

STEMkey
Module IO4



Human anatomy and physiology with smartphones

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Activity 2 – “Construct Your Own Smartscope”

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Module IO4. Human anatomy and physiology with smartphones

Activity 2. "Construct Your Own Smartscope"

Objective: Students will turn their own smartphone into a microscope "Smartscope".

Background: Living beings can be as huge as a blue whale or a sequoia and smaller than a grain of dust. What they all have in common is that they are build up of cells, most of which are invisible to the naked eye, and inside a cell there are even finer structures. Conversely, cells form tissues, tissues form organs and these in turn form organ systems. To observe small organisms or tiny structures and objects, scholars in the past invented magnifying glasses and microscopes. They use them not only to magnify the observed objects but also to image them. Basically, all smartphones are equipped with cameras that can not only be used as a device to take photos and videos, but with a few small adjustments can be turned into an improvised microscope to directly observe and record objects that are too small to fully see with the naked eye.



Work in pairs



90 min

Learning Outcomes

After completing the lesson you will know that / learn about:

- 1) It is possible to use your smartphone as a magnifying glass.
- 2) You can turn your smartphone into a microscope.
- 3) Basic optical and technical principles of how to do this.

You will be able to:

- 4) Construct your own "smartscope".
- 5) Use a smartscope to observe objects in nature/laboratory.
- 6) Evaluate the suitability of the technology used.
- 7) Make suggestions for improvements and alternatives to the device constructed in a laboratory session.

Session description

In this activity, participants use their own smartphones as microscopes or magnifying glasses to look at different objects (alternatively they can use smartphones/tables provided by a teacher). The activity consists of six parts (two of them are optional).

Structure of the lesson:

1. Part 1: Brief introduction introducing the role of observing "invisible" objects in biology. Reminder of the role of a light microscope and magnifying lenses in biology, especially in human anatomy and physiology. Short lesson on the capabilities of smartphones as cameras (resolution, format conversion (15 min.).
2. Part 2: Testing the smartphones as magnifying glasses using an application. Students should download one of the many applications suitable for their system (Android, OS, etc.). The teacher

should provide some objects to observe. Animal organs bought in a grocery shop can be used as models. The students' task is to explore the limits of their devices, e.g. transparency (20 minutes).

3. Part 3: Students are asked to expand the capabilities of their smartphones by adding a lens to their camera. Students are asked to experiment with their devices and take photos (videos) of the objects (25 min).

4. Part 4 (optional) (additional 1-2 hours of work in the school lab or as homework. Students should build their own microscope from parts available at home or follow the instructions and assemble a microscope from parts provided by the teacher (90 min).

5. Part 5: Discussion and creativity exercise (30 minutes).
Students should discuss the use of smartphones as magnifying glasses and smartscopes in different contexts, not only in human anatomy and physiology inside and outside the classroom. They should share ideas and suggest improvements.

6. Post-lesson: Students should explore the use of smartphones as magnifying devices and smartscopes in different contexts, not only in human anatomy and physiology outside the classroom. They should report on their findings and also suggest other uses.

Activity 2: „Construct your own Smartscope“



Worksheet

Based on the knowledge of the basic structure of the microscope and its operation, you can build a microscope at home or in the school with the help of the instructions and tips on the website <https://www.instructables.com/10-Smartphone-to-digitalmicroscope-conversion/>. Of course, with certain limitations. The advantage of such microscope is that we can observe and photograph or record the observed object at the same time. The most important feature is affordability.



LET'S GO EXPERIMENTING

Home made "smartscope"

Materials and accessories:

- 3x screw M6 × 120 mm;
- 9 times M6 nut;
- 3-fold wing nut M6;
- 5 times M6 washers;
- 1.5 cm × 20 cm × 20 cm;

- plexiglass 3 mm (200 mm x 200 mm and 150 mm x 200 mm);
- lens (obtained from laser display);
- LED light;
- drill with various attachments;
- ruler

Task 1:

Test the smartphone as a magnifying glass with an application. Download one of the many applications suitable for your system (Android, OS, etc.).

The teacher should provide some objects to observe. Animal organs bought in a grocery shop can serve as models. Your task is to test the limits of your device. Take photos of the objects and try to manipulate them (20 minutes).

Task 2: Expand the capabilities of your smartphone by adding a lens to a camera.

Find a convex lens to serve as the objective of the microscope. You can get the lens from a cheap laser display (2,50 EUR) (or use magnifying glasses used for reading and similar). Then clamp the lens into the hairpin and attach it to the smartphone camera. With such a prepared device, you can already observe things that are invisible to your eyes.



