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Researching Pluriliteracies Development

Towards an Evidence-Based Understanding of the Role of Language in (Deeper) Learning

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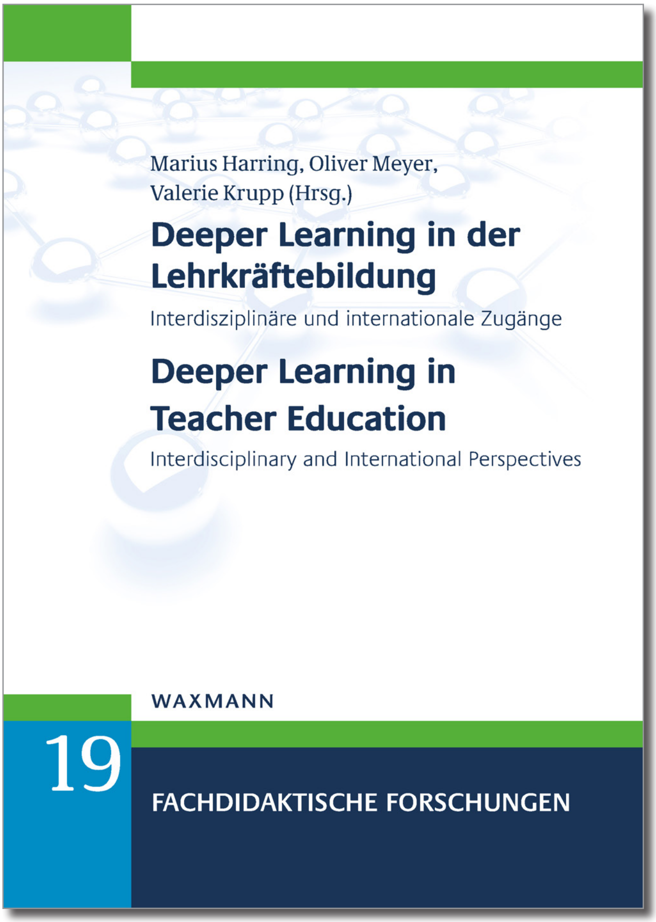

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Researching Pluriliteracies Development

Towards an Evidence-Based Understanding of the Role of Language in (Deeper) Learning

Oliver Meyer, Margarete Imhof, Nicole Hoyer and Teresa Connolly

Introduction

Deeper learning has been defined as »the process through which an individual becomes capable of taking what was learned in one situation and applying it to a new situation« (National Research Council, 2012, p. 5). Whilst there is agreement that the acquisition of transferable skills and competences is the essence of deeper learning, open question remain about the practical implications for teaching to adequately stimulate deeper learning. The Pluriliteracies Approach to Teaching for Deeper Learning (PTDL) provides a framework for designing learning environments, materials and tasks with the potential to foster sustainable and transferable knowledge and skills (Coyle & Meyer, 2021). In this paper, we briefly outline the main principles of PTDL and then present two intervention studies to test if empirical evidence supports the claims of the theoretical model.

1 The role of language and literacies in deeper learning

The core principle of the PTDL approach is the assumption that the development of transferable knowledge and skills depends on domain-specific processes of constructing and communicating knowledge (National Research Council, 2012; Christodoulou, 2017). Therefore, deeper learning is directly linked to the acquisition of disciplinary literacies. McConachie and Petrosky (2010, p. 16) argue that disciplinary literacy »involves the use of reading, reasoning, investigating, speaking and writing required to learn and form complex content knowledge appropriate to a particular discipline«. In a similar vein, Putra and Tang (2016) emphasize the two-fold goals of disciplinary literacy education which aims to »nurture students to be literate in the discipline they are pursuing« and to foster »the ability to use specialised language and practices valued and used in a given discipline to navigate and participate in the discipline« (p. 569), which entails that »students have to be apprentice disciplinarians and practise what disciplinarians do« (Putra & Tang, 2016, p. 569). In line with this, Goldman et al. (2016) identify five higher-order categories of disciplinary literacy:

(a) epistemology
(b) inquiry practices, reasoning, and strategies
(c) overarching concepts, themes, and frameworks
(d) forms of information representation / types of text
(e) discourse and language structures

Any teaching approach for promoting disciplinary literacy in the classroom faces the challenge to incorporate and adjust these categories to both content and curriculum and the respective competence levels of the learners. In PTDL, this is done through two principles: The first is *alignment* (Coyle & Meyer, 2021) of disciplinary content with the (meta-) cognitive and affective dimensions of learning, e.g., prior knowledge, competence level, and motivation. Teachers promote deeper learning through design principles, such as adaptive task complexity, connecting assignments and student experience, complementing domain-specific content with related language and communicative functions.

We posit that the alignment of content, language, and learner characteristics will increase cognitive learner engagement, e.g., use of strategies associated with deep processing and cognitive elaboration, which, as a result, will yield deeper learning (Lam et al., 2012; Sani & Hashim, 2016). This is because cognitive elaboration of content facilitates »detailed, knowledge-rich mental models stored in long-term memory«, which are prerequisite for successful task performance and sustainable learning (Christodoulou, 2017, p. 34).

The second principle of PTDL rests on the assumption that content learning is inextricably linked with the process of *languaging understanding* (Coffin & Donohue, 2014; Lantolf & Poehner, 2014; Swain, 2006). Thus, conceptual understanding of content develops in line with the growing command of procedures, skills, and strategies pertaining to the discipline. This way, conceptual learning is intertwined with the acquisition of adequate ways of demonstrating and communicating understanding. In that sense, progression in disciplinary literacy encompasses both growing mastery of disciplinary ways of constructing *and* communicating knowledge.

We concur with the idea that progression in disciplinary learning follows an ›idealized knowledge path‹ (Coffin, 1997; Polias, 2016; Veel, 1997). It consists of four so-called knowledge and activity domains which comprise typical ways of constructing and communicating disciplinary knowledge. In case of school science, these four activity domains are ›doing science‹, ›organising science‹, ›explaining events scientifically‹ and ›arguing science‹. According to Martin (1992), this progress needs to be accompanied by a shift from the ›grammar of speaking‹ to the ›grammar of writing‹ and from ›language as action‹ to ›language as reflection‹ (Martin, 1992).

