Examination of primary school children’s playing habits through digital puzzle games, and the impact of non-educational commercial puzzle games on the development of logical thinking in primary school children

An ethnographic case study with Supaplex

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Abstract

Supaplex is a single player video-game released at the beginning of the 90's which known as a challenging puzzle game developed for MS-DOS and Amiga. Although Supaplex did not get an intense interest and did not become a "POP" icon like PacMan or Super Mario or Sonic during the 90's, it was quite popular among people who like puzzle games such as Boulder Dash. This paper aims to revive this nostalgic video-game and show if Supaplex help to improve the development of logical thinking in primary school children. This paper examines how can Supaplex effect on primary school children's way of developing problem-solving techniques. Moreover, this case study examines primary school children's playing habits at their own homes. The paper is based on an ethnographic case study in which I collaborated with a Turkish family to let their children play Supaplex at their home as a spare-time activity approximately five-month long period. During this five-month period, I went to their home and played Supaplex with the triplets.

Keywords: Supaplex, development of logical thinking in children, attitude to problem-solving, games roles in development of logical thinking, ethnographic case study
Acknowledgments

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# Table of Contents

1 Introduction .................................................................................................................. 1

2 Background ................................................................................................................... 2
   2.1 Edutainment and Today’s Children’s Learning Motivation ........................................... 2
   2.2 Educational Games as Teaching Materials in Schools .................................................... 3
   2.3 Puzzle-Based Learning ............................................................................................. 3

3 Problem and Case Study Design .................................................................................. 6
   3.1 Problem Statement .................................................................................................. 6
   3.2 Ethnographic Case Study ....................................................................................... 6
   3.3 Participant Observation ......................................................................................... 6
   3.4 Interview Modeling ............................................................................................... 7
   3.5 Method ................................................................................................................... 8
      3.5.1 Supaplex ........................................................................................................ 9
      3.5.2 PISA Tests, Sudoku and Tangram Puzzles ....................................................... 10
   3.6 Ethical Considerations ........................................................................................... 13
   3.7 Limitations ............................................................................................................ 14
   3.8 Observation Protocol ............................................................................................ 15

4 Results ........................................................................................................................ 16
   4.1 Child1 .................................................................................................................... 17
   4.2 Child2 .................................................................................................................... 17
   4.3 Child3 .................................................................................................................... 17

5 Findings ....................................................................................................................... 18
   5.1 Family Life ............................................................................................................ 18
   5.2 Children’s Natural Environment ............................................................................ 20
   5.3 Children’s playing habits and their first impressions about Supaplex ....................... 21
   5.4 The evolution of children’s playing habits and their approach to Supaplex throughout the time ........................................................................................................ 23
   5.5 Supaplex and Mathematics .................................................................................... 24
   5.6 Themes ................................................................................................................. 25
      5.6.1 Patience ......................................................................................................... 25
      5.6.2 Competition .................................................................................................. 26
      5.6.3Exploring New Game Mechanics and the Wow Effect ....................................... 27
      5.6.4 Fast Fingers .................................................................................................. 28
      5.6.5 Helping Each Other ..................................................................................... 29
      5.6.6 Seeking for Diversity ................................................................................... 30
      5.6.7 Comfort Zone ............................................................................................... 30
      5.6.8 ”I can achieve!” ............................................................................................ 31
      5.6.9 Creating New Challenges ............................................................................ 32
   5.7 The changing of children’s attitudes towards to video recording over time ............ 33

6 Conclusion .................................................................................................................... 35
   6.1 Summary .............................................................................................................. 35
   6.2 Discussion ............................................................................................................. 36
   6.3 Future Work ......................................................................................................... 37

References ....................................................................................................................... 38
1 Introduction

The key challenge of the educational games is keeping the balance between entertainment and education in the context of the basic requirements of a game design. Although the popular games like Minecraft have released educational versions, it is still quite hard to conduct a game-based curriculum (Marklund & Alklind Taylor, 2016). According to Ito (2012), children tend to forget about the tasks which given by their teachers and focus on the "fun" side of the educational games due to their nature:

“Although adults will try to orient kids toward the more school-like content in some of the educational games, kids tend to see play in this genre as a process of open-ended exploration focusing on the pleasure in visual and interactional special effects.”

Ito’s findings of the way that how children approach an educational game pushed me to ask the following questions; What if the gaming sessions in schools are not only “educationally”? Can even “pure fun” bring the education by itself? What if children play a fully-commercial entertaining game without knowing that it also has educational aspects? This questions led me to examine the educational sides of the existing games which also described as challenging and fun.

Supaplex is a grid-based puzzle video game which was released in 1991. At first, Supaplex was designed as a copy of the video-game Boulder Dash. However, the creators decided to announce Supaplex as a totally disparate new game. The original Supaplex has 111 levels, and the reason makes Supaplex unique is that each level acts as a mathematics question which pushes players for brainstorming. Players have to control the time (levels which needs effective time management strategies), manage their sources (levels which players have to use limited red-floppy discs called “Utility Disks”), have quick reflexes, and such. There are no life and time limitations in Supaplex. Players are able to play Supaplex as much as they want, and whenever they want. However, if a player dies in the middle of the level, Supaplex does not let the player start the part where he or she died. The player has to play the current level from the very beginning. Supaplex allows to skip up to three levels for each player. Additionally, Supaplex does not show score points to players. Supaplex identifies the top player by the last level which achieved by the players; but if there is more than one player who achieved the same level, then it compares the time they have spent by playing the game. For instance, assume that a player achieved the 15th level in Supaplex by playing 4 hours; but on the other hand, another player achieved the 15th level in Supaplex by playing only 2 hours. Thus, the second player would be the top player. If a player achieved a level, Supaplex just allows them to pass to the next level. Players can compete with each other through their total game playing time or the levels they achieved.
2 Background

2.1 Edutainment and Today’s Children’s Learning Motivation

The edutainment games are known as serious games that combines both education (edu-) and entertainment (-tainment) at the same time. Edutainment is declared as an educational concept by Robert Heyman from American National Geography Academic Union (Aksakal, 2015). The main purpose of Edutainment is to attract students’ attention and to make their focus on events and teaching materials during learning (Okan, 2003, as cited in Aksakal, 2015).

The unstoppable change of the new generation makes the previous ones take a hard time to keep up with. Every single innovative development necessitates the change of methods which the previous generations used for learning. Today, the children are growing up in a world full of diversities which are just focused on to entertain and educate them. The educational technology concept has an aim which serves to children learn by playing and having fun (İsmail, 2005, as cited in Çankaya & Karamete, 2009). The digital games came up as perfect tools to carry out educational aims. However; we needed to re-design the digital games to apply the edutainment concept firstly. According to Prensky (2005), the reasons of why we need to re-design the computer and video games for teaching "the real world" from them are:

- Our learners have changed radically.
- These learners needed to be motivated in new ways.

Our learners have changed radically: Prensky mentions on "Digital Natives" and highlights the differences between generations according to technological development (2005). According to Prensky (2005), growing up with computer and video games has changed the way people raised in this time think and process information. Therefore; when we compare with their parents, today’s generation has a different style to understand and analyze the problems (Prensky, 2005).

These learners needed to be motivated in new ways: With the change of the way of understanding and analysing the problems among today’s generation, a need to change the way of motivation for learning has appeared. The things that were effective in past do not motivates today’s students (Prensky, 2005). According to Prensky (2005), computer games can provide a new way to motivate today’s students to learn. Including online learning to the teaching process is keeping students motivated to stick with the learning process at the end of the classroom, lesson, session, course, semester or degree (Prensky, 2005).

Firstly, we should understand the young generation. We need to learn their own unique language before we start to teach something to them. What makes them keep playing a game? What kind of things (prizes, competition, draw applause, etc.) motivates them? Even if it is enjoyable, would they prefer to play a game which introduces to them as an educational game?
2.2 Educational Games as Teaching Materials in Schools

It has been known that challenging puzzle games pushes people to think strategically. Since there is no research regarding Supaplex's effects on children, this dissertation would be the first one which examines Supaplex's effects on the development of logical thinking in primary school children. However, there are several researches which helped me to shape the problem area I want to work on. For instance, according to interviews with K-12 teachers after the employing the experiment of involving Minecraft Educational Version to create a game-based curriculum by Berg Marklund and Alklind Taylor (2016); teachers noted that they had experienced some difficulties with children during this experiment. Children were not playing the game "in the way they should be played" on the class hours. One of the teachers described their experience that:

"I think, just as you have switched [some game components] off, there needs to be a focus on [the school subject]... Because, when they play on their own, a part of the whole thing, a part of the whole game is to survive, or avoid zombies coming to get you, or something else. But now we didn't have that, because now 'it was school', kind of. Because you need to feel that difference, that 'now the focus is on [school, and not the game]".

(Berg Marklund & Alklind Taylor, 2016, p.132)

As you can see above, teachers had a quite difficult time while they are trying to make Minecraft Educational Version a part of their lectures, because children wanted to play only the entertaining part of the game. Children were not interested in "the school kind of things", even if they are playing a game which some of them already familiar with. On the other hand, teachers needed a third party (which in this case was the assisting researchers) to established the technological infrastructure required to make gaming sessions possible (Berg Marklund & Alklind Taylor, 2016, p.133). As Berg Marklund and Alklind Taylor (2016) were also mentioned before: As put by Bourgonjon and Hanghøj (2011), “teachers don’t necessarily need to become experts with every new medium, but at the very least need to know what is going on [...] in order to participate” (p. 71). This interpretation is also true for gaming sessions too. Teachers have to have enough knowledge to guide the children in gaming sessions. Consequently, I would like to show if a commercial game, which has not needed to be played at school -could be played at home environment too-, can take educational game's place. Thus, teachers do not have to waste hours in order to conduct a game-based curriculum.

2.3 Puzzle-Based Learning

According to Prensky (2005) Digital Natives are an intellectual problem-solving oriented generation who enjoys the complex logic, challenging puzzles, spatial relationships, and other demanding "thinking" tasks are built into the computer and video games. This fact led me to think about adapting puzzle-based learning into edutainment concept.

Meyer et al. (2014) described the Puzzle-Based Learning as; “a foundational approach to develop thinking skills, mental stamina, and perseverance at solving problems” (p. xi).

“Puzzle-Based Learning approach aims to motivate the students how to frame and solve unstructured problems. In addition to this, Puzzle-Based learning approach helps the students to increase their mathematical awareness and problem-solving skills by discussing a variety of puzzles and their solution strategies” (Meyer et al., 2014, p. xi).
Combining video games and puzzle-based learning would be an effective educational game alternative which can be used as a learning material even without noticed by the students. When we interpret Mayer’s sayings about puzzle-based learning, we can reach that playing a random puzzle game (even the ones which does not include any content from curriculum) could help students to think from outside the box and improve their problem-solving skills as a result.

Gyorgy Polya is a mathematician who was born in 1887 and has been known from his contributions to mathematical sciences. Gyorgy Polya published a book called "How to Solve It" in 1945. Gyorgy Polya identifies how to solve a problem step by step in this book. Meyer et al. (2014) aforementioned these steps as a guide for the puzzlers to make them rearrange the problem and find a way to create a solution. Polya reduces problem-solving techniques into four main principles:

1. “Understanding the problem. You have to understand the problem. What is unknown? What are the data? What is the condition? Is the condition is sufficient to determine the unknown? Or is it insufficient? Or redundant? Or contradictory?
2. Devising a plan. Find the connection between the data and the unknown. You may be obliged to consider auxiliary problems if an immediate connection cannot be found. You should obtain eventually a plan of the solution. Have you seen it before? Do you know a related problem? Look at the unknown. Here is a problem related to yours and solved before. Could you use it? If you cannot solve the proposed problem try to solve first some related problem. Could you imagine a more accessible related problem?
3. Carrying out the plan. Carrying out your plan of the solution, check each step. Can you see clearly that the step is correct? Can you prove that it is correct?
4. Looking back. Examine the solution obtained. Can you check the results? Can you check the argument? Can you use the result, or the method for some other problem?”
   (Polya, G., 1945, p. xvii)

Based on Polya's four basic principles for problem-solving techniques, Michalewicz and Michalewicz presented a simplified approach to Puzzle-based Learning:

1. “Understand the problem, and all the basic terms and expressions used to define it
2. Do not rely on your intuition too much; solid calculations are far more reliable
3. Build a model of the problem by defining its variables, constraints, and objectives”
   (Meyer et. al, 2014, p. x)

Puzzle-based learning approach gives the flexibility to use any kind of puzzle game instead of the games which developed only for educational purposes. We can apply Polya’s four basic principles for problem-solving techniques to any puzzle games.

According to Meyer et al. (2014), “the ultimate goal of Puzzle-based Learning is to lay a foundation for students to be effective problem-solvers in the real world. At the highest level, problem solving in the real world calls into play three categories of skills: dealing with the vagaries of uncertain and changing conditions, harnessing domain-specific knowledge and methods, critical thinking and applying general problem-solving strategies” (Figure 1)
To summarize all of these information all together; puzzle-based learning is the main key that helps people to reach the solutions in the most effective way. Learning with puzzles among the young students would help to improve their problem-solving skills and after years, this method would led them understand project-based learning easily. Every single project is consists of various problems, and all of these problems is consists of various puzzles. The children who getting used to solve puzzles from the beginnings of early childhood, gains the logic to how to approach a problem from different perspectives. As a puzzle-based video game, Supaplex is fulfills the requires of being a completely suitable material to evaluate the effect of using commercial puzzle games as an educational game on primary school children.
3 Problem and Case Study Design

In this section, the problem statement and the methodology employed for this case study had been stated.

3.1 Problem Statement

The problem area I will cover in this dissertation is that the investigation of the use of educational elements in the games which produced for commercial purposes, in considering of the problems caused by the difficulties and the deficiencies encountered in educational games. According to previous researches, we may say that children tend to use the educational games out of the games' purposes. In terms of reinterpreting the educational games and their needs, I am examining the young children's play habits and their expectations from the games while playing Supaplex with them at their own houses. By using a non-educational game, I would like to examine the young children's attitude regarding the commercial games which also could be sorted as an educational game in terms of the puzzle-based learning model. On the other hand, I would like to use the outcomes and findings of this ethnographic case study as an instrument for reshaping educational games. Using existing games which also has an educational sides like digital puzzle games could change the way of children's learning style. Teaching mathematics by using educational games might not be fun, however, improving the primary school children's problem-solving skills with commercial puzzle games could help these children to understand math problems at school more easily.

3.2 Ethnographic Case Study

Robson (2011) defines the ethnographic approach as “a method that provides a description and interpretation of the culture and social structure of a social group which shares a common culture” (p. 142). According to Robson (2011), “The researcher's task would be to get involved the examining group and to become an accepted member of this group in their natural environment” (p. 142). In this case, being a "known person" by the children got the researcher adapt herself much more easy to the participants' natural environment. Besides this, the researcher was employed another playtest sessions with the same children for a different study a couple of months ago. Thus, the researcher had an experience which can be valuable for this case study. The researcher could identify each children's personalities and interpret accurately the reaction they give to Supaplex.

During each of these gameplay sessions, in order to keep logs of rare events need to be examined carefully, the researcher used her personal mobile phone (with an unshared iCloud and Google Drive account) as a video and audio recorder when it's necessary. In addition to this, the researcher frequently used a personal notebook as a written way of data collection method.

