

Math Detectives

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31.10.-12.12.2017



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LUMA-KESKUS SUOMI



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Introduction

TARGET GROUP: 3.-6. class

DURATION: 31.10. - 12.12.2017, in total 6 times, 90 min. at a time

TURNOUT: 11 pupils

THEME: Math Detectives

THE CLUB'S GOALS:

- Make mathematics fun!
- Inspire and courage children to play and investigate.
- Enhance mathematical thinking and spatial reasoning.
- Add hands-on mathematics

A BRIEF DESCRIPTION OF THE CLUB:

In this math club we familiarized ourselves with hands-on mathematics through interesting problems and fun games. The activities varied from group activities to solitary assignments and involved moving around and also staying put. The children got to use their brains in problem solving activities such as the Cops and the crooks and The Hanoi Tower and also play against each other in activities such as the Battleship and board games.

THE GENERAL STRUCTURE OF THE CLUB:

- Warm-up game
- Activity 1
- Activity 2
- Activity 3
- Clean up & Bye bye



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1. Club gathering: Volume and size

THE GOALS OF THE CLUB GATHERING:

- Get to know each other
- Learn how to work in a group
- Learn a little about the connection between the surface area and volume
- Develop reasoning skills

PRELIMINARIES:

Before the club print the necessary amount of gaming platforms for Skyscrapers and possibly cut the cardboard for Volume challenge.

MATERIALS AND EQUIPMENT, NECESSARY SPACES:

- Big enough space to form a circle and lines for the introduction games
- Cardboard, scissors, tape, scale or other kind of measuring item and pearls or peas for Volume challenge
- For example multilink-cubes or other kind of different sized blocks, 4x4 different size per player/group, gaming platforms (available in link) for Skyscrapers

SCHEDULE OF THE CLUB GATHERING:

0-20 min.	Name game
20-40 min.	Form a line -game
40-70 min.	Volume challenge
70-90 min.	Skyscrapers

DESCRIPTIONS OF WORK INSTRUCTIONS:

Activity name: Name game

A brief description of the activity: In Name game we get to know the names of each other.

Implementation of the activity and the source of the workmanual: Form a circle and everybody comes up with a move of their choice. The first one does their move and says their name out loud and everybody repeats it. The next one makes their move and says their name and we repeat so that first we say(/do) the initiators name and move and then the second name and move. And we continue this so that we go round the whole circle and in the end we say everybody's names (and do the moves).

Activity name: Form a line -game

A brief description of the activity: In this activity the pupils will be divided in groups and they need to form a line based on different qualities.



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Implementation of the activity and the source of the workmanual: Divide the pupils in groups of ~5. The task is to form a line correctly based on different qualities, for example: first letter of the first name in alphabetical order, first letter of the surname in alphabetical order, age (day/month/year) from youngest to oldest, date of birth (day/month) not including the year, height, size of a shoe etc. Can be done as a competition: groups can come up with the name for themselves and the fastest one ready with a correct order gets a point.

Activity name: Volume challenge

A brief description of the activity: In this activity pupils try to form as large item as possible from given material.

Implementation of the activity and the source of the workmanual: Form groups of ~4 pupils. Each group gets the same amount of cardboard (for example half of A4) and tape (about 80cm-1 m of tape). To make the activity more complicated students can get pieces of cardboard cut into different forms (squares, triangles etc). The task is to form as large item as possible from the given material. Students are allowed to cut and tape the cardboard as they wish but the finished item has to have a bottom and walls so that it holds peas/pearls inside. Suitable time to build the item is 10-15 min. When the time is finished volumes of the built items can be measured with peas/pearls either with a scale or for example a deciliter measure.

Instructions in Finnish: <http://blogs.helsinki.fi/summamutikka/tilavuushaaste/> (28.10.2017)



Photograph: Emma Karjalainen



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Activity name: Skyscrapers

A brief description of the activity: In this sudoku-like game the point is to fill a gaming platform with different size blocks: skyscrapers.

Implementation of the activity and the source of the workmanual: For this activity we need altogether 16 skyscraper blocks four of each: 1 block, 2 blocks, 3 blocks and 4 blocks. Multilink-cubes are perfect for this. This activity can be done in small groups, pairs or preferably alone. The goal is to fill the board with all of the 16 skyscrapers so that horizontally and vertically there are one of each of the skyscrapers. The boards have numbers that need to be followed: the number corresponds the amount of skyscrapers that can be seen from that spot. The idea is that a shorter skyscraper cannot be seen behind a taller one. For example if the number is four, it means that all four of the skyscrapers can be seen and thus there is only one possible solution for that line.

