MASTERARBEIT / MASTER'S THESIS

Titel der Masterarbeit / Title of the Master's Thesis

„Integration of content and language: Acquisition of scientific competences in the CLIL biology classroom"

verfasst von / submitted by

Beatrice Binder, BEd

angestrebter akademischer Grad / in partial fulfilment of the requirements for the degree of

Master of Education (MEd)

Wien, 2023 / Vienna, 2023

Studienkennzahl lt. Studienblatt / degree programme code as it appears on the student record sheet:	UA 199 502 507 02
Studienrichtung lt. Studienblatt / degree programme as it appears on the student record sheet:	Masterstudium Lehramt Sek (AB) Lehrverbund UF Biologie und Umweltkunde Lehrverbund UF Englisch Lehr-verbund
Betreut von / Supervisor:	Univ.-Prof. Mag. Dr. Julia Hüttner, MSc

Acknowledgements

The act of writing a master's thesis is an incredibly demanding one, especially while at the same time starting a teaching career, that I could not have done without the direct and indirect support of many people in my life.

First of all, I would like to express my gratitude to my supervisor Julia Hüttner, who provided me with generous support and guidance throughout all the stages of this project. I am thankful to her for raising my interest in CLIL in one of her seminars and her willingness to become my supervisor to support me in my further exploration of this topic. Her feedback and encouragement were invaluable in helping me achieve my goals.

To the participating teachers, I am grateful for their willingness to open their classrooms to me and their flexibility when the Covid-19 pandemic made everything much more difficult to organise and carry out. I am grateful for their readiness to take on this extra work in addition to their already high workload.

I also want to extend my thanks to my family, whose unwavering love and support (financial and emotional) have been crucial for writing this thesis. They have allowed me to take the time I needed to write a thesis that I am satisfied with. As long as I can remember they have always encouraged my independence and ambitions which is the reason I am where I am today.

Last but not least, I want to thank my friends who have been there for me through it all. Their emotional support and willingness to listen to me complain about my workload kept me sane throughout this process. While I am equally as grateful to all my friends, I want to give a special shoutout to my friends from university (Jutta, Karoline, Anna, Florian), who share my dream of being a teacher and who have been with me every step of the way.

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List of abbreviations

AHS	Academic secondary school
CDF	Cognitive discourse function
CLIL	Content and language integrated learning
EFL	English as a foreign language
ESP	English for specific purposes
FL	Foreign language
HTL	Upper-secondary college of technology
L1	First language (theory), Lesson 1 (analysis)
L2	Second language (theory), Lesson 2 (analysis)
L3	Lesson 3
L4	Lesson 4
L5	Lesson 5
L6	Lesson 6
NS	Native speaker
OED	Oxford English dictionary
T1	Teacher 1
T2	Teacher 2
T3	Teacher 3

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1. Introduction

Over the last few decades, globalisation and the increasing interconnectedness of our modern economies and societies have made the ability to communicate with people around the world more important than ever. Due to this growing necessity for communication with people from other countries and the development of English to become the most important international lingua franca (Baker W. 2018, Seidlhofer 2011), policymakers, educators and parents have searched for innovative educational practices to enhance foreign language learning. One popular approach is the integration of language into content-driven subject instruction. The European approach to this, Content and Language Integrated Learning (CLIL), was coined in the 1990s and considers Europe's unique societal, economic and cultural context of multilingualism within the borders of the European Union.

As the name suggests, CLIL is "a dual-focused educational approach in which an additional language is used for the learning and teaching of both content *and* language" (Coyle et al. 2010: 1, [original emphasis]). Thus, CLIL should provide an integration of subject and language teaching. However, as "CLIL lessons are timetabled as content-lessons, taught by specialist teachers of those subjects through the medium of English, and follow the national curriculum of the content subject" (Dalton-Puffer 2013: 219), CLIL teachers in Austria mostly are not experts in language teaching (Hüttner et al. 2013: 276). Therefore, the language focus is often neglected. Morton (2020) sees a lack of true integration in curricula and materials. He argues that often the content knowledge is simply presented in the same way as in lessons using the learners' mother tongue (L1) or "watered down" (Morton 2020: 14). He further argues that the language component of CLIL is often reduced to "glossaries of key terms" with a focus on relevant text types and their linguistic structures missing. Moreover, most of the research also focuses on only one of the two in isolation (Morton 2016: 256-257). The CLIL approach has the potential to familiarise the learners with discipline specific genres and thinking processes and their common linguistic realisations and thus prepare them to successfully take part in subject-specific discourse. The explicit focus on language can benefit the learners by providing them with examples for academic language, which is often expected from them but seldomly provided during lessons.

In response to the lack of integration of content and language, Dalton-Puffer (2013) developed her construct of cognitive discourse functions (CDFs). The seven CDFs, namely

CLASSIFY, DEFINE, DESCRIBE, EVALUATE, EXPLAIN, EXPLORE, and REPORT (Dalton-Puffer 2013, 2016) derive from “patterns which emerge from the needs humans have when they deal with cognitive content for the purposes of learning, representing and exchanging knowledge” (Dalton-Puffer 2016: 31). Thus, they occur in all teaching and may provide a link between subject-specific and linguistic matters. Over the last decade, several empirical research projects investigated the validity of the CDF construct in different subjects, such as physics (Kröss 2011), biology (Hofmann & Hopf 2015), economics (Brückl 2016), history (Bauer-Marschallinger 2016) and mathematics (Dobner 2020).