3.3 Participant Observation

For this research, the book called Participant Observation which published in 2002 and written by Kathleen M. DeWalt & Billie R. DeWalt has been used as a guideline to determine the observation methods. In Table 1, you can see the entire participant observation models and their definitions according to DeWalt & DeWalt (2002).
Table 1. Participation Observation Models (DeWalt & DeWalt, 2002)

<table>
<thead>
<tr>
<th>Participation Observation Model</th>
<th>Definition</th>
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<tr>
<td>Passive Participation</td>
<td>“In the passive participation method, the ethnographers are on the spot, but acts as a pure observer and do not interact with the participants; in fact, those participants may not be even aware of they are observing at all” (p. 19).</td>
</tr>
<tr>
<td>Moderate Participation</td>
<td>“Moderate participation occurs when the ethnographer is present at the scene of the action, is identifiable as a researcher; however, does not actively participate with people in it except occasionally interacts” (p. 20). DeWalt et al. (2002) describe this participation method that; “the researcher is at the scene but acting like a pure observer, often with a very structured observational framework” (p. 20).</td>
</tr>
<tr>
<td>Active Participation</td>
<td>“In active participation method, the ethnographer engages in almost everything that other people are doing as a means of trying to learn the cultural rules for behaviour” (p. 20).</td>
</tr>
<tr>
<td>Complete Participation</td>
<td>“In the complete participation method, the ethnographer is or becomes a member of the group that is being studied. Spradley is referring a temporary event in which the researcher suspends other roles to entirely integrate with the group but continues to record observations in field notes” (pp. 20-21).</td>
</tr>
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</table>

In this research, the researcher places the method she follows somewhere between active participation and complete participation. The researcher sits in the living room while the children playing Supaplex, and helps them to figure out how to solve difficult parts in Supaplex. Moreover, the researcher sometimes achieves some levels instead of the kids if they ask for it. The participants were always aware of that the researcher is sitting just next to them, observing them, taking notes about them, helping them, or even joins daily activities (such as playing other games, doing Turkish homeworks, learning how to write in Swedish, etc.) with them.

3.4 Interview Modeling

To measure the entertaining effect of Supaplex, the researcher asked unstructured informal questions to both the mother and the children and observed the children’s enthusiasm for Supaplex during the playtests instead of having a questionnaire with children. Besides this, the researcher was quite rigorous about the issue that for having conversations only the time when the children were focused on playing Supaplex in their everyday life in their own house. Thus, the play tactics developed by the children would have come into view (Kallio, 2008). On the other hand, the researcher observed the kid’s evolution of the change of interest through to Supaplex and the moments they mention on Supaplex during their daily activities; such as, while they are having the dinner or while going to the supermarket with the researcher.

The researcher was fairly sensitive about getting more information from the children during the gameplay sessions and was followed the patterns stated by DeWalt & DeWalt (2002) about asking questions in interview, which are given below:
“The ‘tell me more’ questions is as simple as saying ‘Then what happened?’, ‘What did you do, then?’ ‘What else?’ and ‘That’s interesting, tell me more.’ It is one step beyond the ‘uh-huh’ prompt. The goal is the prompt the informant to continue with the same issue, not to introduce a new topic. In a slightly different form it is the ‘What did you think about that?’ question. The ‘tell me more’ question is short, succinct, and is generally followed by the use of silence. [...] (Clarification) Questions are used to clarify words, ideas, chronologies, in short, anything that the researcher does not understand. Early in fieldwork, many things may need to clarification. Actually, it is probably a good idea early in fieldwork to avoid asking for too much clarification. Asking for clarification breaks the flow of conversation and can end up in changing topics. Many things that are unclear or not entirely understood early in fieldwork will probably become clear just through experience. [...] A common problem for most people is that they become overzealous in trying to demonstrate their competence in their own cultural setting or in a different cultural setting. Rather than asking questions, these people make statements and then ask the person being interviewed for confirmation (naive questions). Thus they say, ‘People here make their living from farming, don’t they?’ or ‘Everyone here is Catholic, right?’”

(pp. 132-133).

As a result of being someone who does not know the special language the children use in their daily activities with each other, the researcher sometimes asked for clarification from the statements which were referred by the children while playing Supaplex. The age and generation gap between the researcher and the participants occasionally caused some misunderstandings. Therefore, the researcher asked the children to be more clear about what they are talking. On the other hand, the researcher mostly included naive questions into conversations with the children such as; "You are having fun while playing Supaplex, aren’t you?”, or "Achieving a level makes you happy, isn’t it?”

3.5 Method

In this paper, the researcher carried an ethnographic case study to examine how Supaplex affects the development of logical thinking in primary school children who have never played this game before. The methods used throughout the case study has given below:

- Pre-tests to evaluate the volunteer's condition in the very first place,
- Post-tests to evaluate the volunteer’s condition after the gameplay sessions,
- Participant observation protocols,
- Video and audio records of the gameplay sessions,
- And unstructured and informal interviews (conversations) with the participants.

This paper researches on that to reveal the educational aspects of an old video-game Supaplex (Figure 2) and how these aspects can affect the primary school children's development of logical thinking. To that aim, the research employs case studies to examine the long-term effects of Supaplex when kids playing this game as a spare-time activity in their homes. For this case study, the researcher collaborated with an immigrant Turkish family with 8-year-old triplets who lives in Sweden for almost 6 years. The mother is working as a freelance beautician from their home, and the father is working as a grill chef at a restaurant. When we examine this family from a perspective of their social-economic situation, they have lower standards than an average Swedish family. According to OECD data, the GDP (Gross Domestic Product) per capita of Sweden is $50,090 in 2017 and the family's annual income equals to $34,000 for the same year.
Since the researcher knows personally this family for a while before this research, the kids were already socialized with the researcher. For the kids, the researcher in a place who mostly comes to their house with presents and joy.

### 3.5.1 Supaplex

Supaplex (Figure 3) has been chosen for this dissertation for the following reasons; the last version of the original Supaplex was released on 1991 for MS-DOS and Amiga, therefore Supaplex could not be randomly discoverable by today’s children. Secondly, the levels are not only getting harder throughout the game, Supaplex’s game mechanics are also changing level by level. For instance, before the level 21 (Level name: Gravity), player do not have to deal with Supaplex’s universe’s physical rules. However, on the 21st level, a brand new game mechanic shows up and the player has to consider about gravity during the gameplay. Thirdly, Supaplex is not customizable. Therefore, players have to abide by the given objects and the rules. And the fourth and the last reason is Supaplex cannot be finished by an 8-year-old child in that time scale, because Supaplex has 111 levels and it is quite difficult to finish all of them in 5 months. This indicator shows that Supaplex is a suitable game for this type of long period researches.

![Figure 3. Supaplex, the “Cast”.](image)

Besides the reasons given above, there is a very limited number of research papers that used Supaplex as a research material. One of them is a case study which employed in one of the private elementary school in Turkey by Bakar et al in 2005. They have been used Supaplex and other seven different games for analysing and determining the interaction patterns among the primary school students while they were playing computer games (Bakar et al., 2006). Bakar et al. conducted a case study which took 12 weeks carries with 10 students (4 girls and 6 boys) between the ages 7 and 8. In the results, Bakar showed that Supaplex was mostly played by the boys instead of the girls during the case study.

In this research, the children had the clues about Supaplex's edutainment side, but this situation has never been entirely reflected by the researcher when they are playing it. Since the children already took the pre-test that contains mathematics questions, they easily might
be thought Supaplex is an educational game which aims to improve logical thinking skills. In addition, the researcher asked random questions about whether Supaplex's narrative connoted to them as a math problem during the gameplay sessions. For this reason, throughout this period the children had always the clues show "you are playing something about mathematics". Indeed, we can conduct the connection between player's enthusiasm and whether be playing a game just for entertainment or be playing a game knowing it is something about training mathematics.

3.5.2 PISA Tests, Sudoku and Tangram Puzzles

Originally, PISA Tests' aim described by OECD as: "The Programme for International Student Assessment (PISA) is a triennial international survey which aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students". In other words, these PISA Tests are preparing for evaluating teenage children's scientific knowledge and logical thinking capacity. It means that these tests consist of questions are not kind of type that can be learned at school by an 8-year-old child. Therefore in this research, the participated children answered PISA Test questions by only using their logical thinking and problem-solving skills, without any knowledge of high school mathematics.

Before and after the case studies, the selected mathematics questions from OECD'S PISA (Programme for International Student Assessment, years between 2006 and 2012) items which have identified as suitable for 8-year-old children by the researcher have been used in pre and post tests as a tool for evaluation of the child's development throughout the gameplay sessions. Table 2 shows the questions which have been selected. On the pretest, the researcher had kept the record of how many questions out of 13 have been solved successfully by each child for making a comparison to check if there is any improvement at the end of the research. On the posttest, these same 13 questions have been solved by the children to observe the development of their logical thinking and problem-solving skills. Each child's post-test results were compared with exactly the same child's pre-test results for all of the evaluation methods which have been used throughout the case study including the PISA tests. PISA tests' worldwide ranking methods were not used for interpreting the children's pre-test and post-test results. Besides the PISA questions, Sudoku and Tangram puzzles had been used to measure and evaluate Supaplex' effects.
Table 2. PISA Questions which have been selected from PISA 2012 and PISA 2006 Released Items for using in pre-test and post-test.

<table>
<thead>
<tr>
<th>Question Name</th>
<th>Source</th>
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<tbody>
<tr>
<td>Charts</td>
<td>PISA 2012 Main Survey Items, pp.9-11.</td>
</tr>
<tr>
<td>Sauce; Question 1</td>
<td>PISA 2012 Main Survey Items, p.16.</td>
</tr>
<tr>
<td>Ferris Wheel</td>
<td>PISA 2012 Main Survey Items, pp.17-18.</td>
</tr>
<tr>
<td>Garage; Question 1</td>
<td>PISA 2012 Main Survey Items, p.29.</td>
</tr>
<tr>
<td>Memory Stick</td>
<td>PISA 2012 Field Trial Items, pp.36-40.</td>
</tr>
<tr>
<td>MP3 Players</td>
<td>PISA 2012 Field Trial Items, pp.51-53.</td>
</tr>
<tr>
<td>A Construction with Dice; Question 1</td>
<td>PISA 2012 Field Trial Items, pp.64-65.</td>
</tr>
<tr>
<td>Holiday Apartment</td>
<td>PISA 2012 Field Trial Items, pp.66-69.</td>
</tr>
<tr>
<td>Car Drive</td>
<td>PISA 2006 Items, pp.80-82.</td>
</tr>
<tr>
<td>Height</td>
<td>PISA 2006 Items, pp.83-84.</td>
</tr>
<tr>
<td>Making a Booklet; Question 1</td>
<td>PISA 2006 Items, pp.85-86.</td>
</tr>
<tr>
<td>Seeing The Tower; Question 1</td>
<td>PISA 2006 Items, pp.90-91.</td>
</tr>
</tbody>
</table>

One of the reasons for choosing Sudoku puzzles as an evaluation device for this research is that it was an unknown puzzle for all of the participated children. According to the records from the conversations with the children and the mother, they have encountered Sudoku puzzles only once before they took the pre-tests. Besides this, they have not solved any Sudoku puzzles throughout the research period as they mentioned. The second and main reason for choosing Sudoku is that, Sudoku has been defined as a helpful device to develop players logical reasoning skills (Baek, Kim, Yun, & Cheong, 2008; Mepham, 2005). A typical Sudoku has 9x9 grid, and these grids had been divided into 9 piece of small 3x3 grids which some of those grids filled by numbers according to its difficulty level. According to Sun et al. (2011), “Players must use a divergent thinking approach to identify possible solutions, and a convergent thinking approach to select the best one” (p. 2119). The examples of Sudoku puzzles have been found from a website called www.sudokukingdom.com (Figure 4). Each Sudoku puzzles were on a 9x9 grid and each one of them had 30 given numbers as initial. The researcher has kept the record of how many numbers were entered successfully by each child on grids to create an improvement chart of the children.
The last procedure used as an evaluation method was Tangram puzzles which are an unknown puzzle for the participated children. According to Kamii et al. (2001): “Tangram puzzles encourage children to solve the problem with the geometrical objects; thus, Tangrams can be very useful for spatial reasoning” (p. 23). Hence, Tangram puzzles have been used as an evaluation method for this case study. Tangram puzzle examples have been found from The Scottish Science and Technology Roadshow’s (SCI-FUN) website (Figure 5). Additionally, the researcher has kept the record of how many tangram puzzles by each child tried to solve, and how many of them they were solved successfully. The results were used as a monitoring reference as the Sudoku puzzles.

During the case studies, the researcher collaborated with an immigrant Turkish family who lives in Sweden with their three 8-year-old male children shown in Table 3. The children’s native languages are Swedish and Turkish. Since the researcher’s native language is Turkish, PISA tests have been taken in Turkish. On the other hand, the children are going to a Swedish public primary school. Consequently, their Turkish knowledge does not enough to read properly for understanding the questions. Hence, the researcher helped them out while they were taking the tests to make them understand the questions better.
### Table 3. Their mother’s impressions about the children.

<table>
<thead>
<tr>
<th>Child</th>
<th>Age</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child1</td>
<td>8-year-old</td>
<td>Good at playing football, chess and other board games.</td>
</tr>
<tr>
<td>Child2</td>
<td>8-year-old</td>
<td>Cerebral palsy patient. Has concentration problems. Good at understanding game mechanics.</td>
</tr>
<tr>
<td>Child3</td>
<td>8-year-old</td>
<td>Good at mathematics, digital games and electronic devices.</td>
</tr>
</tbody>
</table>

The children's took the tests separately in their own houses' kitchen without having any interaction except the researcher and their mother. Pre-test took approximately 1 hour (less than half an hour for PISA questions, more than half an hour for Sudoku and Tangram puzzles). The children's answers to the PISA questions have been measured by considered their approaches and problem-solving techniques to the questions. Although the children did not give the correct answer for a problem, if their approaches were suitable for the question, then this situation counted as a positive score for the test. For the Sudoku tests, even if the children could not fill all of the grids correctly in Sudoku puzzles, their records have been kept as "number of given figures-number of correct answers-number of wrong answers". For the Tangram tests, the number of Tangram puzzles which were successfully solved by children has been kept for each child individually. In other words, we can divide the evaluation criteria for this case study into four stages:

1. Compare each child individually between his own pre and post test results.
2. Be aware of the evolution of their problem solving skills.
3. Be aware of the evolution of the ways they approach a problem.
4. Be aware of their mental and physical development during these five months.

The researcher guided the children during the pre and post-tests. She helped them out equally to make them understand and interpret the tests better. These tests were not used to place a child into a category or a worldwide ranking list. The PISA test, Sudoku, and Tangram puzzles were only used for observing and evaluating the child's logical development individually. The test results were not compared between participants.

During the case study, the children's mother was in charge to control the time when the kids were allowed to play. The researcher prepared a Lenovo T60 ThinkPad laptop with Windows 7 Home Premium operating system for the kids with having a bunch of protection; such as creating a Guest account on Windows, disabling the internet connection, setting the players in Supaplex individually, etc. The kids have shared this laptop in the gameplay sessions, which is also the one and only computer at their home. The only third-party software which used in this research was DOSBox emulator for running Supaplex properly. On the other hand, DOSBox increases any DOS game’s speed at least two times. The player list has been set as "Child1's name, Child2's name and Child3's name" in Supaplex, thus the researcher can monitor how many hours each child spent with playing this game.

### 3.6 Ethical Considerations

Gameplay sessions were conducted by the researcher at least one time in a month. In order to not to disrupt home's natural balance, the researcher leaves the decision making of "start or end time of the gameplay sessions" to mother; since the children accept their mother as a "natural authority" at home. Gameplay sessions started when the mother allowed the children to play Supaplex; and terminated whenever she wanted. Furthermore, even the mother let them play Supaplex if a child is not want to play it; then, according to Declaration
of Helsinki, the researcher or the mother was not able to insist for making the child play Supaplex.

During the pre-test and post-test, participants have right to reject to take the test and/or have right to terminate the test sessions anytime they want. According to parents permission letter; the researcher obliges to share the notes about the children that have been taken by her during the gameplay sessions, and the pre-test and post-test results to the parents if they want. Besides this, the researcher guarantees that any kind of media records (audio, video, photograph) would not be shared with the third parties including this paper.

