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LETS CREATE A WORLD WITH TINKERCAD

BIOS4YOU AR 2.0

BIO-INSPIRED STEM TOPICS FOR ENGAGING YOUNG GENERATIONS
THANKS TO THE USE OF AUGMENTED REALITY

Project Number: KA220-BW-23-30-126516

KIT Karlsruher Institut für Technologie · ktu kaunas university of technology · Università degli Studi di Palermo · CEIPES · Eduact

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Card of the learning path

GENERAL TOPIC OF THE LEARNING PATHNERAL TOPIC	Let's Create a World with Tinkercad
Specific name of the learning unit	Modeling with Free Online 3D Design Software Tinkercad
Age of the target users	14-18 years
Requirements for the learner	Basics of using a computer, basic knowledge of what projection is, spatial primitives (sphere, cylinder, cube)
Description of the learning unit	Modeling environment and its main parts. Setting the model material; setting the model location; grouping elements; exporting the model and preparing it for printing. Additionally, students will enhance their models using Augmented Reality (AR) tools to visualize their creations in real-world environments.
Subject: Parties involved	Basic Computer Literacy, Geometry, Spatial Visualization, Augmented Reality (AR)
Keywords	Modeling Environment, Projections, 3D Models, AR
Key qualifications, skills and knowledge that can be acquired	1 Selecting Front and Side Projections 2 Understanding How to Model a Character Using 3D Primitives 3 Learning to Use a Ruler for Precise Model Positioning 4 Learning to Select Solid and Hollow Masses 5 Learning to Group Components 6 Learning to Prepare a Model for Printing ● Learning to Export and Visualize 3D Models in Augmented Reality ● Developing Skills in Using AR Platforms (e.g., Tinkercad AR Viewer, Sketchfab, WebAR)
Resources and didactic aids used	Tinkercad – Free, Web-Based 3D Modeling Software Tinkercad AR Viewer, Sketchfab, WebAR Tools – for Augmented Reality Visualization
Assessment criteria and evaluation	● Ability to determine front and side projections ● Ability to import the desired part ● Ability to use a ruler for precise model adjustments ● Ability to change the grid step size ● Ability to select a solid or hollow component mass ● Ability to group components ● Ability to prepare the model for printing ● Ability to preview the prepared model ● Ability to export and view models in AR environments

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1. Creating an Account and Logging In

Tinkercad is a virtual modeling program. To work in a virtual environment, you first need to create an account and log in. This is a convenient method because, when working virtually, the same project can be accessed from different computers. Additionally, multiple users from different locations can collaborate on the same project.

1.1. Creating an Account

Open a web browser and enter the URL: ***https://www.tinkercad.com/***

If you are logging in for the first time, you must create an account. To do so, you need a valid email address. Click on "Sign in" in the upper-right corner of the window to open a menu with different account creation options.

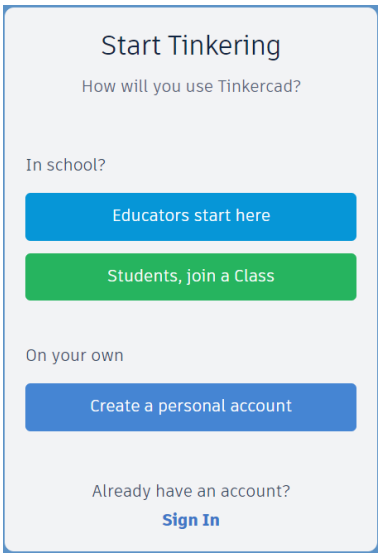

Figure 1. *Sign-in options based on user roles*

When creating a personal account, select "Create personal account". In the next window, you will be given different options for setting up your account.

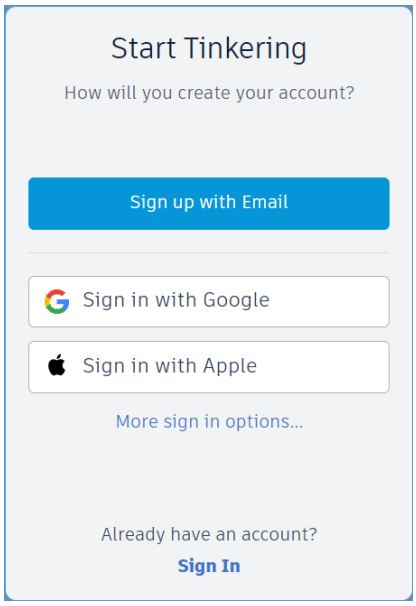

Figure 2. *Sign-in options based on user identification*

The simplest way to create an account is by using an existing Gmail email address. Enter your email address and password. If you are using a different email provider, you will need to provide your name, surname, age, country, and email address.

For users under 16 years old, a parent or guardian's email address is required for account verification. In this case, the child does not need their own email address.

Once you create your Tinkercad account, you must verify it through your email. This links the account to your email address, ensuring that no other accounts can be created with the same email.

1.2. Logging into Your Tinkercad Account

To log into your account, go to the **Tinkercad** homepage and click **"Join Now"** in the upper-right corner. A new window will open, allowing you to choose a login method.

- If your account is linked to a **Gmail email address**, select **"Sign in with Google"**, then enter your Gmail email and password.
- If your account is linked to an **Apple email address**, you can log in the same way by selecting **"Sign in** with **Apple"**.

- If you are using a different email, select **"Email or Username"** and log in with the username and password you created during account setup.

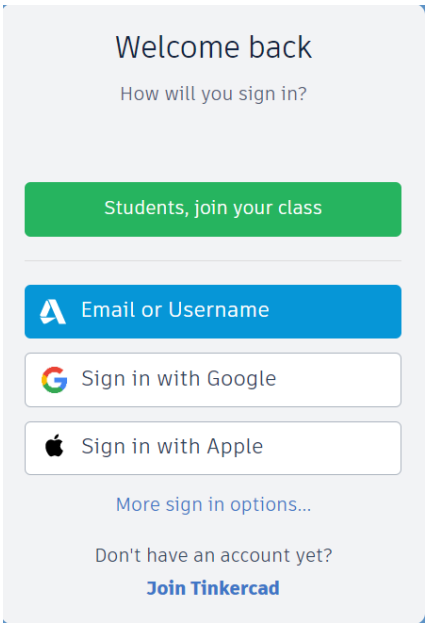

Figure 3. *After creating an account, you need to log in*

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2. Program Interface and Main Elements

2.1. Program Interface

After logging into your Tinkercad account, you will see the **main interface**.

Main Interface Sections:

1. – **Account Information** – Here, you can check and update your personal account settings.

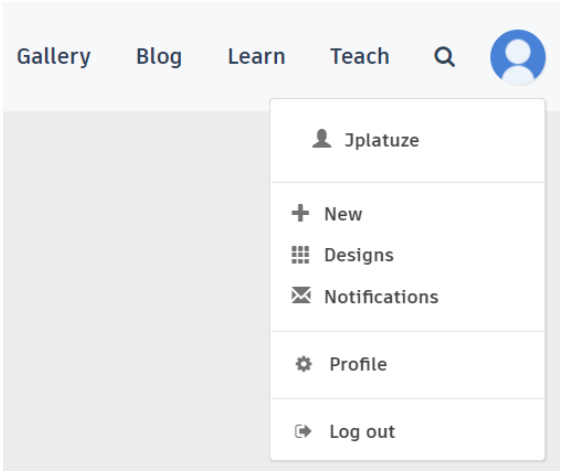

Figure 4. *Personal Account Information*

2. – **Teaching Tools** – Standard guidelines are provided for teaching how to use Tinkercad. You can also create a custom teaching plan.
3. – **Learning Tools** – Lessons on how to design specific models.
4. – **Blog** – A space where users share their experiences and insights on 3D modeling with Tinkercad. You can also create your own blog
5. – **Project Gallery** – Most created designs can be downloaded as finished products. You can also download and modify existing models.
6. – **New Modeling Workspace Setup** – This feature allows you to prepare a new modeling environment, which we will discuss in more detail in the next section.