Accordingly, in PTDL learning progression is conceptualised as the individual extension of a learner's meaning-making potential in several subjects and in one or several languages of schooling. It entails:

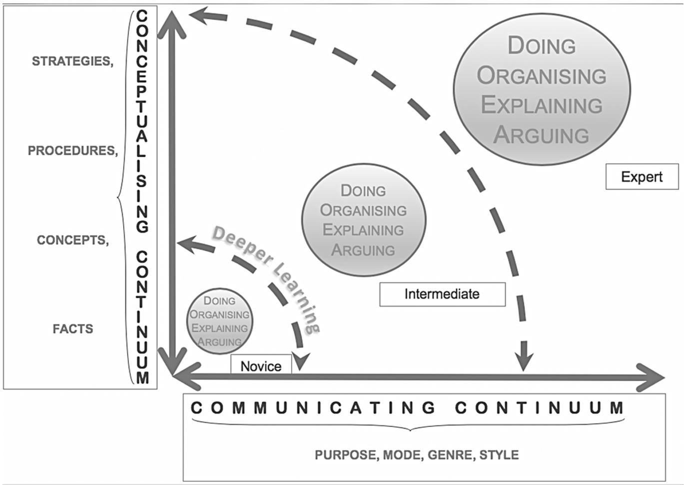

Figure 1: Deeper learning as conceptualised by the Graz Group (Coyle & Meyer, 2021)

- growing command of genres and genre moves in continuous and non-continuous texts
- increasing depth of content information provided in each of these moves as an indicator of growing conceptual understanding resulting from engaging in the major activity domains integral to a discipline (i.e., *doing, organising, explaining & arguing*)
- higher quality of language use at the discourse, syntactic, and lexico-grammatical level
- growing mastery of subject-specific skills and strategies.

2 Operationalising the construct of deeper learning

In Brown's (Brown & Wilson, 2011) model of cognition, a continuum of understanding ranging from intuition to expertise is established, in which »learning is conceived as a progress toward higher levels of sophistication and competence as new knowledge is linked to existing knowledge and deeper understandings are developed« (Brown & Wilson, 2011, p. 225). Growing understanding results from increased depth and breadth of conceptual knowledge: whereas the construct of conceptual depth describes »increasingly deep structures of understanding« of a given disciplinary phenomenon or concept, the breadth construct describes a »hierarchy of increasingly wider ranges of applicability« of a concept (Brown, 2005, pp. 6–8).

Concepts are »perceived regularities in events or objects, or records of events or objects designated by a label« (Novak, 2002, p. 550). They are hierarchically struc-

Level		Description of Person	Description of Response
5 Emergent	**B** ↑ **$A_1 \leftrightarrow A_2$**	The phenomenon is seen as an emergent property of a system, made up of interacting components. The system evolves over time, eventually producing the observed effect.	A_1 and A_2 happen. Over time, they interact and evolve, until eventually B happens. Meanwhile, A_1 and A_2 continue to happen.
4 Multiple	**A_1**, **A_2** → **B**	The phenomenon is seen as an effect produced by multiple causal elements. All are necessary; if one is removed the effect is not produced.	A_1 and A_2 cause B when they both happen at the same time.
3 Justified	**A** → ⎍ → **B**	The phenomenon is seen as an effect produced by a single causal element. Justification or a mechanism is necessary.	A causes B, and this is how.
2 Elemental	**A** → ■ → **B**	The phenomenon is seen as an effect produced by a single causal element. Justification or a mechanism is not necessary.	A causes B.
1 Acausal	**B**	The phenomenon is seen as an instantiation of reality. No cause is necessary.	B happens because that`s the way things are.
0 Absent	**B ?!?**	The phenomenon is surprising. No explanation seems possible.	I can`t explain why B happens.

Figure 2: Depth of conceptual understanding (Brown & Wilson, 2011)

tured and represent the building blocks of organised knowledge. Learning occurs and evolves »when a new regularity is perceived […] leading to concept formation and/or the construction of new propositions« (Novak, 2002, p. 550). Deeper learning necessitates the successful internalisation of conceptual knowledge because internalisation is an essential prerequisite for transfer of learning (Lantolf & Poehner, 2014).

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Language, or more precisely, ›languaging‹, »the process of making meaning and shaping knowledge and experience through language« (Swain, 2006, p. 98) both complements and supports conceptual learning. The process of transforming conceptual knowledge into language to appropriately communicate understanding plays a pivotal role in deeper learning because it shapes conceptual development and is a necessary precursor of understanding. In that sense, language can be viewed as the »primary evidence of learning« (Mohan et al., 2010, p. 221): when learners communicate their understanding and reasoning that learning becomes ›visible‹. Therefore, we posit that a learner's ability to adequately communicate content knowledge indicates their level of conceptual understanding.

In the context of schooling, learners typically use specific genres or text types to express their understanding of disciplinary content. These genres differ in scope and size and integrate a variety of communicative functions (Coffin and Donohue, 2014). Accordingly, a complex text type, like a *lab report* in chemistry, constitutes a macro-genre because it consists of several smaller building blocks or ›embedded‹ micro-genres like *hypotheses*, *explanations* and *definitions*. When these micro-genres stand alone, they are also referred to as Cognitive Discourse Functions (CDFs). Dalton-Puffer (2013) lists seven CDF types (*classify, define, describe, evaluate, explain, explore, report*) with specific communicative intentions and components. CDFs serve as linguistic representations of cognitive learning goals:

> … they are patterns which have arisen from the demand that participants within the institution school orient towards explicit or implicit learning goals and the fact that they have the repeated need for communicating about ways of handling and acting upon curricular content, concepts, and facts (cf. cognitive process dimension of Anderson et al., 2001). It is their very nature to provide speakers with schemata (discoursal, lexical, and grammatical) for coping with standard situations in dealing with the task of building knowledge and making it intersubjectively accessible. (Dalton-Puffer, 2013, p. 16)

Our assumption that progress in subject understanding translates into the ability to communicate knowledge in increasingly adequate ways also pertains to CDFs. We presume that a growing command of CDFs in terms of depth of content information provided and quality of language use at various levels can be considered indicative of progress in subject learning and thus deeper learning.

