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

Experiences

This teaching material was tested with the refraction, 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 of both measurands, e.g. change of one measurand by … causes change of other measurand by … or they describe the relationship by differences between force in air and force in water. This often happens if the different masses are measured in equal intervals. If one wants to get students watching at the quotient, one should choose masses, which are not multiples of each other.
Students chose words, letters or units as names of their variables.
A lot of students realized that the formula has to change if one does the same experiment using saltwater. Only a few could transfer that and tell how the formula changes.

The forces can be measured in saltwater, too. But one has to measure sensibly, to notice a difference. Considering saturated saltwater the force there is about 0,85 times the force in air compared to 0,9 if using tab water. Therefore it seems better to discuss this phenomenon only, without doing measurements.

Before doing the experiment, students should be familiar how to measure forces by a dynamometer. The best way is to let them measure two or three forces and let them tell. Besides that the dynamometer has to be calibrated. This is especially important, since force in water is just 0,9 times the force in air. Particularly if small masses are measured, students might measure equal values, which could cause confusions among them. Therefore students should be familiar how to handle measuring errors, too. 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.

Further investigations done by problem-oriented interviews have shown that the different aspects of the concept of variable can be touched on a descriptive and abstract level. Hence introduction to the concept of variable by buouyancy allows differentiation within a class. Besides the concept of variable, aspects of the concept of function, equivalent equations and modelling competencies can implicitly be touched.

The Experiments should be rather used to introduce the concept of variable than to show an application of it. When doing the interviews some students had preknowledge of the concept

of variable and some hadn't. A lot of students who got to know the concept in class 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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