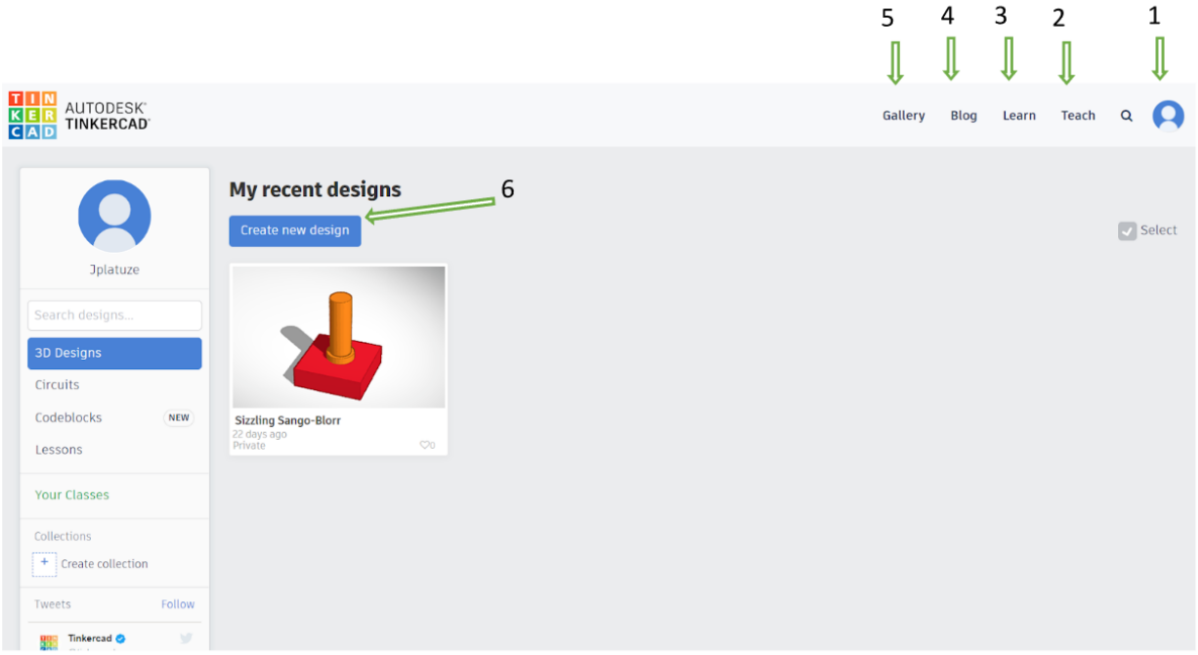

Figure 5. *Workspace Environment*

2.2. Key Interface Elements

When you select **"Create New Design"**, a new window opens with the main modeling tools and interface elements.

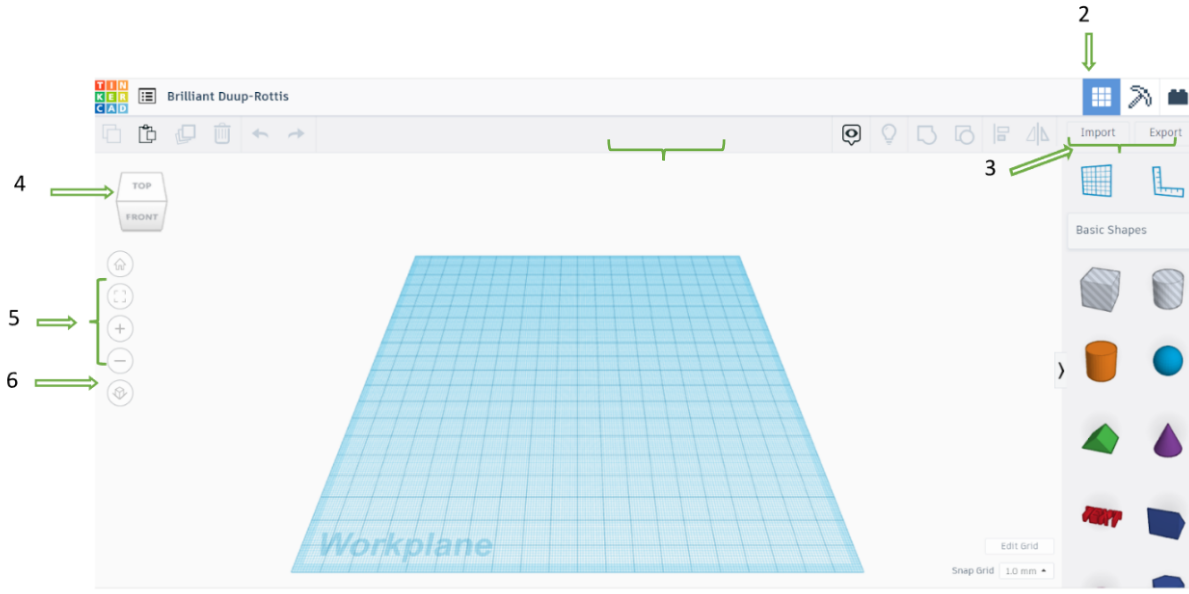

Figure 6. *Main Parts of the Workspace*

1 – *Collaboration Tool.* This feature allows multiple users to work on the same project. A unique link is generated, which can be shared with other users. Any changes made by one user are visible to others in real time.

2 – *3D Design Space.* The main workspace where all modeling tools are available.

3 – *Import and Export Tools*. "**Import**" allows you to upload another project or a part of it into the scene. "Export" enables you to download your design in a specific format. For example, to prepare a project for 3D printing or CNC cutting, export it in **.stl** format.

4 – *Navigation Tools*. These tools allow you to move the entire scene and set different viewing angles (front, side, top, etc.). Note that this tool rotates the entire scene, not individual objects. You can also rotate the scene using the right mouse button.

5 – *Zooming Tools*. These tools allow you to zoom in and out on the scene view.

6 – *View Mode Tool (Orthogonal or Perspective).* Perspective Mode simulates real-life vision, where objects appear smaller as they move further away, and parallel edges converge at a vanishing point. Orthogonal Mode helps with precise modeling by displaying all parallel edges as truly parallel, ensuring accurate alignment and true-size representation of objects.

