Chain experiment on the wall and on the floor

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Instructions are intended for

This instructions are intended for educators, mentors, adult educators and anyone else who wants to promote the manual skills of the preschool children and encurage their interest in technical professions.

Basic idea

The third LTT3 workshop in Gdansk, Poland, is an extension of the Chain experiment into a living space: classroom, gym, hall, yard, meadow, street… Due to its simplicity and wide combinability, it is suitable for both individual activity of children and adults as well as working in large groups. It does not require prior knowledge, so we can inspire every child to show their imagination and creative skills.

The elements for the chain experiment are simple and cheap. With some resourcefulness also waste material (from households, commerce or crafts) can be used. Chain wall experiment is very suitable activity implementation in school camps, it can be used for various activities in the classroom and in play areas, and also at public events. With family we can do it on picnics. With a touch of imagination, we can use every terrain to set up a chain experiment in nature. It is well suited for demonstration and promotional purposes of a Chain experiment in public.

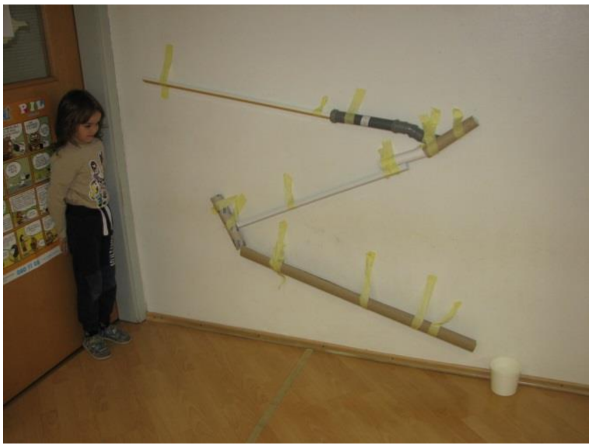
The proposed implementation of the chain experiment on LTT 3 is divided into two separate units:

a.) a chain experiment on the wall

b.) a chain experiment on the floor

In practice, the two units can always be combined with each other. From an elementary element we can set up an arbitrarily long Chain experiment.

Chain experiment on the wall






Chain experiment on a wall is builded up on a vertical plane: wall, screen, cardboard or particle board, school board, fence, retaining wall .... We can also use a oblique plane- slope uphill, a concrete or asphalt slope, grass slope, snow slope, ..., even the stairs is fine. The choice is left to the mentor according to the options the environment allows and the elements available to him / her. At the LTT3 workshop, each team is expected to use a vertical wall 2 m high and about 4 m long.

The basic elements are cardboard tubes and gutter, which are diferent in length and cross-section size. For cardboard tubes, we can use tubes that we get as scrap (waste) material in print shops (wrapped with printing paper), shops (wrapped with textiles, plastic sheets, or floor coverings, or shopping plastic bags, etc.), in factories (wrapped with plasticfoil).... We can make gutter ourselves from round pipes by cutting it in half lengthwise (with a saw, circular saw or angle grinder). In addition to round ones, we can use square pipes and grooves. They are usually obtained as scrap from electricians and electronics (used to distribute cables around the premises), but can be purchased at a technical store. The cardboard can also be replaced with plastic.

In addition to tubes and gutters, we also use plastic bottles, plastic yoghurt pots, various waste packaging pots, boxes containing food, tubes from paper towels, ... There are many household packaging waste items that can be used for a chain wall experiment. Therefore, it is useful to instruct children to collect material for a chain experiment at home and bring it to the nursery. This encourages them to actively participate in the design of the chain experiment. At the same time, with the possibility of reuse of household waste, we remind them of their additional usefulness as well as takeing care of their ecological awareness. We also indirectly influence on parents to participate consciously and actively in the Chain experiment.

