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SchriFT II: DESCRIBING, EXPLAINING AND JUSTIFYING: HOW TO SUPPORT WRITING LAB REPORTS IN PHYSICS CLASSES

Theoretical Background of the Design and Enactment

Language is an important part of scientific literacy (Wellington & Osborn, 2001; Yore, Bisanz & Hand, 2003). Educational policies worldwide demand to convey communication competencies within science classrooms (e.g. Achieve, 2013; KMK, 2004). International studies showed that writing in science classes can enhance students‘ content knowledge (Keys, 1994; Storch, 2005) and that supporting writing activities yields positive effects on students‘ conceptual understanding (Gleason, 1999). In contrast, only benefits for the language skills but not for content learning have been proved in German speaking countries, yet. This might be due to the fact that international writing to learn approaches like the Science Writing Heuristic (Akkus, Gunel & Hand, 2007) focus on discourse and text structure, whereas in German speaking countries the focus is on linguistic means of expression. Therefore, this study compares in German physics classes of grade 8 the effect on content learning and writing abilities of an intervention fostering necessary means of expression for specific discourse functions with an intervention that emphasizes their functional scheme. For instance, the first intervention promotes the use of if-then-clause for observations, whereas the second intervention explains that a relation between independent and depend variables must be drawn for observations.

Research questions and hypothesis:

1. To what extent can language development aimed at text types and text procedures improve technical understanding in physics lessons?
2. Which differences in learning outcomes occur between the promotion of functional schemas and the promotion of linguistic means of expression for specific discourse functions?

Our hypothesis: The subject-specific functional schemas are of central importance for the technical understanding and promote a deeper technical understanding compared to the promotion of linguistic means of expression.

Design

Both interventions turn the intention on the discourse functions DESCRIBING, EXPLAINING and JUSTIFYING which are integral parts of lab reports (Krabbe, 2015).
In functional pragmatics DESCRIBING is explained as the precise, factual representation of the external form of a fact or object with the aim of establishing a common perception between speaker and listener (Stutterheim & Kohlmann, 2001; Redder, 2012). In contrast, Feilke (2005) emphasizes that DESCRIBING is not limited to the visible spatial area, but can also refer to processes and states. The facts of the case are constituted by the speaker with reference to already established knowledge through comparisons and distinctions by highlighting and marking relevant features. Typical means of expressions are temporal, local, final and conditional phrases in the method and observation parts of lab reports.
Osborne and Patterson (2011) offer a distinction of JUSTIFYING and EXPLAINING for the natural sciences (see tab. 1). EXPLAINING is based on the deductive-nomological model of Hempel und Oppenheim (1948) whereas JUSTIFYING is seen as part of Toulmin’s argumentation model (1958).

Table 1: Differentiation of EXPLANTION and JUSTIFICATION according to Osborne & Patterson (2011), supplemented by conclusions from physics didactics (Krabbe, Timmerman, Boubakri (2019)).

Linguistic action	**Differentiation** (Osborne & Peterson, 2011)	**From the perspective of physics didactics** (Krabbe et al., 2019)
JUSTIFYING	• begins with an assertion, which in principle is provisional and has to be motivated • justifies the validity of a declaration or acceptance; has a conviction intention • uses accepted data and established evidence as justification • the justification is more secure than the reasoned submission	A law, a rule or a causal relationship is generally asserted and made plausible with arguments (e.g. empirical data). Iron conducts electricity because the lamp shines.
EXPLAINING	• begins with the statement to be explained, which is not in doubt • makes a phenomenon understandable through scientific facts and theory • uses relations, laws and theories as causal explanation • the declaration is less secure than what is declared	A phenomenon exists and is explained by the application of known laws, rules or contexts. The lamp shines because iron conducts electricity.

Following this distinction, two kinds of conclusion in lab reports must be distinguished. In explorative (inductive) experiments new laws and generalizations are justified, that is a conceptional statement is supported by observations. In confirmative (deductive) experiments observed phenomena are explained by theoretical considerations. In both kinds of conclusion causal relationships are expressed, but in a contrary scheme (see tab. 1). In order to differentiate discourse functions in the interventions in more detail we added specific prepositions to the functional operations (see following tab. 2).