Consequently, our studies focus on the development of CDFs and, more specifically, on explanations. The decision was made based on the observation that writing valid explanations is a central for building scientific arguments and, yet, it is a challenge which learners in secondary education and beyond quite frequently fail to master (Vollmer, 2008; Brown et al., 2011; Özcan, 2013; Rautenstrauch, 2017).

This presents the challenge of defining distinct criteria and parameters to assess and evaluate the quality of learner explanations. Ideally, those metrics are aligned and consistent with the logic of the discipline, the communicative purpose and mode (written vs. oral) and the level of learning. To achieve this, adequate criteria to assess the quality of learner explanations had to be identified. Next, complex rubrics and descriptor bands were created as viable tools for assessing the degree of CDF mastery with regard to both disciplinary content knowledge and disciplinary discourse competence as a measure of disciplinary literacy.

3 Intervention studies to foster disciplinary literacy

What are the implications of the PTDL model for the classroom? What would learning arrangements look like that are designed in in line with the PTDL principles? Two long-term intervention studies were designed to address the research gaps we had identified. The aims of the studies were twofold: First, to develop tasks and materials suitable for teaching disciplinary content alongside the corresponding language competences; and second, to empirically test if the predicted effects of deeper learning can be demonstrated.

To design adequate materials and tasks for deeper learning, teachers need to have a full grasp of these principles. Consequently, teachers were trained in the principles of PTDL and how to put them into practice. Two research assistants who were qualified both in their respective discipline and in English language education, cooperated with the head researchers on transferring PTDL principles to materials and tasks that could be shared with the teachers in the schools. To ensure final implementation fidelity, the research assistants observed the lessons taught by the teachers.

The interventions were administered in two disciplines which are staple subjects in secondary schools, i.e., chemistry (Intervention Study I) and geography (Intervention Study II). The specific content topics were taken from the regular curriculum to ensure ecological validity and practical relevance of the study.

In the case of Intervention Study I (chemistry), the learning arrangement centred around redox-reactions. It centred on learner experiments and subject-specific strategies of scientific reasoning to improve explanations in the written mode. In Intervention Study II (geography), the focus was on global heating and specific listening and speaking tasks and strategies to improve learners' command of oral explanations.

The actual instruction was carried out by the regular teachers in the schools, data collection was administered by the co-authors as part of their assignments as research assistants. Each study was conducted in an environment where subject content was taught through an additional language (English). In both studies, control and experimental groups were selected from within existing CLIL branches through »direct experimental control« (Cozby & Bates, 2012, p. 157) and controlled for age, intelligence, motivation, grades, language proficiency, etc., to account for potentially confounding variables.

4 Intervention Study I: Written explanations in the chemistry classroom

4.1 Aims and research questions

Connolly (2019) conducted an extensive study to examine the development of disciplinary literacy in the bilingual chemistry classroom. Her thesis was driven by the following research question:

Does a pluriliteracies intervention (PTDL) focusing on strategies to improve learners' written explanations foster the development of disciplinary literacy and deeper learning?

4.2 Intervention for disciplinary literacy and material

The goal of PTDL intervention was to promote a deeper understanding of chemical reactions by providing learners with opportunities to engage in the knowledge and activity domains of chemistry (*doing, organising* & *explaining*): learners conducted experiments and received instructions in scientific reasoning to structure and language their understanding adequately. For this purpose, the PRO (premise-reasoning-outcome) strategy (Putra & Tang, 2016) was introduced and illustrated through various examples centred on the topics of metals and oxidation.

In a first step, learners were tasked to analyse written explanations and to identify the underlying principles and patterns using sample explanations and cause-and-effect-diagrams. Particular emphasis was placed on demonstrating how explanations work and on clarifying the pertaining linguistic features, i.e., the words, phrases and sentence structures used to express and link cause and effect patterns. In a second step, learners were given a series of complex science tasks. They had to conduct their own experiments to dispel common misconceptions about chemical reactions. In addition, they were asked to demonstrate their content understanding through written explanations. The tasks were specifically designed to facilitate transfer of learning by challenging learners to move from collaboratively analysing sample explanations to applying their newly gained skills of scientific reasoning and their understanding of written explanations in different contexts.

The following hypotheses guided the study:

H1: Learners in the PTDL intervention groups will demonstrate a higher command of disciplinary written discourse than learners in the control group. Higher command of disciplinary discourse is indicated by a higher quality of written explanations. This effect is expected to occur due to the specific language component in the instruction.

a. Learners in the PTDL monolingual German group benefit from the additional language component and will show comparable quality of written explanations as learners in the PTDL bilingual English group. Learners in the PTDL monolingual German group will outperform the bilingual English group in terms of quality of written explanations.

H2: Learners in the PTDL intervention groups will show higher gains in disciplinary content knowledge than learners in the control group. Higher learning gains will be represented by test scores of conceptual knowledge.

5 Method

Sample. Learners from six classes of seventh and eighth graders from two different middle schools in Germany participated in the study. Four classes were in the bilingual chemistry program and had two years of experience of studying chemistry in a foreign language (English), and two classes received chemistry lessons in German as the official language of schooling. Learners had been placed into the bilingual program by their own choice. No selection process (e.g., through grade or other restrictions) had been applied. Prior to the intervention, a set of control variables was measured to control for equivalence of the groups, school grades, subject-specific interest, and self-efficacy (Jerusalem & Satow, 1999) and no significant differences were detected between groups. In addition, two subscales from a diagnostic test of general cognitive ability, i.e., verbal ability and figural thinking (KFT 4–12+R, Heller & Perleth, 2000) were administered to control for differences in cognitive ability. Again, measures confirmed that all classes could be assumed to be equivalent in terms of cognitive ability and learning potential.