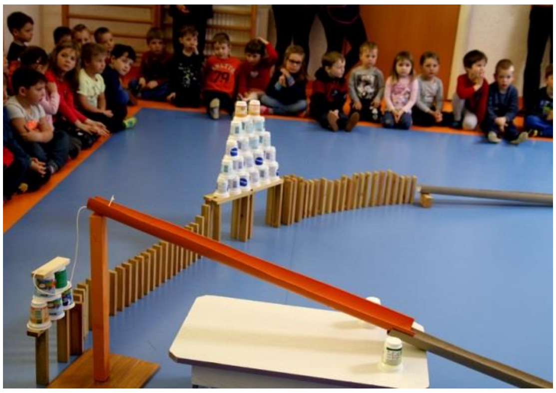
For a chain experiment on the wall, find a vertical surface where pipes and grooves can be glued to the wall. The surface should not be dusty and too rough, because then the adhesive tape does not grip. The vertical surface can also be made of wooden board or cardboard, which is fixed vertically to the wall. We can also use freestanding screens. Chairs and tables can also be used for gutter supports. We glue with adhesive tape (used by malarians in wall bleaching), which does not damage the wall and after use is detached from the wall without damage and without leaving a trace on the base. The strength of the adhesive tape is usually short and after a few hours the laden adhesive just peels off. Therefore, the Chain experiment on the wall is not permanent and is torn down at the end of the workshop.

Use plastic, metal or wooden balls (heavier balls get the speed more quickly), which should have a diameter of about 2.5 cm (so they can go through the throath of the bottles). In nature, tennis balls can be used because small balls often get lost in the grass. In the beginning, we only one ball which can go through the whole experiment. Children use prefer more rolling balls, so it can be predicted that in some places the starting ball will ~~be~~ triggers the balls that are set at individual places in the experiment itself. At the end of the experiment, place a catching box so that we do not chase the balls around the room.

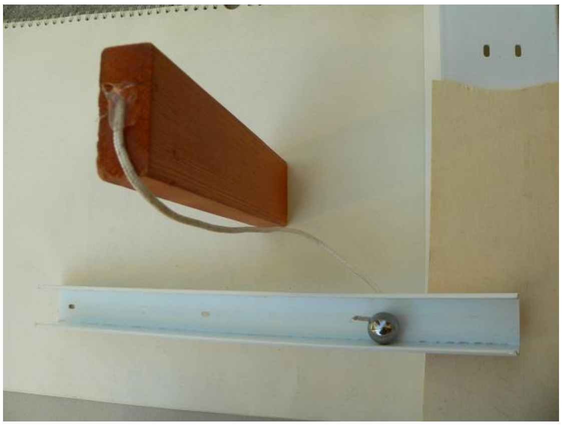
We start building a chain experiment at the very top. We include each new element in the chain already builted when we are satisfied with the ball running through the added element. We try to find the right pitch and the right link to the previous element. The new element shall be firmly adhered to the base with adhesive tape or fastened with elastic or metal wire or with rope. We create the ball path on an ongoing basis and use the basic elements that we have prepared in advance. It is useful to make a preliminary sketch of the route, especially in teamwork. By drawing a sketch, we stimulate the initial motivation in children and get them used to teamwork.

During building a chain experiment on a wall, children have a strong motivation and concentration, so the activity can make them busy for an hour or even more. The group should consist of no more than five children so that everyone can put their ideas into action and be active. A chain experiment on a wall can also be built by a single child alone or together with an adult.

Chain experiment on the floor

We use for the chain experiment on the ground, large wooden dominoes, empty yogurt pots, cardboard grooves and a spiral slope made of paper (plastic) plates and a flexible rope. Chairs or wooden supports can be used to set the ramps. Setting up a chain experiment on the ground is left to the creative imagination of the team. It is useful to draw a basic sketch before layout. Dominoes can be erected upright, floor buildings can be built from them, yogurt pots and other elements can be laid on them. To trigger a raised ball, for example in a sloping tube, use a rope attached to a domino. When the domino falls, it pulls a rope behind it and a trapped ball is released. We can also push forward dominoes via a cord attached to a domino or ball.