The aim of this thesis is to extend the empirical backing of the CDF construct by providing further insight into its use in the CLIL classroom. The content subject chosen for this undertaking is biology because even though previous work has already focused on CDFs in biology CLIL lessons (Hofmann & Hopf 2015), a comprehensive and detailed analysis of the compatibility of the CDFs with the curricular competence model of natural sciences (BMBWF 2018) is still missing. According to the Austrian curriculum for academic upper secondary schools (BMBWF 2018), biology lessons should promote scientific literacy by adhering to this competence model. It is based on the characteristics of natural science research work and consists of three dimensions: acquiring and communicating content knowledge (W), gaining new insights through observation and experiments (E), and applying the knowledge by taking a stance and reflecting (S). Dalton-Puffer (2013: 242) argues that her CDFs can serve as a shared framework for analysing language and subject content, and that this type of construct attends to the interests and needs of their subjects. This thesis will examine whether, compatibility between the competences-based content curriculum of biology and the CDF construct can be established.

2. Content and language integrated learning (CLIL)

The aim of this thesis is to provide further insight into the classroom discourse of CLIL biology lessons; thus, an outline of what is understood by CLIL is needed. CLIL can be described as an educational approach that uses a language different to the learners' first language (L1) for the teaching and learning of content and language matter (cf. Coyle et al. 2010: 1). To arrive at a better understanding of this approach it is useful to examine it in its wider context of bilingual education. Therefore, the following section, firstly, presents and contrasts weak and strong bilingual education approaches, and then moves on to describe the multilingual European context of CLIL in more detail. Then, a more comprehensive definition of CLIL itself is provided, followed by a description of its characteristics and limitations.

2.1. Context

Around the world, subject instruction in a language that is not the learners' L1 exists in different contexts, for example immersion, heritage language bilingual education as well as submersion for minority language students in general education. In a way these are related to each other and share some features but differ in others. Dalton-Puffer argues that the exact classification as one or the other often depends on the cultural or political context the programme is embedded in rather than particular characteristics (2011: 183). Therefore, it is important to look at the context of the different bilingual approaches to help us understand their differences. The next few subsections will present a historical overview of the beginnings of bilingual education, different bilingual approaches and the multilingual European context.

2.1.1. A brief history of bilingual education

The practice of using a foreign language (FL) for teaching and learning content has not developed recently; on the contrary, this practice has been present for thousands of years. Several authors provide examples from the past of people from different language backgrounds living together resulting in some of them receiving their education in a foreign language. The Roman Empire is provided as an example by Coyle et al. (2010: 2). Two thousand years ago, when the Roman Empire included Greek territories, the Romans incorporated Greek language and culture into their lives. Having their children learn the Greek language prepared them for the future by giving them access to professional opportunities in Greek-speaking territories (Coyle et al. 2010: 2). While the value of bilingual or multilingual education was known throughout Europe over the last few centuries, it was, like education in general, mostly accessible for rich people only (Mehisto et al. 2008: 9).

2.1.2. Bilingual education approaches

Over the last decades, various forms of bilingual education have developed in various cultural and political contexts around the world. Though they share some similarities, they pursue different aims. In his book *Foundations of bilingual education and bilingualism*, C. Baker (2011: 207) distinguishes ten varieties of bilingual education and further divides them into weak and strong forms depending on their aims. While the aim of weak forms is not true bilingualism but rather monolingual education of mostly minority learners in an L2, strong forms truly promote the acquisition of two languages (Baker C. 2011: 207). Another distinction C. Baker (2011: 207) makes is between transitional bilingual education types that aim at assimilating minority language speakers to the majority language and maintenance types that promote the minority language with its associated culture and identity alongside the majority language.

The weak forms of bilingualism, submersion, segregationist education, transitional bilingual education, mainstreaming with foreign language teaching, and separatist education will be discussed. Firstly, submersion is a popular educational approach in the United States and the United Kingdom and follows the aim of assimilating minority language students to the majority language (Baker C. 2011: 2011). To achieve this, the L1 is completely replaced with the second language (L2) which is often stressful for the learners as this can cause comprehension problems and does not value the minority students' language, culture, and identity (Baker C. 2011: 213). Secondly, segregationist education is connected to apartheid; minority children are educated in the minority language separated from mainstream education. The aim is to foster subservience by not giving minority language speakers the possibility to take part in the majority culture (Baker C. 2011: 215). These two types of bilingual education do not promote true bilingualism but rather monolingualism in the majority or minority language. The other weak forms aim at limited bilingualism. Thirdly, while transitional bilingual education also follows the aim of assimilating minority children to the majority language (cf. submersion), the learners are temporarily allowed to use their L1. Then the amount of L2 is successively increased and the use of the L2 decreased (Baker C. 2011: 215). Fourthly, in mainstream education with foreign language teaching, it is majority language children who are educated in their L1 with foreign language lessons in an additional language (Baker C. 2011: 217-2018). This is the prevalent type in most Austrian schools where English is taught as a foreign language. Lastly, in the rare separatist education, a language minority aims at fostering monolingualism in the L1 to detach itself from the majority (Baker C. 2011: 219).

The strong types C. Baker (2011) presents are dual language bilingual education, heritage language bilingual education, immersion and CLIL; they share the aims of bilingualism, biliteracy and biculturalism. Firstly, in the dual language bilingual education, an equal number of majority and minority students are instructed using a relatively equal amount of both languages (Baker C. 2011: 222). The central idea is to keep boundaries between the languages by separating them based on factors such as time, curriculum content or teachers (Baker C. 2011: 226, 228). One example for this type is the US Cuban community in Florida (Baker C. 2011: 229). Secondly, in heritage language bilingual education, language minority children; for example in Hawaii, Australia or Ireland; use their native language as a medium of instruction for about half or more of the curriculum while they are surrounded by the majority language outside of school (Baker C. 2011: 232-233, 235). This educational approach is concerned with preserving ethnic languages and fostering full bilingualism at the same time (Baker C. 2011: 232, 236). Thirdly, Immersion was first established in Canada and has since developed into various programmes around the world that differ in various aspects such as starting age and amount of time spent on instruction in the L2 (Baker C. 2011: 239). However, they usually share some core features such as that learners are instructed in an L2 while following the same curriculum as mainstream students (Baker C. 2011: 240-241). The aim of immersion programmes is bilingualism in two high-status majority languages, for example English and French. Immersion is discussed in more detail in the next section (2.1.3). The last strong type C. Baker presents is the bilingual education in majority languages which includes CLIL. This type uses at least two majority languages jointly to foster bi- or even multilingualism and bi- or multiliteracy. This type occurs in regions that are already mostly bilingual, such as Luxembourg, but also in regions where many locals want to become bilingual, such as parts of Asia and Europe (Baker C. 2011: 245).

