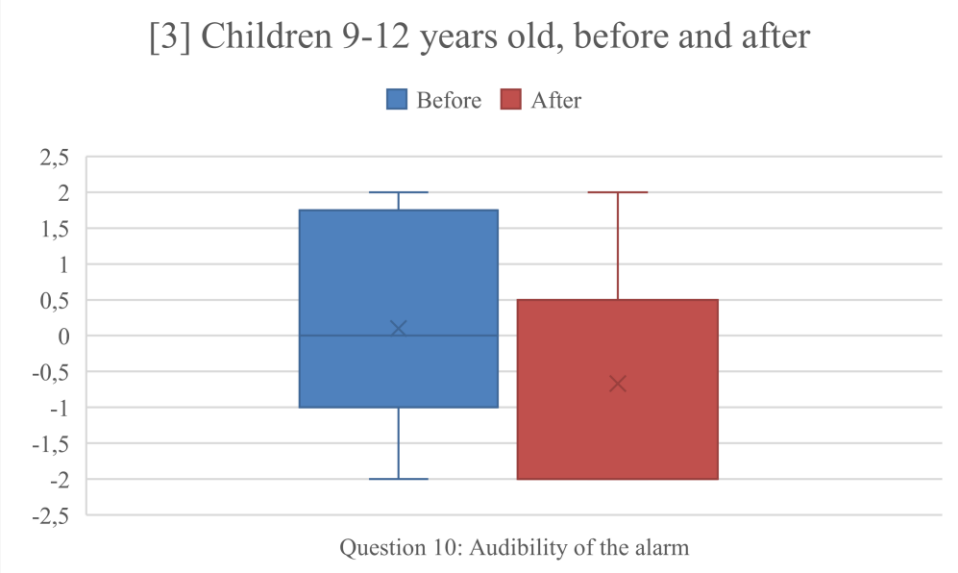

[4] Difference between age groups, before drill
6-8 years
9-12 years
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 9: Panic

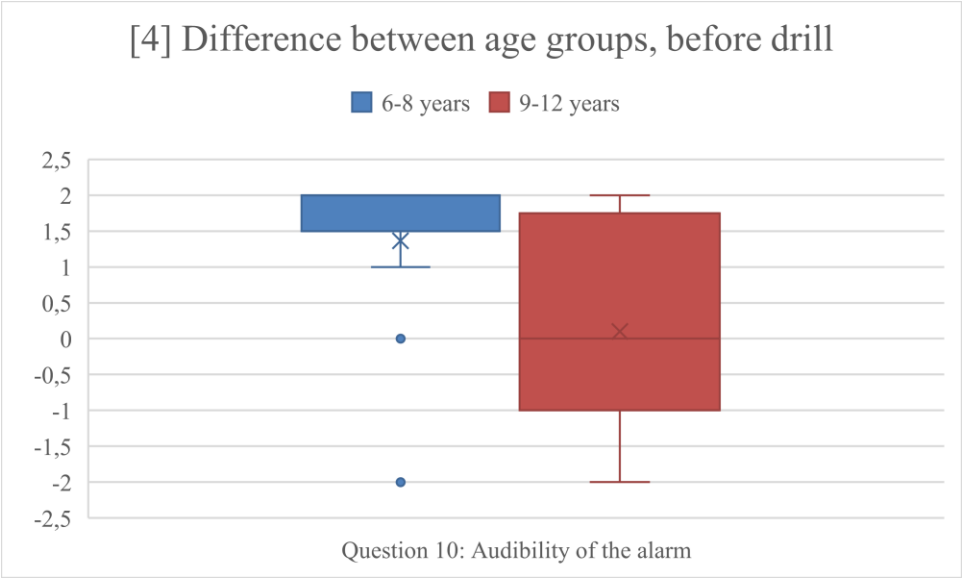


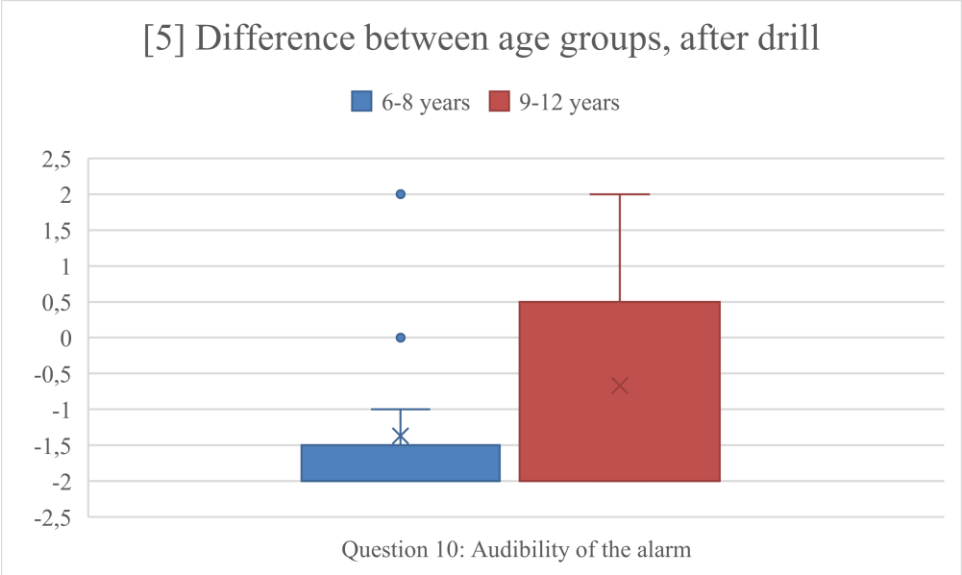
Question 10: The audibility of the alarm is enough for everyone to hear.




[2] Children 6-8 years old, before and after
Before
After
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 10: Audibility of the alarm


[3] Children 9-12 years old, before and after
Before
After
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 10: Audibility of the alarm


[4] Difference between age groups, before drill
6-8 years
9-12 years
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 10: Audibility of the alarm


[5] Difference between age groups, after drill
6-8 years
9-12 years
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
-2
-2,5
Question 10: Audibility of the alarm