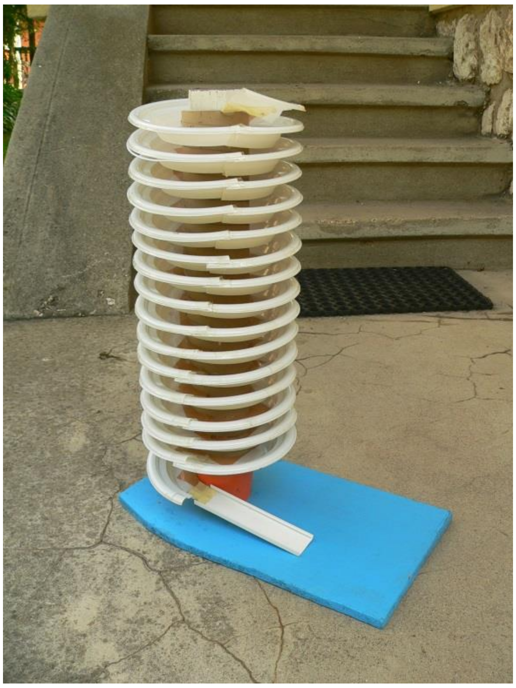
If we have more than one team, each team builds their own chain. Then we connecte all the experiments together and trigger the experiment with the ball.

We make dominoes ourselves from wooden lath , 4 cm x 1.5 cm in cross section (the cross section may vary with the purchase option). The length of the lath does not matter. From the (lath) moldings we cut dominoes of different lengths: 5 cm (5 pc), 10 cm (20 pc), 20 cm (50 pc), 30 cm (20 pc) and 40 cm (5 pc). Practically the most useful dominoes are 20 cm in length. From the team is expected to make in total 100 dominoes, or more. We grind the dominoes to make them smooth. Later, after the workshops, they can be painted or just impregnated with oil, so that they can also be washed with water if necessary.

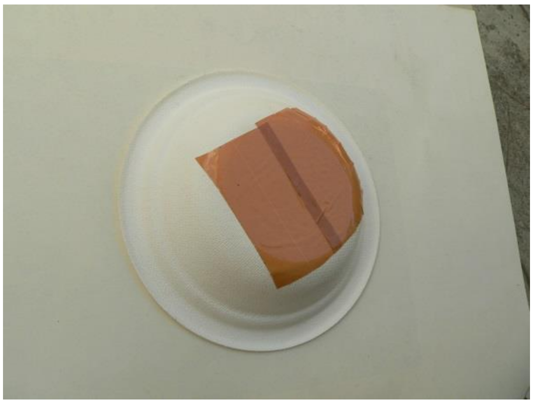
The production of dominoes should take 4 hours and the installation of chain experiment on the ground around 2 hours. A final trigger time of 0.5 hours is expected.

Spiral slope made of paper plates

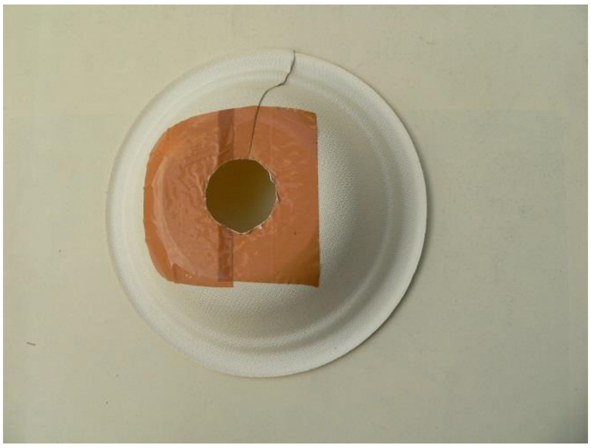
We will use a spiral slope made of paper (plastic) plates in a chain experiment on the ground. In practice, it is a great freestanding toy that will catch your child's attention.