This section provided an overview of bilingual education types and their main characteristics. As immersion can be considered the most similar to CLIL, the next section will look into Canadian immersion in more detail to work out its differences and similarities.

2.1.3. Canadian immersion

Immersion is an educational approach that originated in the 1960s in the Canadian province of Quebec. Though French was, and still is, spoken by most of the population as it is the official language of Quebec, there were large areas were English was spoken as L1. Many of these English speakers learned French as a second language at school; however, the instruction they received mostly did not result in language skills that were adequate to participate efficiently in the French-speaking community, either in a professional or a private setting. The English-speaking community recognised that "economic survival there would require high levels of proficiency in French" (Swain & Johnson 1997: 2), which could not be achieved with conventional language teaching. This led to the implementation of a new approach where in addition to the L1 the L2 was used as medium of instruction to varying degrees (total or partial immersion) and starting at different learners' ages (early, mid or late immersion) depending on the context as the approach spread across Canada (Swain & Johnson 1997: 2-3).

The overall goal of immersion programmes was, and still is, the enhancement of L2 proficiency by introducing the L2, as a medium of instruction for content subjects. Even though the extent of exposure to the L2 and the starting point vary depending on situational context variables, Swain and Johnson (1997: 6-8) stipulate eight core features that define the prototypical immersion programme and exist at least to some extent in all immersion programmes:

1. The L2 is a medium of instruction.
2. The immersion curriculum parallels the local L1 curriculum.
3. Overt support exists for the L1.
4. The program aims for additive bilingualism.
5. Exposure to the L2 is largely confined to the classroom.
6. Students enter with similar (and limited) levels of L2 proficiency.
7. The teachers are bilingual.
8. The classroom culture is that of the local L1 community.

According to these core features, an important aspect of immersion education is the explicit support of the L1 which is provided by bilingual teachers who speak both the L1 and the immersion language at a high proficiency level. This support of the L1 is necessary to achieve the ultimate goal which is to foster additive bilingualism, where the learners' L1 proficiency should be comparable to those who have studied through the L1 (Swain & Johnson 1997: 6-8, Swain & Lapkin 2005: 171-172).

Even though immersion education is often considered a predecessor of CLIL and they share some common features, they exist in their unique contexts and CLIL is characterised by its unique European context (cf. Dalton-Puffer et al. 2014). Thus, the terms immersion and CLIL should not be used interchangeably. The close relationship was important in the early stages of CLIL as immersion had already existed for several decades at the time. Consequently, a large amount of research on the effects of immersion education has accumulated since the 1960s; Lasagabaster and Sierra (2009: 373) mention this accumulation of research as an advantage immersion has over CLIL which lacked longitudinal studies in the beginning. However, over the last two decades, CLIL has been catching up as there has been much research into CLIL with several longitudinal studies (see 2.3.1, 2.3.2 or Goris et al. 2019). While the focus of immersion research tends to be on language learning (Coyle et al. 2010: 133-135), CLIL's dual focus makes the investigation and assessment of content learning of utmost importance in CLIL research. Thus, immersion research outcomes cannot be applied to CLIL programmes without critical reflection of the differing foci and contexts (Dalton-Puffer et al. 2014: 215-216).

2.1.4. Multilingual Europe

While bilingual education was not a new phenomenon in Europe, the CLIL approach started developing in the 1990s in the European context (Coyle et al. 2010, Mehisto et al. 2008). At the time, globalisation and the associated increase of internationality and mobility created a context that attributed more value to the role of language (Nikula et al. 2013: 71). The emergence of new technologies enabled exchange of information with people from other linguistic backgrounds which caused the world economies and societies to become integrated into a "mixed global village" (Mehisto et al. 2008: 10). Accompanying this integration was a worldwide change in language patterns (Coyle 2007: 543) that led to, as Maurais calls it, a "new linguistic world order" (2003: 13). As a consequence of these societal changes, both top-down and bottom-up processes developed that facilitated the emergence of the CLIL approach.

On a societal level, the European Union was one of the most important supporters of the CLIL approach. Its ultimate aim is to achieve multilingualism and to bring forth plurilingual citizens who possess the "capacity to successfully acquire and use different competences in different languages [...] for different functions" (Council of Europe 2007: 116). To achieve this aim, the EU encourages its member states to embrace the development of plurilingual citizens who can speak at least two other official languages of the EU at the end of secondary education (European Parliament 2021).

The European Union's clear aim of achieving multilingualism within its borders, renewed the interest in a bilingual educational approach that moves away from the previous elitism of bilingualism (more on elitism in section 2.3.4). Even though immersion, with its decade long accumulation of experience and good practice examples, seems like the obvious choice, it became apparent that this approach did not entirely fit the complex socio-political European context (Marsh 2002: 56). Therefore, the new term CLIL was established "as a generic umbrella term which would encompass any activity in which a foreign language is used as a tool in the learning of a non-language subject in which both language and the subject have a joint curricular role" (Marsh 2002: 58). The adaptation of a new term for the European context was necessary due to its unique context that is characterised by interculturality and multilingualism (Coyle 2007). Overall, the implementation of CLIL was used as a tool to promote multilingualism and European unity between EU's citizens.

