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STEM
E-CONTENT
3D VIRTUAL REALTY

The Key To Global Life,
Digital Change Of Nature

**Total Duration:** 6 - 10 hours

**Student's Age:** 12-18 Years

**Application Area:**
- Healthy food,
- Bacteria cultures,
- Plastic waste,
- Biology,
- CAD design

**Keywords: Making yoghurt, bacteria cultures, biochemistry, food science, microorganism, material science.**

# W5 - Do It Yourself Yoghourt Pots-Self Made Yoghurt

**Module**
- Water and healthy food

## W5 - English Version

**Materials:**
- **Yoghurt (Natural, Tasteless) (125 ml)**
- **Whole Milk (2 lt)**
- **Whisk, Bowl, Large Spoon**
- **Heavy pot with lid**
- **Towels**
- **Cooker/stove (to heat the milk)**

**To build a vacuum former**
- **Two 18 to 30 mm thick 30x30 cm square MDF sheets (for the bottom and top)**
- **4 MDF pieces 4 cm x 30 cm with a thickness of 18 mm to 30 mm (to create a frame)**
- **20 mm size spade bit**
- **The desired amount of sintra plastic (PVC sheet) with a thickness of 2-3 mm**
- **2 plywood sheets 1 cm high 40 cm wide square (for PVC frame)**
- **Drill and drill bit of various sizes (1/8" drill bit is important)**
- **Glue**
- **Heat gun or hot water**
- **Vacuum cleaner**
- **Clamping clamps for fixing MDF tables**
- **Screws of various sizes**
- **Several moulds for producing yoghourt cups from PVC sheet (can be printed with a 3D printer, or made from foam or potatoes).**

**Notes:**
- Students should work in groups during the activity,
- Should get help from an adult during the use of drill, spade bit, heat gun,
- Each student should design the experiment process himself.

## Introduction

The goal of this activity is tw fold: teach the students about healthy food and give them insights into fabrication techniques used for small series production. Additionally, they will apply the scientific method to carry out an experiment and to draw conclusions (Picture 1).

The students will make their own yoghurt based on yoghurt purchased in a store. They will test different yoghurts looking for the one that gives the best results, based on which yoghurt contains which bacteria cultures. Once the yoghurt is ready, they design and make their own yoghurt jars by vacuum forming techniques.


Picture 1. Yoghurt

Picture 2. Let's analyze yoghurt

Yoghurt is a yummy treat, but how is it made? With the help of microorganisms called bacteria, milk is turned into yoghurt. There is historical evidence that yoghurt-making developed 4,500 years ago as a way to preserve milk. Yoghurt is the result of bacterial fermentation of milk. In fermentation, the bacteria consume the milk sugar, lactose, and produce lactic acid. The end-product is a thick, creamy, and tangy food product.

But what conditions produce the creamiest yoghurt? Is it the temperature at which the yoghurt culture is added to the warm milk? Is it the fermentation time or temperature? Can you make yoghurt from yoghurt bought in a supermarket? Are there variables you can play with to get the best results? Is there a way to check if there are really living bacteria in the yoghurt?

In this cooking and food science project, you will try out a recipe to make yoghurt from bought yoghurt and investigate different factors to see which conditions produce the best yoghurt.

The most commonly used 'starters' (live culture of bacteria) used in yoghurt are lactic acid producing bacteria, Lactobacillus bulgaricus and Streptococcus thermophilus. They are added to the milk and after fermenting for a few hours at a certain temperature, yoghurt is created.

Many manufacturers also add live cultures to their yoghurt (this is in addition to the original starters used to make the yoghurt). The added strains vary by manufacturer, but the most commonly used are Lactobacillus acidophilus, Lactobacillus casei, and Bifidobacterium strains. The Latin names may sound intimidating, but these extra living cultures are a good thing nonetheless. The more good bacteria in your yoghurt, the better for your gut!

Once you make lots of yoghurt, where will you store it? What kind of jars do you find most often in the supermarket? Could you make your own? What kind of techniques are used to make the plastic yoghurt pots? How would you design a nice shaped jar?