A harder version of the game is with 5 by 5 boards and 25 skyscrapers. Again, the boards have numbers on them and the idea is to fill the board with the skyscrapers so that the horizontal and vertical lines have only one of each of the skyscrapers.

<http://blogs.helsinki.fi/summamutikka/pilvenpiirtajat/> (28.10.2017)

REMEMBER!

- We had planned one more game but the Halloween party and less students than expected mixed the beginning a bit -> these games might not take this long so plan an extra game
- On Volume challenge try to see that everybody in a group gets to participate



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2. Club gathering: Getting to know each other

THE GOALS OF THE CLUB GATHERING:

- Get to know each other (new pupils this time)
- Learn how to work in a big group and let everyone to participate
- Develop reasoning skills
- Explore the spreading of a disease and see the effects of vaccination

PRELIMINARIES:

In case one wants to perform the activity “Frogs” on smaller groups: possibly make the waterlily pads and frogs ready from cardboard

MATERIALS AND EQUIPMENT, NECESSARY SPACES:

- Big enough space to form a circle (of chairs) for name games and Infection game
- Up to 3 stuffed animals/soft toys for Toy name game
- Different color post-its for Frogs (optional)
- Different color cardboard and possibly scissors for Frogs (optional)

SCHEDULE OF THE CLUB GATHERING:

0-15 min.	The Rules for the club
15-25 min.	“I like” -game
25-40 min.	Toy game
40-70 min.	Frogs
70-90 min.	Infection disease game

DESCRIPTIONS OF WORK INSTRUCTIONS:

Activity name: The Rules for the club

A brief description of the activity: Coming up with the rules for the club together with the students.

Implementation of the activity and the source of the workmanual: Make the rules on the board and let the students come up with their own rules. The rules should follow the schools rules, but there might be some extra rules they/you would like to have and it’s good to iterate that the school rules are also valid during the math club.

Activity name: “I like” -game

A brief description of the activity: Game to get to know the names of each other and what we like.

Implementation of the activity and the source of the workmanual: Form a circle of chairs. On “I like” there needs to be one less chair than there is participants on the game. The first one



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stands in the middle and says “My name is ... and I like ...” and everybody who likes this same thing too stands up and changes the place with someone else who stood up. Then someone else stays in the middle and the game goes on. I like -things can be whatever, for example a hobby, food, sport, animal.

Activity name: Toy game

A brief description of the activity: Repeating the names and memorizing them in a playful manner.

Implementation of the activity and the source of the workmanual: On Toy game we need one more chair in the circle (as many chairs as players). The starter has a toy and says someones name out loud and throws the toy for this person. The next one says somebody elses name (that is not said yet/didn't get the toy yet). We do this until the last person throws the toy back to the starter. We do this again a bit faster, throwing the toy to the same person everyone did on the last round. Do this as many times needed (maybe 3-4) and take another toy which will start off a little after the first one. Again doing the same round. Then add a third toy.

Activity name: Frogs

A brief description of the activity: On this game pupils help frogs to jump from one end of the waterlily pad row to other end of it.

Implementation of the activity and the source of the workmanual: There is couple of ways to do this game. One is to craft the waterlily pads and frogs from cardboard/paper, another play online and the one we used is to let the pupils to play the situation. Anyway the idea is to form a line of waterlily pads. On our play the chairs were the waterlily pads. First start with the simple situation where is three waterlily pads on a row, on one end is one yellow frog and on the other end is one green frog (one free pad in between). Pupils were the frogs and we gave them different color post-it papers to mark the color of the frog. The frogs are allowed to move only to one direction (they can't go backwards) and they can either jump to an empty lilypad next to them or they can jump over one frog. The idea of the game is to help the different color frogs change the place with each other/get from one end to other end by following these rules. The game comes harder the more pads and frogs there is (5 pads and 4 frogs, 7 pads and 6 frogs etc.)

Instructions in Finnish: <http://blogs.helsinki.fi/summamutikka/sammakot/> (1.11.2017)

Link to play online: <http://smart-kit.com/s7284/frog-jumping-puzzle/>



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Photograph: Emma Karjalainen

Activity name: Infection disease

A brief description of the activity: Trying to simulate how an infection disease spreads and how a vaccination effects on spreading. Simulating this via handshakes and exploring how many pupils get the infection disease when there is one sick person in the beginning.