At the same time, grassroots initiatives led by parents or teachers appeared throughout Europe to promote bilingual education. In these cases, parents or individual teachers were the driving force behind the implementation of CLIL as they perceived good language skills, especially in English, as a necessity on the job market as well as an advantage in private life in our increasingly globalised and interconnected economy and society (Dalton-Puffer 2011: 184). Many countries attempted innovative methods, such as CLIL, to enrich FL learning. For schools, the implementation of CLIL meant that they could react to the growing demand for more language instruction without having to make drastic changes to their curricula or timetables (Ioannou Georgiou 2012: 497).

While most European countries offer some form of CLIL instruction on a voluntary basis, some countries, such as Spain and Italy, made CLIL a compulsory part of the school system at least in some subjects (Nikula 2017). In Austria, CLIL became a mandatory element of education for upper-secondary colleges of technology (HTL) in 2011, where at least 72 hours per school year from year 3 onwards needs to be taught in English in any chosen subject (Dalton-Puffer et al 2021: 98). On the other hand, for academic secondary schools (AHS) each school can decide if and how to implement CLIL (Hofstadler et al. 2021: 221).

To summarise this section, learning non-language content in a foreign language has been practiced for thousands of years in different areas around the world. In more recent times, the immersion approach developed as a grassroot initiative in Canada. In the 1990s, bilingual education in Europe started to come into focus and the CLIL approach was coined to factor in the unique European context.

2.2. Definition of CLIL

So far, this thesis has tried to provide a brief overview of bilingual education before and besides CLIL and analysed the context for the establishing of CLIL in Europe. This next section attempts to give a definition of CLIL and clarify some issues with terminology.

CLIL as form of bilingual content instruction has been widely implemented over the last few decades. As already mentioned above, CLIL can be seen as an umbrella term that covers a range of educational approaches that teach content subjects in an additional language (Goris et al. 2019, Mehisto et al. 2008), some of which have already existed before CLIL. While the term CLIL covers various, sometimes quite diverse, approaches that use a language that is different to the learners' L1 – the target language – for the learning of content, it needs to be distinguished from other bilingual approaches (see section 2.1.2). The main purpose of CLIL, as the full name Content and Language Integrated Learning suggests, is to combine the learning of content and the learning of a foreign language in a way that ensures beneficial effects on the learners. This objective is also present in one of the most referenced definitions of CLIL by Coyle et al. who describe CLIL as "a dual-focused educational approach in which an additional language is used for the learning and teaching of both content *and* language" (2010: 1, [original emphasis]). Thus, the essential feature of CLIL is that of providing an integration of subject content and language content. According to these authors, in CLIL there cannot be a singular focus on either content or language. Instead, the focus is always on both, as these two aspects are intrinsically linked (2010: 1). The authors argue that for CLIL to be successful one cannot simply translate L1 lessons into a foreign language, but rather the integration of content and language requires "synergies", a term that comes from Greek and means as much as a dynamic collaboration of individual parts that amount to something greater when taken together (Coyle et al. 2012: 27). Similarly, the Eurydice report states that to achieve a real integration of content and language, special methods are necessary to ensure that the content subject "is not taught *in* a foreign language but *with* and *through* a foreign language" (Eurydice 2006: 7).

Another distinguishing feature of CLIL is mentioned by Mehisto et al. (2008: 12) as possessing a flexibility regarding the amount of exposure to the target language. Considering this flexibility, two variants of CLIL can be distinguished. On the one hand, there is what Llinares et al. call the "weak" version; on the other hand, the "strong" version (2012: 5). While the weak approach focuses more on linguistic objectives, content learning is the main focus of the hard approach (Llinares et al. 2012: 5).

Some authors critique the rather broad definition of CLIL as it makes it difficult to distinguish it from other bilingual education practices (Bruton 2013, Bruton 2015, Bruton 2019, Cenoz et al. 2014). As already mentioned above, CLIL is often seen as an umbrella term for bilingual content education with a certain flexibility allowing adaptation to individual situational context variables (Marsh 2002, Mehisto et al. 2008). In fact, several researchers regard this flexibility as crucial for the success of CLIL because it ensures transferability to many contexts in countries worldwide (Coyle et al. 2010, Dalton-Puffer et al. 2021). However, Cenoz et al. (2014) and Bruton (2015) argue that the deliberate vagueness of the term leads to unnecessary confusion. Bruton (2015: 126) criticises that the vagueness is used to justify the failure to provide a clear definition and not to specify important key features. He insists that CLIL needs a clear definition to allow comparison to other practices and to "operationalise the concept for empirical research" (Bruton 2019: 594). Moreover, Cenoz et al. argue that the variations of CLIL are too inclusive and cannot be distinguished from other bilingual practices (2014: 246.

Even though there seems to be some confusion on the characteristics and limits of CLIL, there are certain prototypical features that characterise CLIL. In their analysis of similarities and differences between CLIL and immersion, Lasagabaster and Sierra declare that the "differences are remarkable" (2009: 373). The authors found differences to other bilingual programmes regarding the language of instruction, teachers' language background, the starting age, the teaching material, the language objective and the inclusion of immigrant students (2009: 370-373). Moreover, in response to the call for clarification of CLIL by Cenoz et al. (2014), Dalton-Puffer et al. counter that while it is important to keep concepts clear in research, the same concepts, in this case CLIL and immersion act like all words in natural languages do, namely "they have histories, migrate from one discourse to another, acquire connotations, and generally have fuzzy boundaries" (2014: 214). Based on empirical research on CLIL implementation in different countries, Dalton-Puffer et al. (2014: 214-215) have deduced three core features: CLIL lessons typically (1) use an international lingua franca, English being the most common one, as target language, (2) accompany the foreign language lessons and (3) are timetabled as content lessons taught by content experts.