In this activity, students will make their own yoghurt and yoghurt jar (Picture 3). They will follow a 3-step plan:

1. ***First Stage:*** The activity will start with yoghurt fermentation, yoghurt containers will be designed during the waiting period. During the waiting time, the students prepare a vacuum forming table to then create the yoghurt containers. They make their own designs using MDF plate, drill, saw, 3d printer etc.
2. ***Second Stage:*** Students learn to make yoghurt. At this stage, yoghurt includes the stages of fermentation.
3. ***Third Stage:*** The students design a scientific experiment to determine what factors affect the production of yoghurt and ascertain what are the best conditions for producing yoghurt.

Picture 3. Yoghurt Jar

## Considerations

- Students may work in groups
- Students must participate and be active in the preparation for, data collection of, and reporting during the experiment,
- Knowledge of Tinkercad is needed,
- Each group must prepare a short film (1.5 min) after the steps are completed.

## Aim of the Activity

- Understanding the science behind making yoghurt, experimenting with different bacteria cultures and optimising your own yoghurt farm.
- Getting to know a new technique called vacuum forming and its applications.
- To have knowledge about scientific working methods by conducting experiments.
- Develop spatial reasoning and mathematical skills while designing yoghurt containers.

## Activity Process

### Before Activity

At this stage, the teacher asks the following research questions:

- Ask the students what thermoforming is?
- Ask and discuss homemade yoghurt cultures?

We have two goals to achieve:

1. We want the students to apply the technique of vacuum forming to manufacture yoghurt jars. If you haven't got a vacuum former at your disposal, you can build one. Watch the video on how to build one:
   youtu.be/vFjnC47Y_i0
2. We want them to experiment in yoghurt making. Visit the link on homemade yoghurt:
   www.thekitchn.com/better-homemade-yogurt-5-ways-125442

Provide the students with background information about the technique of vacuum thermoforming.

Vacuum thermoforming is the process of heating thin plastic sheets to its forming temperature and stretching it over a mould, a vacuum is generated underneath the sheet to draw the plastic sheet against the mould until it takes its shape.

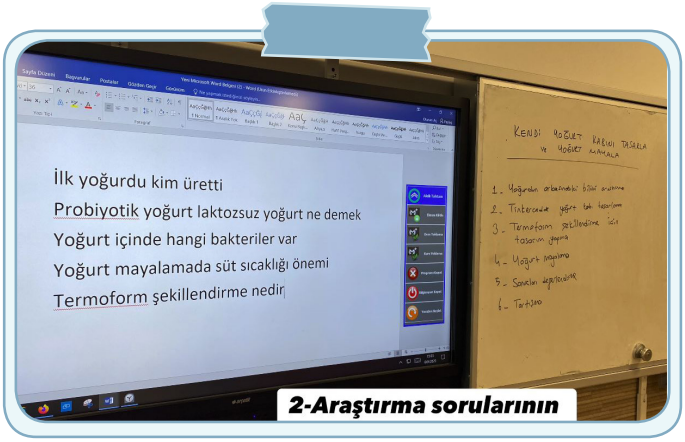
# Let's Start

## 1 Design Steps:

In STEP 1 and STEP 2 the students go through the process of designing a mould for the yoghurt jars and building a DIY vacuum thermoformer (Picture 4).

It is their task to create yoghurt containers using the technique of vacuum thermoforming.

If you own a thermoformer you can skip STEP 1 and start with STEP 2.