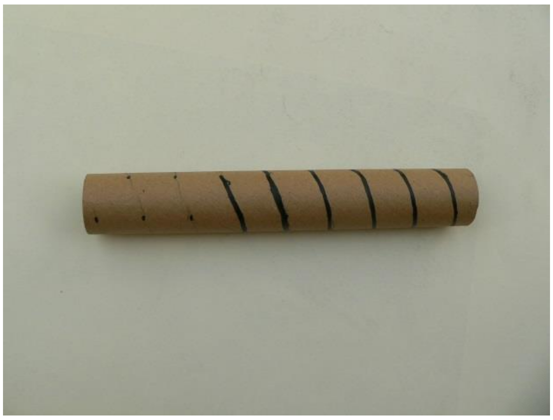

For spiral slopes made of paper (plastic) plates, we need a cardboard tube about 8 cm in diameter and about 80 cm in length (different dimensions can be chosen). We need 30 paper (plastic) plates with a high side edge that prevents the ball from jumping out of the plate (if we are working with double plates we need 60 plates). The diameter of the plate should be at least 20 cm. I recommend paper plates because they are firmer and more resistant to damage. Plastic plates are fragile and break quickly when we make a spiral slope (cutting the center opening in plate). Strength of plates is increased by combining two or three plates together (if we combine plates, we need to increase the »step« of the spirals).We reduce breaking plates cutting of the center opening if the center of the plate is glueed with adhesive tape.

In the middle of the plates we cut the opening that is the size of the outer diameter of the cardboard tube. The opening is first drawn with **a compass** on one plate. Before that, the center of the plate is determined by trying if the compass is stabbed in the center, then the second leg of the compass must slide all the way around the outer edge of the plate. We can define the center of plate also by constructing it, but this is a job for mathematicians. If the center deviates a few millimeters from the true center, the spiral slope will be asymmetrical but still function. Once the circle is drawn, we affix a wide adhesive tape to the other side of the plate (bottom) so that the plate does not break when cutting the opening. When we cut off the opening at the first plate, we use it to draw a circle at all other plates. We write on plate BASE. We put the base plate on another plate and draw a circle on it. Since we have determined the center only approximately, it is useful to immediately identify and mark the same spot on each circle on the plates where we will radially cut the plate. This ensures a finer finish to the spiral slope.



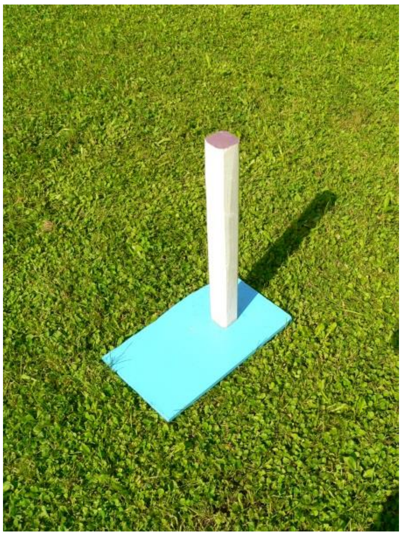
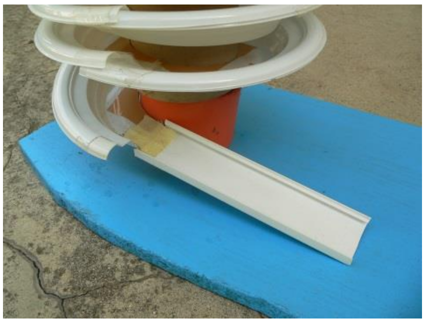
Glue all the plates (with the circle drawn on the underside) with a wide adhesive tape and cut them radially through the marked spot. Then cut out the center circle. You can use scissors or a Stanley knife.



On the cardboard tube we draw a spiral with a pencil. On the shape of the spiral we will glue the plates. The spiral step should be 2.8 cm or 3.2 cm (at least 3 mm larger than the diameter of the ball). We use points to draw a spiral.