2.3. Characteristics and limitations

After having established a definition of CLIL that is at the basis of this thesis, this section will give a succinct outline of the most important features of CLIL, its characteristics and objectives, focusing on providing some information on content learning, language learning, the integration of both as well as learning outcomes of both aspects, before presenting some limitations of CLIL.

2.3.1. CLIL and content learning

CLIL lessons are usually regarded as content lessons; therefore, this section will analyse what counts as content in the CLIL context and how content is learned in CLIL before looking at learning outcomes of conducted empirical studies.

The concept of content in CLIL constitutes not only subject concepts from subjects, such as biology, history or geography; rather it also includes cognitive procedures and linguistic resources. The definition of CLIL as having a dual focus on content and language, which are integrated (Coyle et al. 2010), suggests that those two aspects are two separate entities. However, there is consensus that the learning of content cannot happen without language and vice versa (Ball et al. 2015, Cummins 2000, Schleppegrell 2004). Therefore, it is not easy to make a clear distinction between content and language because content needs language to be articulated and language can be seen as linguistic content. Thus, what is meant as *content* in CLIL depends on contextual variables. While it can, in its narrow sense, focus on individual concepts that are defined in the curriculum, it could also be "thematic, cross curricular, [or] interdisciplinary" (Coyle et al. 2010: 28). The realisation of these different types of content determines the need for a greater focus on either content or language or both (Coyle et al. 2010: 28). In a similar manner, Ball et al. (2015: 50-52) explain the flexibility of the concept of content in CLIL through it having three dimensions: concepts, procedures and language (Figure 1). In their chapter on objectives they provide the rather general example objective "To differentiate between the planets in the solar system" which only includes the conceptual dimension of content. They then go on to specify this objective by adding the procedural and the language dimension; the former includes the cognitive skills, such as interpreting or describing, while the latter involves specific language items connected to the conceptual content.

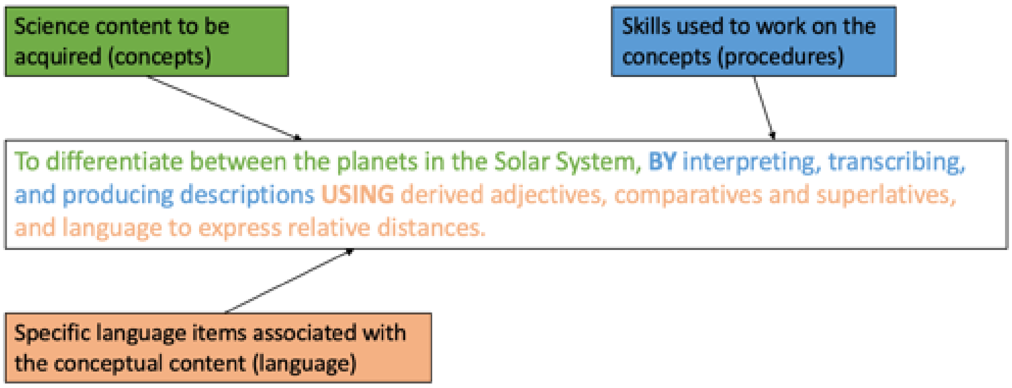

Figure 1*. The three dimensions of content in CLIL (Ball et al. 2015: 52).*

Even though the three dimensions have different foci; concepts, procedures or language; they all constitute some kind of content and co-exist with each other. However, according to the authors, the emphasis on the individual dimensions can vary depending on the activity, sequence of activities or learners (Ball et al. 2015: 53-54).

Effective content learning in CLIL needs to be based on a sound theoretical framework; in providing this framework for content learning in CLIL, Coyle et al. (2010: 28-29) reference current general learning theories, such as social-constructivism. Social constructivist approaches articulate the importance of actively involving the learners in the act of learning as learning requires interaction between the learner and someone who is more expert. This can be the teacher or even other learners. Through this social interaction and adequate support by the expert, learners acquire knowledge (Cummins 2005: 108). This approach is based on Vygotsky who talks about the "zone of proximal development" (1978) as learning situations that provide a challenge to the individual but can be solved if suitable scaffolding and support are available to the learner. Taking into account these theories, Coyle et al. (2010: 29) reason that for content learning in CLIL to be successful, learners need to be actively engaged through student-centred methods and support for developing metacognitive skills. It is not enough to just teach the subject specific concepts and skills specified in the curriculum; but to ensure effective content learning learners need to know how to apply them. More information on cognitive skills will be provided in section 4.2.

Although CLIL lessons are mostly time-tabled as content lessons, research into the content learning outcomes of CLIL students has been scarce (Anghel et al. 2016, Fernández-

Sanjurjo et al. 2019, Jäppinen 2005, Meyerhöffer & Dreesmaann 2019, Pérez Cañdo 2018, Piesche et al. 2016, Rosi 2018). Thus, more research into this issue is needed as there are some concerns that learning content in a foreign language could lead to significant losses in content competence (see Bruton 2019, Dalton-Puffer 2011, Mehisto et al. 2008). Mehisto et al. (2008: 20) state that even though it seems impossible for learners to take in the same quantity and quality of content when learning in a foreign language opposed to their L1, CLIL students often achieve the same or even better results in content tests (e.g., Meyerhöffer & Dreesmaann 2019, Pérez Cañdo 2018, Rosi 2018). They even suggest that CLIL is also suitable for students with average grades as can be seen in Luxembourg where several languages are used as media of instruction throughout compulsory education for all students. However, Bruton casts doubt on this as “a student’s weakness in a content subject could be compounded by a weakness in the FL, and vice versa” (2019: 597). Moreover, some fear that teachers might anticipate problems with the understanding of content and therefore simplify the content which might also lead to less content competence (Hajer 2000). Furthermore, Dalton-Puffer (2011: 188) points out that research into content learning in CLIL is difficult to test because there is a lack of standardised content test that could be used to compare CLIL to non-CLIL students in typical CLIL subjects.