2.3. Main Modeling Tools

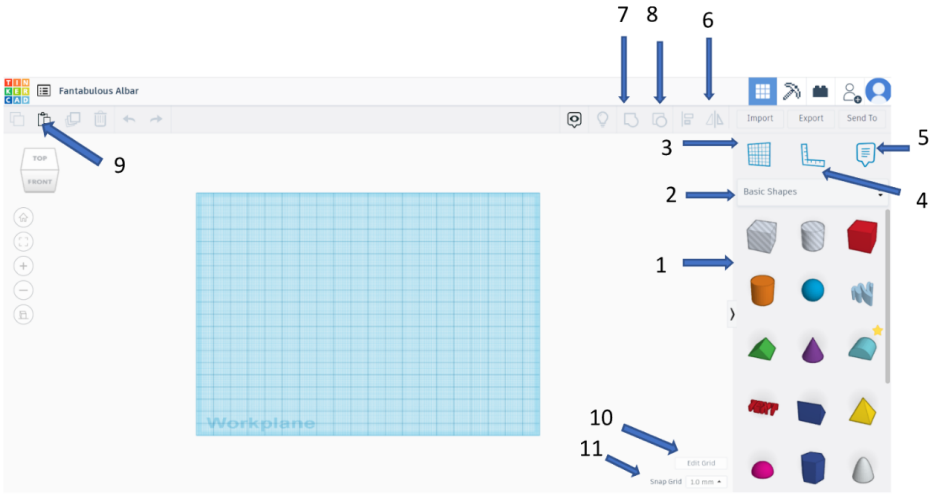

***Figure 7**. Main Modeling Tools*

1 – ***Basic Shapes Library***. This is the primary collection of 3D shapes used for modeling.

2 – ***Shape Library Selection*** *("Basic Shapes")*. Clicking this option opens a menu with additional libraries containing more shape options.

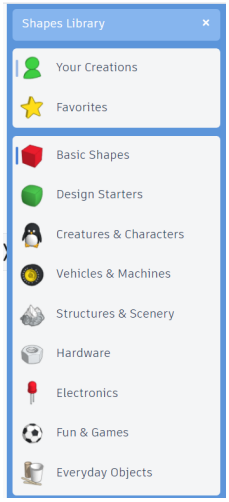

***Figure 8**. Standard Shape Library Options*

3 – ***Workplane Tool***. Allows you to change the active workplane, meaning the surface on which new parts are designed.

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4 – ***Ruler Tool***. Can be placed on the workplane or directly on a specific object to measure and align elements accurately.

5 – **N*otes & Comments Tool***. Used for communication between users or for adding personal notes to the project.

6 – ***Mirror (Symmetry) Tool***. When designing symmetrical objects, instead of drawing both sides separately, you can create one side and then mirror it.

7 – ***Grouping Tool***. When designing an object made of multiple separate parts, you can group them into a single solid model. Without grouping, the model remains just a collection of separate parts

8 – ***Ungrouping Tool*.** The opposite of grouping. This tool is useful when you need to modify an object by separating it into smaller parts.

9 – ***Copy & Paste Tool*.** Instead of clicking this tool, you can also use the keyboard shortcuts CTRL+C (copy) and CTRL+V (paste).

10 – ***Grid Editing Tool*.** Adjusts the scene grid, allowing you to increase or decrease the density of grid divisions in both directions.

11 – ***Grid Snap (Step Size) Tool*** – Determines the precision of object movement. Smaller step size allows for more detailed adjustments when working with tiny objects. Larger step size is useful when working with bigger models, where extreme precision is unnecessary.

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3. Task “Hollow Cylinder Modeling“

Before starting the task, take a moment to visualize the final outcome using **the Tinkercad AR Viewer**[1] and using projects: *https://www.tinkercad.com/search?q=cylinder&staffPicks=0* or by scanning the provided QR codes or exporting sample models into the AR viewer (CoSpaces EDU, XR viewer, AR Viewer – Augment, etc.) you and your students will be able to see the 3D models projected into your real-world environment through your mobile device. This will help you better understand the structure, proportions, and details of the object before you begin modeling. Exploring sample designs in augmented reality will give you a clearer idea of what to aim for, making the modeling process smoother and more intuitive.

QR example for Hollow Cylinder into Cospaces (https://edu.cospaces.io/WJF-DHM):

1.1. Objective: Create a hollow part where:

1. The outer ring dimensions are 100x100 mm
2. The inner ring dimensions are 90x90 mm
3. The height of the part is 60 mm

[1] Officially available for the Apple iPad as a free download from the App Store.

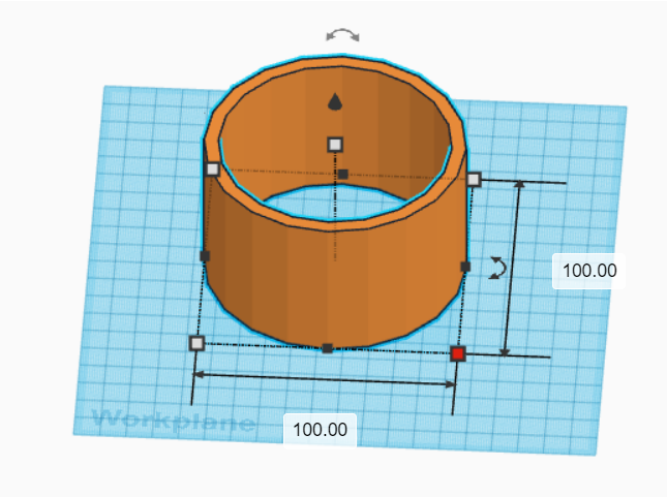

Figure 9. *Hollow Cylinder Modeling*

1.2. Insert a Cylinder:

- Open the **Basic Shapes Library** and select a **solid cylinder**.
- Click and **drag** the cylinder onto the workplane.

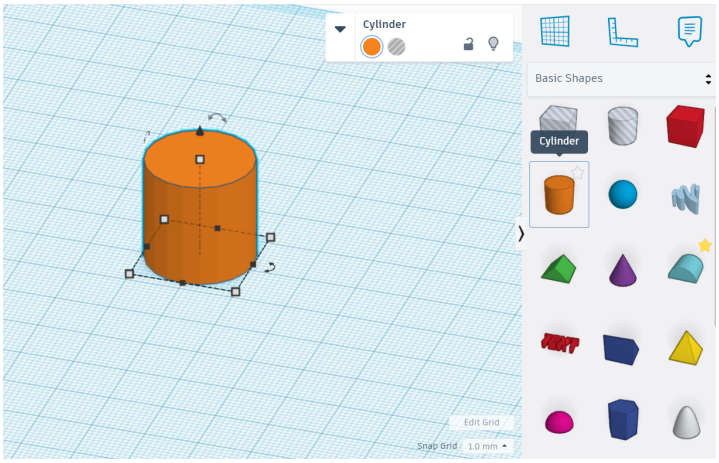

Figure 10*. Inserted Standard Solid Cylinder*

1.3. Adjust Cylinder Dimensions:

- Select the **base of the cylinder.**
- Click on the **square handles** that define its **dimensions**.
- Change the values to **100x100 mm.**

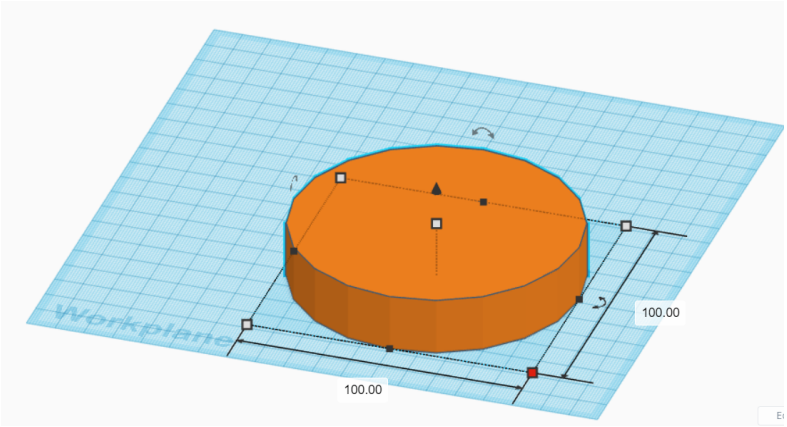

***Figure 11**. Adjusting Cylinder Dimensions*

1. To adjust the **height**, rotate the view to **side perspective.**
2. Click on the **top square handle** and set the height to **60 mm**

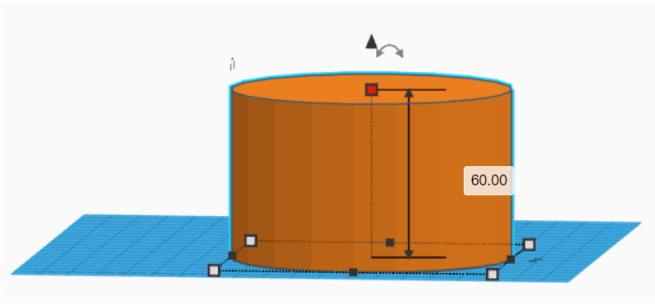

***Figure 12.** Adjusting Cylinder Height*

1.4. Creating the Hollow Section. A hole can be modeled using the same cylinder by changing the part style from solid to empty space.

