# The Scientific Graphic Organizer for Practical Work

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**Abstract.** To better align assessment and learning goals for practical work, without increasing the teacher's workload, we developed the scientific graphic organizer (SGO). The SGO can be considered a pre-structured but simplified lab journal that in many cases allows to replace the practical's worksheet as well as students' written report. We elaborate on the educational value of the SGO, discuss its elements, and report on the practical implementation and preliminary results of research into, and with the SGO.

## Problem statement

Experiments are frequently utilised in secondary school for various purposes [1-4]. After conducting the experiment, students are often asked to write a report. However, this diminishes students' joy to engage in experimental work, increases teacher's workload as yet another pile of reports is to be graded, but also often does not allow to infer what the students have learned and which skills are mastered. As especially students' ability to communicate is assessed (e.g. in prose and in tables and graphs), it does not align with the intended aims (e.g. making sense of a phenomenon). We thus need a tool that allows to establish the two levels of effectiveness of practical work as distinguished by Millar *et al*. [2]: whether students (1) did what was intended, and (2) learned what was intended.

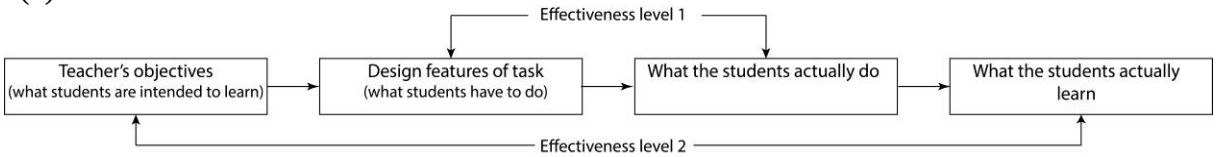


Figure 1: Millar et al. propose a model of the process of designing and evaluating practical work

## The Scientific Graphic Organizer

To address the problems above, we developed the Scientific Graphic Organizer (SGO) [5, 6], see figure 2. The SGO can be regarded as a pre-structured but simplified lab journal. It provides a schematic for reporting the essentials of the practical: the research question, the chosen instruments and method, theory used, data displayed in tables and graphs, a conclusion, the argumentation supporting the conclusion and a critical evaluation. The SGO allows for a clear focus on the experiment as the cognitive load is reduced and distracting factors that create noise [7, 8] – such as report writing, formatting, data representation in tables and graphs – are avoided.

The unique features of the SGO afford effective and versatile use of the SGO. A researcher can use it to make inferences about the learning of the students. A teacher can also use it in the classroom in several ways. The following sub-sections will show how the SGO may be used.

### *Research with and into the SGO*

Pols *et al*. [9, 10] used the SGO to monitor and compare students' approach to practical work. A blank SGO was provided, where students themselves provided the bare minimum information to understand what was done and found. In a recent master study [11], it was studied whether the SGO allows to engage students minds-on rather than only hands-on. Only the research question and materials were provided, students had to look up the theory and devise the methods. It was concluded that the SGO successfully made the practical more open.

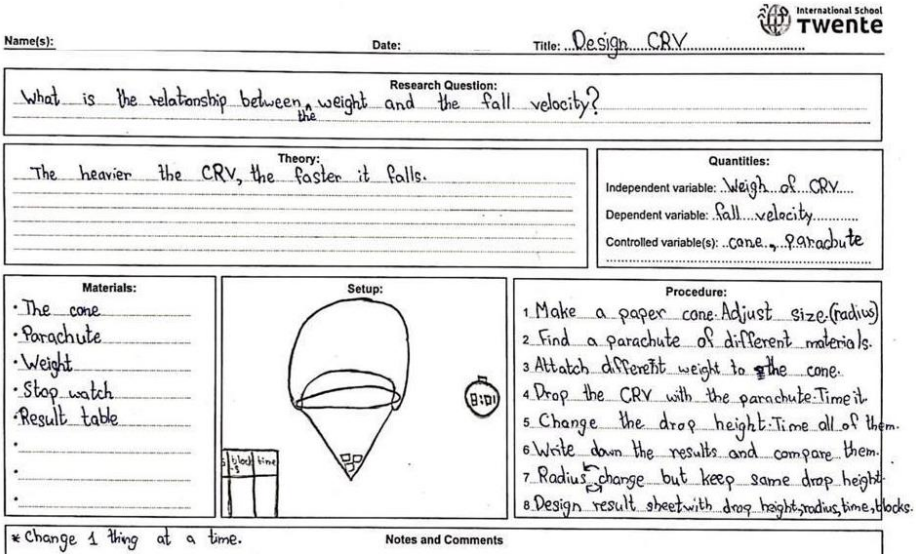


Figure 2: The front of the SGO – which relates to the design of the practical activity - filled in by students working on a practical activity from [12],

*Teaching with the SGO*

In my(2) teaching the SGO is used to help students design and plan an experiment: After the research *objective* is given, the students plan the experiment by completing the SGO as much as possible. It also frequently replaces the report. I have found the SGO in particular useful for students who are non-native speakers (EAL) as the task of communicating about an experiment becomes a lot less daunting, less time is spent on language and formatting. Students can focus on the task and learning goals. I will more deeply elaborate on the use of SGO in my teaching.

## Conclusions

The SGO is a useful tool for students, teachers and researchers. It provides all essential information to produce a fair judgement of the attainment of the learning goals without the necessity to write an extensive lab report.

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