Parents, teachers, and students had been informed about the purpose and the procedure of the study and they had given informed consent for the learners to participate. The sampling process yielded three groups with unequal group sizes, i.e., $n = 71$ in intervention group 1: bilingual/CLIL instruction (English) + PTDL, $n = 43$ in intervention group 2: monolingual instruction (German) + PTDL, and $n = 25$ in the control group: bilingual/CLIL (English) – PTDL.

Design and Procedure. A quasi-experimental design with a three-group, pre-post design was conducted over an intervention period of three months, which allowed for nine chemistry units covering various subtopics of redox reactions. Each unit spanned two or three lessons and was taught by the respective chemistry teacher. Three out of the four bilingual chemistry classes were assigned to the experimental condition and followed a PTDL approach.

The remaining bilingual class functioned as control group and received ›regular‹ chemistry lessons on the same topic in English using a CLIL approach. The two classes which received chemistry instruction in German also followed a PTDL approach. All classes were provided with the specifically designed resources and learning materials to ensure equivalence of instructional material for the disciplinary

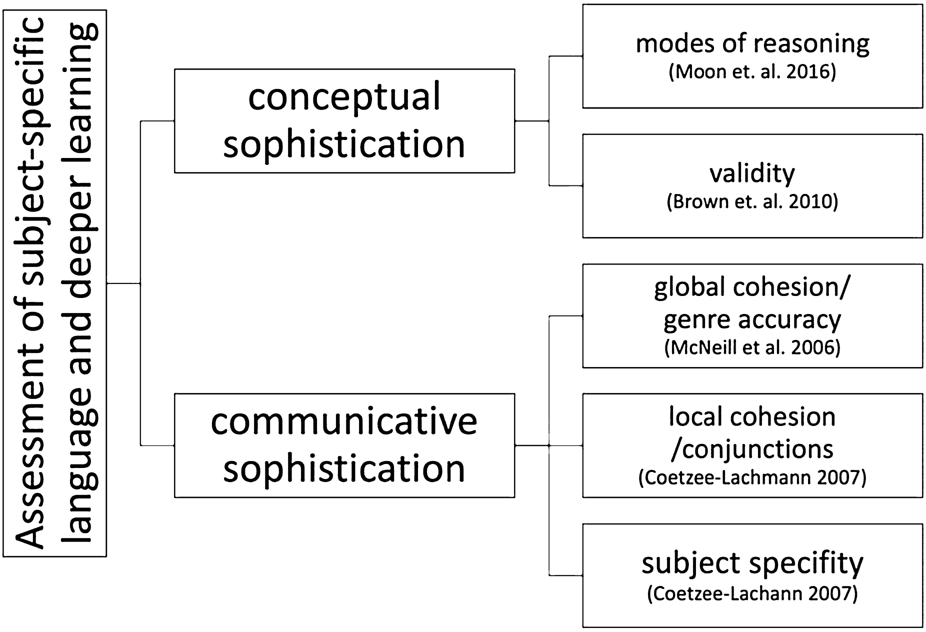

Figure 3: Assessment of disciplinary literacy (Connolly, 2019: this publication also contains the actual descriptor bands and rubrics used in the study)

content. In addition, instructional time in terms of numbers of scheduled lessons was identical for all classes.

Instruments. An author-generated test was used to assess student learning. The first part focused on conceptual knowledge and complexity and consisted of several sets of multiple-choice, single-choice and cloze questions. The measurement of subject-specific language skills, which included ways of assessing conceptual and communicative sophistication of learner explanations (see Figure 3), was done through an open question format: learners were tasked to explain the chemical reaction of corrosion in writing.

The assessment of learner explanations is based on the assumption that a higher degree of sophistication of an explanation reflects a higher degree of complexity of a learner's conceptual knowledge and understanding. In line with this claim and based on the PTDL principles, an assessment tool was developed and validated to allow for the evaluation of both content knowledge and disciplinary language including the structure of the student generated explanations (Connolly, 2019). Following Moon et al. (2016) and Brown et al. (2010), Connolly (2019) designed a set of rubrics to analyse and assess various aspects of conceptual sophistication such as modes of reasoning and conceptual validity in student explanations. To assess the level of *conceptual sophistication*, learner explanations were analysed and assessed with regard to various aspects of cohesion (Coetzee-Lachmann, 2007; McNeill et al., 2006) and use of subject-specific terms:

Table 1: Group Means for Concept Knowledge and Subject Literacy for $N = 25$ Matched Triplets in Groups With and Without PTDL-Components Before and After the Intervention (Berg, 2020)

	Intervention Group Bilingual + PTDL		Intervention Group Monolingual + PTDL		Control Bilingual	
	M	*SD*	*M*	*SD*	*M*	*SD*
Conceptual Knowledge*						
Pre-test	4.92	1.75	5.01	1.87	5.00	1.91
Post-test	11.29	1.80	10.84	2.71	9.36	2.32
Disciplinary Literacy						
Pre-test	6.29	3.95	8.44	4.40	6.92	4.28
Post-test	11.90	4.03	13.75	4.28	9.29	4.42

Note.
* theoretical maximum: 25 points

6 Results

Data were prepared to run an analysis of variance for repeated measures. To avoid statistical bias due to unequal cell sizes and to control for individual level of initial competence, we composed a subset of 25 triplets with learners who had identical scores on the conceptual knowledge pre-test. This matching procedure ensured that we could control for competence level, so that the degree to which groups reported different amount of progress could be attributed to the type of instruction.