- Insert **another cylinder** from the **Basic Shapes Library.**
- Set its base dimensions to 90x90 mm.
- Set its height to 90 mm (larger than the outer cylinder to ensure a clean cut).
- Insert a **ruler** to assist with **precise alignment** and let's identify it with the square of the cylinder (when viewed from above):

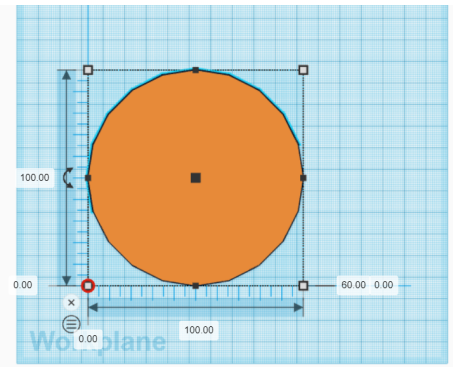

***Figure 13**. Inserting a Ruler*

- Move the smaller cylinder and align it to the corner of the ruler.

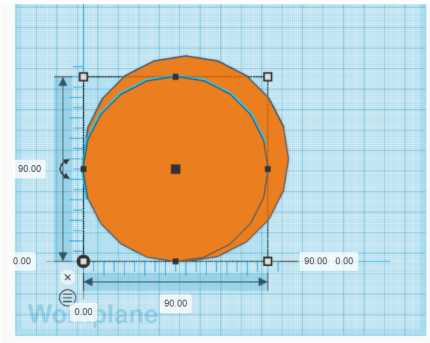

***Figure 14.** Aligning the Second Cylinder with the Ruler*

- To **center** the smaller cylinder inside the larger one, adjust its position by setting the **offset values** to **5 mm** in both directions.

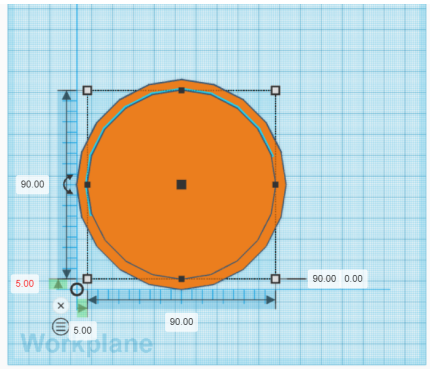

***Figure 15.** Centered Inner Cylinder*

- Convert the **inner cylinder** into a **hole** by selecting the **"HOLE"** option in the properties panel.

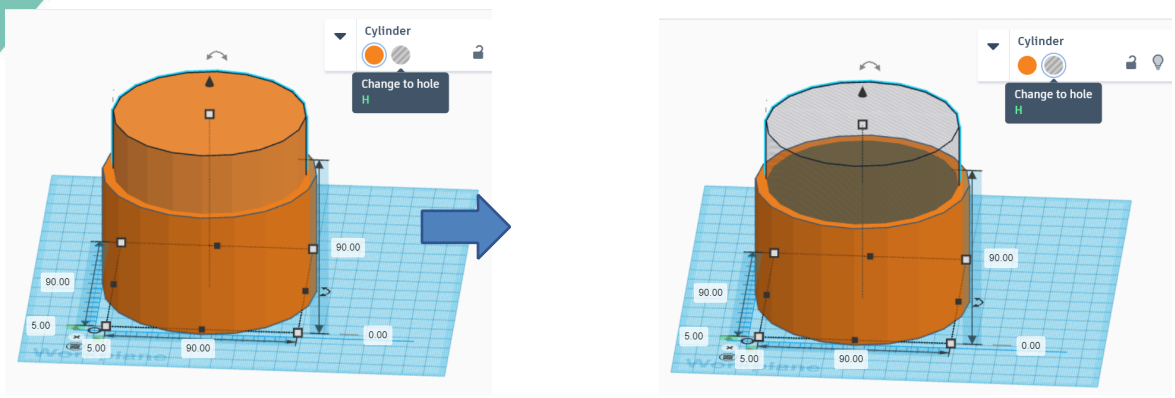

***Figure 16**. Changing Cylinder Material to "HOLE"*

1.5. Grouping the Cylinders to Create the Hollow Shape:

- Select **both cylinders** (outer and inner).
- Click **"Group"** to combine them and remove the hollow section.

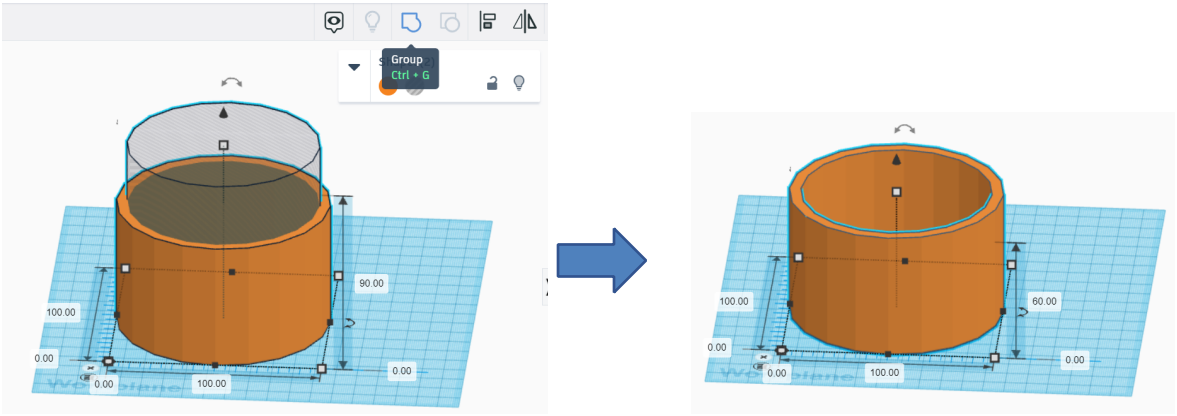

***Figure 17**. Grouping the Parts*

1.6. Exporting for 3D Printing

- Click **"Export"** to prepare the file for **3D printing**.
- In the pop-up window, select **".STL"** as the file format.