Implementation of the activity and the source of the workmanual: Stage 1: Form a circle. Everybody closes their eyes. The teacher walks around the circle and gives a mark (for example a cross on the back) for a pupil that is going to be the sick one. A sick student is a transmitter of the disease. Everybody shakes the hand of for example three persons. The transmitter has a special handshake (for example twice harder than normal) and everyone who gets this special handshake gets the infection and comes a transmitter themselves. Check how many got the infection. Repeat the stage 1 for example three times and mark how many got infected each time.

Stage 2: Explore the effect of vaccination. Agree another secret mark for the ones who get a vaccine against the infection (for example circle on the back). Vaccinated ones won't get the infection and won't become transmitters either. On stage 2 small amount of pupils (20-50%) get the vaccine. Count how many got infected. Repeat the stage 2 for example three times.

Stage 3: Same as stage 2 but now bigger amount of players will get the vaccine (80-90%). Count how many got infected. Repeat the stage 3 for example three times.

How did the vaccination and amount of vaccinated ones effect on the spreading if the infection)

<http://blogs.helsinki.fi/summamutikka/tartuntatautipeli/> (1.11.2017)



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REMEMBER!

- Rules could have been done at the first meeting but most students forgot to come so we did it on the second meeting
- Normally the name games can be held on the first meeting, but as we had many new pupils on the second meeting we planned this activity for the second meeting too
- Again we had one extra game but lively group and little late snacking made the beginning slower -> plan one more game



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3. Club gathering: Police officers

THE GOALS OF THE CLUB GATHERING:

- Learn to think about the bigger picture
- Develop reasoning skills
- Learn to work in pairs

PRELIMINARIES:

Before the club print the villages and police officers for Cops and crooks and make tags for the countries/cities for Traveling game.

MATERIALS AND EQUIPMENT, NECESSARY SPACES:

- Big enough space, country/city tags and (masking) tape/ropes for Traveling game
- The villages and cops and scissors to cut the police for Cops and crooks
- Different sized blocks for Hanoi tower (5-7 sizes for each group)

SCHEDULE OF THE CLUB GATHERING:

0-45 min.	Cops and crooks
45-75 min.	Hanoi tower
75-90 min.	Traveling game

DESCRIPTIONS OF WORK INSTRUCTIONS:

Activity name: Cops and crooks

A brief description of the activity: On Cops and crooks pupils try to place the minimum amount of policemen to villages as allowed by instructions.

Implementation of the activity and the source of the workmanual: We start by telling a story about a village called Crime where is too many crooks. The villagers get tired of crimes and decide to take action. They have a village meeting and a police expert advises them the following: There should be a police in maximum one block distance from each house. This means for each house that either in that particular house is a police or then in the house next to it. Police patrols are expensive and the villagers have lost a lot of money for crooks so they try to place a minimum amount of police officers to village following the expert's advice. Each group/pair (or big group) then try to solve the minimum amount of police for each village (there is 8 village options) and place the police officers correctly. First pupils can cut the police officers and then concretely move them around the village maps. If it is difficult the teacher can tell the amount of police officers needed in each village. In Finnish instructions there is attached propositions for village maps and police officers (and solutions).

<http://blogs.helsinki.fi/summamutikka/rosvot-ja-poliisit/> (6.11.2017)



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Activity name: The Tower of Hanoi

A brief description of the activity: The Tower of Hanoi is a deduction game where a tower made of different sized disks is to be moved on the other side of the board.

Implementation of the activity and the source of the workmanual: Before the activity the story of the Tower of Hanoi can be told (e.g. from the Wikipedia article). The Tower of Hanoi has a board of three slots. The goal is to move the Tower of Hanoi built from different sized disks from one end to the other. Only one disk can be moved at a time and a disk can only be placed into an empty slot or on top of a bigger disk. Only the uppermost disks are free to move. The more disks the tower has the more difficult the task becomes. A more difficult version of the game is to try and come up with the minimum amount of moves that the moving of the tower takes.

<http://blogs.helsinki.fi/summamutikka/hanoiin-torni/> (6.11.2017)

https://en.wikipedia.org/wiki/Tower_of_Hanoi (6.11.2017)



Photographs: Emma Karjalainen

Activity name: Traveling game

A brief description of the activity: On Traveling game there is a train network made from tape/rope on the floor. There is different traveling destinations (for example capitals of countries) marked on the floor. Pupils can choose their holiday destination and then they are given a home country. To goal is to get each traveler (pupil) back to their home country.