3.7 Limitations

In this case study, the researcher ran into some problems and these problems pushed her to draw a border to the survey. The very first problem the researcher tried to overcome was the lack of communication between her and the children. The researcher is a Turkish student in a Swedish university -who is one quite new for Sweden and Swedish language-, and the children worked with are ethnically Turkish, yet they are living in Sweden since they were 3-year-old. Therefore, their native language is originally Swedish. The children are talking in Turkish only with the researcher, their parents and some of their elderly relatives who’s Swedish knowledge does not enough to make a good conversation. When the siblings talk to each other, they prefer to talk in Swedish generally. For this reason, the researcher sometimes had hard times while trying to catch up what the siblings talking with each other during the gameplay sessions.

Secondly, carrying an ethnographic case study at children’s home sometimes caused unforeseen problems. For example, the mother is working as a freelance beautician and she hosts her customers at their home. This situation causes a crowded and noisy environment and interruptible gameplay sessions. Although the researcher classified this unique condition as a "problem", this situation provided her to observe their natural playing environment perfectly. Because, having stranger people at home all the time is a pretty ordinary situation for the participants, and this is an unusual circumstance for many people.

The third reason the researcher might specify as a "problem" is, she already had known this family due to her personal relationships. Under this circumstances, the researcher had some question marks about the pre and post test results throughout the survey. Because, the fact that kids have known the researcher might cause an untrustworthy research data. The kids may try to influence the researcher on the gameplay sessions and may get stressed, and they could have conditioned themselves as "I have to be successful at Supaplex". Whereas, the children did not try to impress the researcher. It is thought to be the reason that the gameplay sessions took approximately five months. During this period, the children just forgot about the pre-tests; and playing Supaplex had turned into a fun activity with their "big sister Kübra". Therefore, the researcher did not feel uneasy about this situation too much and she mainly focused on their playing habits.

The fourth problem was the family were not available for every weekend. For example, after the first two sessions, one of their relatives started to stay at their home with his wife. Consequently, the researcher was not able to stay at the family’s house and to spend the entire weekend with the children. On the other hand, the researcher strived to conduct at least one gameplay session for every single month.

The fifth limitation has unexpectedly occurred during the gameplay sessions. Sweden's weather conditions become much better after March, thus the participated children mostly prefer to go out and play outside with their neighbors' children who are almost at the same age as them than staying at home during the sunny days. Therefore, the researcher was obliged to terminate last two gameplay sessions earlier than the expected time schedule.
3.8 Observation Protocol

The observation protocol followed in this case study has been declared in the following part:

1. The fact of recording (video or audio) only significant and unique happenings in the gameplay sessions (except the last one) might be affected the children's attitude to being recorded.

2. In the first gameplay session, the researcher saw Child3 was searching Supaplex videos on Youtube to figure out how to solve when they stuck on a level. To prevent the odds towards the case study, the researcher forbade to children to watch Supaplex videos on Youtube.

3. The fact of being someone who is already known by the participants might be changed the children's attitude to gameplay sessions and tests.

4. In the gameplay sessions, naive questions were asked according to measure the children's interest and thoughts towards Supaplex.

5. Although a bunch of precautions was taken in terms of minimizing the impact of the researcher, it was pretty hard to control every single interaction between the children and the researcher. For instance, in the first gameplay session, Child1 was very impressed with the way of how the researcher plays Supaplex (5.6.4 Fast Fingers). In the following sessions, Child1 turned his impression into a challenge: being able to play Supaplex as fast as he can.

6. The researcher got very hard times when she was writing down her observations in gameplay sessions. Because time to time, the children asked about what she was writing about. The researcher explained to children about why she is writing down and what she is writing about. Which are:
   a. What do they do in one day?
   b. How do they play Supaplex?
   c. What are they looking for in games?
   d. How do they interpret the games?
   e. Significant happenings when they are playing Supaplex.

7. These children are only 8-year-olds and for this five months, they developed mentally and physically, which can be also observed visibly. In terms of prevent to affect this case study, PISA questions were determined as the main evaluation instrument.
4 Results

In this section, the results of the pre-tests and post-tests which held with the children will be present.

The pre-tests were performed in children's own houses on the 9th of December 2017, and post-tests were held in 5th of May 2018 at the same place. The pre-test was held right before starting the first gameplay session, and the post-test was held a couple of hours later from the last gameplay session.

Since the children's Turkish language knowledge was not enough to understand the questions, the researcher was stood as a guide for the PISA test. In the pre-test, the following questions for PISA test had skipped due to communication problems caused by language difference between children and the researcher: Sauce, MP3 Players, Holiday Apartment, Height, Making a Booklet. In the post-test the researcher found a way to interpret the "Sauce" and "MP3 Players" questions; however the questions "Holiday Apartment", "Height", and "Making a Booklet" could not be interpreted into a question which is understandable for an 8-year-old child with limited language knowledge. Hence, those three questions were skipped by the researcher in the post-test for every child.

Table 4 and Table 5 show the duration comparison between pre and post-tests. In the pre-test, the researcher did not use a chronometer to calculate the exact duration spent by children for each test. Nevertheless, the researcher logged the approximate duration of each child's spent on the tests. In the post-test, the researcher used her personal smartphone to measure the total time to compare each child's progress individually.

Table 4. Pre-test duration comparison

<table>
<thead>
<tr>
<th>Pre-test duration comparison</th>
<th>PISA</th>
<th>TANGRAM</th>
<th>SUDOKU</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child1</td>
<td>~25-30 minutes</td>
<td>~25 minutes</td>
<td>~15 minutes</td>
<td>~70 minutes</td>
</tr>
<tr>
<td>Child2*</td>
<td>NULL</td>
<td>NULL</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td>Child3</td>
<td>~25-30 minutes</td>
<td>~10 minutes</td>
<td>~10 minutes</td>
<td>~50 minutes</td>
</tr>
</tbody>
</table>

*He did not want to take the pre-test.

Table 5. Post-test duration comparison

<table>
<thead>
<tr>
<th>Post-test duration comparison</th>
<th>PISA</th>
<th>TANGRAM</th>
<th>SUDOKU</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child1</td>
<td>0:53:00</td>
<td>0:19:00</td>
<td>0:48:00</td>
<td>120 minutes</td>
</tr>
<tr>
<td>Child2</td>
<td>0:26:00</td>
<td>0:04:00</td>
<td>0:05:00</td>
<td>35 minutes</td>
</tr>
<tr>
<td>Child3</td>
<td>0:49:00</td>
<td>0:03:00</td>
<td>0:08:00</td>
<td>60 minutes</td>
</tr>
</tbody>
</table>

From the Table 5, you can see each child's concentration progress towards mathematics problems in PISA Test from the difference between the total time spent on pre-test and post-test. Each child's development will examine individually in the following sections.
4.1 Child1
In the pre-test, Child1 answered 9.5 questions correctly out of 26 questions in the PISA test. In the post-test, he increased this results up to 15.5 questions out of 26. For Sudoku puzzles, in the pre-test Child1 filled only 8 grids (6 correct, 2 wrong). However, in the post-test, he filled 28 grids (15 correct, 13 wrong) in more than 45 minutes with full concentration. When it comes to Tangram puzzles, he was more like willing to solve them in the pre-test. He tried to solve 14 puzzles out of 28, and he solved 2 of them correctly. On the other hand, in the post-test, he was quite exhausted and he would like to skip the Tangram puzzle test. Nevertheless, he tried to solve 7 out of 28 puzzles, and he solved 1 of them correctly.

4.2 Child2
As his mother mentioned before he took the pre-test, Child2 has no self-confidence about himself when it comes to mathematics and subjects that challenge him and push for brainstorming. She suggested that not to force Child2 to solve Sudoku puzzles or solve PISA questions which are already not suitable for his age group. But still, the researcher asked Child2 for if he wants to take the tests. In fact, the researcher said that she will not grade him and even she will help him to solve the questions, yet he did not accept to take the pre-test.

In the last gameplay session, while all of the participant children were sitting at the living room together with the researcher, she mentioned about that this gameplay session is the final one, and they are going to take the post-test at that day after playing Supaplex. Right after she mentioned about the post-test, the following conversation has taken place with the researcher and Child2 (translated from Turkish):

Child2: “Are you going to do a test to us?”
Kübra: “Yes, the one exactly the same that I have done before. Mathematics –...”
Child2: “Before?”
Kübra: “Ohh yes, you haven’t done it. You did not want to try at that time.”
Child2: “I want to do it this time!”

(Gameplay session 7; May 5, 2018)

From the dialogue with the researcher and Child2 that mentioned above, we can inference that he was willing to solve the mathematics questions which are he was afraid of formerly, and also he was seemed very enthusiast towards to something which will challenge him.

In the post-test, Child2 answered 11.5 questions correctly out of 26 in PISA test. For Sudoku puzzles, he could not understand the Sudoku concept, therefore he filled only 1 grid correctly. In Tangram puzzles he tried to solve 2 of them, but he got bored very quickly and terminated the post-test session.

4.3 Child3
In the pre-test, Child 3 answered 8.5 questions correctly out of 26 in the PISA test. In the post-test, he answered 14 of those PISA questions correctly. In the pre-test, he was pretty regardless towards to Sudoku puzzle and he was filled all of the grids randomly. On the other hand, in the post-test, he actually tried to solve the Sudoku puzzle and he could fill only 22 grids (6 correct, 16 wrong). Child3 was tried to solve only 3 out of 28 Tangram puzzles in both tests, however, he only solved 1 of those correctly in the pre-test.
5 Findings

5.1 Family Life

Child1
Child1 is an 8-year-old male Turkish child, who is living in Sweden for 5 years. He can speak Swedish and Turkish very well by considering his age. He is quite helpful and sensitive towards to his mother and his brothers. He likes to play football. Indeed, he is a very promising player at his school’s football team. He wants to be a professional football player and his parents are supporting Child1 about his career dreams.

Child2
The Child2 is an 8-year-old male Turkish child with cerebral palsy, who is living in Sweden for 5 years. He can speak Swedish (fluently), Turkish (moderate), English (beginner) and Kurdish (beginner). His vocabulary knowledge in the Turkish language is not good enough to make an effective conversation. Therefore, he used his brothers as an interpreter from time to time during the gameplay sessions. Due to his developmental disability; he is not able to walk and to use his fingers effectively. He tends to pretend crying when his requests denied by his brothers or his mother or others; for example (translated from Turkish):

Child1: "[Playing Supaplex]"
Child2: "Mama! I want to play Supaplex!"
Mother: "But now it’s your brother’s turn."
Child1: "You can play after I die."
Child2: "[Pretends like he's crying]"
Mother: "Okay. Okay. [Talks with Child1] Just let him play for this time, your brother really wants to play it. You can continue playing after he [Child2] plays."
Child2: "[Stops pretending like he’s crying and starts to play Supaplex]"

(Gameplay session 5; March 24, 2018)

Another example of this situation has happened after the second gameplay session. The mother’s older brother and his sons came by for dinner and the following conversation took place between the Child2 and his uncle (translated from Turkish):

Uncle: "Come on Child2, we want to watch Şevkat Yerimdar (TV series, Turkey, 2018)"
Child2: "Noooo! [crying]"
Uncle: "But we all want to watch Şevkat, just give the remote controller to me."
Child2: "[Holds the remote controller and cries more loudly] Mam-maaa! Come!"
Uncle: “Come on! We have democracy in here and we all want to watch Şevkat except you. We did not say anything when you were watching music [videos]. Now it’s our turn. Give that remote controller to me!”
Child2: “[Shouts and cries]"
Uncle: “Oh, come on!”
Mother: “[The mother comes in and whispers to Child2’s ear. She tries to convince him to let them watch Şevkat Yerimdar]”

[After a few minutes, Child2 calms down and gives the remote controller to his uncle.]

(Gameplay session 2; January 27, 2018)

Child2 has a special interest in cars and anything related to cars. According to the researcher’s observation notes, he skips music and game videos in less than 30 seconds on Youtube, but when a video which something about cars appears, he likes to watch it until the video ends. Additionally, he really loves to talk about cars either. He knows most of the brands and models. The following (represented) conversation has occurred multiple times*:

Child2: “Kübra abla [tr., big sister]...”
Kübra: “Yes...”
Child2: “Can I ask you something?”
Kübra: “Of course. What?”
Child2: “Do you have a car?”
Kübra: “Yes, but it is not here.”
Child2: “Which brand?”
Kübra: “It’s an Alfa Romeo.”
Child2: “Which one?”
Kübra: “Giulietta.”
Child2: “What color?”
Kübra: “It’s black.”
Child2: “Is it a cabrio?”
Kübra: “No, it is not.”
Child2: “Is it automatic?”
Kübra: “No, it has a manual gearbox.”

* The similar dialogues between Child2 and the researcher have occurred in almost every gameplay session.

Child3

The Child3 is an 8-year-old male Turkish child, who can speak Swedish quite fluently. He has the same problem as Child2 about insufficient vocabulary knowledge in the Turkish language. If we compare with his other brothers, he is the most competitive one when it comes to games. An example that shows his impatience and the competitive side of Child3’s has occurred right after Child2 took the PISA test in post-test, while he was still sitting in the kitchen right about to start the next test:

Child3: “[comes into the kitchen] Kübra abla [tr., big sister], How many did Child1 solved from these [points at the Child1’s post-test papers]? The one that I did too.”
Kübra: “Which one? Sudoku?”

Child3: “No no. The one like a notebook [PISA Tests were consist of more than one paper, therefore he described it as a notebook].”

Kübra: “A-ha, Okay I get it. I’ll tell you the results later. I’m not one hundred percent sure right now, I’m gonna check them out when I get home. I’ll call your mother and tell how many correct answers you have, Okay?”

Child3: “[Waits for a while] No... Child1's notebook... The one like you gave me... Where is it?”

Kübra: “It’s here [points at the papers] but I cannot give it to you right now.”

Child3: “[He starts to search for the Child1’s PISA Test on the table] Where is it? Where is it?”

Kübra: “[Gives Child1’s PISA Test papers] Okay, here you are.”

Child3: “Can you tell me how many [questions] did he solve?”

Kübra: “I’ll tell you after I get home. I’ll check how many of them are correct and I’ll send an e-mail to your mother about it, Okay? Then you can learn how many [questions] did Child1 solved correctly. Okay?”

Child3: “Okay.”

(Gameplay session 7, Post-test; May 5, 2018)

5.2 Children’s Natural Environment

These children's media habits are quite different when we compare today's Swedish children's media habits. Since they had some technical problems, the family could not connect a Wi-Fi modem to their house. The only electronic device with an unlimited Internet access is the television in their living room. When they moved into their house, they accidentally cause to cut the ethernet cable too short by the technician. Therefore, the ethernet cable is now only as long as enough for the television. This situation caused to develop considerably different media habits by the children. For example, these children have no laptops, no iPads, no smartphones, no Xbox's, or no PlayStation's. These children have only a 3-year-old Samsung Smart Television. Besides this, their parents also think that it is still too soon to buy them a computer, or a smartphone or any other technologic device. Their parents usually have to keep in touch with their customers, thus the children have access to their father's or mother's smartphone quite hardly, and they are not always allowed to use their parent's smartphones.

If we compare this attitude to a ordinary Swedish family's behaviours towards to let their children own technological devices, we can say that it is not a rare manner according to a survey (Figure 6) conducted in 2016 45% of 8-year-old children who lives in Sweden has no smartphone. However, this survey does not includes a research about children's ownership of any other technological devices besides smartphones; such as tablets, Playstation or Xbox, etc..
The children’s room (Figure 7, right) contains a bunk bed for Child1 and Child3, and a single bed for Child2. There is not enough space for playing games or studying in the room. The children are usually spending time in the living room (Figure 7, left) altogether by watching television or playing online games or doing their homework. In the living room, there is a big couch with a short coffee table which is placed right in front of it. The children use the coffee table as a desk when they do homework. When we examine their living area, the furniture are not comfortable or adequate for kids because there is only one child-seat in the living room which is mostly reserved for Child2 who’s a CP patient. When they are playing Supaplex from the laptop placed on the coffee table, they generally have to sit on the ground or sit on the couch in a position that may hurt their back. Child2 has to do his daily exercise with an assistive device for his disease, and this process takes more than an hour. His mother sets up the device right in the middle of the living room, therefore Child2 never felt bored because he can watch TV while he is exercising.