Table 1 presents the descriptive data for conceptual knowledge and disciplinary literacy. Not surprisingly, all groups showed increases after three months of instruction, so it is possible to conclude that all learners made progress both in terms of conceptual knowledge and in disciplinary literacy. An analysis of variance for repeated measures was run to test for group differences in growth of both conceptual knowledge and disciplinary literacy and results revealed significant group differences for both outcome criteria, i.e., as to how much progress was made for conceptual knowledge ($F(2, 23) = 5.45$, $p < .05$, $\eta^2 = .32$) and for disciplinary literacy ($F(2, 23) = 6.72$, $p < .01$, $\eta^2 = .37$). In line with Hattie's (2009) interpretation, this effect size is considered to fall into the *zone of desired effects* as it substantially exceeds simple *teacher effects* (Lenhard & Lenhard, 2016). Post-hoc tests confirmed that both PTDL groups, the bilingual as well as the monolingual classes, showed significantly higher gains in conceptual knowledge and disciplinary literacy than the control group who was taught the same material in an additional language but without the explicit PTDL component.

6.1 Discussion

The purpose of the three-month intervention study was to investigate if learner performance can be improved to reach deeper learning goals through PTDL. A total of six classes from 7th and 8th grade chemistry programs were sampled to represent three different learning environments, two of which were following a PTDL approach. The difference between the two PTDL environments was the language of instruction, which was either the language of schooling (i.e., German) or an additional language (i.e., English). The control group was instructed in an additional language, namely English, but did not follow a PTDL approach. All three groups achieved higher scores in content knowledge and understanding of the subject matter in the post-test, which is a common teacher effect after three months of instruction (Hattie, 2009). However, increase in content knowledge and disciplinary literacy was substantially higher in both PTDL intervention groups than in the control group so that the zone of desired effects could be reached (Hattie, 2009). As we had controlled for initial competence levels, it is safe to say that the progress that learners made depended on the type of instruction and that PTDL instruction resulted in a greater increase in conceptual knowledge and in a growing command of disciplinary literacy. What is more, the combined disciplinary literacy gains could be achieved at no extra cost in terms of instruction time in the classroom. This is remarkable for two reasons:

1. **PTDL vs. control group (CLIL)**: learners from the PTDL intervention groups outperformed the control group in terms of conceptual knowledge and disciplinary literacy. It is important to note that learners from the experimental and the control groups were selected from a CLIL branch. That means that the study did not simply pit groups that received ›content-only‹ instruction against learners who would receive a pluriliteracies-based training that also included an academic language component. Instead, learners from the control groups had received several years of *Content and Language Integrated Learning* and were taught by highly experienced CLIL teachers who made sure that the learning materials, tasks and activities were state of the art. We interpret this to mean that following a CLIL (Content and Language Integrated Learning) approach does not automatically ensure greater depth of learning. Our results support the assumption that learners who receive a PTDL-based instruction, i.e., instruction that focuses on ***ways of increasing conceptual understanding*** and explicit ways of promoting the ***active use of CDFs***, reach a deeper level of disciplinary literacy in a similar amount of instructional time than learners who receive a CLIL-based instruction, i.e., instruction that uses an additional language to teach disciplinary content.
2. **PTDL: L1 vs. L2 instruction**: It is significant to see that learners from the intervention group who were taught in the language of schooling (German) reported similar learning gains in terms of disciplinary literacy as the learners who were

taught through English as an additional language, and that both PTDL intervention groups outperformed learners from the CLIL control group. We interpret this to mean that a focus on deeper learning via PTDL is beneficial to subject learners ***in any language*** (i.e., primary language of schooling or additional language). Teaching content through additional language without a specific focus on deeper learning alone does not seem to yield the desired effects in terms of disciplinary literacy.

6.2 Limitations of the study and perspectives for future research

As encouraging as the results of this study may be, limitations of the research need to be addressed. First, the design and the preparation of the learning material is quite time consuming and requires additional training for teachers who need to be aware of the PTDL design principles and their implications for preparing materials and tasks. Secondly, we need to caution that replication studies are necessary to confirm the pattern of results. Although we found that the intervention works across different schools, larger and more diverse samples need to be included in the research program in the long run. In addition, the validation of the rubric that was used to measure disciplinary literacy is still an issue, which we will need to put on the agenda for subsequent studies.

Overall, our results are in line with the findings of previous studies. The connection between an explicit focus on subject-specific language skills and increased content knowledge in chemistry has already been documented in CLIL (Özcan, 2013) and L1 classrooms (Rautenstrauch, 2017). Byrnes (2013) also reports increased knowledge structures after extensive writing tasks. Results indicate that the key findings of Putra and Tang (2016) and McNeill et al. (2006) also apply to secondary school contexts: explicit and content-specific instruction of how to write explanations in an authentic disciplinary setting increases both the quality of written scientific explanations and the level of conceptual understanding.

7 Intervention Study II: Listening for literacies: Oral explanations in the geography classroom

Subsequent to the findings of Study I, we wanted do replicate the intervention with a slightly different focus. First, we changed the discipline and turned to geography, and, second, we looked at disciplinary communication in the oral mode, i.e., oral explanations. We expected that the educational benefits of implementing PTDL principles would also hold if transferred to a different context and mode. The study was administered in a completely different school system, both structurally and geographically.

7.1 Aims and research questions

Berg's (2020) study examined the development of disciplinary literacy in secondary CLIL geography classrooms adopting a PTDL approach. The placement policy of the school system stipulated that assignment to the bilingual CLIL track was restricted to learners with consistently high performance in English as a foreign language, so that only the top students were permitted to the bilingual track. This way, the bilingual cohort represented a pre-selection of the most gifted students of a year. This was an ideal backdrop to investigate if PTDL instruction can produce additional value and deeper learning in a group of high potentials. The study was driven by the following research question:

Can a PTDL intervention focusing on speaking and listening tasks foster the development of subject-specific literacy and deeper learning?

