

How to improve the image of a camera obscura – an inquiry-based approach from the middle school optics curriculum.

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Introduction

The camera obscura (pin-hole camera) and lens images are part of a phenomena orientated optics curriculum in Lower Saxony. Based on a more conventional teacher-centered approach, the contribution to be presented demonstrates an alternative which integrates processes of inquiry-based

learning. Starting with the question “How can you improve the image of a camera obscura?” students are given the opportunity to plan and conduct their own research into image definition and brightness.

Students' Pre - knowledge

Geometrical optics: emitter-receiver concept of light; light and shadow; linear propagation of light

Students built their own camera obscura out of a crisps can and were introduced to work with a Science Optics Kit (LD-Didactic).



The black tube with a sandwich paper screen slides inside the can



Technical equipment

Self-built camera obscura, scissors, glue, adhesive tape, different materials like cardboard



Science Optics Kit
LD-Didactic including lenses
($f = 5\text{ cm}$, $f = 10\text{ cm}$); slides

(3) Man stellt die Lupe vor die
M...
Objekt Farbe Mattscheibe
Licht Loch
* Die Farbe muss nicht sein.
@Linse

Lens in front of the screen

Put a lens in front of the screen

Better definition, brighter image

More light
Lampe zum aufhalten
auf der Kamera montieren.

Mount a lamp on the front of the camera for more light

After we shone a light on a teddy bear, its image was much brighter.

Image is brighter

4. Idee: "Lupe hinter das Loch kleben"

Lens behind the screen

Glue a lens behind the hole

(no further documentation)

More and larger holes

Enlarge holes on the front (more light), also the central hole

Image is brighter, but completely blurred.

Task: How can you improve the image of a camera obscura?

The students are asked

- to form groups and to develop ideas to improve the image of the camera obscura,
- to write them down,
- possibly to plan the technical realization and
- to test them in experiments.

2. Man könnte Wasser auf das Objekt tropfen lassen.

Water drips on the object

Let water drip on to the object

This idea was given up (note the association 'water drip - lens').

Reduce the light on the screen

Put a cone on the back to eliminate (interfering) light

Better definition, more intense colours of the image

enlarged hole

Enlarge (central) hole on the front

Reasons (and results): The larger hole lets in more light, so the image becomes larger, more colourful and less defined.

smaller hole

ein kleineres Loch für ein schärferes Bild!

smaller (central) hole for a sharper image

More ideas

2. Man könnte die dicke Mattscheibe nehmen.

Take a thinner screen

nicht wirklich (does) not really (work)

(Klarsichtfolie anstatt Pergamentpapier)

(transparent sheet instead of sandwich paper)

- eine Hülle für die Lichtquelle für konzentriertes Licht

The inside of the tube white instead of black (because black swallows all colours!)

Teaching experiences

The task seemed to be very motivating for the students. Many groups worked very independently and developed a lot of different ideas – in a variety which we don't know from teacher-centered tuition. There was definitely more room for creativity.

Of course, not every idea was a success, but we encouraged the students to document (keep records of) wrong approaches also. On the other hand there was a lively exchange of ideas between some of the groups while they were conducting their investigations.

The groups concentrated partly on their self-built cameras, others focused mainly on using the optics kits or changed between both of them.

Different groups had the idea of using a lens (a magnifying glass) as they knew that it is an important part of a regular camera.

Still – as foreseen - they had problems finding suitable positions for the lens, the object and the screen (for certain positions there is no chance to obtain an image). Here the teachers gave hints to some groups.

After an exploratory phase of 2 hours the groups presented their findings. A compilation of ideas and the way they influence the image of the camera was put up.



Conclusion

We found that inquiry-based learning sequences on subjects of the current curriculum can open up the process of conventional tuition in a positive way. Students are given the opportunity to plan and conduct their own research, the outcome of which can be a broad spectrum of creative ideas.

We find it essential that the student groups diligently document their ideas, their experimental process and their findings.

In future we would put more emphasis on these documentations, as they help students put together their presentations more efficiently later on. We think it is important to train documentation skills as part of the inquiry-based learning process.