5.3 Children's playing habits and their first impressions about Supaplex

After the pre-tests, the researcher allowed children to play Supaplex in the living room together to observe their first impressions of the game. Since Child2 doesn’t able to use his hands efficiently, his brothers helped him to play the game. Child1 and Child3 used the keyboard and play the game instead of Child2. Child2 gave directions to his brothers while they were playing; such as up, down, left, right, push that ball, etc. Child1 and Child3 were the first ones to try the game. The researcher gave a mini-tutorial about the home page; such as how they can change the player, how can they skip a level, where to see their total hours of playing, etc. Child1 and Child3 figured out how to play the game itself without researchers’ guidance. Child3 asked if the researcher has another game because after a couple of minutes he said Supaplex is fairly difficult to play, and he decided that he cannot play it anymore. But
the researcher informed him that Supaplex is the one and only game she has; thus, Child3 had convinced and he started to play Supaplex again. After 30 seconds of playing experience, Child1's first comment of the game was "It's very hard, I can't play this game!". It took more than 15 minutes for him to get used to every single mechanic within the game. He decided to explore every item in Supaplex, for example, he got together the "Zonk"s in the first level like the representation in Figure 8. According to teachers, educational games’ un-related mechanics conflicts with their educational purposes and affects negatively to the children (Marklund & Alklind Taylor, 2016). Supaplex may prevent this situation because Supaplex's all mechanics are related to the entire puzzle itself. Therefore, players have to solve another puzzle to get all "Zonk"s together, or to think about the "Electron"s, "Snik Snak"s, and "Bug"s to eat all of the "Base"s in a level.

During the first playing session, Child1 and Child3 showed the ways how they escaped from the balls and get an "Inforton" to each other. Child3 completed the first level in 14 minutes. Child1 completed the same level in 35 minutes. Both Child1 and Child3 got quite excited when they saw how the story, game mechanics, and the design has changed level by level in the game. This situation led them all to play more to unlock the other levels.

Supaplex was released only in English. During the gameplay sessions, some accidents happened which caused by Supaplex's native language. For instance, Child3 accidentally deleted his player information from Supaplex when he tried to skip a level he didn't want to play anymore. He accidentally pressed "Delete Player" button, which is right above the "Skip Level" button and since he can not be understood what is written in the message line, he just pressed "OK" button and assuming he is just skipping a level (Figure 9). Fortunately, the researcher was there while his name was deleting. Thus, the deleted time manually added to Child3's gameplay time information after every gameplay session to researcher's data.

![Figure 8. Child1 got all of the "Zonk"s together in the first level (simulated figure).](image)

![Figure 9. The control buttons (on the left) and the "message line" (on the right) in Supaplex' main menu.](image)
In Supaplex, Murphy (the main character) is having interaction (Figure 10) with the player himself. It looks very excited when the player keeps playing. If the player stops to play Supaplex, then Murphy looks upset and depressed. If the player does not play the level more than one minute, then Murphy starts to sleep. Some of the times, the children stop playing to observe Murphy’s gestures. In the first time the children realized that Murphy tries to have interaction with them, then this situation made them think they become "Murphy" itself; they became more engaged to Supaplex.

![Figure 10. Murphy's moods/gestures.](image)

5.4 The evolution of children's playing habits and their approach to Supaplex throughout the time

From the very beginning, Child1 and Child3 were more into to discover the new mechanics and focus on to solve the puzzle. They both mostly followed a path to complete a level successfully. Child1 and Child3 were more tend to play Supaplex in accordance with the basic rules. However, Child2 was playing Supaplex in a way that makes no sense to no one except him. In the first gameplay sessions, I did not understand his approach to the game. One day, a remarkable event happened:

“Today, Child2's attitude towards to the scissors (*Snik Snak*) and his concentration through to achieve one single challenge (passing smoothly through between the scissors) made me understand that children (players) can make their own versions while they are playing a game. Children (players) re-adapt the games' dynamics and create new variations by combining different un-related challenges. For example, here, Child2 has no necessity to pass very carefully between those scissors, because it's irrelevant for the main goal (Figure 11). The only aim is to gather a certain number of *Infortons* and reach the *Exit*. But he just wanted to achieve a 'challenge' or a 'task' which created by himself. I thought he did not understand the game completely or how to play it... However, he plays the game in his own way. Sometimes he does not interested in a game's main goal, thus he prefers to interpret the game's dynamics and play it in his way with full concentration.”

(Notes from the 4th Gameplay session; March 10, 2018)
This situation triggered me to think about how did I ignore Child2's needs and misunderstand his way to enjoy a game. Child2 is suffering from CP and he won't be able to use his fingers probably for the rest of his life. Therefore, he likely to develop new approaches when he met a new game and play it in his own way.

A child can have fun from a game just using his/her creativity instead of using the given rules that established by the game designers. If a game can give the maximum flexibility to the player to interpret the game entirely, then it would be the best game to reflect a child's way of thinking.

5.5 Supaplex and Mathematics

Throughout the case study, the researcher searches the moments that if one of the children able to figure out the connection between Supaplex and mathematics. Child1 was the one who achieved this first. Creating geometric shapes with bases, counting the balls, and solving a level by thinking out loud were the first clues for Child1. In the following part, some of the examples from observation protocol has been given place.

On the 6th gameplay session, Child1 was playing the level called Anonymous (Level 13) with full concentration and suddenly he stopped and turned to the researcher and said:

Child1: “Hey, look! I made stairs!” (Figure 12)

Kübra: “Oh, wow!”

Child1: “[After a couple of seconds] I like this ones... the ones that I like [the levels] 13, 14, 15, 8, 4. I am very good [at that levels]. I love the ones that makes me go go go go... [he was trying to explain that he likes the levels which has more longer paths and with lots of infortons in it]”

(Gameplay session 6; April 14, 2018)

After a while, Child1 called the researcher to show how he placed the Zonks (grey balls) equally in a shape of triangles. Before he pushed the last ball, he counted the balls on each side and decided to push it to the right side (Figure 13).
Child1: “I won! I passed this part too!”
Kübra: “Oh! That’s great!”
Child1: “Woow! Did you see that? I escaped in the last minute!”
Kübra: “Yeah! You are going so good.”
Child1: “Oh wait... How can I pass this part?”
Kübra: “OK, let’s think about it!”
Child1: “[Points at with his fingers] If I follow this path.. From here to there... And I will pass this part and get that (Inforton)... Or I will follow this path.. Down and right.. Oh wait.. Nooo, then I stuck myself (Murphy)! ”
Kübra: “Then do not follow that path.”
Child1: “[Decides which path he should take, and moves on]... [Stops suddenly] Noooo if I go down just one more time then this one [ball] will fall right over me (Murphy)! (Figure 14)

(Gameplay session 6; April 14, 2018)

5.6 Themes
In this section, has been given placed to the themes noticed by the researcher during the gameplay sessions.

5.6.1 Patience
According to my personal impressions during this five months, I could easily say Child2 and Child3 can be considered as impatient kids when we compare both of them to Child1. Child1 has a more compatible and understanding personality. He usually knows the times he needs to wait to get a response. Child2’s nature is very different, he wants instant responses from both humans and electronic devices. Otherwise, if the one he is waiting for a response is a
human, he keeps asking the questions again and again until he gets an exact and satisfying answer; if the one he is waiting for a response is a device; such as a computer, then he keeps pressing all of the buttons until he gets a response. Throughout this time, I could not see an improvement or a changing regarding Child2’s patience tolerance towards to Supaplex, humans or electronic devices.

Likewise, Child3 is as impatient as Child2 and it is hard to convince him to be calm when he is waiting for a response (Please see 5.1 Family Life; Child3). However, according to my observations; there is an improvement in his impatience while he was playing Supaplex. The changing regarding his impatience has begun on the 3rd gameplay session. One of the observation protocol, notes that:

“Child3 and Child1 are discussing the 9th level’s (Bug Funny) mechanics and how to achieve the level without getting "shocked" by the Bugs (New mechanic: Electric shock; Bug, Figure 15). I can barely understand what they are talking about (because they are talking in Swedish) but I know that they are brainstorming about the game. Child3 is playing the 9th level. He is keep going step by step to decrease the risk of being shocked by Bugs. He is planning to eat all of the green bases. It is too weird because Child3 is the most impatient one of these kids. He died once but he didn’t give up and tried again. He completed the 9th level in 20-25 minutes with reducing risk to %0 by eating all of the bases.”

(Notes from the 3rd Gameplay session; February 24, 2018)

The dialogue declared above gives us a clue that Supaplex taught Child3 to be calm and patient when it needed. On the other hand, in the next gameplay sessions, and in the post-test; the researcher noticed that Child3 has become more calm and careful when he does a task.

5.6.2 Competition
It was getting more obvious that Child3 is becoming more ambitious when there is something includes a contest as time goes by. The subject does not matter if there is a chance for him to defeat someone. He likes to watch his siblings when they play Supaplex, and he makes comments about how should they take action to pass the level/part successfully. While one of his siblings is playing Supaplex; even if Child3 is busy with something else if he hears about something in a conversation between the researcher and the player refers that one of his siblings achieves a level he could not achieve before; he instantly joins to that conversation. An example of this situation took place on the 4th gameplay session:

Child2: “Did I play very well?”
Kübra: “Yes, you played soooo well!”
Child3: “[In an extremely curious manner] Did he win or died?”
Child2: “I died.”

Kübra: “But he played very well. It was a tough level.”

(Gameplay session 4; March 10, 2018)

On the other hand, as I mentioned before, he really likes to be the one and only winning contestant in a game. However, this situation brings up some issues due to his personality. Child3 tends to disclaim his unsuccessfulness when he is not "the best" in a contest:

Child3: “What are these [points at the Rankings section]?”

Kübra: “Which ones? A-haa. That one sorts all of the players.”

Child1: “The one [top player] who plays better?”

Kübra: “Yeap. See, you can follow who is better now. On the top is Child1. The second one is Child3. The third one is Child2.”

Child1: “Am I the best one?!?”

Kübra: “Yes.”

Child3: “[In an evil mode] I’m gonna beat you!”

Child1: “Noooo! You cannot beat me! I’m playing with lots of techniques...”

Kübra: “A-ha. See, he has techniques. Do you have any techniques, Child3?”

Child1: “(In a spoiled attitude) No he-does-not-have-any!”

Child3: “It’s because I do not play too much...”

(Gameplay session 7; May 5, 2018)

But it shows that Child1 has played less than Child3 (Figure 16).

![Image](image.png)

**Figure 16.** Total playing hours of each child’s

### 5.6.3 Exploring New Game Mechanics and the Wow Effect

Supaplex does not introduce the entire game mechanics it has from the very first level. Instead of this, Supaplex following a path that uses its hidden game mechanics as a gift to unlock the remaining levels. Supaplex gives clues and spoilers about the upcoming levels to the player by presenting demos. Thus, Supaplex convinces the player to there are still lots of things to explore and be experienced.
According to average playing duration of each children, there is an incontrovertible increment (Figure 17 and Figure 18). The reason of this development is, after the second gameplay session the children kept playing Supaplex and unlocked the next levels which include a brand new game mechanic "Snik Snak" (the scissors). This new game mechanic got the children's interest easily. Moreover, the researcher mentioned on "Wow effect" in the observation protocol repeatedly. Besides exploring the new game mechanics, the participated children shows their interest into the next levels by "wowing" whenever the children encounter every level they unlocked. Every new level had makes the children more curious about the next ones.

**Figure 17.** The graphical representation of the change of each child's total playing hour per gameplay session. At first, they were discovered Supaplex. On the 2nd gameplay session, they stuck in some levels. On the 3rd gameplay session, they figured out how to solve the levels they were stuck, and also they unlocked new game mechanics. On the 4th gameplay session, the researcher had to terminate the session early. On the 5th gameplay session, they unlocked new levels and new mechanics. On the 6th and 7th gameplay sessions, the weather was quite good and the children wanted to play outside instead of playing Supaplex.

**Figure 18.** The graphical representation of the change of total playing hour after each gameplay session.

### 5.6.4 Fast Fingers

Being able to play in a way that they did not succeed before is making Supaplex more interesting in their standpoints. In the first gameplay session the researcher was noticed this fact by coincidence:

"In the very first gameplay session, the kids asked me to show how to run away from the balls without dying. They had kind of started to lose their enthusiasm towards to Supaplex, thus I decided to help them out. The fact that, I used to play Supaplex when I was a child; therefore, I am able to control Murphy quite fast. Child1 was shocked when he saw my fingers all moving very rapidly while I was playing. Then, "being able to move fingers as fast as possible" was became "a challenge" to them
(especially for Child1 and Child2). They were concentrated on both to solve the game and to move their fingers as fast as they can.”

(Notes from the 1st Gameplay Session; December 9, 2017)

Another example from the observation notes:

“Although it was hard for Child2 to move his fingers because of his disease, he tried hard to control Murphy much faster day by day. He mostly compares himself with me to see his progress. During the last game session, he asked me if he could use his fingers as well as I did. After he gets a “yes” as an answer, his enthusiast, and interest towards Supaplex were increased. For instance, his brothers wanted to go and play outside but he chose to stay at home and play Supaplex for one more hour.”

(Notes from the 7th Gameplay session; May 5, 2018)

5.6.5 Helping Each Other

From the very beginning, children tended to help each other even though they like to compete. Child1 and Child3 were helping Child2 while playing Supaplex most of the time because of Child2’s physical disability. Child1 and Child3 helped Child2 for the parts needed to quick moves in a level. Besides this, Child2 never hesitate to be the one who frequently needs help. As their mother mentions; helping each other is one of those children’s natural inner dynamic in daily activities; such as playing a game, doing homework, preparing a dish for Child2, etc..

Throughout this case study period, the researcher observed and noted “helping each other” occurrences at various time intervals on the observation protocol. For instance, one observation protocol notes that;

“Child1 and Child3 are discovering the game’s mechanics and dynamics together. Child3 helped Child1 in a part of the first level because he could not understand how he can pass through the other side without dropping the balls. But Child3 mentioned the ball’s dynamics and how the player can make them fall down and he helped Child1 to pass that part. They were talked these parts in Swedish, therefore I could not involved the dialogue between them. But after a while, they translated to me what they were talked about.”

(Notes from the 1st Gameplay Session; December 9, 2017)

Besides this, the children frequently asked for help from the researcher herself too. When they were stuck in a part, or could not solve how to eat one specific Inforton, they were asked help from the researcher to pass that specific part or the entire level itself (when they thought the level is too hard to achieve by themselves). When it comes to achieving a level for one child, on behalf of keeping up the equality between the siblings the researcher helped all of the children to pass that level. For instance, one observation protocol notes that;

“The children were tried to complete the 4th level by collecting all of the Infortons. However, it is practically not necessary because, in that level, there is more Infortons than it needed to be collected. Unfortunately, the children did not notice the Inforton counter right on the right-bottom side. Therefore, they kept try and try until collecting all of the Infortons even they were reach the amount needed to achieve the 4th level. So, they gave up and asked me to achieve the level for them.”

(Notes from the 2nd Gameplay Session; January 27, 2018)

On the other hand, whenever one of the children successfully achieve a level, he helps the other two to reach the level he reached. For instance, one observation protocol notes that;
“I skipped some levels for all of the children and make them all play the 18th level (Quicky) at the same time. Quicky is one of the levels that I would like to evaluate the children's approach through the game individually. This level needs to be more awake than the previous ones. You should complete the level within 1 or 2 seconds without make any mistakes. Otherwise, the bomb will exterminate the Exit button and the Inforton that should be eaten by Murphy.