Picture 4. Design Steps

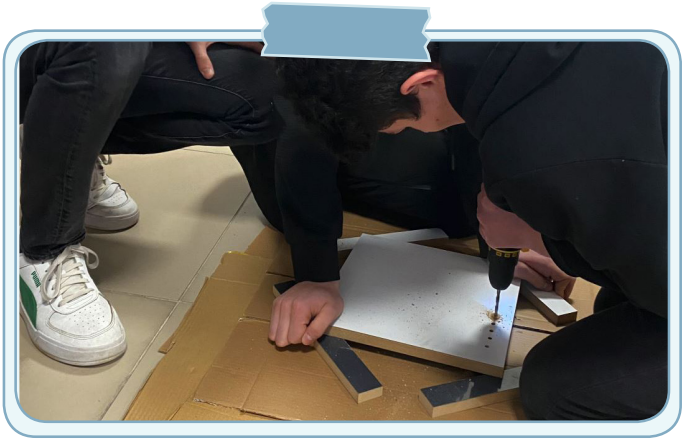
1. Provide 2 MDF square shaped boards, take 30 cm for the length of the sides, choose a thickness between 18 mm and 30 mm. These squares will be the bottom and top plates of the vacuum forming table (Picture 5).

Picture 5. 2 MDF

2. To prepare the top plate, drill a 26 cm x 26 cm grid of holes with 2 cm spacing. This grid can be printed on paper, which you place over the plate, so the holes are drilled in the correct place. Use a 1/8" thick drill bit. These holes will have a vacuum effect and will ensure that the air is evenly distributed over the entire area when the machine is working (Picture 6). There are many tutorials that can be found on how to build a thermoformer, you can for example visit the link.

## 2 We will go through the steps to build a basic thermoformer

This step consists of many stages, so it requires teamwork. Help students to create yoghurt containers.

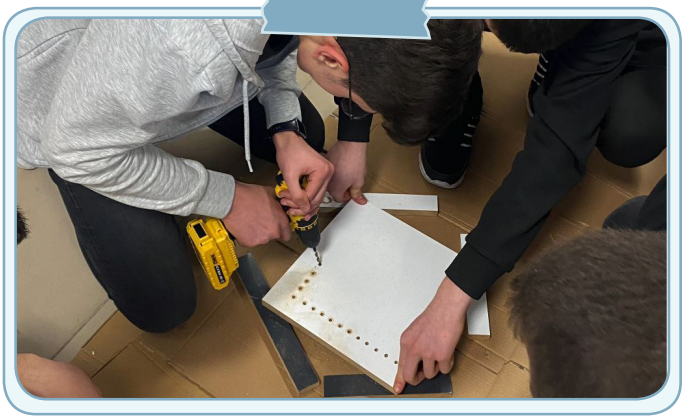


Picture 6. Drill the holes

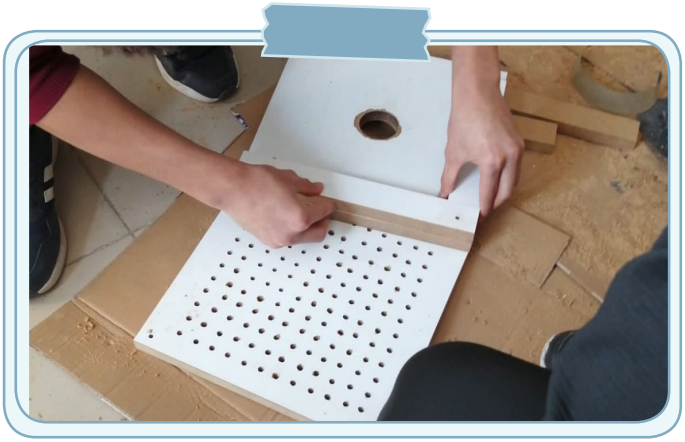
www.instructables.com/Vacuum-Forming-for-Free.

3. Prepare the bottom plate with the second plate. Make a circular hole of diameter 20 mm in the centre of the plate with the 20 mm spade bit. Make this hole as big as necessary to fit the hose of your vacuum cleaner. As will be seen later, the vacuum cleaner will create a vacuum effect for the heated PVC material and will allow it to gain shape (Picture 7). Take for example a look at:

www.youtube.com/watch?v=vFjnC47Y_i0.