7.2 Intervention for disciplinary literacy and material

The intervention emphasised both explicit instruction in oral explanations and training in decoding authentic, disciplinary native speaker language through a newly developed listening comprehension format. On top of the content-oriented geography tasks and activities, learners were taught how to decode and analyse prosodic features of spoken language (intonation, stress, pausing, etc.) in topically related podcasts. Furthermore, they were instructed how to apply that knowledge to structure and formulate their own explanations of subject-specific content in the oral mode. We posit that the additional focus on prosodic features of disciplinary language will facilitate phonological chunking (Lewis, 2007) and thus support automatisation and retrieval of those chunks and thus lead to gains in linguistic fluency.

Based on the assumption that training of disciplinary oral literacy affects both general oral proficiency (see Figure 4) and disciplinary proficiency, the following hypotheses have been proposed (Berg, 2020, p. 166):

H1: Oral explanations of learners in the intervention group show higher increases in fluency of academic speech in the additional language than those of learners in the control group.

H2: Oral explanations of learners in the intervention group show higher increases in disciplinary oral language proficiency than those of learners in the control group.

7.3 Method

Sample. In April 2018 and June 2018, data were collected from a total of $N = 52$ learners in two eighth grade bilingual geography classes of a German secondary school. The classes were randomly assigned to the intervention ($n = 26$; 16 female, 10 male, mean age 13.77 years, $SD = .43$) and the control condition ($n = 26$; 18 female, 8 male; mean age 13.85 years, $SD = 1.05$). Statistical tests for group differences in the disciplinary performance level confirmed that the classes were equivalent prior to the intervention.

Design and Procedure. For the present study, a repeated measures quasi-experimental design was used with both intervention and control group from the bilingual track. Across a period of 20 lessons both groups covered six topics related to the human impact on climate change and global heating. The PTDL intervention was integrated into the classroom routines of the intervention group while the control group proceeded with their regular CLIL geography lessons. Implementation validation was taken care of as the researcher attended the lessons in both groups to ensure that the teachers used assignments and materials as intended and as required by PTDL principles. Measurements of the quality of oral explanations were collected within three days before and after the teaching unit for both groups.

Instruments. A complex rubric was created to analyse the audio recordings of the student explanations in terms of generic academic language and disciplinary language (Figure 4). A measure of fluency was selected as the indicator of automatization of generic academic language performance. According to previous findings, Pruned Speech Rate (PSR) is seen as a strong indicator for speech fluency (Derwing et al., 2009; Michel, 2011; Préfontaine et al., 2016; Segalowitz et al., 2017). PSR represents the amount of time needed to articulate an utterance including all of the relevant words, filled and unfilled pauses and reformulations. PSR is calculated through the number of pruned[1] syllables per second, including pause time. In addition, total speaking time was measured.

Disciplinary Oral Language proficiency was assessed by a coding scheme which entailed five subscales characterising appropriate causal geographic explanations with an evaluation range from zero to three points in each category (Berg, 2020): *conceptual depth and structure of explanation*, *linking of explanation, evidence, subject-specific terms* and *subject-specific verb use*.

Since oral language does not adhere to genre conventions and restriction in the same way as written language does, Berg's (2020) approach to assess disciplinary meaning-making differs from Connolly's (2019) approach. Berg (2020) argues that disciplinary literacy contains elements of disciplinary language (such as conceptual depth, linking, evidence, use of subject-specific terms and verbs) as well as elements of generic academic language (such as linguistic complexity or fluency). Therefore, assessment of the quality of disciplinary meaning-making has to include both language components. This is illustrated in Figure 4.

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1 »Pruned« words are the ones remaining when all redundancies from repetitions and repairs are removed.

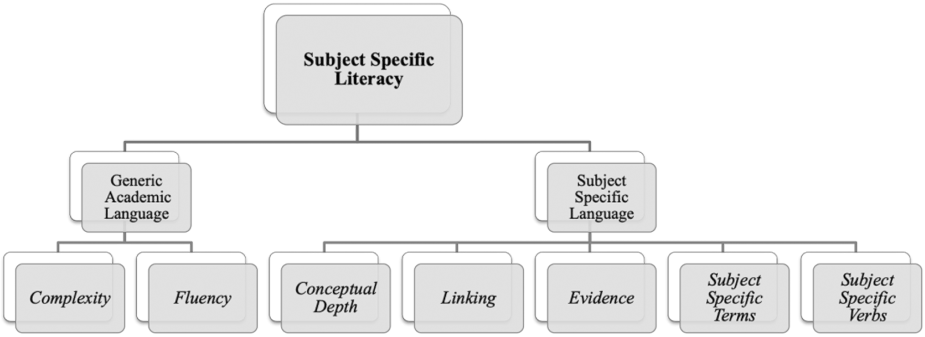

Figure 4: Assessment of subject specific literacy (Berg, 2020: this publication also contains the actual descriptor bands and rubrics used in the study)

7.4 Results

Effects on Generic Academic Language Performance

To secure the reliability of the rubric that was administered, four independent raters were trained to use the rubric and listened to the audio recordings of the student explanations for independent ratings. An intra-class coefficient was calculated for an indicator of interrater agreement. The values that were returned for the disciplinary, subject-specific oral language proficiency were excellent (*ICC* = .93), particularly so when taking into account that the agreement of four independent raters was confirmed.

Table 2: Descriptive statistics of measures for fluency in learners' oral explanations in the pre- (T1) and post-test (T2) (Berg, 2020)

		Intervention group (N = 26)				Control group (N = 23)			
		M	SD	Min.	Max.	M	SD	Min.	Max.
Fluency: (PSR)*	T_1	1.73	.47	.80	2.90	1.73	.57	.80	3.70
	T_2	2.07	.48	1.00	3.10	1.68	.58	.80	2.70
Speaking time (sec.)	T_1	65.85	30.50	20.00	167.00	85.17	30.00	41.00	154.00
	T_2	90.35	40.37	37.00	190.00	55.17	27.5	24.00	135.00

Note. * PSR: Pruned Speech Rate.

To test Hypothesis 1, Berg (2020) analysed whether fluency of learners from the intervention group (IG) improved through the PTDL *Listening for Literacies* intervention from pre- to post-test in contrast to the control group (CG) from regular bilingual geography classes. Fluency was measured via Pruned Speech Rate. Additionally, total speaking time of each student was gauged.