Table 2: Text procedures and their function in the lab report (Krabbe et al., 2019).

text procedures		**Function in lab report**
DESCRIBE-WHEREBY	*the experiment is carried out*	Experimental setup (materials)
DESCRIBE HOW	*the experiment is conducted*	Experimental execution (instructions)
EXPLAIN-WHAT-FOR	*the lamps serves*	Experimental setup and execution
DESCRIBE-WHAT-HAPPENS-WHEN		Observations
EXPLAIN WHAT	*a ladder is*	Definitions
EXPLAIN-WHY	*the lamp shines*	Causal explanation (deductive)
JUSTIFY-WHETHER	*all metals conduct electricity*	Generalization (inductive) from data
JUSTIFY-WHICH	*explanation is better*	Decision justification

According to Schmölzer-Eibinger et al. (2017) the ability to describe, explain or give justify is not available to all pupils from the outset and should therefore be specifically developed in (subject) lessons. It has been shown, that the integration of language and content learning is best achieved if the texts prepared by the pupils are supplemented by assignments for content recapitulation (e.g. describe the emergence of ...). For this reason, the teaching series in both interventions are structured according to the Genre Cycle (Rose & Martin, 2012) or Teaching and Learning Cycle (TLC) (Hyland, 2007), respectively (see fig. 1). This consists of five stages. First, students' knowledge of the topic and field (1) and the focus genre (2) is built. Then, pieces of the intended genre are written

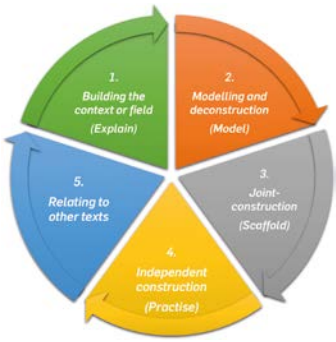

Figure 1. TLC.

in teacher-guided collaborative tasks (3) and later independently by each student (4). Finally, the learned genre and writing abilities are related to other texts (5).

Methods

Research design

To answer our research questions, an intervention in pre-post design (see tab. 3) was carried out in the second half of the school year 2018/19 (February to June 2019) within regular physics lessons of ten classes (approx. N=300 pupils) in grade 8 at four comprehensive schools (federal state NRW).

Table 3: Overview of the research design and timeline of the study.

Pre-test (January to February 2019)	**Intervention** (February to June 2019)	**Post-test** (June to July 2019)	**Follow-up-test** (September to October 2019)
• Writing task *(lab report, with video impulse)* in physics + subject knowledge test • Writing task *(construction manual, with video impulse)* in German/Turkish + reading-test (SLS) + writing-test (C-test) • IQ-test (CFT) • control variables	**Intervention A: "linguistic means"** 3 blocks á 270 min (=3*90 minutes), each block corresponds to one TLC run **Intervention B: "Action schematics"** 3 blocks á 270 min (=3*90 minutes), each block corresponds to one TLC run	• Writing task *(lab report, with video impulse)* in physics + subject knowledge test • Writing task *(construction manual, with video impulse)* in German/Turkish • Student feedback questionnaire about intervention • Teacher interviews	• Only writing task *(lab report, with video impulse)* in physics • Only writing task *(construction manual, with video impulse)* in German

Intervention & Sample (Students, Teachers)

For each discourse function (DESCRIBING, EXPLAINING, JUSTIFYING) a block of 270 minutes teaching time is implemented following the TLC with the lab report as genre. The content of the three blocks are electric charges (describing), electric current (explaning) and electric voltage (justifying). The intervention is carried out in two comparative versions, each in half of the sample. One version promotes "linguistic means of expression" (surface), the other version functional schemas (depth structure). The lessons are given by the regular physics teachers which received trainings for each cycle

Test instruments in pre-, post- and follow-up tests

The students' performance in writing lab reports (physics) and construction manuals (German) is tested a total of three times. The evaluation is carried out according to interdisciplinary standardized category systems. In the pre-test and post-test, the same subject knowledge test on electricity and magnetism is taken in physics, and a language ability and reading test in German. An IQ test and a questionnaire on interest and motivation in physics lessons and on the socio-economic backgrounds of the students are used only in the pre-test.

Outlook

Currently (08/2019), the follow up test and the transcription of the students' solutions are carried out. All three measurement times are concurrently coded afterwards. Detailed results are expected towards the end of 2019.

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