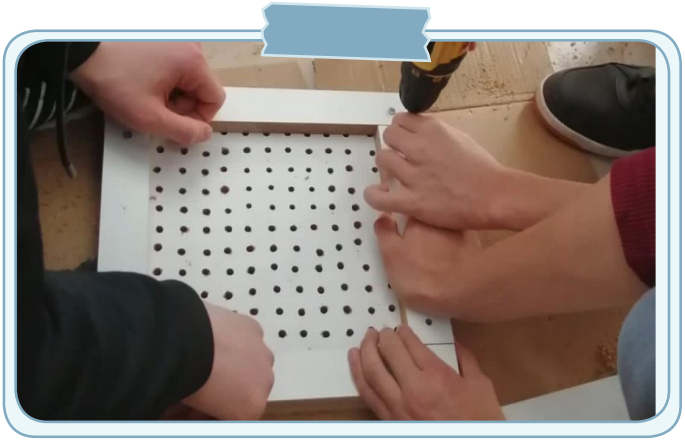
**Picture 7.** Drill the holes



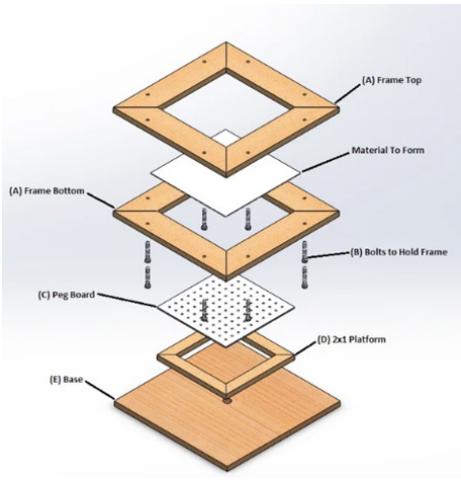
**Picture 8.** Drill the holes

4. To complete the box, prepare a square frame using 4 rectangular pieces of MDF sized 4 cm x 30 cm with a thickness of 18 mm to 30 mm. Glue the lower plate to the frame and glue on top the upper plate: think of it like making a sandwich lower plate - frame - upper plate, shorten the rectangular pieces to fit, for example by creating 45 degree angles that fit (Picture 8).

5. Prepare a frame to hold the sheet material you are going to use during the moulding process. Cut 2 squared plywood sheets, 40 cm x 40 cm of thickness 1 cm. Cut a square hole out of the middle of both sheets of 28 cm x 28 cm. Use holes and bolts to clamp the plastic sheet between the two frames you just obtained. (Picture 9).



**Picture 9.** Drill the holes




**Picture 10.** Drill the holes

6. Watch the links given in the steps above to understand how to use the vacuum forming table.
7. Test your DIY vacuum former using a convex shape made out of a substance that will not deteriorate with heat. Use for example a piece of wood or a potato you cut in convex shape (Picture 10).

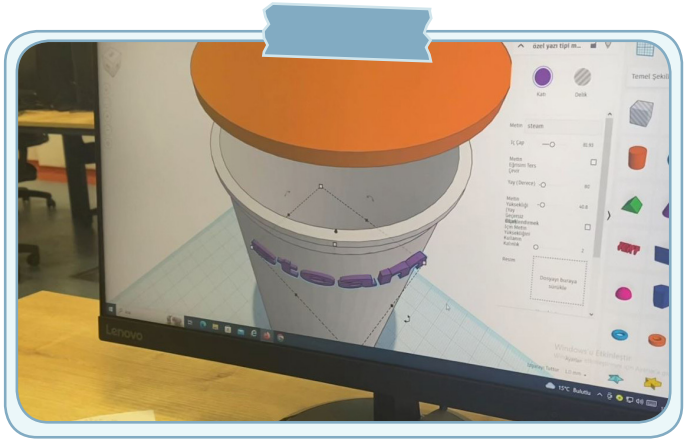
## 3 Yoghurt jars:

In this step, the students design a mould that will be used to manufacture the yoghurt jars. Let them first investigate which material they can use that is safe to store food, and what kind of shapes are suitable for this kind of moulding.