Table 2 shows the descriptive statistics for the measurements of fluency with pruned speech rate and total speaking time. As shown, learners from the intervention group (IG) produced considerably more syllables per second after the intervention. Moreover, their average total speaking time of 65.85 seconds ($SD = 30.50$) prior to the intervention increased by 25 seconds to an average total speaking time of $M = 90.35$ seconds ($SD = 40.37$), while the average total speaking time of the learners from the CG substantially decreased by 30 seconds. While the Pruned Speech Rate increased for the IG, no difference was found between pre-test and post-test in the CG. A repeated measures ANOVA yielded a main effect for time ($F\ (1, 47) = 7.94$; $p < .01$; $\eta^2_{part} = .14$) and a significant interaction ($F\ (1, 47) = 11.18$; $p < .001$; $\eta^2_{part} = .11$) between groups. The increase of fluency over time is only visible in the IG after the intervention. The effect size can be interpreted as a mean effect, which would fall into the zone of desired effects (Hattie, 2009). This pattern of results supports H1, specifically that oral explanations of learners from the IG increased in fluency from pre-test to post-test whereas the control group shows no such increase.

Berg (2020) also reports consistent gains in overall complexity of generic language performance in terms of lexical and syntactic complexity (figures 5 and 6):

Effects on Disciplinary Language

The second hypothesis addressed the question whether disciplinary language proficiency of learners from the IG improves through the *Listening for Literacies* intervention from pre- to post-test. Table 3 shows the descriptive statistics for the results of the overall scale for both measurement points:

According to these results, mean scores in disciplinary language proficiency increase in the intervention group. In contrast, little development is found in the con-

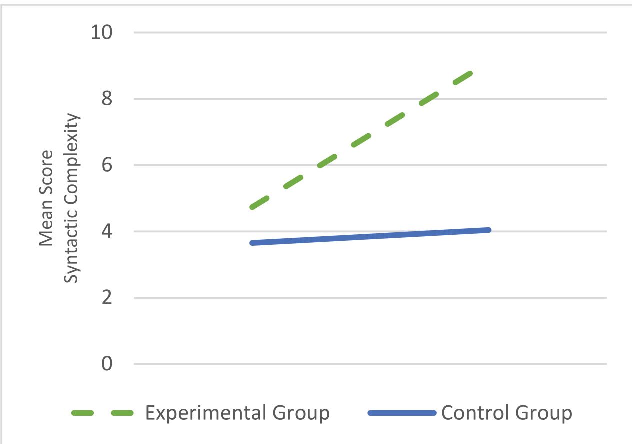

Figure 5: Development of Syntactical Complexity from Pre- to Post-Test (Berg, 2020)

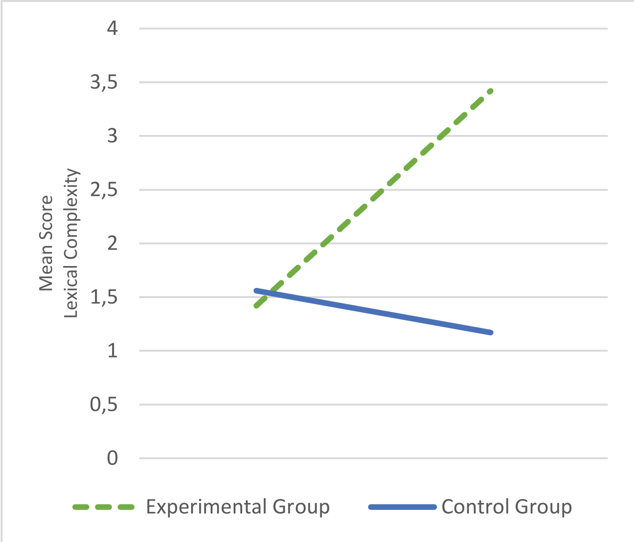

Figure 6: Development of Lexical Complexity from Pre- to Post-Test (Berg, 2020)

Table 3: Descriptive statistics of measures of subject-specific proficiency in the pre- (T1) and post-test (T2) (Berg, 2020)

		Intervention Group (N = 26)		Control Group (N = 23)	
		M*	SD	M	SD
Disciplinary Language Proficiency	T_1	6.05	1.93	5.36	1.93
	T_2	9.76	2.62	6.15	2.20

Note. *The theoretical range for the scale of subject-specific proficiency was 0 to 15 points.

trol group. Results indicate a main effect of time (F (1,47) = 58.36; $p < .001$; $\eta^2_{part} = .55$) and a statistically significant interaction effect (F (1,47) = 24.78; $p < .001$; $\eta^2_{part} = .34$) for groups, which again indicates a large effect in the zone of desired effects (Hattie, 2009). This interaction confirms the claim of the Hypothesis 2 that instruction in decoding, reflecting on and practicing explanations substantially supports increases in subject specific performance.

When we break the scores down into the individual categories of the rubric (*conceptual depth and structure, linking, evidence, subject-specific terms, specific verb use (see Table 4)*), we find that the intervention group consistently outperformed the control group in every single indicator. What is more, the level of oral disciplinary language competence in the control group seemed to stagnate across the 20-lesson instruction period.