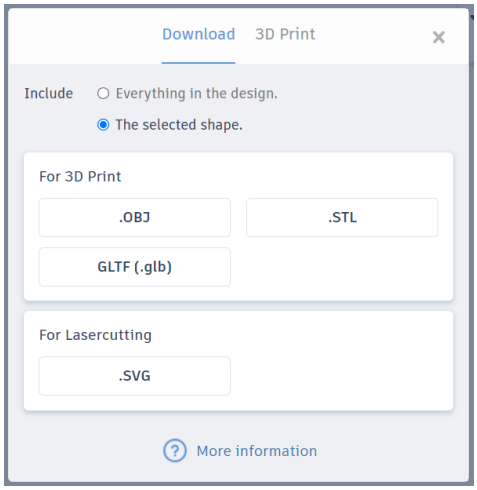

***Figure 18**. Selecting STL File Format for Export*

The file is now ready for 3D printing!

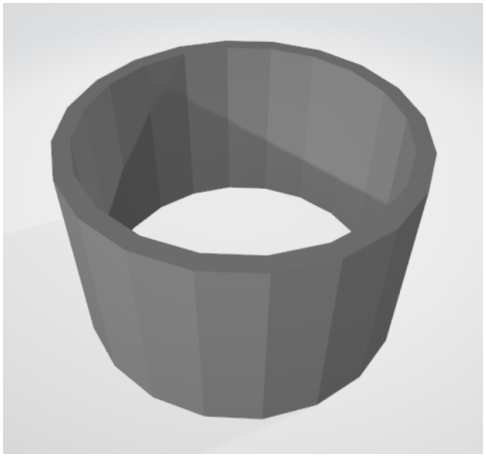

***Figure 19.** Detail preview*

Enhance with AR

AR Visualization in the Real World: After creating their 3D models, students can export their designs not only in .STL format for 3D printing but also to an AR viewing platform, such as Tinkercad AR Viewer, Sketchfab, or WebAR solutions. This will allow them to project their created objects into their real-world environment using a smartphone or tablet. For example, a student could "place" their designed trophy on an actual table to see how it looks in a real-life setting.

4. Task by yourself – „Gift Yourself a Trophy“

Before starting the task, take a moment to demonstrate the final outcome using **the Tinkercad AR Viewer** and using created projects: https://www.tinkercad.com/search?q=Trophy&staffPicks=0.or by scanning the provided QR codes or exporting sample models into the AR viewer. This will help for students better understand the structure, proportions, and details of the object before you begin modeling.

4.1. Objective

Design a 3D trophy using Tinkercad by applying the skills learned in previous exercises.

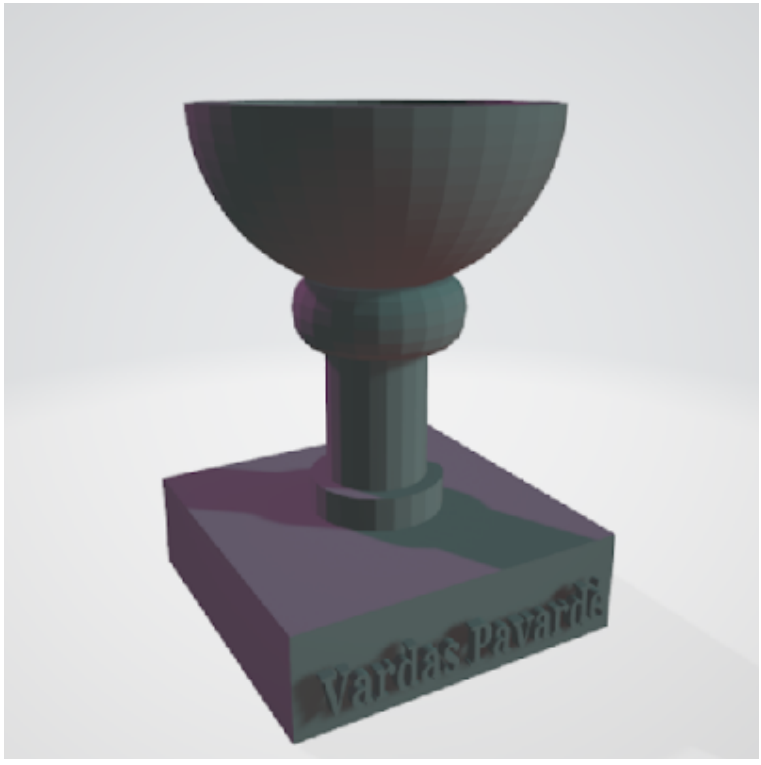

Figure 20. *Task goal - modeled cup*

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4.2. Task Completion Steps

Step 1: Create the Base

1. Insert a **red box** from the **Basic Shapes Library.**
2. Adjust its dimensions:
    1. **Length: 100 mm**
    2. **Width: 100 mm**
    3. **Height: 30 mm**

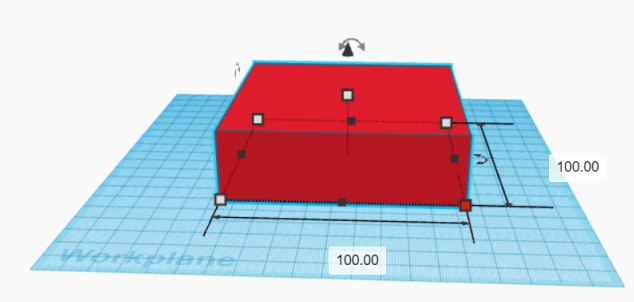

Figure 21. *Modeling the Base*

Step 2: Add the First Ring

- Insert a **ring** shape.
- Set its dimensions:
    - **Length: 40 mm**
    - **Width: 40 mm**
- Align it in the **center of the red base.**

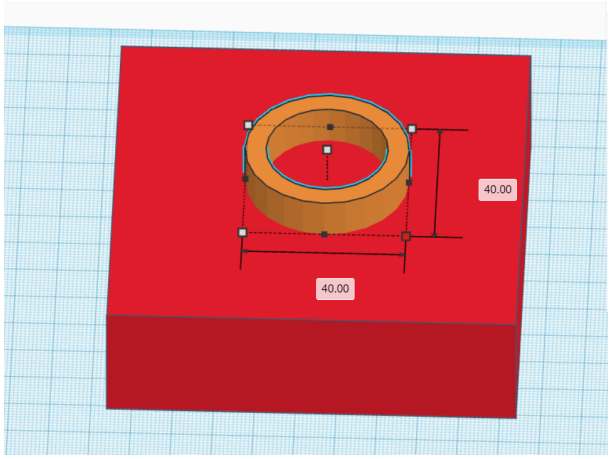

Figure 22. *Base Ring Placement*

Step 3: Create the Trophy Stem

- Insert a cylinder.
- Adjust its dimensions:
  - **Length: 30 mm**
  - **Width: 30 mm**
  - **Height: 100 mm**
- Place it **on top of the base inside the ring.**

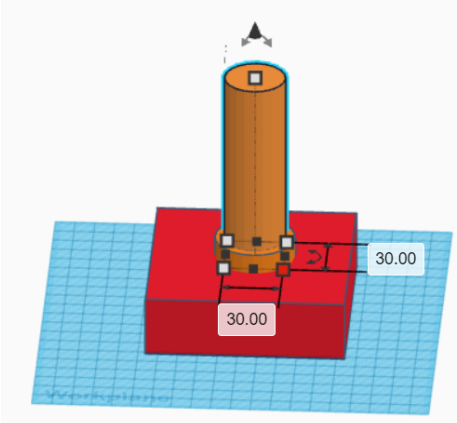

Figure 23*. Forming the Trophy Stem*

Step 4: Add the Second Ring

- Insert a **blue ring**.
- Adjust its dimensions:

- **Length: 50 mm**
- **Width: 50 mm**
- **Height: 30 mm**
- Position it **on the cylinder, 80 mm from the ground**.