Implementation of the activity and the source of the workmanual: On preparation of Traveling game there should be made a train network on the floor from (masking) tape/rope and the traveling destinations (for examples capitals of countries) marked with tags and preferably flags attached. One possible model of the train network is attached on Finnish instructions. In this model is 11 “knots”/capitals. Then pupils can choose a holiday destination. The game is more difficult the more pupils there is on the network. Maximum in this network is 10 travelers (one less than there is capitals). But it’s easier to start with for example 5 pupils/travelers and do



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the game again with more travelers when everybody got the idea. When the pupils have decided their destinations and took their place on the network they will get their home countries. Now the goal is to get everyone to their home country. The rules for moving are following: there is a ball (or more than one, then the game comes easier) and the traveler with the ball is the one allowed to move. Only one train (traveler) can be on each station at a time so basically the traveler with the ball can move to an empty train station/city next to them. Then the traveler throws the ball to another traveler and they are allowed to move. Note that the traveler might have to move again even if they reached their home country already to make it possible to others to reach their home countries. If the game comes impossible there can be railways or balls added to the game also in the middle of the game. If you need to make the game more difficult add more travelers.

<http://blogs.helsinki.fi/summamutikka/internet-peli/> (6.11.2017)

REMEMBER!

- Cops and crooks gets a little boring for the younger children if played for too long.
- 15 minutes is not enough for Traveling game, we ran out of time.
- Traveling game takes a lot time for preparations/making the network: maybe do this before the club or during some task the pupils can do independently.



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4. Club gathering: Spatial reasoning 2D and 3D

THE GOALS OF THE CLUB GATHERING:

- Improve one's spatial reasoning
- Learn some basics of probability
- Have fun!

PRELIMINARIES:

Before the club make yourself familiar with the instructions for the games and if possible take photographs of the 2D versions of the Happy cubes. This way it is quicker to solve the puzzles at the end of the club if the children haven't managed to do so. Think about how to explain the probability in rolling the two dice.

MATERIALS AND EQUIPMENT, NECESSARY SPACES:

- pentomino pieces, game boards, paper, pencils and centimeter cubes
- Horse race boards, play figures and enough dice
- Happy cubes

SCHEDULE OF THE CLUB GATHERING:

0-35 min. pentominoes
35-60 min. Horse race
60-90 min. Happy cubes

DESCRIPTIONS OF WORK INSTRUCTIONS:

Activity name: Pentominoes

A brief description of the activity: The children try to come up with all the pentomino pieces and then try to fit them in given shapes.

Implementation of the activity and the source of the workmanual: There are 12 pentomino pieces which the children try to come up with using centimeter cubes and paper and pencils. They are given for example 10 minutes' time after which the shapes are drawn on the blackboard together with the children. The children are then given the pentomino pieces that are made of paper and they have to try and fit them into the given shapes.

<http://blogs.helsinki.fi/summamutikka/pentamino/> (11.11.2017)

Activity name: Horse race

A brief description of the activity: This game is played in pairs. Children get play figures and a game board and try to win the horse race.

Implementation of the activity and the source of the workmanual:



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The main idea of the game is that when you roll two dice and calculate the sum there are certain numbers that occur more recently than others. This should not be told to the students beforehand.

Two children play as a pair against each other. They both pick a lucky number between 2 and 12. They take turns in rolling two dice and get to move their play figure one step further on the board whenever the sum of the two dice is their lucky number even if it's not their turn in rolling the dice.

The second version of the game is a game board of 11 racing horses. This we played so that one person was moving the horses with lucky numbers from 2 to 6 and another was moving the ones with lucky numbers from 7 to 12. Two people were rolling the dice and the rest said the sum of the two dice. At the end of the game we showed the children why certain horses moved so slowly compared to the winners. <http://blogs.helsinki.fi/summamutikka/hevoskilpailu-2/> (11.11.2017)



Photograph: Emma Karjalainen



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Activity name: Happy cubes

A brief description of the activity: Children get to solve jigsaw puzzles made of foam. The first task is to make a cube and the other is to fit the pieces back into their places in the frame.

Implementation of the activity and the source of the workmanual: There are four levels of Happy Cubes: the Little Genius, the Happy Cube, the Profi Cube and the Marble Cube. They each have six different models, which differ in color and the degree of difficulty. We gave the children first the ones we considered to be the easiest and then when they got them done they got a harder one. Some wanted to start with the harder ones and didn't get to finish.