Child1 was the one who willing to solve the 18th level and he solved it in just a couple of minutes (which is quite fast for a child in his ages). Conversely, Child3 -who is sitting right next to Child1 and observing how he is solving the 18th level from the very beginning- did not understand how his brother achieves the level. After a while, Child1 was giving a hand to his brother to solve the level, and the successfully complete it for Child3 too.”

(Notes from the 5th Gameplay Session; March 24, 2018)

5.6.6 Seeking for Diversity

From time to time, the children referred to the lack of different kind of digital games in their lives. Although their classmates own his/her personal smartphone, iPad, Xbox, PlayStation, etc., they only have a limited Internet connection on Smart TV. One of the observation protocol, notes that:

“Throughout this case study, I quite frequently asked if they willing to play Supaplex in their spare time. Each child told me that they really enjoyed playing Supaplex, but they prefer other game platforms because of diversity. These children are seeking for different games and different stories. They sometimes do not care about how a game has great graphics or brilliant fiction. Child3 do not want to play any game over and over again except Minecraft. Child2 is bored from any kind of game very quickly. Child1 prefer a game which encourages physical activity (such as football) than any digital game. They all have different priorities and these priorities cannot be reduced to a stereotype. For example, in one of the gameplay sessions, they were watching Fortnite clips from Youtube, and I asked them; if they had PlayStation or XBox at their home, will they still want to play Supaplex again? And their answers were surprised me because, from hundreds of options in PlayStation, Child1 said that he will only prefer FIFA than playing Supaplex because he loves football. Additionally, he told that he probably would not stop playing Supaplex entirely, because he really enjoyed some of the levels which have longer paths in Supaplex. Child2 did not make too much comment on the question, but he told that he would prefer to play both of them. On the other hand, Child3 said that playing the same game or playing the games in the same platform over and over again would not be fun.”

(Notes from the 6th Gameplay Session; April 14, 2018)

Under this circumstances, we can say that these children's play habits have been shaped by the accessibility of electronic devices.

5.6.7 Comfort Zone

Throughout this case study, the children have developed their own comfort zones. They all chose a couple of favorite levels and favorite puzzle styles, and all of these choices evolved naturally while they were playing Supaplex. One of the observation protocol, notes that:

“All of the children are prefer some specific levels they chose to play when they got bored with trying to complete an unlocked level. Each of them has at least one favorite level. For instance, Child1 likes to play the levels 4, 8, 13, 14, 15 according to him. Additionally, he mentions some specific type of puzzle he likes in Supaplex. According to Child1, he likes the levels which have longer paths in Supaplex. Child2’s
favorite level is 14th because he discovered he is actually able to move his fingers as fast as his siblings while he was playing at this level. Child3's favorite level is the 3rd one because he says that the 3rd one is the easiest one and although he is the most competitive one, he does not like to waste too much time in the same level to try to achieve it. Therefore, he prefers to spend time on the levels which he has already proved his success.

Moreover, whenever they played their favorite level; they liked the fact the chance to develop a brand new technique to complete the level or at least show an improvement which increases their chance to win. Whenever they solve any part of a level they were brainstorming for minutes, they show a "Eureka!" reaction. Their comfort zones keep them in the game, at the same time, give them to rediscover the same level and highlights the solutions they missed before.”

(Notes from the 7th Gameplay session; May 5, 2018)

5.6.8 “I can achieve!”

Due to his disease and physical disability, Child2 is the most shy one among these three siblings. Also, according to statements given by his mother, he was known as gives up very quickly when it comes to doing a challenging task; such as trying to solve a math question, solving puzzles, etc. This situation has been experienced by the researcher. Child2 rejected to solve the pre-test and his mother suggested not to force him (Please see 4.1 Pre and Post Test Results, 4.1.2. Child2, 4.1.2.1 Pre-test Results).

When Child2 first met with Supaplex, he was usually asking help from the researcher or his siblings to control Murphy. Sometimes he gave up trying to succeed a level in Supaplex, and asked the researcher to pass. However, as time goes by there is a significant improvement appeared regarding to his self-confidence. Supaplex made him braver and turned into someone who does not afraid to try and try again against his failures and weaknesses:

Kübra: “So... Seems like you do like this level, don't you? [Suddenly] Oj! Nice... Now there is some Infortons over there, look.”

Child2: “[Points at with his fingers] If I go down, then I will die.” (Figure 19)

Kübra: “I would not let you die. Would you like let me to try for you?”

Child2: “No!”

Kübra: “No?”

Child2: “I will try to achieve.”

Kübra: “OK then...”

Child2: “[He goes successfully to a certain point, but he dies after five moves] I am going to play it again!”

(Gameplay session 6; April 14, 2018)
One of the observation protocol, notes that:

"Child2 was too excited about running through between the Zonks (balls) and he wanted to show me how he achieves. He asked me for (video) recording him while he was playing. He does not get stressed about being recording anymore. Contrariwise, he was the one who wants to show his talent in front of the camera."

(Notes from the 7th Gameplay session; May 5, 2018)

Another conversation regarding to this situation was took place on the last gameplay session between Child2 and the researcher:

Kübra: “Yes... I started recording... [Child2 dies] Oj! Ohh... I think you can try again. Look, I am still recording... Because you are playing so good. [Child2 continued to play for a while, then;] You do not need your brothers anymore (while playing), don't you?”

Child2: “Nooo!”

Child1: “He needs actually... But he never let us help him.”

Kübra: “Why don't you let them help your, Child 2?”

Child1: “He wants to play more by himself.”

Child2: “Yes.”

(Gameplay session 7; May 5, 2018)

5.6.9 Creating New Challenges
As the days go by, the children got used to the Supaplex’s universe and the game mechanics. As longs as they become more successful and familiar with the game, they started to create new challenges to make the game more interesting to them. One of the observation protocol, notes that:

"I've recorded the last gameplay session from the beginning to the end. Right now, I'm recording the screen with my phone while Child2 is playing Supaplex. Surprisingly, he is not that stressed like he was before. Even he made up a challenge called "don't look at the screen". He tried to play Supaplex looking from my phone’s screen (through the video recording screen). Once, Child1 tried to play Supaplex without looking the screen too. But as I remember, he had preferred to close his eyes and play it from his memory."

(Notes from the 7th Gameplay session; May 5, 2018)

Another recorded example for this theme took place while Child3 was playing the 17th level:
Kübra: “What are you doing right now? Are you playing with the scissors [Snik Snak]? ”

Child3: “I will open everywhere [by eating all of the bases], then they [Snik Snak] will try to catch me.”

Kübra: “But... What if they don’t? I think you should disturb them. [The Snik Snaks can sometimes get into a loop and moves like it is trapped in a 2x2 size cube. Only a block (Zonk, another Snik Snak or Murphy) can break this loop. For example, if a Snik Snak gets into a loop and the player somehow gets into the loop (the cube) just for one second, the Snik Snak will break away the loop.]”

Child3: “Oh, right... Wait... I am going to disturb this one. [He pushes down a Zonk right into the loop. The Zonk breaks the loop but then, the Snik Snak gets into the loop again.] ...Noooo! It get stuck again! No! Wait... I will try this... [Tries to get Murphy as a block into the loop, but the Snik Snak kills him.] Yeah. I wanted to die anyway.”

(Gameplay session 5; March 24, 2018)

5.7 The changing of children's attitudes towards to video recording over time

In the beginning, the all of the children were being uncomfortable and stressed whenever the researcher shows up her smartphone for video recording. They were requesting to shut the camera down, or at least do not record their faces. One of the observation protocol, notes that:

“Child3 were playing Bug Funny (Level 9) and he was fully concentrated to prevent the chance to run into any bug. He even did not notice that I was recording him on my personal mobile phone. I got closer to him with my mobile phone to make him realize that I am recording. But suddenly, he stopped and he turned his head to me. With a great seriousness, he politely held my hand [which was holding mobile phone] and slowly pushed away from his view. Then, I understood that he was quite stressed because of being recorded, through his gestures.”

(Notes from the 3rd Gameplay session; February 24, 2018)

Another example for this situation occurred on the 4th gameplay session with Child2 -who is the most shy one from these children--:

Kübra: “Wow! You rock! Oh.. Wait, there is one more over there! See? On the left side. Go get it too.”

[After a while, I informed Child2 that I am going to record him on my mobile phone. ]

Child2: “[He dies.] Can you turn that [he pointed at the camera] off?”

Kübra: “Oh... Did the camera make you stressed?”

Child2: “Yes. Turn it off.”

Kübra: “Okay.”

(Gameplay session 4; March 10, 2018)
However, in the last gameplay session the researcher decided to record the entire session and the time she asked the children their opinion about it, they got really excited and happy. The following conversation has taken place at the last gameplay session:

Child2: “[He dies] Oh! How did I died?”

Kübra: “I think that your finger accidentally touched the left arrow button, and then you moved right under the balls. While you were looking at me...”

Child3: “I want to play too!”

Kübra: “After Child2 gets in the treatment machine, then you can play, yes.”

Child2: “[Keeps playing. He successfully achieved a very tough part in the level 14.]”

Kübra: “Wow, you were wonderful!”

Child3: “What? What did he do? I want to see it.”

Child1: “Can you record me when I play too?”

Kübra: “Yes, yes I am going to record all of you today.”

Child2: “[Keeps playing]”

Kübra: “Guys, is the camera not push you in stress anymore, is it?”

All together: “No.[And shakes their heads as “No”]”

Child2: “[Keeping track of how much time does it take to fall down all of the balls in level 14.] ... [Counting the seconds.] ... I don't want it [the mobile phone - camera] to see my hand.”

Kübra: “Okay. [Pushed the mobile phone away from Child2, and only recorded the screen.]”

Child2: “Yes... [He died after a couple of moves.] But I played well, right?”

Kübra: “Yes, you were amazing! I believe you can finish this level on your own.”

Child2: “[Restarts the game.] Hello. My name is Kübra abla [tr. big sister]. You... What is your name?... Murphy!”

Kübra: “[Laughs] Are you talking with my phone?”

Child2: “Yes, kanki [tr., informal; best friend]! How you doin'? Ohh... Murphy gets sad.”

(Gameplay session 7; May 5, 2018)

If we should make an inference from this changing, the following potential reasons would come in sight:

- The children may get used to the camera.
- Recording their success may have begun to motivate the children.
6 Conclusion

6.1 Summary

In this study, I used the puzzle-based learning model to examine the effect of digital puzzle games on the improvement of primary school children's logical thinking skills. Besides this, I also examined the primary school children's playing habits in their home environment to answer the following questions;

- What makes them keep playing a game?
- What kind of things motivates them when they are playing a game?
- A digital game which is not produce for educational purposes but also has an educational side in its root (such as puzzle games), can be used instead of educational games?

1. What makes those children keep playing Supaplex?

Child1: Curiosity about the next levels.

Child2: Being successful. Being able to reinterpret Supaplex's mechanics. Curiosity about the next levels.

Child3: Curiosity about the next levels.

2. What kind of things motivates them when they are playing Supaplex?

Child1: Thinking out loud. Playing a game by developing strategic techniques. (Also proving why he loves to play chess). Being able to move his fingers as fast as he can while playing Supaplex motivates him.

Child2: Applause from the audience. Being encouraged and motivated by someone else while he is playing.

Child3: Competition. Being able to compete for someone to beat.

3. What kind of things demotivates them while playing Supaplex?

According to observation notes, the researcher highlighted the fact that very difficult and challenging levels are demotivating them and they easily decline to pass those levels. Instead of achieving very difficult levels, they prefer to stay in their comfort zones and play their favourite levels.

4. Would they prefer to play a commercial game which introduces to them as an educational game?

The answer to this question is a little bit confusing because the researcher avoided telling the children the aim of this study. However, the children already understood that this case study is about the relationship between Supaplex and something related to mathematics. The pre-tests already gave the hint about this relationship before they play Supaplex. Moreover, from the first gameplay session, the researcher keep asked questions about if the children able to see a relationship between Supaplex and mathematics. Throughout the case study, only Child1 became partially aware of the researcher used Supaplex as a tool for the puzzle-based learning model. Of course, he did not understand the entire concept; but he realized the link between a puzzle and mathematics. One of the observation protocols, notes that;
“Since the beginning, only Child1 said YES to my question about 'Do you think that playing Supaplex is similar to solving math problems?'. Additionally, he mentioned on he is getting better in math class, but I am not sure if this improvement has a connection with Supaplex or not. On the other hand, Child2 and Child3 said NO every single time to my questions about if there is a relation between Supaplex and maths.”

(Notes from the 7th Gameplay session; May 5, 2018)

According to the conversation stated above, we can say that if a game does not contain something that "smells like school", then the children may not see the relation between the game and school. This outcome may lead to a new perspective in the educational games.

6.2 Discussion

According to these children’s pre and post-test results, we can see the noticeable improvement they developed throughout this case study. According to their mother, Supaplex was the only new variable in this past five months. The children have the same standards which they had before December 2017.

The first improvement is; Duration. All of the children spent much more time in the post-test. Especially Child1 spent approximately two times longer without having any break. He spent almost an hour on one single Sudoku puzzle. Child2 was too excited when he heard about the post-test, and he volunteered to be the first one who is going to took the test. This outcome shows us these children are now more willing to solve challenging tests. Yet, the post-tests took place after the 7th gameplay session and the children were quite tired because before they took the test, the researcher took the children out and played football with them. After the PISA test, it was obvious that the children were very exhausted and they could not continue with the tests. Therefore, the Sudoku results and the Tangram results in the post-tests are not one hundred percent reliable. If we take only the PISA tests into consideration;

- Child1 answered 36,53% of the questions correctly in the pre-test. He increased this percentage up to 59,61% in the post-test.
- Child2 did not participate in the pre-test. He solved 44,23% of the questions correctly in the post-test.
- Child3 answered 32,69% of the questions correctly in the pre-test. He increased this percentage up to 53,84% in the post-test.

Moreover, in the pre-tests, the children's attitude through the Sudoku puzzle was quite frivolous. According to the observation notes, they did not want to participate in something challenge them. However, in the post-tests, it was obvious that they were not scared or running away from something will challenge them. On the contrary, their interest was increased through this challenging puzzles.