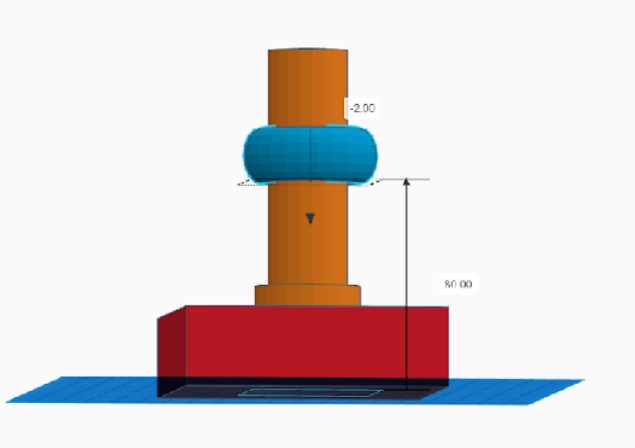

***Figure 24**. Adding the Second Ring*

Step 5: Create the Trophy Cup

- Insert a **half-sphere** and rotate it **180°**.
- Adjust its dimensions:
  - **Length: 100 mm**
  - **Width: 100 mm**
  - **Height: 50 mm**
- Place it **on top of the cylinder, 96 mm from the ground.**

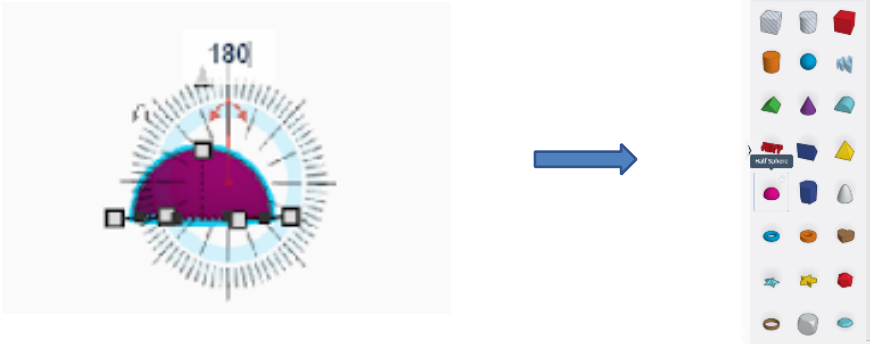

***Figure 25.** A hemisphere loaded and rotated 180 degrees*

View from Above:

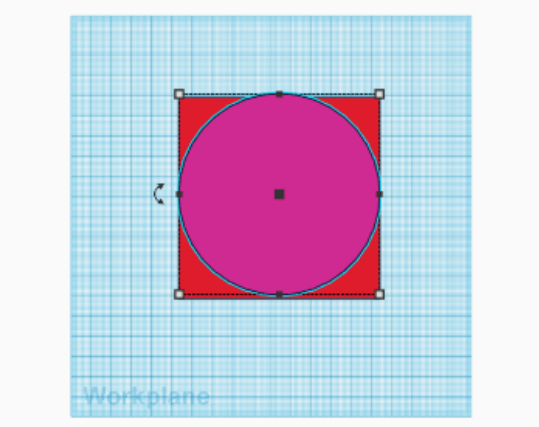

***Figure 26**. Cup viewed from above*

View from Front:

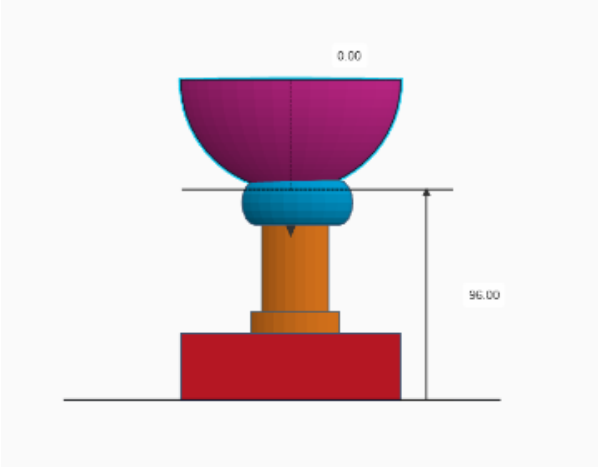

***Figure 27.** Cup viewed from front*

Step 6: Hollow Out the Cup

- **Copy the half-sphere** using **CTRL+C** -> **CTRL+V.**
- Adjust the copied half-sphere's size:
  - **Length: 80 mm**
  - **Width: 80 mm**
- Position it **inside the larger half-sphere.**
  - Change the **material** to **"HOLE"** to create an empty space.

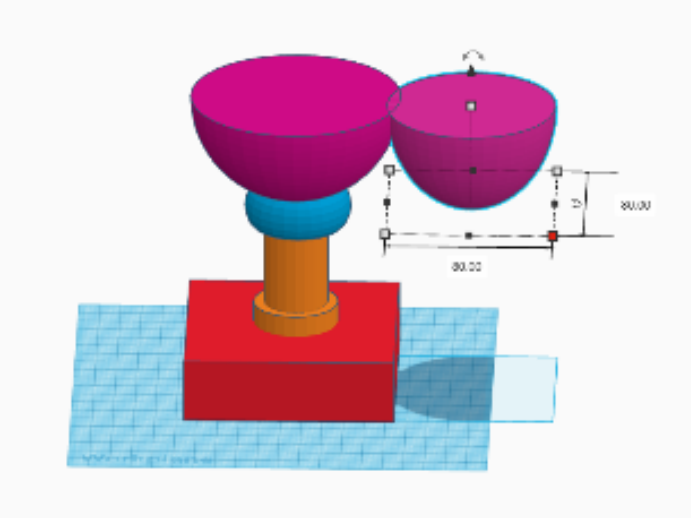

Figure 28. *Creating the Inner Half-Sphere by Copying the Outer Half-Sphere*

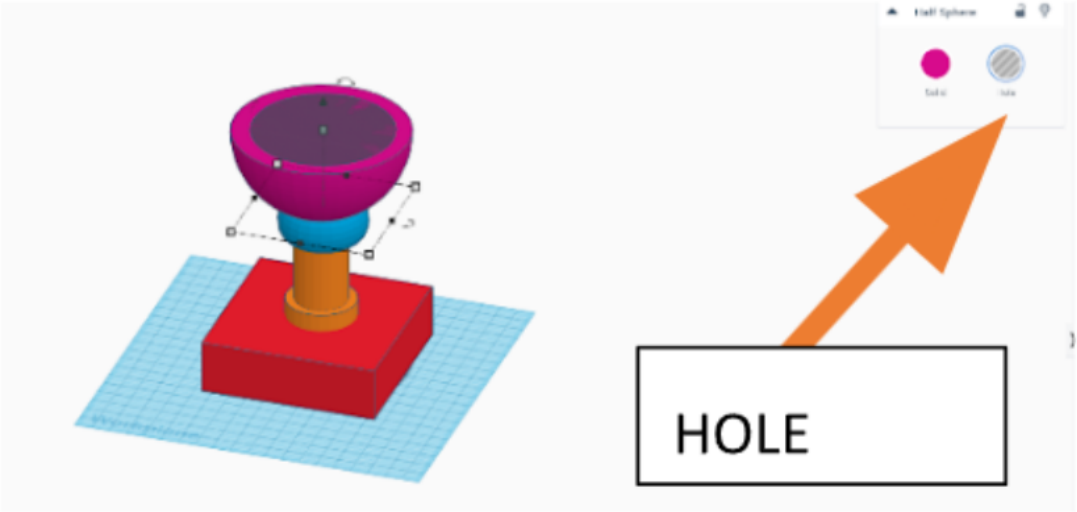

Figure 29*: Changing the Inner Half-Sphere Material*

Step 7: Add a Nameplate

- Insert a **text object** and write your **name**.