Draw points along the cardboard tube in four rows. They are spaced apart by a quarter of a pipe. We draw from the top of each row the multiple of a number of 2.8 cm (step): 2.8 cm; 5.6 cm; 8.4 cm; .... At the first raw we start at the very top. On the radially opposite side of the first raw, we start drawing points at 1.4 cm below the top and continue again with a multiple of the step, that is 2.8 cm. Similarly, we make points on a quarter part of a cardboard tube, only to start at one end 0.7 cm below the top and on other end at 2.1 cm below the top. Drawn points we connect in a spiral line.

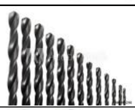
We glue cuted plates along a spiral line on a cardboard tube with thermal adhesive. Attach it by making a slope with a walk (step) of 2.8 cm (the back edge is 2.8 cm lower than the front). Glue on the bottom of the plate, so that the adhesive does not interfere with the rolling of the ball. We need to start at the top of the spiral and continue towards the bottom. At the bottom, leave 5 cm of cardboard tube bare (do not glue plates) so that we can direct the ball forward when it rolls out of the spiral slope. If we forget and paste the plates to the very bottom, we help with a ring cut from a cardboard tube that has the same cross-section as the carrier tube and place it on the bottom itself under the spiral. When we finish and put the spiral slope in the correct position, the recessed part of the plate should look towards the top and the bottom towards the lower end of the tube. The two adjacent plates overlap at the edge of the spiral about 1 cm wide (the rear end of the previous plate is above the first end of the next plate so that the ball cannot roll into the edges when rolling). Bond the overlapping with plastic adhesive or just with adhesive tape (I recommend transparent adhesive tape) to increase the strength of the coil. If the ball jumps out of the spiral slope over the edge of the plate because of the speed, the problem is solved by surrounding the outer part of plates with a transparent foil (it may be thicker, and a transparent foil for wrapping food is also useful). An iron ball 2 cm in diameter is used for rolling down a slope. We can also use other balls, but with a diameter smaller than the distance between adjacent plates (step).

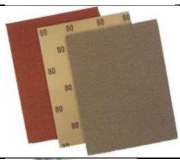
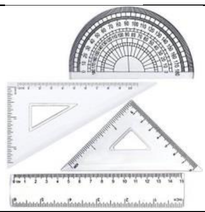
 

The construction needs a strong and stable support. We make it from a board about 1 cm thick and from a round wooden cylinder or square molding that fits tightly with the inside of a cardboard cylinder. The length of carrier should be 5 cm longer than the cardboard roller, in our case it is 85 cm. To the board, measuring about 30 cm x 30 cm, we will screw in a roller or square lath that will carry a spiral slope. At the exit of the spiral slope, the ball is directed with a rectangular groove forward into the ball collector or into a continuation of the chain experiment. The gutter is glued with adhesive tape to allow it to change direction.

Building the spiral slope is expected to take 4 hours.

THE TOOL WE NEED

Tools	
Drill machine	
Various drill bits (for wood and metal) – 2 mm, 3 mm, 4 mm, 5 mm, 6 mm, 7 mm	
Foxtail saw – small saw teeth	
Metal hand saw and metal saw blade	 

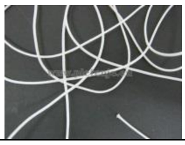
Strong scissors	
Patex thermo gun + glue cartridges	
Hammer (200 g)	
nail puller pliers	
combined pliers	
4 screwdrivers (flathead and Phillips)	
Flat files (for wood and metal)	
Abrasive paper for wood (rough and fine)	
Hot air dryer	
Tape meter (2 m)	
triangle	

clamp	
angle ruler	
pencil	
power strip	
Stanley knife	
Coloring brushes Thin: 1 mm, 3 mm, 5 mm Fat: 1 cm, 3 cm, 5 cm	

<u>Chain experiment on the wall</u>

Consumables

The needed material and tools which has to be prepared for each section for six teams:

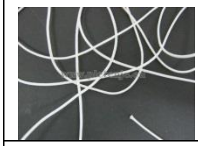
Material for six contraption
Cardboard tubes about 5 to 8 cm in diameter (can be of different diameters) and any length - total length all of them at least 60 m. The pipes should be cut lengthwise into grooves in half.
Plastic pipes of square or rectangular cross-section of different dimensions (most useful: width 30 mm x height 20 mm or 40 mm x 25 mm). That can also be a waste material in electrical or electronic installations. The total length should be at least 30 m.
A thin and flexible twisting rope about 1 mm in diameter. Overall length 25 m. It can be a rope used for interior window blinds. 
Various waste plastic containers (ice cream, food, curd, cream, yogurt, ...)
30 kom – Different plastic stoppers

50 kom – Waste transparent plastic bottles wide throat (diameter 4 cm) 15 kom - Waste transparent plastic bottles (diameter 2,5 cm)
90 pcs of plastic (or metal or woden) balls with a diameter round 2,5 cm
600 kom – erasier for closing jars (they can be different sizes). 
0,5 kg plasticine
6 pcs boxes for collecting balls (you can use ice cream boxes).
Wooden carpentry waste.
Metal wire diameter about 1 mm. Total length 30 m.
18 pcs - Adhesive tape (used by malarians in wall bleaching), which does not damage the wall and after use is detached from the wall without damage and without leaving a trace on the base. The width of the strap should be 3 cm. 
Waste cardboard and newspaper to protect furniture and floors. Waste cloths.

__Chain experiment on the floor__

Consumables

The needed material and tools which has to be prepared for each section for six teams:

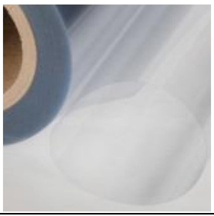
Material for six contraption
6 kom - board 30 cm x 30 cm, thickness of 1 cm (cardboard gutter holder) Footnote: the dimensions may deviate slightly from the proposed dimensions.
6 kom – pillar long 60 cm and cross section 5 cm x 5 cm (cardboard gutter holder) Footnote: the dimensions may deviate slightly from the proposed dimensions
Wooden slats cross section 4 cm x 1.5 cm - overall length 6 x 25 m. Footnote: the dimensions may deviate slightly from the proposed dimensions
300 pcs - Plastic cups (yogurt, cream,…) 
A thin flexible rope about 1 mm in diameter. Overall length 60 m. It can be a rope used for interior window blinds. 
Wooden carpentry waste.

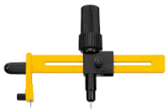
Wood screws of different sizes (from 1 cm to 6 cm). Each type of 30 pcs.
Nails of different sizes (from 1 cm to 5 cm). Each type of 30 pcs.
Waste cardboard and newspaper to protect furniture and floors. Waste cloths

Spiral slope

Consumables

The needed material and tools which has to be prepared for each section for six teams:

Material for six contraption
6 kom - board 30 cm x 30 cm, thickness of 1 cm (spiral base) Footnote: the dimensions may deviate slightly from the proposed dimensions
6 kom – pillar long 85 cm and cross section 5 cm x 5 cm Footnote: the dimensions may deviate slightly from the proposed dimensions
6 pieces of cardboard tubes, about 8 cm in diameter and 80 cm in length
24 pcs of metal balls with a diameter of 2.0 cm
6 pcs transparent plastic film (can be a hard film used for flower bouquets), measuring 70 cm x 70 cm. If it cannot be obtained, then 2 rolls of transparent wrapping fill 
6 x 60 high-edged paper plates (also plastic ones are possible), about 22 in diameter. No humps to brake the ball rolling. 
6 pieces of adhesive tape, 5 cm wide
6 pcs school circle drawing pen 
2 pcs OLFA rotary circle compass cutter


6 pcs transparent adhesive tape, 2 cm wide
For coloring - Colors (black, white, red, yellow, blue). Each color 1 kg. I recommend colors that are thinner with water and are durable when dried. They must not be harmful to children.
Waste cardboard and newspaper to protect furniture and floors. Waste cloths.