The results of the limited empirical research studies that are available are still inconclusive so far. In her large-scale study with 2024 participating students on the effects of CLIL on the learners’ L1 and content knowledge in Spanish primary and secondary schools, Pérez Cañdo found that “[p]ublic and private bilingual school students [...] perform better than or just as well as public and charter non-bilingual pupils on subject content” (2018: 24). The higher achievements of CLIL students were particularly noticeable in the long term. Based on these results, she claims that bilingual instruction does not diminish the quality of content learning. On a much smaller scale, Rosi (2018) found that learners who received CLIL instruction in physics achieved better results on a multiple-choice test as well as on a test of their argumentative skills. Again, these results persisted in a delayed post-test five weeks after the intervention. Jäppinen (2005) examined the thinking and content learning processes of 669 Finnish students aged 7 to 15 in mathematics and science. The experimental group was taught in either English, Swedish or French opposed to the control group who received instruction in the L1 Finnish. The results showed that in “some cases, in the second age group [10-14 years], the cognitional development of the experimental group seemed to be even faster than that in the control group" (2005: 162) while in most of the other cases, the development of the two groups were comparable. She concludes that the examined CLIL environments foster thinking and content learning. Also Meyerhöffer and Dreesmaann's (2019) study shows that CLIL students in Germany achieved similar content knowledge gains as their peers who were taught in their L1.

However, other researchers found contradicting results that indicate weaker learning outcomes for CLIL students. For example, Anghel et al. (2016) found a negative effect of CLIL instructions for children with less educated parents. Likewise, in studies conducted by Fernández-Sanjurjo et al. (2019) and Piesche et al. (2016), CLIL students were outperformed by their traditionally taught peers. However, all three of these studies administered the tests in the L1 for all the students even those who were instructed in an L2. This could be one reason for the lower scores of CLIL students. Saalbach et al. argue that the coding of subject content in school is linked to the medium of instruction and that is why "[o]nce language of testing differs from language of instruction learners may have cognitive costs which result in lower accuracy and processing speed" (2013: 42). Other reasons that are suggested by Fernández-Sanjurjo et al. (2019: 669) are the lack of exposure to the L2 outside the classroom, the missing support of parents who lack English competences themselves and inadequate teacher training.

To conclude, while further research into content learning is still necessary, the existing empirical studies show that CLIL instruction can, generally, achieve good content learning results; at least there seem to be no significant negative effects on content-learning. In some instances, CLIL programmes can even result in higher outcomes on content tests than traditional instruction. However, the unique contextual variables of each CLIL programme should be carefully considered to avoid negative effects on the learners' content knowledge.

2.3.2. CLIL and language learning

It cannot be denied that the role of language in learning is a fundamental one as subject concepts are conveyed through language and their understanding is shown through language. When learning a subject in a foreign language, it becomes even more important as a language that is only partially known serves as the vehicle for concept acquisition and thus makes learning more cognitively challenging.

While in traditional language teaching there is often the debate about whether to focus on form or meaning, the CLIL context requires a focus on both with different manifestations depending on the situational context (Coyle et al. 2010: 35). As a gap is likely between cognitive and linguistic competence levels in CLIL learners because the linguistic level is less developed due to it being a foreign language, lessons need to ensure that learners are presented with the necessary language support that is needed for the activities. That is, if a grammatical structure is needed for the completion of a CLIL task which the learners do not yet know, the structure needs to be explained for students to master the activity (Coyle et al. 2010: 35). For example, the passive voice is often used in lab reports in science; therefore, learners should be made aware of the passive structure before they have to write a report on an experiment. However, grammatical structures are not the only aspects of language that need to be taught. In their textbook *Putting CLIL into Practice*, Ball et al. (2015: 66) describe what is meant by language in CLIL. In general, it encompasses mostly the academic language variety or what Cummins (2000) describes as cognitive academic language proficiency (CALP) but also some informal language skills. Often the language component of CLIL is reduced to "glossaries of key terms" while a focus on "key genres and their grammar and lexis" is missing (Morton 2020: 14). Apart from subject-specific key terminology, there are several more aspects of language that need to be focused on, such as general academic language, subject-specific grammatical features, discourse markers, thinking skills and the four language skills listening/watching, reading, writing and speaking (Ball et al. 2015: 66-70).

To conceptualise the connection between language and content objectives, Coyle et al. (2010) provide the Language Triptych. It analyses the different linguistic demands of CLIL by dividing language into three sections: language *of* learning, language *for* learning and language *through* learning (Figure 2).