To sum up, the only variable that affects these children’s lives during this case study was Supaplex; therefore we can see their development of logical thinking and the increment of their enthusiasm through the mathematics challenges as a result of regularly playing Supaplex. Additionally, the results of this case study fully satisfied the examination of the possibility that if Supaplex had an effect on the children's problem-solving techniques. Child1's developed different approaches for solving Supaplex, which also can be applied to logical problems either.
6.3 Future Work

In conclusion, I would like to maintain and extend this ethnographic case study with teenagers over a longer period, and with more participants (approximately 10-15 people) for teaching history with digital historical games (McCall, 2016). I would like to conduct a case study with a historical game "Assassin’s Creed: Origins" to determine what makes young people learn something from a game, and to examine the outcomes of narrative-based learning method and it’s adaptability to the educational games. The both studies would be useful tools to determine the weak and powerful aspects of today’s educational games and the applications of edutainment approach. The reason for choosing the Origins is that the other Assassin’s Creed series includes the historical events that occurred between the 12th century and 19th century which are already included in high school curriculum; such as Italian Renaissance, French Revolution, Victorian era, October Revolution, etc. However, Assassin’s Creed: Origins is about Ancient Egypt (49-43 BC) which is an era that high school children cannot learn from a standard school curriculum if he or she has not a special interest to Ptolemaic Kingdom. Additionally, Assassin’s Creed: Origins has an educational mode called "Discovery Tour" released on February 2018 which can be used as a learning tool by teachers.
References


Appendix A - Parental Permission Letter

Veli Onay Mektubu (Parental Permission Letter – Turkish, Original)

Sayın Veli,

Högskolan i Skövde Serious Games bölümü yüksek lisans öğrencisi olarak bitirme tezim kapsamında, “Supaplex’in ilkokul çağındaki çocukların mantıksal zeka gelişimine etkisi ve eğitsel oyunlar kullanmasına” konulu bilimsel bir araştırma yürütüyorum. Araştırmamın amacı, puzzle oyunlarının ilkokul çağındaki çocuklarda mantıksal zeka, matematiksel zeka ve problem çözme yetilerini ne derece geliştirdiği; ayrıca ilkokul çağındaki çocukların ev ortamlarında puzzle oyunlarının kullanılarak çocukların ev ortamlarında puzzle oyunlarının kullanılarak çocukların ev ortamlarında puzzle oyunlarının kullanılarak çocukların ev ortamlarında puzzle oyunlarının kullanılarak çocukların ev ortamlarında puzzle oyunlarının kullanılarak çocukların ev ortamlarında puzzle oyunlarının kullanılarak çocukların ev ortamlarında puzzle oyunlarının kullanılarak çocukların ev ortamlarında puzzle oyunlarının kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocukların ev ortamlarında puzzle oyunlarını kullanılarak çocuklarda mantıksal zeka, matematiksel zeka ve problem çözme yetilerini ne derece geliştirdiği; ayrıca ilkokul ç


Çocuklarınızın bu araştırmaya katılmamı bana sağlayacağınız bilgiler, çocukların oyun oynamaları alanının alınması bir laptop bilgisayar ile çocukların kendi evlerinde oynattığını sağlamak için araştırmacı tarafından yönetilecektir. Veli arzu ettiği takdirde, araştırmacı aldığı notları veli ile paylaşmaya yükümlüdür.

Saygılarıyla,

Fatma Kübra Tuğsal

Bahçeşehir Üniversitesi, Yazılım Mühendisliği BE ’15
Högskolan i Skövde, Serious Games MSc ’18

Tel: -
E-posta: -
Adres: -

Lütfen bu araştırmaya katılmak konusundaki tercihinizi aşağıdaki seçeneklerden size en uygun gelen altına imzanızı atarak belirtiniz ve bu formu araştırmacıya teslim ediniz.

Bu araştırmaya tamamen gönüllü olarak katılıyorum ve çocuğum ......................................’nin da katılımcı olmasına ızin vermiyorum.
Bu araştırmaya tamamen gönüllü olarak katılıyorum ve çocuğum ......................................’nin da katılımcı olmasına ızin vermiyorum.
Bu araştırmaya tamamen gönüllü olarak katılıyorum ve çocuğum ......................................’nin da katılımcı olmasına ızin vermiyorum.
Bu araştırmaya tamamen gönüllü olarak katılıyorum ve çocuğum ......................................’nin da katılımcı olmasına ızin vermiyorum.
Bu araştırmaya tamamen gönüllü olarak katılıyorum ve çocuğum ......................................’nin da katılımcı olmasına ızin vermiyorum.
Bu araştırmaya tamamen gönüllü olarak katılıyorum ve çocuğum ......................................’nin da katılımcı olmasına ızin vermiyorum.
Bu araştırmaya tamamen gönüllü olarak katılıyorum ve çocuğum ......................................’nin da katılımcı olmasına ızin vermiyorum.
Bu araştırmaya tamamen gönüllü olarak katılıyorum ve çocuğum ......................................’nin da katılımcı olmasına ızin vermiyorum.
Bu araştırmaya tamamen gönüllü olarak katılıyorum ve çocuğum ......................................’nin da katılımcı olmasına ızin vermiyorum.
Bu araştırmaya tamamen gön

Baba Adı-Soyadı........................................ Anne Adı-Soyadı........................................

İmza ......................................................             İmza ......................................................
Parental Permission Letter (Translated from Turkish)

Dear Parents,

As a graduate student at Högskolan i Skövde Serious Games, I am conducting a scientific research on "The effect of Supaplex on the development of logical thinking of primary school children and the use of the digital puzzle games as educational games". The purpose of my research is to understand how puzzle games can help to improve the primary school children's logical thinking skills, mathematical intelligence, and problem solving skills; and observing digital playing habits of the primary school children's in their home environments. The game that will be used in the research is "Supaplex"; your child will be provided with a laptop computer that does not have internet access and has limited by essential adjustments to protect your child.

If you give the permission, your children will play Supaplex at your own house with the researcher. The researcher will be able to record video and audio if necessary, and she will be able to keep these records in the local environment of the personal mobile phone and/or in her personal iCloud account. These records will be kept confidential between the researcher and the participants only for scientific research purposes. The name and the residence information of participants who participated in this survey, the video and audio records which has been taken, will definitely not be published regardless of the circumstances. If the parent requires, the researcher is obliged to share the audio/video records and the notes that she kept during the gameplay sessions with the parents.

The participation of your children in this research will be an important contribution to my study that aims to observe primary school children's playing habits and to examine the impact of digital puzzle games on these children. You can forward your questions to me via the email address or phone number below.

Best regards,

Fatma Kübra Tuğsal

Bahçeşehir University, Software Engineering BE '15
Högskolan i Skövde, Serious Games MSc '18

Tel: -
E-mail: -
Address: -

Please select your choice that the one best suits to you from the options below for participating in this study. Then, put your signature and submit the form to the researcher.

I participate in this research voluntarily and I allow my child ................................. to participate this research as a volunteer either.         I do not allow.

I am aware that I can terminate the study and do not let my children to participate anymore anytime I want. And I accept that all of the information I gave can be used as a scientific purpose.         I do not accept.

Father’s Name-Surname............................ Mother’s Name-Surname............................

Signature.......................................................... Signature............................................
## Appendix B - Tables

*Table 6. Child1 Pre-test, PISA Test results*

<table>
<thead>
<tr>
<th>Question Name</th>
<th>Total Number of Questions</th>
<th>Correct Answers</th>
<th>Wrong Answers</th>
<th>Null</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charts (contains 3 different questions)</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Sauce; Question 1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Ferris Wheel (contains 2 different questions)</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Which Car (contains 3 different questions)</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Garage; Question 1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Memory Stick (contains 2 different questions)</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>MP3 Players (contains 3 different questions)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>A Construction with Dice; Question 1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Holiday Apartment (contains 2 different questions)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Car Drive (contains 3 different questions)</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Height (contains 3 different questions)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Making a Booklet; Question 1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Seeing The Tower; Question 1</td>
<td>1</td>
<td>0,5</td>
<td>0,5</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>26</strong></td>
<td><strong>9,5</strong></td>
<td><strong>0,5</strong></td>
<td><strong>16</strong></td>
</tr>
</tbody>
</table>

*Table 7. Child1 Pre-test, SUDOKU results*

<table>
<thead>
<tr>
<th>Pre-test (Sudoku)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The number of given figures</td>
<td>30</td>
</tr>
<tr>
<td>The number of correct answers</td>
<td>2</td>
</tr>
<tr>
<td>The number of wrong answers</td>
<td>6</td>
</tr>
</tbody>
</table>
Table 8. Child1 Pre-test, TANGRAM results

<table>
<thead>
<tr>
<th>Pre-test (Tangram)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The total number of puzzles</td>
<td>28</td>
</tr>
<tr>
<td># puzzles has been tried to solve</td>
<td>14</td>
</tr>
<tr>
<td># puzzles has been solved successfully</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 9. Child1 Post-test, PISA Test results

<table>
<thead>
<tr>
<th>Post-test (PISA)</th>
<th>Total Number of Questions</th>
<th>Correct Answers</th>
<th>Wrong Answers</th>
<th>Null</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charts (contains 3 different questions)</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sauce; Question 1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ferris Wheel (contains 2 different questions)</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Which Car (contains 3 different questions)</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Garage; Question 1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Memory Stick (contains 2 different questions)</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>MP3 Players (contains 3 different questions)</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>A Construction with Dice; Question 1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Holiday Apartment (contains 2 different questions)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Car Drive (contains 3 different questions)</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Height (contains 3 different questions)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Making a Booklet; Question 1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Seeing The Tower; Question 1</td>
<td>1</td>
<td>0.5</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>26</strong></td>
<td><strong>15.5</strong></td>
<td><strong>1.5</strong></td>
<td><strong>9</strong></td>
</tr>
</tbody>
</table>

Table 10. Child1 Post-test, SUDOKU results

<table>
<thead>
<tr>
<th>Post-test (Sudoku)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The number of given figures</td>
<td>30</td>
</tr>
<tr>
<td>The number of correct answers</td>
<td>15</td>
</tr>
<tr>
<td>The number of wrong answers</td>
<td>13</td>
</tr>
</tbody>
</table>
Table 12. Child1 Post-test, TANGRAM results

<table>
<thead>
<tr>
<th>Post-test (Tangram)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The total number of puzzles</td>
<td>28</td>
</tr>
<tr>
<td># puzzles has been tried to solve</td>
<td>7</td>
</tr>
<tr>
<td># puzzles has been solved successfully</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 13. Child2 Pre-test, PISA Test results

<table>
<thead>
<tr>
<th>Pre-test (PISA)</th>
<th>Total Number of Questions</th>
<th>Correct Answers</th>
<th>Wrong Answers</th>
<th>Null</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charts (contains 3 different questions)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Sauce; Question 1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Ferris Wheel (contains 2 different questions)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Which Car (contains 3 different questions)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Garage; Question 1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Memory Stick (contains 2 different questions)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>MP3 Players (contains 3 different questions)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>A Construction with Dice; Question 1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Holiday Apartment (contains 2 different questions)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Car Drive (contains 3 different questions)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Height (contains 3 different questions)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Making a Booklet; Question 1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Seeing The Tower; Question 1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>26</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
<td><strong>26</strong></td>
</tr>
</tbody>
</table>

Table 14. Child2 Pre-test, SUDOKU results

<table>
<thead>
<tr>
<th>Pre-test (Sudoku)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The number of given figures</td>
<td>30</td>
</tr>
<tr>
<td>The number of correct answers</td>
<td>0</td>
</tr>
<tr>
<td>The number of wrong answers</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 15. Child2 Pre-test, TANGRAM results

<table>
<thead>
<tr>
<th>Pre-test (Tangram)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The total number of puzzles</td>
<td>28</td>
</tr>
<tr>
<td># puzzles has been tried to solve</td>
<td>0</td>
</tr>
<tr>
<td># puzzles has been solved successfully</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 16. Child2 Post-test, PISA Test results

<table>
<thead>
<tr>
<th>Post-test (PISA)</th>
<th>Total Number of Questions</th>
<th>Correct Answers</th>
<th>Wrong Answers</th>
<th>Null</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question Name</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charts (contains 3 different questions)</td>
<td>3</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sauce; Question 1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Ferris Wheel (contains 2 different questions)</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Which Car (contains 3 different questions)</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Garage; Question 1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Memory Stick (contains 2 different questions)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>MP3 Players (contains 3 different questions)</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>A Construction with Dice; Question 1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Holiday Apartment (contains 2 different questions)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Car Drive (contains 3 different questions)</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Height (contains 3 different questions)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Making a Booklet; Question 1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Seeing The Tower; Question 1</td>
<td>1</td>
<td>0,5</td>
<td>0,5</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>11,5</td>
<td>1,5</td>
<td>13</td>
</tr>
</tbody>
</table>
### Table 17. Child2 Post-test, SUDOKU results

<table>
<thead>
<tr>
<th>Post-test (Sudoku)</th>
<th></th>
</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>The number of correct answers</td>
<td>1</td>
</tr>
<tr>
<td>The number of wrong answers</td>
<td>4</td>
</tr>
</tbody>
</table>

### Table 18. Child2 Post-test, TANGRAM results

<table>
<thead>
<tr>
<th>Post-test (Tangram)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The total number of puzzles</td>
<td>28</td>
</tr>
<tr>
<td># puzzles has been tried to solve</td>
<td>2</td>
</tr>
<tr>
<td># puzzles has been solved successfully</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 19. Child3 Pre-test, PISA Test results

<table>
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<tr>
<th>Pre-test (PISA)</th>
<th>Total Number of Questions</th>
<th>Correct Answers</th>
<th>Wrong Answers</th>
<th>Null</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question Name</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charts (contains 3 different questions)</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Sauce; Question 1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Ferris Wheel (contains 2 different questions)</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Which Car (contains 3 different questions)</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Garage; Question 1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Memory Stick (contains 2 different questions)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>MP3 Players (contains 3 different questions)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>A Construction with Dice; Question 1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Holiday Apartment (contains 2 different questions)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Car Drive (contains 3 different questions)</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Height (contains 3 different questions)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Making a Booklet; Question 1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Seeing The Tower; Question 1</td>
<td>1</td>
<td>0,5</td>
<td>0,5</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>26</strong></td>
<td><strong>8,5</strong></td>
<td><strong>1,5</strong></td>
<td><strong>16</strong></td>
</tr>
</tbody>
</table>
In the pre-test, Child3 started to solve the Sudoku puzzle with full concentration. However, after a couple of minutes he got bored and he placed random numbers into grids even without checking whether he is solving it correctly or not.

*Table 20. Child3 Pre-test, SUDOKU results*

<table>
<thead>
<tr>
<th>Pre-test (Sudoku)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The number of given figures</td>
<td>30</td>
</tr>
<tr>
<td>The number of correct answers</td>
<td>2</td>
</tr>
<tr>
<td>The number of wrong answers</td>
<td>49</td>
</tr>
</tbody>
</table>

*Table 21. Child3 Pre-test, TANGRAM results*

<table>
<thead>
<tr>
<th>Pre-test (Tangram)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The total number of puzzles</td>
<td>28</td>
</tr>
<tr>
<td># puzzles has been tried to solve</td>
<td>3</td>
</tr>
<tr>
<td># puzzles has been solved successfully</td>
<td>1</td>
</tr>
</tbody>
</table>
### Table 22. Child3 Post-test, PISA Test results

<table>
<thead>
<tr>
<th>Question Name</th>
<th>Total Number of Questions</th>
<th>Correct Answers</th>
<th>Wrong Answers</th>
<th>Null</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charts (contains 3 different questions)</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sauce; Question 1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Ferris Wheel (contains 2 different questions)</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Which Car (contains 3 different questions)</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Garage; Question 1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Memory Stick (contains 2 different questions)</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MP3 Players (contains 3 different questions)</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>A Construction with Dice; Question 1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Holiday Apartment (contains 2 different questions)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Car Drive (contains 3 different questions)</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Height (contains 3 different questions)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Making a Booklet; Question 1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Seeing The Tower; Question 1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>26</strong></td>
<td><strong>14</strong></td>
<td><strong>1</strong></td>
<td><strong>11</strong></td>
</tr>
</tbody>
</table>

### Table 23. Child3 Pre-test, SUDOKU results

<table>
<thead>
<tr>
<th>Post-test (Sudoku)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The number of given figures</td>
<td>30</td>
</tr>
<tr>
<td>The number of correct answers</td>
<td>6</td>
</tr>
<tr>
<td>The number of wrong answers</td>
<td>16</td>
</tr>
</tbody>
</table>

### Table 24. Child3 Pre-test, TANGRAM results

<table>
<thead>
<tr>
<th>Post-test (Tangram)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The total number of puzzles</td>
<td>28</td>
</tr>
<tr>
<td># puzzles has been tried to solve</td>
<td>3</td>
</tr>
<tr>
<td># puzzles has been solved successfully</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 25. Approximate time spent at home per gameplay session

<table>
<thead>
<tr>
<th>Gameplay Session</th>
<th>Date</th>
<th>Approximate Time Spent at Home</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>08.12.2017-10.12.2017</td>
<td>48 hours</td>
</tr>
<tr>
<td>2</td>
<td>26.01.2018-28.01.2018</td>
<td>33 hours</td>
</tr>
<tr>
<td>3</td>
<td>24.02.2018</td>
<td>9 hours</td>
</tr>
<tr>
<td>4</td>
<td>10.03.2018</td>
<td>6 hours</td>
</tr>
<tr>
<td>5</td>
<td>24.03.2018</td>
<td>7 hours</td>
</tr>
<tr>
<td>6</td>
<td>14.04.2018</td>
<td>8 hours</td>
</tr>
<tr>
<td>7</td>
<td>05.05.2018</td>
<td>11 hours</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>112 hours</strong></td>
</tr>
</tbody>
</table>

*The researcher arrived home after 10pm (8/12) and spent the night with children.

