The **ScienceMath**-project: **refraction and Concept of Variabl**e
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Further Information

Experiences

This teaching material was tested with the buouyancy, thermal expansion and Boyle's law experiment in three different classes.
Students discover the functional relationship between both variables. Most of them first describe the functional relationship by noting the changes, e.g. change of one measurand by … causes change of other measurand by … or they describe the relationship by differences between angle of incidence and angle of refraction. This often happens if the different angles of incidence are measured in equal intervals. If one wants to get students watching at the quotient, one should modify the table by writing down angles of incidence, whose values next to each other have not the same difference.
Students chose words, letters or units as names of their variables.

Many students think that the formula doesn't change if one does the same experiment with water instead of glass, since both materials are transparent. Those students, who said the formula would change, could mostly tell which part of the formula changes.

This experiment is very technical and needs quite a lot of material. The teacher should be familiar with the experiment and should be ready for all eventualities considering the material involved, e.g. having spare light bulbs. If students know how the experiment is set up and know how to measure the angles involved, they will get good results. Therefore the experiment and one measurement should be presented in advance.

Though the measuring values are good, students should be familiar how to handle measuring errors. It is sufficient if a short introduction is given before starting the experiment. While finding the formula students should be reminded to consider measuring errors as well.

At task 4, when finding a formula, teacher should give hints to apply elementary arithmetic operations on the pairs of measurands. Particularly weaker students will benefit by that.
Students would benefit as well if a classroom discussion is done after the experiments. During that students may ask questions and misconceptions can be reduced.
The worksheet artificially considers variables only. It could be expanded by a task to graph the measurands, so that it may serve as an introduction to the concept of function as well.

The Experiments should be rather used to introduce the concept of variable than to show an application of it. Interviews done on similar experiments have shown, if students had preknowledge of the concept of variable often thought that a formula should be "something with x". Students who didn't cover variables in class, approached to the problem more naturally without thinking about this "ominous" x.

Literature

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