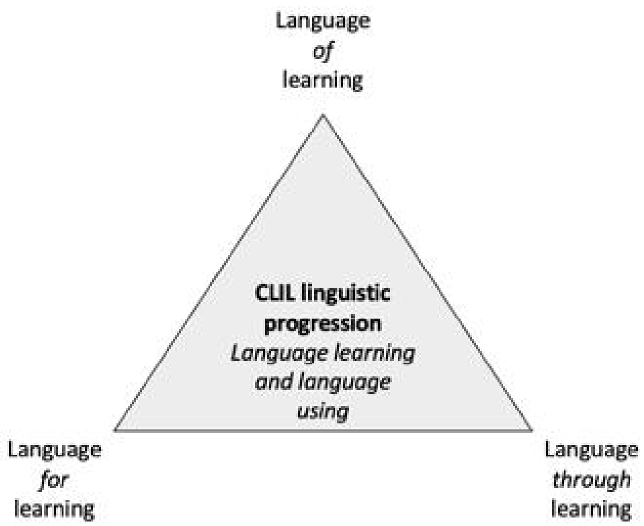

Figure 2. *The Language Triptych (Coyle et al. 2010: 36).*

1. **Language of learning:** The language of learning is necessary for the learners to understand the basic subject concepts and skills. An interesting approach for analysing the language of learning is through genre analysis which uncovers language specific for certain subjects or topics (more on genre in section 3.2). Thus, CLIL teachers should focus on teaching the language that is necessary for the learners to engage with the content in an appropriate way (Coyle et al. 2010: 37).
2. **Language for learning**: Language for learning means the language that is needed for learners to take part in classroom learning situations. That means that learners need to be supported in developing language learning strategies and skills that allow them to cooperate in pair or group work. Moreover, they need to know how to ask questions, take part in a discussion etc. In addition to these general learning skills, the learners need to accumulate different speech acts that are needed in the subject, such as describing, reporting and explaining (Coyle et al. 2010: 37).
3. **Language through learning:** Language through learning presupposes that learners are actively engaging with language and content. It is the language that the learners need "to support and advance their thinking processes whilst acquiring new knowledge" (Coyle et al. 2010: 37-38). This need for new language emerges through the encounter with new content and needs to be strategically developed in the classroom.

The three perspectives on language described above are interrelated and can be used as an aid to analyse which language the learners need in the specific context.

Since the early 2000s, there has been an increasing amount of empirical research into different aspects of CLIL learners' target language competence (for an overview see Goris et al. 2019). In general, the learning outcomes of CLIL students seem to be positive for the four language skills speaking (Admiraal et al. 2006, Hüttner & Rieder-Bünemann 2010, Lasagabaster 2008, Lorenzo et al. 2010, Pérez Cañado & Lancaster 2017), reading (Admiraal et al. 2006, Lorenzo et al. 2010, Martínez Agudo 2019), listening (Lasagabaster 2008, Lorenzo et al. 2010, Martínez Agudo 2019, Pérez Cañado & Lancaster 2017), writing (Jexenflicker & Dalton-Puffer 2010, Lasagabaster 2008, Lorenzo et al. 2010, Ruiz de Zarobe 2010) as well as vocabulary (Martínez Agudo 2019, Ruiz de Zarobe 2008) and grammar (Lasagabaster 2008). According to Dalton-Puffer (2011: 186), better language learning outcomes of CLIL students might be expected as CLIL lessons are usually content lessons and occur in addition to traditional English as a foreign language (EFL) lessons, and therefore CLIL students have a much higher exposure to the target language.

Early research such as Admiraal et al.'s longitudinal study (2006) with 1305 participants found a positive effect of CLIL on reading comprehension and oral proficiency. However, in this setting, no effects on vocabulary growth could be found. Moreover, the authors acknowledge some limitations of their work as the CLIL students already started with higher scores in the vocabulary section and the participating bilingual schools were pioneer schools which might prevent the results from being generalisable. Another study that looked at vocabulary among other things was conducted by Martínez Agudo (2019). He compared CLIL to non-CLIL students at three different grades, at the end of primary school, at the end of compulsory secondary school (age 16) and one year after that. The study showed that while there were no significant differences between the two groups at the end of primary school for vocabulary, listening, reading and use of English, this changed at the end of compulsory secondary school and a year after that when the CLIL students outperformed their peers. Another study investigating the oral narrative competence of German-speaking secondary school students, found that CLIL students were more proficient in spontaneous oral production (Hüttner & Rieder-Bünemann 2010). CLIL students showed not only higher grammatical accuracy and consistency, but they also possessed better communicative strategies and flexibility in producing paraphrases and descriptions when they lacked the L2 resources for what they wanted to articulate. Non-CLIL students, on the other hand, resorted to switching to the L1 more often. With regards to writing, Jexenflicker and Dalton-Puffer (2010) investigated the written language competence of 16-year-old students at higher technical colleges in Austria. CLIL students scored higher in lexico-grammatical accuracy, vocabulary range and orthographic correctness. Moreover, they showed a greater awareness of the pragmatical demands of the text. However, no significant differences between the CLIL and non-CLIL groups could be found in the textual organisation and structure of the texts. From her two studies focusing on productive skills, Ruiz de Zarobe concluded that while CLIL students outperform non-CLIL students in most of the analysed aspects of oral (2008) and written production (2010), CLIL instruction seems to have a bigger effect on oral competence. This might be the case because oral skills are more often focused on in CLIL lessons.

As can be seen from the examples above, the context, focus and methodology in CLIL research are very diverse and thus difficult to generalise. Several of the researchers acknowledge limitations of their studies (e.g., Admiraal et al. 2006, Hüttner & Rieder-Bünemann 2010, Jexenflicker & Dalton-Puffer 2010). One highly relevant limitation is the possible pre-selection of students for the CLIL programmes at schools. Thus, to take part in the CLIL programme, learners might have to take part in an admission exam. Even if there is no such exam and the CLIL programme is open to everyone, which is getting more common as CLIL is becoming obligatory in more contexts (cf. 2.1.4), often the learners who are encouraged to take part are those who are already more proficient and motivated. Bruton (2011) argues that comparing the CLIL students to those who "are left" might result in distorted outcomes. He criticises that some of the conducted studies do not have a pre-test to match the proficiency of the experimental group and the control group before the intervention. More recent studies responded to this claim by properly matching experimental and control groups and factoring in selection effects. For example, Pérez Cañado and Lancaster (2017) conducted a study focusing on listening and speaking with a matched pre-test, to account for homogeneity of the two groups at the beginning of the study, a post-test and a delayed post-test. They found that for listening the effect of CLIL at the post-test was only minimal and even disappeared after six months. However, for speaking they found significant differences between the groups with CLIL students scoring higher. Feddermann, Möller and Baumert's (2021: 10) study found that selection and preparation are main reason for CLIL students achieving higher test scores. When these effects are taken into account, the CLIL advantage declines. In the light of the critique of CLIL research, Goris et al. (2019) reviewed longitudinal CLIL studies conducted over the past 20 years only considering studies that measured proficiency at least at two different times. Their findings showed that "the majority of studies produced null effects" (Goris et al. 2019: 692) and therefore no significantly higher proficiency for CLIL learners. They also addressed the issue of properly matching the proficiency of the control group to the experimental group. One study that involved properly matched control groups was conducted by Verspoor et al.'s (2015) and did not find any significant differences. In general, Goris et al. (2019: 695) found that CLIL instruction produced better outcomes in countries with lower EFL-proficiency, such as Spain or Italy, than countries with already high EFL-proficiency, such as Germany or the Netherlands.