Table 26. Children's total playing hours

<table>
<thead>
<tr>
<th>Total Playing Hours (Data from Supaplex)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child1</td>
</tr>
<tr>
<td>Child2</td>
</tr>
<tr>
<td>Child3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

Table 27. Children's total playing hours (detailed)

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Child1</td>
</tr>
<tr>
<td>Child2</td>
</tr>
<tr>
<td>Child3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

*The researcher spent the night at the children's home.

Table 28. Children's total playing hours (detailed)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Child1</td>
<td>7:21:51</td>
<td>3:00:24</td>
<td>7:44:09</td>
</tr>
<tr>
<td>Child2</td>
<td>9:45:10</td>
<td>7:51:46</td>
<td>10:19:56</td>
</tr>
<tr>
<td>Child3</td>
<td>5:01:34</td>
<td>2:25:15</td>
<td>5:14:34</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13:17:25</strong></td>
<td></td>
<td><strong>1:10:04</strong></td>
</tr>
</tbody>
</table>

*The researcher spent the night at the children's home.
Table 29. Children’s total playing hours (detailed)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Child1</td>
<td>8:35:32</td>
<td>0:51:23</td>
<td>9:37:39</td>
<td>1:02:07</td>
</tr>
<tr>
<td>Child2</td>
<td>11:00:35</td>
<td>0:40:39</td>
<td>11:58:42</td>
<td>0:58:07</td>
</tr>
<tr>
<td>Child3</td>
<td>5:37:36</td>
<td>0:23:02</td>
<td>7:58:46</td>
<td>2:21:10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>1:55:04</strong></td>
<td><strong>4:21:24</strong></td>
</tr>
</tbody>
</table>

Table 30. Children’s total playing hours (detailed)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Child1</td>
<td>09:45:21</td>
<td>0:07:42</td>
<td>9:45:21</td>
<td>*0:00:00</td>
</tr>
<tr>
<td>Child3</td>
<td>10:10:56</td>
<td>2:12:10</td>
<td>11:10:15</td>
<td>0:59:19</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>5:00:08</strong></td>
<td></td>
<td><strong>2:01:37</strong></td>
</tr>
</tbody>
</table>

*Child1 was at the football training all day long.  
**On the 4th Gameplay Session, the researcher had to terminate the session quite early.

Table 31. Children’s total playing hours (detailed)

<table>
<thead>
<tr>
<th></th>
<th>5. Gameplay Session (24.03.2018) - Before</th>
<th>(11.03.2018-23.03.2018)</th>
<th>5. Gameplay Session (24.03.2018) - After</th>
<th>5. Gameplay Session - Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child1</td>
<td>10:39:50</td>
<td>0:54:29</td>
<td>12:17:11</td>
<td>1:37:21</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>9:48:12</strong></td>
<td></td>
<td><strong>3:03:35</strong></td>
</tr>
</tbody>
</table>

Table 32. Children’s total playing hours (detailed)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Child2</td>
<td>28:51:06</td>
<td>5:27:26</td>
<td>30:21:00</td>
<td>1:29:54</td>
</tr>
<tr>
<td>Child3</td>
<td>14:53:32</td>
<td>01:05:44</td>
<td>15:32:14</td>
<td>0:38:42</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>7:05:07</strong></td>
<td></td>
<td><strong>2:37:34</strong></td>
</tr>
</tbody>
</table>
Table 33. Children’s total playing hours (detailed)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Child1</td>
<td>13:18:06</td>
<td>0:00:00</td>
<td>13:45:47</td>
<td>0:27:41</td>
</tr>
<tr>
<td>Child2</td>
<td>30:35:48</td>
<td>0:14:48</td>
<td>31:10:33</td>
<td>0:34:45</td>
</tr>
<tr>
<td>Child3</td>
<td>15:43:37</td>
<td>0:11:23</td>
<td>16:01:05</td>
<td>0:17:28</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0:26:11</td>
<td></td>
</tr>
</tbody>
</table>

Table 34. Children’s total playing hours – per gameplay session (total)

<table>
<thead>
<tr>
<th></th>
<th>Child1</th>
<th>Child2</th>
<th>Child3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Gameplay Session (26/27.01.2018) - Total</td>
<td>0:22:18</td>
<td>0:34:46</td>
<td>0:13:00</td>
</tr>
<tr>
<td>4. Gameplay Session (10.03.2018) - Total</td>
<td>0:00:00</td>
<td>1:02:18</td>
<td>0:59:19</td>
</tr>
<tr>
<td>5. Gameplay Session (24.03.2018) - Total</td>
<td>1:37:21</td>
<td>1:01:43</td>
<td>0:24:31</td>
</tr>
<tr>
<td>7. Gameplay Session (05.05.2018) - Total</td>
<td>0:27:41</td>
<td>0:34:45</td>
<td>0:17:28</td>
</tr>
</tbody>
</table>

Table 35. Child1’s total playing hours – daily average

<table>
<thead>
<tr>
<th></th>
<th>Total Days</th>
<th>Child1</th>
<th>Child1 - Daily Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>After 1. Gameplay Session</td>
<td>47</td>
<td>3:00:24</td>
<td>0:03:50</td>
</tr>
<tr>
<td>After 2. Gameplay Session</td>
<td>26</td>
<td>0:51:23</td>
<td>0:01:59</td>
</tr>
<tr>
<td>After 3. Gameplay Session</td>
<td>12</td>
<td>0:07:42</td>
<td>0:00:39</td>
</tr>
<tr>
<td>After 4. Gameplay Session</td>
<td>12</td>
<td>0:54:29</td>
<td>0:04:32</td>
</tr>
<tr>
<td>After 5. Gameplay Session</td>
<td>19</td>
<td>0:31:57</td>
<td>0:01:41</td>
</tr>
<tr>
<td>After 6. Gameplay Session</td>
<td>19</td>
<td>0:00:00</td>
<td>0:00:00</td>
</tr>
</tbody>
</table>

Table 36. Child2’s total playing hours – daily average

<table>
<thead>
<tr>
<th></th>
<th>Total Days</th>
<th>Child2</th>
<th>Child2 - Daily Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>After 1. Gameplay Session</td>
<td>47</td>
<td>7:51:46</td>
<td>0:10:02</td>
</tr>
<tr>
<td>After 2. Gameplay Session</td>
<td>26</td>
<td>0:40:39</td>
<td>0:01:34</td>
</tr>
<tr>
<td>After 3. Gameplay Session</td>
<td>12</td>
<td>2:40:16</td>
<td>0:13:21</td>
</tr>
<tr>
<td>After 5. Gameplay Session</td>
<td>19</td>
<td>5:27:26</td>
<td>0:17:14</td>
</tr>
<tr>
<td>After 6. Gameplay Session</td>
<td>19</td>
<td>0:14:48</td>
<td>0:00:47</td>
</tr>
</tbody>
</table>
**Table 37. Child3’s total playing hours – daily average**

<table>
<thead>
<tr>
<th></th>
<th>Total Days</th>
<th>Child3</th>
<th>Child3 - Daily Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>After 1. Gameplay Session</td>
<td>47</td>
<td>4:51:22</td>
<td>0:06:12</td>
</tr>
<tr>
<td>After 2. Gameplay Session</td>
<td>26</td>
<td>0:23:02</td>
<td>0:00:53</td>
</tr>
<tr>
<td>After 3. Gameplay Session</td>
<td>12</td>
<td>2:12:10</td>
<td>0:11:01</td>
</tr>
<tr>
<td>After 4. Gameplay Session</td>
<td>12</td>
<td>2:13:02</td>
<td>0:11:05</td>
</tr>
<tr>
<td>After 5. Gameplay Session</td>
<td>19</td>
<td>1:05:44</td>
<td>0:03:28</td>
</tr>
<tr>
<td>After 6. Gameplay Session</td>
<td>19</td>
<td>0:11:23</td>
<td>0:00:36</td>
</tr>
</tbody>
</table>
Appendix C - PISA Questions

Soru 1: LİSTELE

Grup Sarmagık Nisan ayında kaç albüm satmıştır?

A. 250
B. 500
C. 1000
D. 1270
Soru 2: LISTELER

Grup Heykel ilk kez hangi ayda Grup Ispanak’tan daha fazla albüm satmıştır?

A. Hiçbir ayda  
B. Mart  
C. Nisan  
D. Mayıs

Soru 3: LISTELER

Grup Ispanak’ın menajeri, grubun albüm satışları Şubat ayından Haziran ayına kadar düşüş gösterdiğiinden dolayı endişe etmektedir.

Bu olumuz gidişet aynı şekilde devam ederse, grubun Temmuz ayı albüm satış tahmini olarak ne kadar olur?

A. 70 albüm  
B. 370 albüm  
C. 670 albüm  
D. 1340 albüm
**Soru 1: SOS**

Kendi salata sosunuzu yapmaktanız.

Bu salata sosunun 100 milyonluk (ml) tarif aşağıdaki gibidir:

<table>
<thead>
<tr>
<th>Salata yağı:</th>
<th>60 ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sirke:</td>
<td>30 ml</td>
</tr>
<tr>
<td>Soya sosu:</td>
<td>10 ml</td>
</tr>
</tbody>
</table>

Bu salata sosunun 150 ml’si için kaç miliyute (ml) salata yağı gerekir?

Yanıt: ..................... ml
DÖNME DOLAP

Bir nehir konanında büyük bir dönmə dolap bulunmaktadır. Aşağıdaki resim ve şekle bakınız.

Dönmə dolabın dış yarıçapi 140 metre olup en yüksek noktası Thames nehri yatağının 150 metre üzerindeydır. Olulara gösterilen yönde dönmektedir.

Soru 1: LONDRA'NIN GÖZÜ

Şekildeki M harfi dönmə dolabın merkezini göstermektedir.

M noktasını Thames nehri yatağının kaç metre (m) üzerinden?

Yanıt: .................................................. m
Soru 2: LONDRA'NIN GÖZÜ

Dönmeye dolap sabit bir hızda dönüyordur. Dolap bir tam dönmemi 40 dakikada tamamlamaktadır.

Can'ın dönmeye dolap üzerindeki turu P binış noktasından başlıyor.

Can'ın saat sonra nerede olacaktır?

A  R noktasında
B  R ve S noktaları arasında
C  S noktasında
D  S ve P noktaları arasında
HANGİ ARABA?

Ceren ehlîyetini yeni almıştır ve ik-arabası satın almak istemektedir.

Aşağıdaki tablo Ceren'in yerel bir araba galerisinde bulduğu dört arabanın aynıtlarını göstermektedir:

<table>
<thead>
<tr>
<th>Modül</th>
<th>Alfa</th>
<th>Beta</th>
<th>Gama</th>
<th>Tetra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yıl</td>
<td>2003</td>
<td>2000</td>
<td>2001</td>
<td>1999</td>
</tr>
<tr>
<td>İstenen fiyat (zed)</td>
<td>4500</td>
<td>4450</td>
<td>4250</td>
<td>3990</td>
</tr>
<tr>
<td>Kat ettiği mesafe (kilometre)</td>
<td>105 000</td>
<td>115 000</td>
<td>128 000</td>
<td>109 000</td>
</tr>
<tr>
<td>Motor hacmi (litre)</td>
<td>1,79</td>
<td>1,798</td>
<td>1,82</td>
<td>1,783</td>
</tr>
</tbody>
</table>

Soru 1: HANGİ ARABA?

Ceren, aşağıdaki tüm şartları karşılayan bir araba istemektedir:
- Kat ettiği mesafe 120 000 kilometreden fazla olmayacak.
- 2000 yılı veya daha sonrasında üretilmiş olacak.
- İstenen fiyat 4500 zedden fazla olmayacak.

Hangi araba Ceren'in şartlarını karşılamaktadır?

A. Alfa  
B. Beta  
C. Gama  
D. Tetra

5545 Sayılı Filtre ve Sanal Eserleri Koruma Kanunu gereği tüm hakların Milli Eğitim Bakanlığına aittir. MEB’in İzni olmadan bu ekraklık bilgilerin kullanılması, başka yere taşınması, internet üzerinde ve ya her ne şekilde dönüm olun ticari amaçla yayınlanması ve kullanılması.
Soru 2: HANGİ ARABA?

Hangi arabanın motor hacmi en küçüktür?

A. Alfa  
B. Beta  
C. Gama  
D. Tetra  

Soru 3: HANGİ ARABA?

Ceren, vergi olarak, arabanın istenen fiyatın %2,5'i kadar ekstra ücret ödemek zorunda kalacaktır.

Alfa modeli için bu ekstra vergi ne kadardır?

Ekstra vergi: ........................................... zod
GARAJ

Bir garaj üretilmeyi yaptığı "basit" garaj çeşidi, sadece bir penceresi ve bir kapılı olan modelleri içermektedir.

Gökhan, "basit" garaj çeşitlerinden aşağıdaki modeli seçmiştir. Pencerenin ve kapının yeri aşağıda gösterilmektedir.

Soru 1: GARAJ

Aşağıdaki çizimler, farklı "basit" modellerin arka plan görünüşlerini göstermektedir. Bu çizimlerden sadece bir tanesi Gökhan'ın seçtiği yukarıdaki modelde aynıdır.

Gökhan'ın seçtiği model hangisidir? A, B, C ya da D seçeneklerinden birini yuvarlak içine alınız.

A

B

C

D
USB BELLEK

USB bellek küçük, taşınabilir bir bilgisayar depolama aracıdır.

İrfan'ın müzik ve fotoğraf yükli bir USB belleği vardır. Bu belleğin kapasitesi 1 GB (1000 MB)'tir. Aşağıdaki grafik USB belleğin şu anki doluluk durumunu göstermektedir.

**USB belleğin doluluk durumu**

- Müzik (650 MB)
- Fotograflar (198 MB)
- Örnek alan (152 MB)
Soru 1: USB BELLEK

İrfan 350 MB’lik bir fotoğraf albümünü USB belleğine aktarmak istemektedir, fakat USB belleğinde yerine boş alan bulunmamaktadır. İrfan, bellekteki fotoğrafları silmek istemektedirken, en fazla iki adet müzik albümünü silmeyi tercih etmektedir.

İrfan’ın USB belleğine yüklenmiş olan müzik albümlerinin büyüklüğü aşağıdaki gösterilmektedir:

<table>
<thead>
<tr>
<th>Albüm</th>
<th>Büyüklük</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albüm 1</td>
<td>100 MB</td>
</tr>
<tr>
<td>Albüm 2</td>
<td>75 MB</td>
</tr>
<tr>
<td>Albüm 3</td>
<td>80 MB</td>
</tr>
<tr>
<td>Albüm 4</td>
<td>55 MB</td>
</tr>
<tr>
<td>Albüm 5</td>
<td>60 MB</td>
</tr>
<tr>
<td>Albüm 6</td>
<td>80 MB</td>
</tr>
<tr>
<td>Albüm 7</td>
<td>75 MB</td>
</tr>
<tr>
<td>Albüm 8</td>
<td>125 MB</td>
</tr>
</tbody>
</table>


Yanıt: Evet / Hayır
Soru 2: USB BELLEK

İlerleyen haftalarda İrfan bazı fotoğraflar ve müzik dosyalarını alımı ve aynı zamanda da yeni fotoğraflar ve müzik dosyaları eklemiştir. USB belleğin son durumunu aşağıdaki tabloda göstermektedir:

<table>
<thead>
<tr>
<th>Müzik</th>
<th>550 MB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fotoğraflar</td>
<td>338 MB</td>
</tr>
<tr>
<td>Boş Alan</td>
<td>112 MB</td>
</tr>
</tbody>
</table>

Kardeşi, İrfan'a tamamen boş olan 2 GB (2000 MB)lık yeni bir USB bellek vermiştir. İrfan eski USB belleğinde bulunanların tamamını yeniyine eklemiştir.