<http://www.happycube.com/> (11.11.2017)

REMEMBER!

- Take photographs of the Happy cubes before the club when the pieces are still in their places in the frames.
- Don't spoil the fun of the horse racing by telling the idea of the lucky numbers beforehand.
- The hardest pentomino game board (where you have to use all the pentomino pieces to form a rectangle) is really hard. Consider taking the solution with you and/or giving hints in how to fill it.



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5. Club gathering: Deduction games

THE GOALS OF THE CLUB GATHERING:

- Make mathematics fun
- Improve one's deduction skills
- Have fun

PRELIMINARIES:

Before the club make yourself familiar with the instructions for the games and take with you the answers to the sky scrapers.

MATERIALS AND EQUIPMENT, NECESSARY SPACES:

- Sky scrapers and game boards
- Pencils and grid paper
- Hanoi tower discs

SCHEDULE OF THE CLUB GATHERING:

0-30 min.	Battleship
30-80 min.	Sky scrapers
80-90 min.	Hanoi towers

DESCRIPTIONS OF WORK INSTRUCTIONS:

Activity name: Battleship

A brief description of the activity: Try to sink your opponent's ships by sending bombs into the coordinates.

Implementation of the activity and the source of the workmanual: Battleship doesn't need almost any equipment, all you need is grid paper and pencils. There are 5 types of ships you need to place in a 10 by 10 grid where the squares are marked from 1 to 10 on one axis and A to J on the other axis. The ships need to be drawn so that they can touch each other only from the corners but not sides. The ships are drawn as follows: one ship that is 5 squares long, one that is 4 squares long, two that are 3 squares long, three that are 2 squares long and one that is only one square.

The opponent tries to sink the other player's ships by bombing coordinates. For example if the first player sends a bomb to A5, the opponent checks their grid and says: "Hit", if the bomb hits, "Miss", if the bomb misses or "Sunk", if the bomb sinks the ship. Whenever one gets a hit they get another turn.

<http://blogs.helsinki.fi/summamutikka/koordinaatistopeleja/> (20.11.2017)

Activity name: Skyscrapers



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A brief description of the activity: In this sudoku-like game the point is to fill the game board with different sized blocks: skyscrapers.

Implementation of the activity and the source of the workmanual: For this activity we need altogether 16 skyscraper blocks four of each: 1 block, 2 blocks, 3 blocks and 4 blocks. Multilink-cubes are perfect for this. This activity can be done in small groups, pairs or preferably alone. The goal is to fill the board with all of the 16 skyscrapers so that horizontally and vertically there are one of each of the skyscrapers. The boards have numbers that need to be followed: the number corresponds the amount of skyscrapers that can be seen from that spot. The idea is that a shorter skyscraper cannot be seen behind a taller one. For example if the number is four, it means that all four of the skyscrapers can be seen and thus there is only one possible solution for that line.

A harder version of the game is with 5 by 5 boards and 25 skyscrapers. Again, the boards have numbers on them and the idea is to fill the board with the skyscrapers so that the horizontal and vertical lines have only one of each of the skyscrapers.

<http://blogs.helsinki.fi/summamutikka/pilvenpiirtajat/> (20.11.2017)

Activity name: The Tower of Hanoi

A brief description of the activity: The Tower of Hanoi is a deduction game where a tower made of different sized disks is to be moved on the other side of the board.

Implementation of the activity and the source of the workmanual: The Tower of Hanoi has a board of three slots. The goal is to move the Tower of Hanoi built from different sized disks from one end to the other. Only one disk can be moved at a time and a disk can only be placed into an empty slot or on top of a bigger disk. Only the uppermost disks are free to move. The more disks the tower has the more difficult the task becomes. A more difficult version of the game is to try and come up with the minimum amount of moves that the moving of the tower takes. <http://blogs.helsinki.fi/summamutikka/hanoiin-torni/> (20.11.2017)



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6. Club gathering: Board Games

THE GOALS OF THE CLUB GATHERING:

- Have fun with mathematics
- Improve one's spatial awareness and reasoning

PRELIMINARIES:

Before the club make yourself familiar with the instructions for the games so that they are easy enough to explain to the children.

