Thinking-Back-and-Forth in Practical Work

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Abstract. During practical work students are typically more concerned with hands-on aspects, than with underlying minds-on aspects. Hence, it is hard to reach any minds-on learning goals, leading to relatively ineffective lesson time. In this workshop the framework of Thinking-Back-and-Forth (TBF) between hands-on and minds-on is presented and it is used to analyse existing practical work about possibilities to connect hands-on to minds-on. The framework has been developed to enable teachers to critically reflect on and improve their current practice regarding practical work in small, tangible steps. It has proven to be a valuable addition to pre- and in-service teacher education.

Introduction and theoretical background

Most teachers probably recognise a scene in which students are occupied by hands-on doing instead of minds-on learning during practical work. This is an important reason for the relative ineffectiveness of practical work [1,2]. To improve this situation, teachers need to become better equipped, as they facilitate their students' learning. It has, however, proven to be difficult to change educational practice decisively, despite a considerable amount of effort [3,4]. Potentially valuable pedagogies such as inquiry-based learning, run into several challenges, regarding teacher conduct and external stipulations [5]. As an alternative, the framework of Thinking-Back-and-Forth (TBF) between hands-on and minds-on has been developed [6]. This allows to focus attention on the paramount connection between the domain of observables and the domain of ideas.

To establish the framework of TBF the distinction between the domain of observables and the domain of ideas as used in previous studies [1,7] and teacher training programs [3], has been elaborated by explicitly mentioning the linking of these two domains as criterium for TBF. In doing so, TBF is defined as any reasoning activity in which a student uses at least one aspect from both domains. The four possible ways of linking the domain of observables to the domain of ideas are regarded as main categories of TBF activities: *explain*, *conclude*, *predict*, *design an experiment* (see Figure 1). From the literature a total of 30 activities that require TBF have been identified. Sources for these activities vary from literature on pedagogy of practical work [e.g. 8,9] to learning about the nature of science and learning inquiry skills [e.g. 10,11].

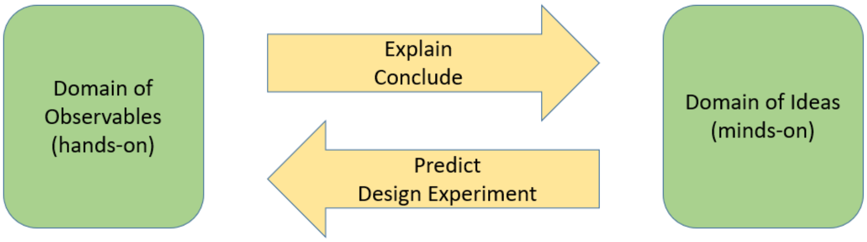

Fig. 1. Four ways of linking the domain of observables to the domain of ideas constitute the four TBF categories.

To clarify the distinction between minds-on activities and TBF activities, it is important to emphasize that for a TBF activity there must be a link between the domain of ideas and the domain of observables. A student who only reasons within the domain of ideas has not used TBF. This is the case, for example, when a student formulates a hypothesis based on scientific ideas learned previously. Only when a student uses this hypothesis to predict an outcome or to guide the design of an experiment, minds-on ideas are connected to hands-on observables or experiments.

Teachers respond favourably to the TBF framework as it allows them to improve their practical work in small, tangible steps. Major impediments to give more attention to TBF during practical work are incognizance with the possibilities, concerns about student abilities, and available time [6]. During earlier presentations of this workshop aimed at Dutch pre- or in-service teachers, participants were requested to fill in a brief learner report which contained the question how valuable they regard the concept of TBF for improving their practice. More than 90% responded with either ‘valuable’ or ‘very valuable’, consistently. Whether the workshop has indeed led to improvements in their practice remains to be investigated. The TBF-framework has, however, successfully been used to design practical work for grades 8-10 and this resulted in most of the participating students reporting a minds-on learning experience [12].

Goal of the workshop

The goal of the workshop is threefold: 1. Introduce the concept of TBF, 2. Provide examples of analyses of practical work using the TBF framework, and 3. Provide participants with a first opportunity to use the TBF framework to collect ideas about improving one’s own practical work. Hence, participants are going to analyse practical work using the TBF framework and obtain a first idea how to improve it. The intended audience is teachers and teacher educators.

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