Table 4: Descriptive statistics of measures of disciplinary language proficiency (theoretical maximum: 15 points) and its sub-components (theoretical maximum: 3 points/category) in the pre- (T1) and post-test (T2) (Berg, 2020)

		Intervention Group			Control Group		
		N	*M*	*SD*	*N*	*M*	*SD*
Disciplinary Language Proficiency	T_1	26	6.06	1.93	23	5.36	1.93
	T_2	26	9.67	2.62	23	6.15	2.20
Conceptual Depth and Structure	T_1	26	1.34	.54	23	1.30	.44
	T_2	26	2.05	.62	23	1.34	.61
Linking	T_1	26	1.15	.73	23	1.09	.51
	T_2	26	1.82	.58	23	1.17	.57
Evidence	T_1	26	1.15	.85	23	1.23	.82
	T_2	26	2.11	.57	23	1.15	.83
Subject-specific Terms	T_1	26	1.38	.86	23	1.09	.46
	T_2	26	1.94	.60	23	1.32	.41
Specific Verb Use	T_1	26	1.01	.59	23	.57	.54
	T_2	26	1.82	.70	23	1.15	.46

Discussion

In line with the hypotheses, Study II found a substantial advantage in the increase of both general academic language proficiency and disciplinary language proficiency for learners who received pluriliteracies training. The learners mastered two learning challenges. First, the PTDL tasks directed the learners' attention to speech characteristics relevant to the decoding of oral language input. We presume that the more refined processing of the linguistic input supported the processing and retention of the content. It is interesting to observe that the experimental group made substantially more progress than their peers in the same amount of time. We attribute this to the fact that learners had been asked to analyse oral explanations and their specific linguistic features (prosodic markers, choice of words/collocations, chunks, etc.) to better understand *exactly* how experts explain at a granular level.

Secondly, learners not only gained an understanding of how to analyse given explanations in podcasts but demonstrated that they could successfully transfer their knowledge to structure and formulate their own explanations of newly acquired content in different contexts. By doing so, we could document learning progress both in terms of subject-specific literacies and in terms of content knowledge in the zone of desired effects.

Since we had matched participants for level of competence in the pre-test to control for pre-existing differences, and thus for differential potential for increase, it seems safe to assume that the general pattern of results is unaffected by differences which might have existed between individuals and groups prior to the invention. However, since all learners were enrolled in a highly selective, bilingual program, we cannot say if the results will hold up to experimentation with groups that show a generally lower level of performance altogether. Nevertheless, results are encouraging since we have reason to believe that a focus on deeper learning via PTDL can be added to regular teaching for higher achievement in a similar amount of instructional time for learners.

8 General discussion

Our research aimed to explore and evaluate ways of improving the quality of content learning through a focus on disciplinary or subject specific ways of constructing and communicating knowledge and understanding. The two studies presented in this article pursue the common goal of collecting empirical data that will help us reach an evidence-based understanding of deeper learning. We sought to investigate how this rather broad concept relates to disciplinary teaching and learning and how it could be operationalized and put into practice to see if the central tenets of PTDL can be supported by empirical evidence.

Even though results are certainly encouraging, some apparent limitations need to be addressed in future research. Replication studies in a variety of school subjects representing academic disciplines and with larger samples in a more complex design (e.g., multi-level designs and random assignment of participants) are needed to corroborate the current findings. Due to the complex nature of the PTDL approach, interventions require disciplinary and topic-specific instructional material, tasks and activities that are purposefully designed to stimulate growth in disciplinary literacy. This requires resources for the development of appropriate materials as well as for the professional development of the educators carrying out the instruction, which will need to be considered for future studies.

What we can conclude so far is that the PTDL approach seems to be conceptually robust and some of its main tenets can be corroborated empirically. The depth of student learning is significantly affected by strengthening the connections between the conceptualising continuum and the communicating continuum of the PTDL model (see Fig. 1) and by providing learners with opportunities to engage in the activity domains (DOEA) of a school subject as a way of increasing the focus on disciplinary literacy in the classroom: Connolly (2019) reports that both PTDL groups presented more causal connections and appropriate scientific terms and that they drew more valid links between single observations and underlying universal principles than those of the CLIL control group. In addition, both PTDL groups reported higher increases in disciplinary knowledge and understanding. In Berg's (2020) study, learners in the intervention group showed significant increases in disciplinary language proficiency. In both interventions, the additional explicit focus on the cognitive discourse function of ›explaining‹ facilitated both increasing mastery of that specific discourse function as well as growing conceptual knowledge and understanding of disciplinary content. In other words, teaching linguistic structures pertaining to communication of the content, e.g., fosters conceptual understanding of the subject content.

However, as we stated in the introduction, this only seems to be the case when instruction promotes deep cognitive engagement to support the acquisition of »detailed, knowledge-rich mental models stored in long-term memory« (Christodoulou, 2017, p. 34). This requires a careful balance between what Christodoulou (2017) calls ›*learning tasks*‹ which are designed to create those mental models in the first place and ›*performance tasks*‹ which target the actual use of those models. We propose that this balance in task design might explain the difference in disciplinary or subject-specific language performance and content understanding between learners in the experimental groups and those in the control groups. In the PTDL groups, learners spent considerably more time on learning and practise tasks to facilitate the development of such knowledge-rich mental models before engaging in performance tasks. In the control groups, there was a more distinct focus on performance tasks. This is in line with the current educational paradigm of ›competence-based education‹ and state-of-the-art CLIL methodology (Ball et al., 2016; Mehisto & Ting, 2017). Based on our research, it is becoming increasingly clear that disciplinary literacy – which is an indispensable part of deeper learning outcomes – needs to be addressed explicitly and does not come as an incidental by-product of instruction. Engaging in complex tasks is not sufficient for learners to develop the knowledge-rich mental models required for adequate task performance. Therefore, ›alignment‹ of disciplinary core-constructs, with the linguistic and communicative structures of the disciplines is essential for Deeper Learning Episodes. In conclusion, we advocate to design teaching with a dual focus on both disciplinary concepts and communication and language for deeper learning.

Connolly's (2019) findings suggest that a focus on deeper learning via PTDL is not only beneficial to subject learners who receive content instruction through an additional language, but also to learners who are taught in the primary language of schooling. This indicates that mastery of academic language, or more specifically, command of cognitive discourse functions does not come naturally. Given the positive effect on content knowledge in both intervention studies, we recommend transferring these principles to an even wider range of subjects and cognitive discourse functions (such as *define, evaluate* or *argue*) and to run additional interventions to understand in greater depth if and how the principles of PTDL can be applied in creating deeper learning environments in any language.

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