Photo: A lens attached to a smartphone camera using a hairpin and adhesive tape.
(Photo: Sara Gorenjak)

Experiment with your device and take photos (videos) of the objects (25 min).

Task 3 (optional):

Follow the instructions to make a table for microscopy on which we will mount the lens and place the smartphone. We will use 200mm x 200mm x 15mm wood and mark the X marks.

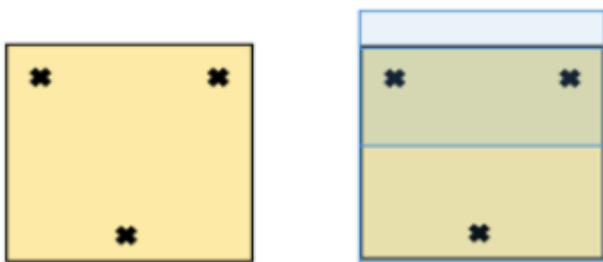


Photo: Wood dimensions 200mm × 200mm with marks drawn in (left). The right side shows the arrangement of wood and plexiglass for easy rotation and accurate holes. Plexiglass measuring 200 mm × 200 mm and then 150 mm × 200 mm is placed on the wood.

To make the holes in the same plane, place the Plexiglas on the wood and drill holes through the whole structure with a drill. Insert screws (M6 × 120 mm) and countersunk them into the wood. Assemble the apparatus. While working, be sure that the components were level horizontally.

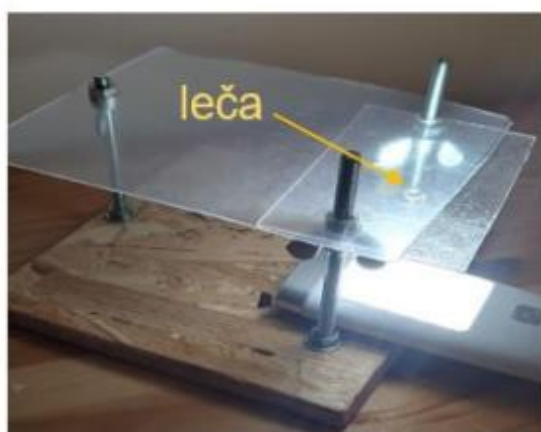


Photo: Microscope stand with smartphone. Photo Sara Gorenjak.

Drill a hole for the objective into the 200 mm x 200 mm Plexiglas. Use a drill bit that is the same size or smaller than the diameter of the objective (lens). Drill the hole in the optimal place to install the cameras of several different smartphones. To make the lens fit perfectly, use sandpaper and lightly sand the edges. Use a LED lamp as a light source.

Place the light directly under the lens. With the lens, it is important which side is put into the hole. The side facing away from the camera is the part that has the virtual transparent strip. If you align them correctly, you will get a larger field of view. In microscopy it is important that the lens is as close as possible to the camera. The wing nuts serve as the microscope's macro screws.

Test the prepared microscope in a laboratory exercise on microscopy with a smartphone camera.

Results of microscopy:

- 1. Draw a sketch or insert a photo of the object observed through the microscope.**

Facility name: _____

Magnification: _____

- 2. Draw a sketch or insert a photo of the object you observe through the magnifying glass.**

Facility name: _____

Magnification: _____

- 3. Draw a sketch or insert a photo of the object you are observing with the help of the smartphone "smartoscope"**

Facility name: _____

Magnification: _____

EVALUATION OF THE WORKSHOP:

We are interested in your opinion about the use of the tablet in the workshop:

1. Because of the use of “smartoscope”, the exercise was:

(Please check only one circle in each row).

	1 – I do not agree at all	2 – I do not agree	3 – I partially disagree	4 – I neither agree nor agree	5 – I partially agree	6 – I agree	7 – I completely agree
a) fun	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) instructive	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) understandable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) unpretentious	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) successful	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2. Answer the question by marking only one circle for each line.

	Task 1 (microscope)	Task 2 (magnifying glass)	Task 3 (“smartoscope”)
a) Which exercise did you have the least difficulty with?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) Which exercise did you have the most difficulty with?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) If you had to repeat the exercise, which method of execution would you choose?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3. Arrange the exercises from least difficult (1) to most difficult (3):

Task1 (microscope)	Task 2 (magnifying glass)	Task 3 (“smartoscope”)