MATERIALS AND EQUIPMENT, NECESSARY SPACES:

- Platonic solids, cocktail sticks, mini marshmallows
- Games: Blokus and Changing labyrinth

SCHEDULE OF THE CLUB GATHERING:

0-30 min. Platonic solids
30-90 min. Board games

DESCRIPTIONS OF WORK INSTRUCTIONS:

Activity name: Platonic solids (shapes)

A brief description of the activity: Children get the five platonic solids and they have to try and make them using mini marshmallows and cocktail sticks.

Implementation of the activity and the source of the workmanual: In the Summamutikka supply closet there are platonic solids that are made from paper. Children get to look at these as they try to construct the platonic solids using mini marshmallows and cocktail sticks. The first four are fairly easy to make so the children are asked to do them all but the dodecahedron with the pentagonal faces is hard to make since it doesn't hold itself together. If some people get the first ones done quickly then this can be done in pairs.

<http://blogs.helsinki.fi/summamutikka/salaperaiset-kappaleet/> (10.12.2017)

https://www.mathsisfun.com/platonic_solids.html (10.12.2017)

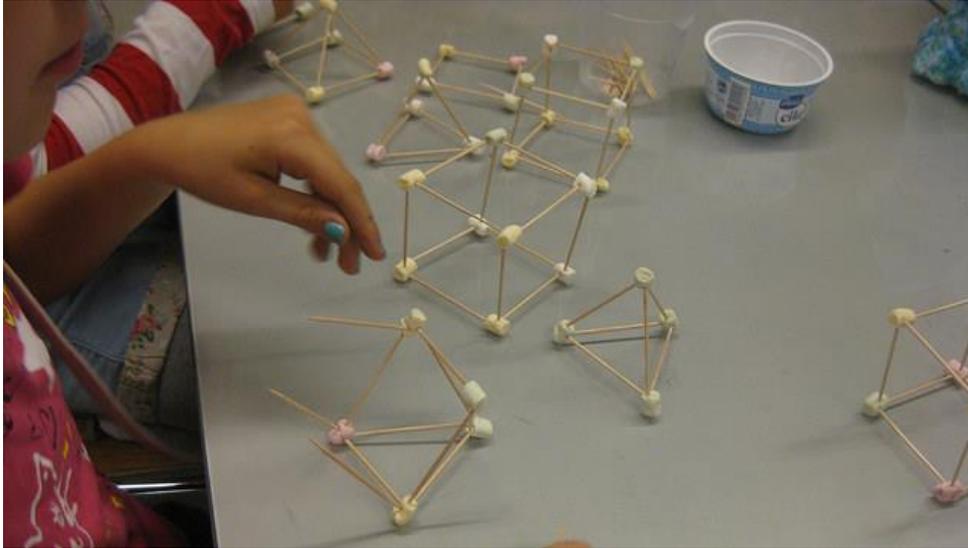


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Photograph: Flickr [LUMA Centre Finland](#)

Activity name: Blokus

A brief description of the activity: The game can be played with 2 to 4 players. The winner is the person who, in the end has the least amount of pieces left.

Implementation of the activity and the source of the workmanual:

Each player has a set of 21 monomino, domino, triomino, tetromino and pentomino pieces. The idea is to fill the board with as many of the pieces as possible. The first piece must be in one of the four corners and the others have to touch one of the vertices of the player's pieces by one of its vertices. The pieces cannot touch each other from the edges except if it's another player's piece. Players can also try to block other players. When a player cannot place another piece they have to quit. The player who wins is the one who is left with the least amount of pieces.

Activity name: Changing labyrinth

A brief description of the activity: For 2 to 4 players. A labyrinth game where players try to find their treasures as quickly as possible. The winner is the one who first collects all their treasures and gets back to their starting point.

Implementation of the activity and the source of the workmanual: The players start at one corner and try to find all of their treasures as quickly as possible. First they have to change the labyrinth somehow and then move their figure as far as it goes or it can also stay put. If by moving the labyrinth a player drops someone else's figure it goes to the opposite side of the game board. The things you can't do is reverse the previous player's move or drop yourself out of the board. When someone finds a treasure they get an extra turn. The winner is the one who first collects all their treasures and gets back to their starting point.



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REMEMBER!

- Important words for Platonic solids
 - tahko = face, särmä = edge, kärki = vertex, kärjet = vertices
 - tetrahedron, cube, octahedron, dodecahedron, icosahedron
 - triangular face, square face, pentagonal face
- Explain the rules well in the board games so you can be an extra player in another game if necessary



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