A. They need to design a convex shaped mould whose exterior surface will give the shape of the inner surface of the jar.
B. They can prototype the mould using 3d printing

## 4 Designing the mould

To design the mould, the student will use a CAD program such as Tinkercad or Fusion 360. They will have to take into account the following rule of thumbs to be able to easily unmould the object (Picture 11).



**Picture 11. Designing the mould**

**Picture 12.** Discuss the results

- Let the student produce at least one shape each.
- Test all the shapes with your vacuum former.
- Discuss and compare results to come up with the best suited shape for the yoghurt jar (Picture 12).

- Compare the different designs among the students
- Which designs were unmoulded smoothly? What were the problems, if any?
- Ask the students if they can make/ give an example of an object that cannot be unmoulded and of an object that can be unmoulded?


**Picture 13.** Compare the differant designs

## 5 Making Yoghurt

As a science experiment, students will try out a recipe to make yoghurt from bought yoghurt and investigate different factors to see which conditions produce the best yoghurt.

They learn about the importance of varying only one condition at a time when carrying out an experiment. They will plan a strategy about which factors they take into account as variables in their experiment and evaluate their effect on the yoghurt.

1. You need (Picture 14).
   - 2 litres of whole milk (you could test with skimmed as comparison),
   - 125 ml yoghurt,
   - a heavy pot with a lid.

Picture 14. Making yoghurt

Picture 15. Making yoghurt

2. Heat the milk. Pour the milk into the pot and place over medium to medium-high heat. Warm the milk to right below boiling, about 90 °C (Picture 15).

3. Stir the milk gently as it heats to make sure the bottom doesn't scorch and the milk doesn't boil over. This heating step is necessary to change the protein structure in the milk so it sets as a solid instead of separating (Picture 16).

Cool the milk. Let the milk cool until it is just warm to the touch, 44 °C to 46 °C. Stir occasionally to prevent a skin from forming. You can help this step go faster by placing the pan in an ice water bath and gently stirring the milk.

Picture 16. Heat - Cool

Picture 17. Whisk the yoghurt

4. Thin the yoghurt with milk. Scoop out about 240 ml of warm milk into a bowl. Add the yoghurt and whisk until smooth and the yoghurt is dissolved in the milk.

5. Whisk the thinned yoghurt into the milk. While whisking gently, pour the thinned yoghurt into the warm milk. This will allow fermentation (Picture 17).

6. Cover the pan and place the whole pot in a turned-off oven. Turn on the oven light or wrap the pot in towels to keep the milk warm as it sets (ideally around 40 °C, though some variance is fine). Lower temperature (room temperature) should be avoided, as it will spoil your yoghurt (Picture 18).

7 . Wait for the yoghurt to set. Let the yoghurt set at 40 for at least 4 hours or as long as overnight. The exact time will depend on the cultures used, the temperature of the yoghurt, and your yoghurt preferences.

The longer yoghurt sits, the thicker and more sharp in taste it becomes. If this is your first time making yoghurt, start checking it after 4 hours and stop when it reaches a flavour and consistency you like. Use a clean spoon EVERY TIME you try the yoghurt, to avoid contamination with other bacteria. Avoid stirring the yoghurt until it has fully set.

Picture 18. Cover the pan

Picture 19. Cool the yoghurt

8. Cool the yoghurt. Once the yoghurt has set to your liking, remove it from the oven. If you see any watery whey on the surface of the yoghurt, you can either drain this off or whisk it back into the yoghurt before transferring to containers. Don't keep yoghurt at room temperature for more than 2 hours (Picture 19).

9. Transfer the yoghurt into storage containers, cover, and refrigerate. Whisking also gives the yoghurt a more consistent creamy texture. Cooling and moving your yoghurt to the fridge should be done within 2 hours.