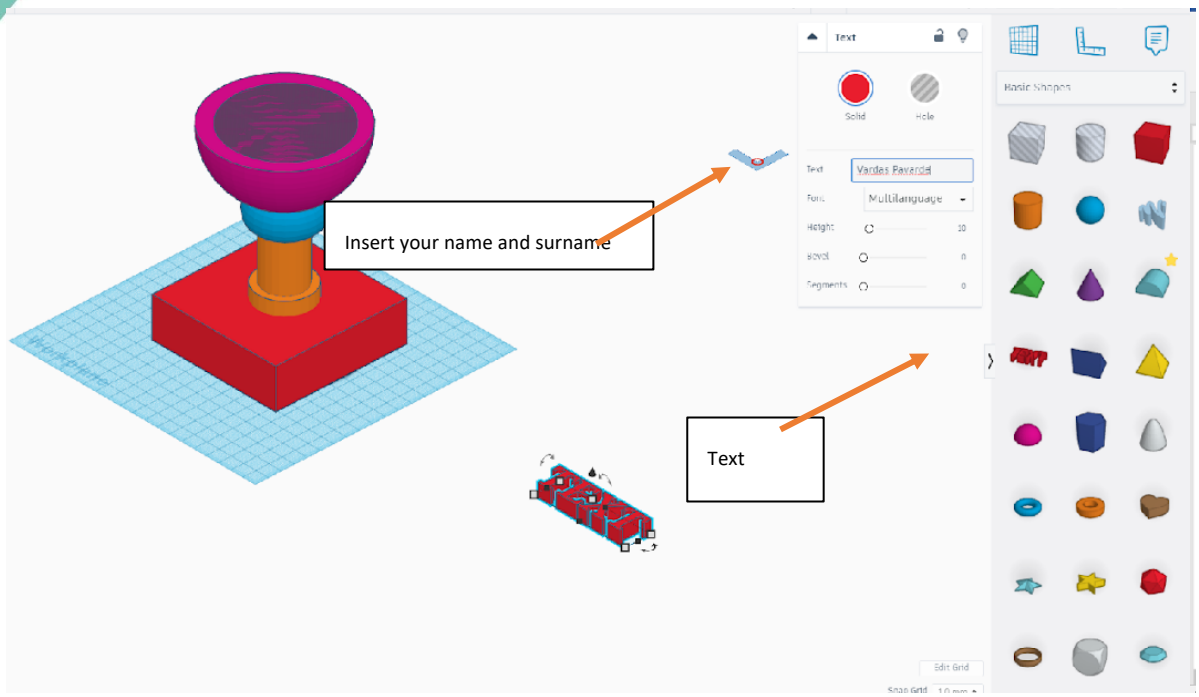

***Figure 30**. Creating Raised Letters*

- Rotate the text **90°.**

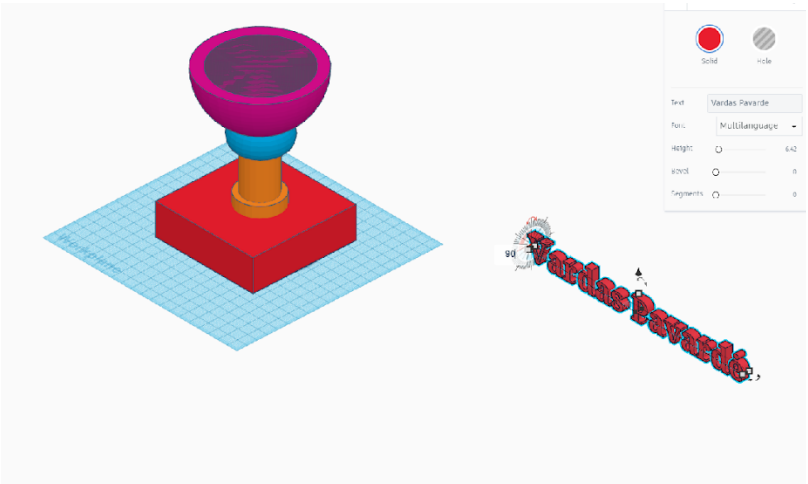

Figure 31.** Rotating Text **90°

- Resize the text to **fit on the side of the red base.**
- Move and **embed it slightly into the box.**

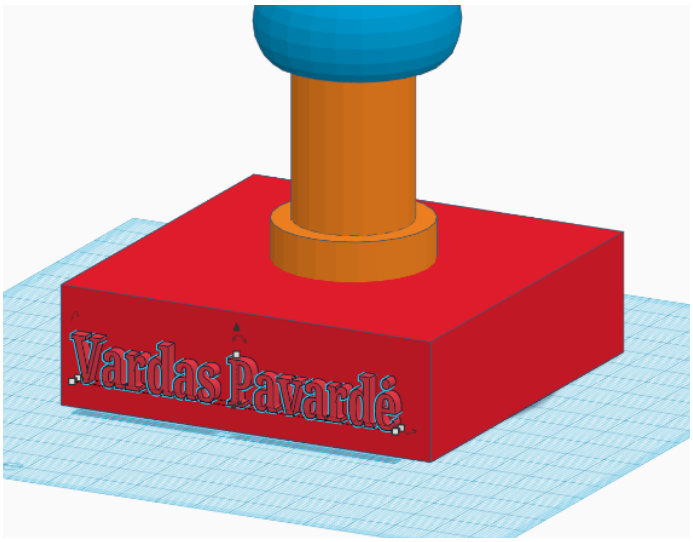

***Figure 32**. Positioning the Name on the Base*

Step 8: Finalizing the Model

- Select all objects and group them together.

