Examining naïve conceptions regarding the enlightenment of a light bulb filament

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Abstract. Within the present study, we empirically examine an example frequently cited in the literature on physics teaching to illustrate that one's naive conceptions can influence the observation of a natural phenomenon. Conducted through an online survey, we challenged 158 participants to predict, reason, and observe the enlightenment of a light bulb filament. Our interim results reveal a contradiction to the description within literature on physics teaching since our participants rarely observed outcomes consistent with their own predictions ($\kappa = .111$) and reasonings ($\kappa = .184$). Details on the present study's design as well as further interim results are outlined in this proposal.

Theoretical Background and Aim of the Study

Students enter physics classes with a multitude of naïve conceptions about natural phenomena that can hinder their learning [1]. These naïve conceptions often originate from everyday life experiences and tend to be quite persistent [1]. One of the reasons for this persistence is that one's conceptions can influence the individual observations of a natural phenomenon [2]. As a result, when conducting an experiment in the physics classroom, some students observe what they expect to see based on their own conceptions. To illustrate this circumstance, the literature on physics teaching (e.g. [3–5]) very often refers to an example provided by Schlichting [6], which Duit & Rhöneck [3, p. C2.3] summarize as follows:

> *'He presented […] [a thin metal wire that is connected to a battery] to a grade 10 class and asked where the thin wire starts glowing when the circuit is closed. There were three different predictions. (1) The wire will glow first at the left or the right side depending of the assumption of direction of current flow taken as current enters the wire there. (2) The wire will glow up First in the middle as two kinds of current […] will come together in the middle. (3) The wire will simultaneously glow up at all places (the correct view). After the prediction the experiment was carried out. Almost everybody saw what he or she expected.'*

However, when reading Schlichting's original paper, it becomes clear that it is not an empirical study but a practice-oriented contribution that addresses physics teachers. Moreover, the paper is unclear as to whether the aforementioned example is a theoretical example created to illustrate a more general issue or whether it is an anecdotal retelling of events that occurred in a physics class. Therefore, given that Schlichting's example is cited frequently in textbooks on physics teaching (see above), generating empirical evidence for this example seems to be highly important for physics education research. Within this proposal, we outline the design of a study we conducted with the aim of generating such empirical evidence. Additionally, we report interim results of our data analysis since our in-depth analysis is still in progress.

Method

To generate empirical evidence for Schlichting's example, we conducted an anonymous and voluntary online survey of adults from the general population (N = 95) and pre-service physics teachers (N = 63) between September and December 2023 (total sample size: N = 158).

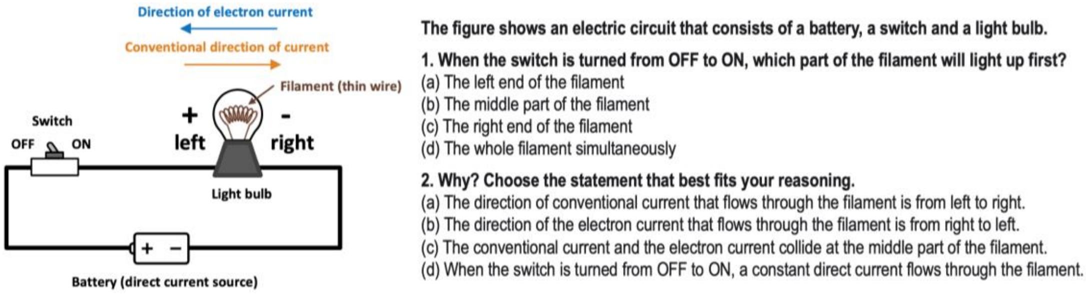

Fig. 1. Two-tier item to assess participants' conceptions on the enlightenment of a light bulb filament.

Within this survey, among further questions, participants were challenged with two tasks: First, they were asked to respond to the two-tier item shown in Figure 1 in order to assess their naïve conceptions regarding the enlightenment of a light bulb filament (based on their corresponding predictions and reasonings). Second, they were shown a slow-motion recording of the experiment described in the two-tier item and were asked to express their observation regarding the enlightenment of the filament. For the interim data analysis, we evaluated participants' response frequencies and statistically checked their concordance (via Cohen's κ).

Interim Results and Outlook

In summary, substantial proportions of our participants have predicted, reasoned and observed that the filament lights up on the right, left, in the middle or as a whole (see Table 1). However, while participants' predictions and reasonings showed a very high concordance ($\kappa = .725$; $p < .001$), this was not the case for their predictions and their observations ($\kappa = .111$; $p = .051$), nor for their reasonings and their observations ($\kappa = .184$; $p = .009$). This indicates that participants rarely saw what they expected to see based on their conceptions, i.e., a result that clearly contradicts Schlichting's example. Currently, we are analyzing the extent to which this—in our view—quite surprising finding is supported by our more rigorous in-depth data analysis. This in-depth analysis is still in progress but is planned to be completed in summer 2024. Therefore, its results are planned to be presented at 4th WCPE as well.

Table 1. Participants' response frequencies.

Variable	Response frequency			
	Left	Middle	Right	Whole
Prediction (two-tier item)	15.2 %	10.8 %	29.1 %	44.9 %
Reasoning (two-tier item)	17.1 %	7.6 %	25.9 %	49.4 %
Observation (slow-motion recording)	8.9 %	36.1 %	12.0 %	43.0 %

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