Aşağıdaki grafiklerden hangisi yeni USB belleğin doluluk durumunu göstermektedir?
A, B, C veya D seçeneklerinden birini yukarıda içine alınız.

A

- Müzik
- Fotoğraflar
- Boş Alan

B

- Müzik
- Fotoğraflar
- Boş Alan

C

- Müzik
- Fotoğraflar
- Boş Alan

D

- Müzik
- Fotoğraflar
- Boş Alan
MP3 ÇALAR

Müzik Şehri MP3 Aksesuarları

<table>
<thead>
<tr>
<th>MP3 Çalar</th>
<th>Kulaklık</th>
<th>Hoparlör</th>
</tr>
</thead>
<tbody>
<tr>
<td>155 zed</td>
<td>86 zed</td>
<td>79 zed</td>
</tr>
</tbody>
</table>

Soru 1: MP3 ÇALAR

Oya hesap makinesi ile MP3 çalar, kulaklık ve hoparlörün fiyatını toplamıştır. Elde ettiği sonuç 248'dir.

![Calculator Display]

Oya'nın yanıtını yerleştir. Oya aşağıdaki hatalardan birini yapmıştır. Oya'nın yaptığı hata aşağıdaki kilerden hangisidir?

A. Fiyatlardan birini iki kere toplamıştır.
B. Üç fiyatdan birini eklemeyi unuttuştur.
C. Fiyatlardan birinin son basamakındaki rakamı yazmamıştır.
D. Fiyatlardan birini toplamak yerine çıkarmıştır.

5846 sayılı İlk ve Sınav Esaretini Koruma Kanunu gereği tüm ilanlar MEB'in web sitesine yönelikler. MEB'te izi olmayan bu evrakta belirtilen bilgiler iyiye alınmamış, böyle yerde tespit edilen, internet üzerinden veya her ne kadar olursa olsun siber güvenlik mesafesi önerilmiştir.
Soru 2: MP3 ÇALAR

Müzik Şeridine indirim vardır. İki yıl da daha fazla ürün aldığımızda, Müzik Şerini, bu ürünlerin normal satış fiyatına %20 indirim yapmaktadır.

Ceyhun’un harçayabileceği 200 zed’1 vardır.

Bu indirimi satışlarda Ceyhun’un paraşı neye yetinektir?

Aşağıdaki her bir seçenek için “Evet” ya da “Hayır” ifadelerinden birini yuvarlak içine alınız.

<table>
<thead>
<tr>
<th>Ürünler</th>
<th>Ceyhun bu ürünleri 200 zed’ı alabilir mi?</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP3 çalar ve kulaklık</td>
<td>Evet / Hayır</td>
</tr>
<tr>
<td>MP3 çalar ve hoparlör</td>
<td>Evet / Hayır</td>
</tr>
<tr>
<td>3 ürünün tümü – MP3 çalar, kulaklık ve hoparlör</td>
<td>Evet / Hayır</td>
</tr>
</tbody>
</table>
**Soru 3: MP3 ÇALARLAR**

MP3 ürünlerinin normal satış fiyatı % 37,5 oranında kâr içermektedir. Bu kâr payını içermemeyen fiyatı, toplam satış fiyatı denir.

Kâr, toplam satış fiyatının yüzde olarak hesaplanır.

Aşağıdaki formüller, toplam satış fiyatı, \( t \), ile normal satış fiyatı, \( n \), arasındaki iliskiyi doğru şekilde göstermek midır?

Verilen her bir formül için "Evet" ya da "Hayır" seçeneklerinden birini yuvarlak içine alınız.

<table>
<thead>
<tr>
<th>Formül</th>
<th>Formül doğru mu?</th>
</tr>
</thead>
<tbody>
<tr>
<td>( n = t + 0.375 )</td>
<td>Evet / Hayır</td>
</tr>
<tr>
<td>( t = n - 0.375n )</td>
<td>Evet / Hayır</td>
</tr>
<tr>
<td>( n = 1,375t )</td>
<td>Evet / Hayır</td>
</tr>
<tr>
<td>( t = 0.025n )</td>
<td>Evet / Hayır</td>
</tr>
</tbody>
</table>
ZARLARDAN OLUŞAN YAPILAR

Aşağıdaki resimde yazılan 1'den 6'ya kadar numaralanmış 7 özdeş zar kullanılarak oluşturulmuş bir yapının görüntütedir.

Üstten Görünüş

Yapına üstten bakıldığında sadece 5 zar görülebilmektedir.

Soru 1: ZARLARDAN OLUŞAN YAPILAR

Bu yapına üstten bakıldığında toplam kaç noka görülebilir?
Görülen Nokta Sayısı: .........................
**TATİL EVİ**

Ceren aşağıdaki eşlik tatil evini internette bulmuştur. Tatilcilere kiralanmak amacıyla bu tatil evini satın almayı düşünmektedir.

| Öda sayısı: | 1 x oturma ve yemek odası  
1 x yatak odası  
1 x banyo | Fiyat: 200 000 zed |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Büyüklik:</td>
<td>60 metrekare (m²)</td>
<td></td>
</tr>
<tr>
<td>Otobüs:</td>
<td>Evet</td>
<td></td>
</tr>
<tr>
<td>Şehir merkezine vang ses:</td>
<td>10 dakika</td>
<td></td>
</tr>
</tbody>
</table>
| Sahile uzaklık: | Düz bir yol üzerinden 350 metre  
(m) |                  |
| Son 10 yıl içerisinde tatilcilere  
tarafından kullanım ortalama: | Yılda 315 gün |                  |
Soru 1: TATİL EVI

Telil evinin fiyatını belirlemek için Ceren bir uzmana danışmıştır. Telil evinin değeri belirlenmek amacıyla uzman aşığida verilen ölçütleri kullanmaktadır.

<table>
<thead>
<tr>
<th>m² başına fiyat</th>
<th>Taban fiyat</th>
<th>m² başına 2600 zed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ek değer ölçütleri</td>
<td>Şehir merkezine vanga süresi</td>
<td>15 dakikadan fazla: +0 zed</td>
</tr>
<tr>
<td>Sahile uzaklık (diz bir yol üzerinden):</td>
<td>2 km'den fazla: +0 zed</td>
<td>1 ila 2 km arası: +5000 zed</td>
</tr>
<tr>
<td>Otopark:</td>
<td>Hayır: +0 zed</td>
<td>Evet: +35 000 zed</td>
</tr>
</tbody>
</table>

Uzmanın belirlediği değer alanında verilen satış fiyatından fazla ise, evi satın almak isteyen Ceren için bu fiyat "çok iyi" olarak kabul edilirken.

Uzmanın kullandığı ölçütlerine bağlı olarak, Ceren için teklif edilen satış fiyatının "çok iyi" olduğunu göstermek zorunda kalıyor.
Soru 2: TATİL EVİ

Son 10 yıl içerisinde evin tatilleri tarafından kullanılan ortalaması yılda 315 gündür.

Bu bilgiden yararlanarak aşağıdaki önermelere yanıt çıkarılmayacağını karar veriniz.

Her bir önerme için "Evet" ya da "Hayır" seçeneklerinden birini yukarıda işaret olunuz.

<table>
<thead>
<tr>
<th>Önerme</th>
<th>Verilen bilgiden bu önerme çıkarılabilir mi?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Son 10 yılın on az birinde tatil evinin tatilleri tarafından tam olarak 315 gün kullanıldığını kesinlikle söyleyebilir.</td>
<td>Evet / Hayır</td>
</tr>
<tr>
<td>Teorik olarak, tatil evinin tatilleri tarafından son 10 yıl içerisinde her yıl 315 günden fazla kullanılmadığı olması mümkündür.</td>
<td>Evet / Hayır</td>
</tr>
<tr>
<td>Teorik olarak, tatil evinin tatilleri tarafından son 10 yılın birinde hiç kullanılmamış olması mümkündür.</td>
<td>Evet / Hayır</td>
</tr>
</tbody>
</table>

Not: Bir yılın 365 gün olduğuna varayınız.
ARABA GEZİNTİSİ

Etra arabayla gezintiyce gitti. Gezinti sırasında, arabanın önüne doğru bir kedi koştu. Esra hemen frene bastı ve kediyi kurtardı.

Halif sarsılan Etra, eve dönmeye karar verdi.

Aşağıdaki grafik, gezinti sırasında arabanın basitleştirilmiş hız kayıtlarını göstermektedir.

![Hız Zaman Grafik](image)

**Soru 1: ARABA GEZİNTİSİ**

Gezinti sırasında arabanın en yüksek hızı nedir?

En yüksek hız: __________________________ km/sa.

---

13446 Sayıli Fikir ve Senat Eserlerini Koruma Kanunu gereğince tüm hakları Milli Eğitim Bakanlığı'na aittir. MEB'in izni alındı bu evrakta belirtilen bilgiler kopyalanamaz, başka yere taşınamaz, internet üzerinde veya her ne şekilde olursa olun telif hakkı saklı kalmalıdır ve kullanılmalıdır.
Soru 2: **ARABA GEZİNTİSİ**

Eşra, kediyi ezmemek için birden frenе bastığında saat kaçtı?

Yanıt: ........................................

Soru 3: **ARABA GEZİNTİSİ**

Eşranın eve dönme için aldığı yol, evden, kediyi karşılaştığı yere kadar aldığı yoldan daha kıaa mıydı? Yanıtınızı detaylamak için grafikte verilen bilgileri kullanarak bir açıklama yapınız.

..........................................................................................................................
..........................................................................................................................
..........................................................................................................................
..........................................................................................................................
..........................................................................................................................
..........................................................................................................................
..........................................................................................................................
..........................................................................................................................
..........................................................................................................................

BOY

Bir sınıfta 25 kız vardır. Kızların boy ortalaması 130 cm'dir.

Soru 1: BOY

Boy ortalamasının nasıl hesaplandığını açıklayınız.

Soru 2: BOY

Aşağıdaki anlatımların her biri için ‘Doğru’ ya da ‘Yanlış’ taraflına alınır.

<table>
<thead>
<tr>
<th>Anlatım</th>
<th>Doğru / Yanlış</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eğer bu sınıfta boyu 132 cm olan bir kız varsa, boyu 128 cm olan bir başka kız olmalıdır.</td>
<td>Doğru / Yanlış</td>
</tr>
<tr>
<td>Kızların büyük bölümünün boyu 130 cm olmalıdır.</td>
<td>Doğru / Yanlış</td>
</tr>
<tr>
<td>Eğer tüm kızların uzunca doğru sıralarsanız, ortadaki boyunun 130 cm'ye eşit olmalıdır.</td>
<td>Doğru / Yanlış</td>
</tr>
<tr>
<td>Sınıftaki kızların yanlarının boyu 130 cm'ın altında ve yanının boyu da 130 cm'ın üstünde olmalıdır.</td>
<td>Doğru / Yanlış</td>
</tr>
</tbody>
</table>

5646 sayılı Atatürk ve Sanat Eserlerini Koruma Kanunu gereğince hakan Milli Eğitim Bakanlığı'nda MEB'in ürün olarak bu errattaki bilgileri paylaşılmasına, başka yerde paylaşılması, internet üzerinde veya her ne şekilde dura olun şairi ile hiçbir şekilde yüklenmemek suretiyle reddedilmiştir.

XXXIV
Soru 3: BOY

Bir öğrencinin boy ölçüsünde bir hata bulunmuştur. Onun boyu 145 cm yerine 120 cm olmalıdır. Bu düzeltmeye göre sınıftaki kızların boy ortalaması nedir?

A 126 cm
B 127 cm
C 128 cm
D 129 cm
E 144 cm
Soru 1: BİR KİTAPÇIK YAPIMI

**Şekil 1**

Şekil 1, küçük bir kitapçığın nasıl yapıldığını göstermektedir. Yapım kilavuzu aşağıdaki gibidir:

- Bir parça kağıt alp ikiye katlayıniz.
- a kenarını zimbalayınız.
- b'deki ikı kenarı kesiniz.

Sonuç sekiz yapraktan oluşacak küçük bir kitapçıktr..

![Diagram](image)

**Şekil 2**

Şekil 2 bu tür bir kitapçık yapmak için kullanılan kağıt parçasının bir yüzünü göstermektedir. Sayfa numaraları kağıdın üzerine önceden yazılmıştır.

Kalin çizgi, katlandıktan sonra kağıdın nereden kesileceğini belirtmektedir.
Aşağıdaki şekilde, 2, 3, 6, ve 7. sayfa numaralarının her birinin arkasında hangi numaraların olduğunu göstermek için, 1, 4, 5, ve 8 sayılarını doğru kutu lara yazınız.
Soru 1: KULEYİ GÖRMEK

Aşağıdaki Şekil 1 ve 2’de, aynı kuleye ilişkin klip çizim görünümünü, Şekil 1’de kulenin çatısının üç yüzeyini, Şekil 2’de ioc dört yüzeyini görmektesiniz.

Aşağıdaki şemada, kulenin çatısının üstten görünümü göslerimekteidir. Şema üzerinde beş noka gösterilmiştir. Noktaların har biri çarpi (×) işaret ile işaretlenmiş ve P1 – P5 olarak isimlendirilmiştir.

Bu noktaların her birinden kuleye bakan bir kişi, kulenin çatısının çeşitli sayıldığı yüzeylerini görebilecektir.
Aşağıdaki tabloda, bu noktaların her birinden görülebilen yüzeylerin sayısını daire içine alınız.

<table>
<thead>
<tr>
<th>Nokta</th>
<th>Bu noktadan görülebilen yüzeylerin sayısı</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>1 2 3 4 4'ten daha fazla</td>
</tr>
<tr>
<td>P2</td>
<td>1 2 3 4 4'ten daha fazla</td>
</tr>
<tr>
<td>P3</td>
<td>1 2 3 4 4'ten daha fazla</td>
</tr>
<tr>
<td>P4</td>
<td>1 2 3 4 4'ten daha fazla</td>
</tr>
<tr>
<td>P5</td>
<td>1 2 3 4 4'ten daha fazla</td>
</tr>
</tbody>
</table>
Appendix D - SUDOKU Puzzle

Daily Sudoku puzzle No. 4064  2017-11-28  Medium level

\[
\begin{array}{ccc|ccc|ccc}
8 & 9 & 4 & 1 & 9 & 7 & 3 & 6 & 7 & 8 & 4 \\
2 & 8 & 5 & 1 & 7 & 8 & 3 & 3 & 1 & 9 & 4 & 6 & 1 \\
2 & 6 & 7 & 1 & 5 & 4 & 6 & 1 & 5 & 6 & & & \\
\end{array}
\]
Appendix E - Tangram Puzzle

Make Your Own Tangram Puzzle!

Cut out the square opposite. (Stick it onto a piece of cardboard first, to make it easier to move the shapes around.) Cut the solid black lines only, to get seven shapes: five triangles, a square and a parallelogram.

If you don't want to cut up this sheet of paper, you can make a tangram on another sheet, by dividing a square up into a 4x4 grid, as shown opposite with the light dotted lines. Then it's easy to draw the dark lines, because they pass through the dotted lines where these lines cross.

Once you've made your tangram, why not try to solve the shapes below? Remember that you must use all seven pieces to make each shape, and the pieces can't overlap. (The solutions are given on the back of this sheet, but don't peek too soon...)