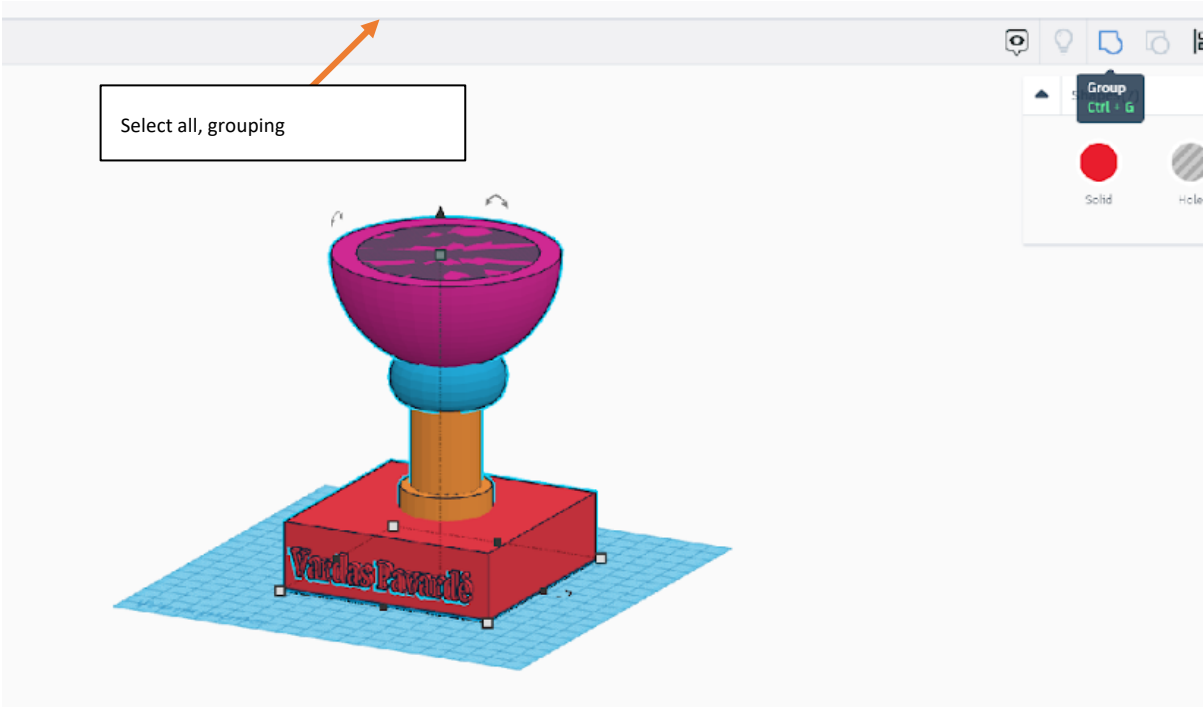

***Figure 33**. Grouping All Components*

Step 9: Export for 3D Printing

- Click **"Export"** and choose **".STL"** format.
- Save the **STL file** to your computer.

The trophy is now ready for 3D printing! 🏆

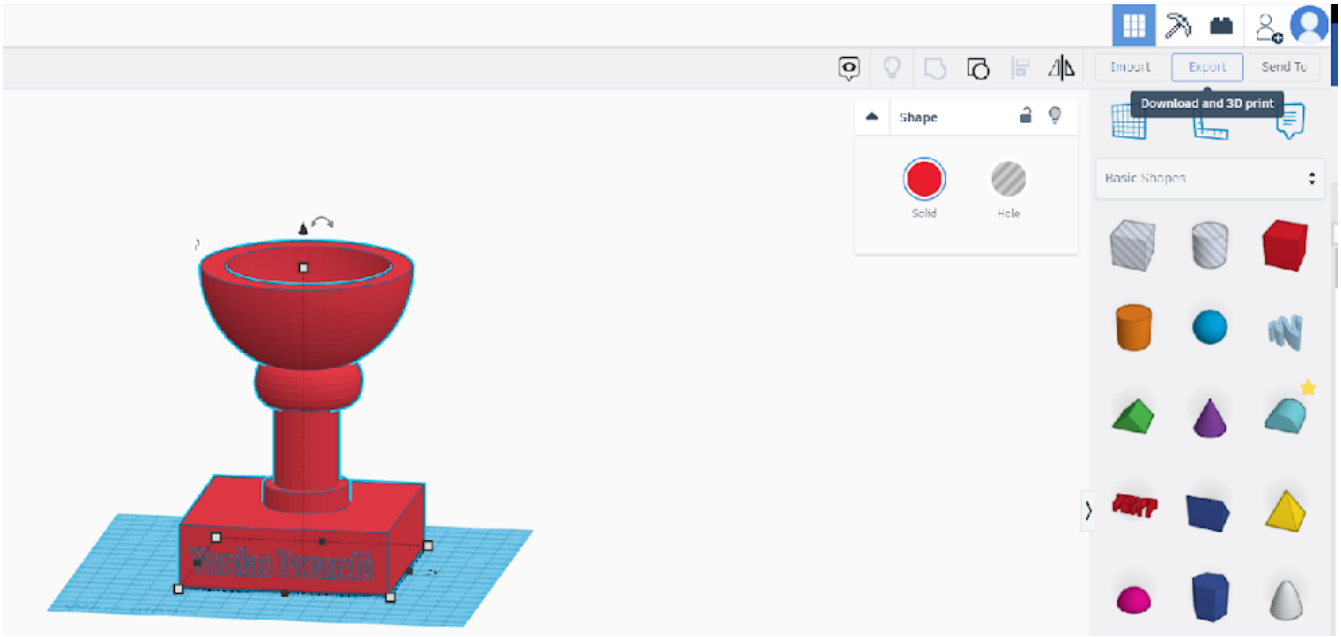

Figure 34. *Exporting the Model*

4.3. Enhance with AR

To further enrich the learning experience in Let's Create a World with Tinkercad, students are encouraged to integrate Augmented Reality (AR) into their design process. After completing their 3D models, learners can export their creations to AR platforms such as **Tinkercad AR Viewer**, **Sketchfab**, or **WebAR** solutions. This allows them to project their models into real-world environments using smartphones or tablets, providing a unique perspective on their designs. For instance, students can visualize their trophies placed on a real table or see how their hollow cylinders would look in a practical setting. Using AR not only helps in evaluating the design's proportions and aesthetics but also brings their virtual creations to life.

For more advanced AR integration, tools like **ZapWorks**, **8th Wall**, or **BlippAR**

can be used to create interactive, marker-based AR experiences. These platforms allow students to generate QR codes or links that can be shared with others for collaborative review and feedback. By incorporating AR, students gain a deeper understanding of spatial visualization and enhance their digital creativity skills, making the learning process more interactive and engaging.

Recommendations for additional AR tools

1. **Tinkercad AR Viewer**: Tinkercad offers a built-in AR viewing tool that allows students to export their 3D models directly into an augmented reality environment. After designing their objects (such as the trophy or hollow cylinder), students can view them in real-time through their tablets devices by selecting the AR viewing option within Tinkercad. This feature helps learners visualize the scale and placement of their models in a real-world context—like seeing how a designed object fits on a desk or shelf—before finalizing their designs or moving on to 3D printing.
2. **Sketchfab**: enables users to upload their 3D models and easily view them in AR using mobile devices. Students can export their Tinkercad designs in compatible formats (like .OBJ or .STL) and upload them to Sketchfab's platform. Once uploaded, they can use the Sketchfab app or browser-based AR features to project their models into physical spaces. This is especially useful for sharing designs with classmates or teachers, as the platform allows for easy sharing via links. For example, students can showcase their trophy designs during presentations, allowing viewers to see the models in their intended physical context.
3. **ZapWorks** / **8th Wall** / **WebAR**: These platforms offer more advanced AR capabilities by enabling the creation of **marker-based** or **markerless** AR experiences. Students can design interactive AR content that can be integrated into educational materials. For example:
    - **ZapWorks** allows students to create QR codes linked to their 3D models. By scanning the QR code, users can view the models in AR directly through a web browser, eliminating the need for a separate app.
    - **8th Wall** supports the development of more dynamic AR experiences, such as embedding animations or interactive elements into the models. This could be used for projects where students add explanations or annotations to their 3D designs, making the learning experience more

immersive.

- **WebAR** solutions offer browser-based AR experiences, allowing students to embed AR content directly into a learning platform or website. This can be especially effective for collaborative tasks where students can share their AR-enhanced models with peers for feedback.

By using these technologies, students not only improve their understanding of 3D modeling but also develop skills in integrating digital designs into real-world applications, fostering creativity and enhancing problem-solving abilities.

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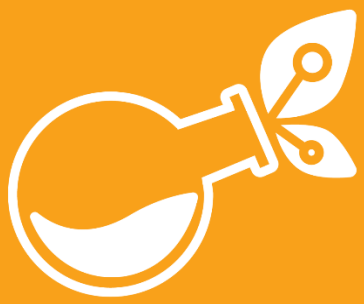

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THANKS TO THE USE OF AUGMENTED REALITY