- **Is my yoghurt safe to eat?**
- *Yogurt should NOT look milky, runny, lumpy, slimy, stringy, gluey, or curdled.*
- ***Colour:*** *Yoghurt should look like the colour of the milk or creamers added to it. A creamy yellow colour on top is normal when heavy cream is added to the milk. The cream rises to the top during incubation and can form a crust. You can scrape this off, spread it on toast or stir it into your yogurt. While rare, any fuzz or pink spots on the surface of yoghurt are an indication of mold and should be discarded.*
- ***Smell:*** *Yoghurt should have a fresh, pleasant, fermented smell. It can smell sour, but should not be pungent (strong or sharp). If it smells rancid, foul, spoiled, strongly acidic, rotten, or off-putting, something other than yoghurt bacteria has cultured and it should be thrown out.*
- ***Taste:*** *Yoghurt should taste pleasant. It can be mild or tangy. Unsweetened yoghurt will taste plain and may taste sour, like sour cream. It should not taste overly sour, acidic, rancid, or "off." If it does, it should be discarded.*
- ***Note:*** *Homemade yoghurt will stay good for about 2 weeks in the refrigerator.*

## Closure

- Testing the yoghurt

Time for action and some scientific enquiry

If you read the recipe carefully, you should be able to guess at least 2 factors that influence the result. Which variables are the students' own choice. However, each group should definitely prepare an experiment report (Table 1).

Make a list of variables that you can control and that could have an effect on the result.

- Temperature of the milk
- Type of milk you used (other brands, whole, semi-skimmed, skimmed)
- Type of yoghurt used (fruit-probiotic-plain market yoghurt- homemade yoghurt, etc.)
- Bacterial culture used (such as Lactobacillus acidophilus, Lactobacillus casei, Bifidobacterium, Streptococcus thermophilus)
- Waiting time.
- Design an experiment where you test the effect of at least 2 factors
- Carry out the experiments and report your finding to the class

**Table 1.Testing form**

| Variable which is used | Factors | Appearance (colour) | Harshness | Smell | Taste |
|---|---|---|---|---|---|
| The culture used | Lactobacillus acidophilus | | | | |
| | Lactobacillus case | | | | |
| | Bifidobacterium | | | | |
| | Streptococcus thermophilus | | | | |
| Temperature of milk in step 5 (adding thinned yoghurt) | 20 °C | | | | |
| | 30 °C | | | | |
| | 40 °C | | | | |
| | 60 °C | | | | |
| Kind of yoghurt | Fruit | | | | |
| | Simple - Market | | | | |
| | Probiotic | | | | |
| | Vegan | | | | |
| | Simple - Homemade | | | | |
| Waiting time in oven | 1 hour | | | | |
| | 4 hours | | | | |
| | 12 hours | | | | |
| | 24 hours | | | | |

Ask the students following questions (Picture 20).

- Discuss the results of the science experiment and the importance of healthy food.
- Was there any brand of yoghurt that gave the best yoghurt (e.g. creamy and smooth flavour) at a given temperature and time to set?
- Is yoghurt healthy? Why?

**Picture 20.Discussion**

## Assesment

# Evaluation

- The following scoring system can be used for evaluation in this activity. In the end, the group with the highest score will be successful.

| Goals | Must be Improved (1) | Medium (2) | Good (3) | Very Good (4) |
|---|---|---|---|---|
| Task sharing, teamwork, effective communication during group work | ( ..... ) | ( ..... ) | ( ..... ) | ( ..... ) |
| The process of designing scientific experiments | ( ..... ) | ( ..... ) | ( ..... ) | ( ..... ) |
| The best yoghurt fermentation at the appropriate temperature and time | ( ..... ) | ( ..... ) | ( ..... ) | ( ..... ) |
| Vacuum plate design | ( ..... ) | ( ..... ) | ( ..... ) | ( ..... ) |
| Ability to use digital tools in the research process | ( ..... ) | ( ..... ) | ( ..... ) | ( ..... ) |
| Sensitivity to occupational safety | ( ..... ) | ( ..... ) | ( ..... ) | ( ..... ) |
| Total | | | | |

## Links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