Overall, it can be said that it is important to acknowledge the flawed methodology of some early empirical studies into the language development of CLIL learners. Moreover, the various different CLIL contexts within Europe make it difficult to generalise the results; thus, one has to be cautious to apply the results from one context to another context. While at the first glance CLIL seems to have a positive effect on learners' proficiency, at a closer look this effect is sometimes insignificant if factors such as selection and preparation of students are taking into account. Moreover, increasingly compulsory CLIL provision reduces the factor of selection. However, there seems to at least be no negative effect of CLIL on the EFL development.

2.3.3. Integration of content and language

After having discussed CLIL and content learning as well as CLIL and language learning separately, this section will deal with the integration of those two central aspects of CLIL. As was already established, there is an interrelationship between content and language as one cannot be learned without the other. According to de Bot "[i]t is obvious that teaching a subject in a foreign language is not the same as an integration of language and content" (2002: 32). Therefore, it is important that CLIL lessons do not just translate L1 content lessons into the target language, but rather a real integration between the content and the language should be strived for through careful considerations and appropriate methodology.

One example of how this integration of content and language can be achieved is provided by Coyle et al. (2010: 41): the 4Cs Framework. The 4Cs framework conceptualises the integration of four contextualised elements that need to be considered to realise integration in CLIL: "**content** (subject matter), **communication** (language learning and using), **cognition** (learning and thinking processes) and **culture** (developing intercultural understanding and global citizenship)" (Coyle et al. 2010: 41, [original emphasis]).

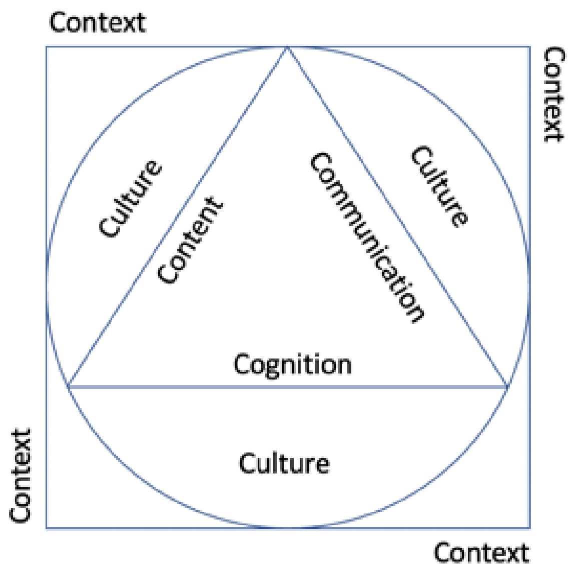

Figure 3. *The 4Cs Framework (Coyle et al. 2010: 41).*

As can be seen in Figure 3, content, communication and cognition are interconnected in this framework with culture being the aspect that links them together. Moreover, all four areas are embedded in the specific context they occur in. The framework suggests that in CLIL the acquisition of content knowledge, cognitive thinking skills and language competence happen through active engagement in interactive communication. In addition, intercultural awareness will be increased (Coyle et al. 2010: 41). While this framework successfully shows the symbiotic relationship between those areas of learning, it does not give any implications on how to achieve integration in practice.

In practice, CLIL teachers need to create environments that allow integration within the specific context. To achieve this, different CLIL programmes can be based on different pedagogies and methodologies as there is "no single CLIL pedagogy" (Coyle et al. 2010: 86). Instead, the pedagogies of the content subjects should be used as a basis and adapted to the specific needs of using a foreign language as the medium of instruction (Coyle et al. 2010: 86). However, one principle of CLIL that promotes integration and holds true for all content subjects is student-centeredness. Learners should not simply acquire knowledge, but they should create their own knowledge through actively engaging with the content (Coyle et al. 2010: 42). Moreover, scaffolding is an important construct in CLIL teaching. In CLIL, scaffolding means that the academic content is not overly simplified; on the contrary, the learners receive enough support which enables them to process even complex content in the target language (Morton 2016: 259). Furthermore, in CLIL the learners' linguistic levels and their cognitive levels are often mismatched. If this mismatch is not considered and either the language level is too high or the cognitive demand is too low, it will lead to ineffective learning and hinder integration. Therefore, it is important that learners face a cognitive challenge with enough linguistic support. This can be achieved through careful planning and analysing what kind of language is needed (Coyle et al. 2010: 44).

This sub-section provided an overview of the well-known 4Cs Framework by Coyle et al. (2010) as well as some general considerations on how to achieve integration of content and language in practice. Another concept that was developed by Dalton-Puffer (2013) as a bridge between content and language, the concept of cognitive discourse functions (CDFs), will be discussed extensively in section 4 as this concept will serve as the framework for the analysis of this thesis.

2.3.4. Limitations and critique of CLIL

This last subsection on CLIL will discuss some of the limitations and critique of CLIL, including accusations of elitism and selectivity, flawed research methodology, the role of the teachers, materials and the dominance of English.

One of the biggest critiques of CLIL is that it fosters elitism through selecting only the best students for the CLIL programmes. Bruton (2011) argues that this selectiveness of students causes flawed methodology in several empirical studies because of differing initial proficiency and motivation between CLIL and non-CLIL students if the non-CLIL strand in the same school serves as basis of comparison. He criticises that in many cases pre-tests are missing to ensure that the non-CLIL students start at the same level of proficiency as the selected CLIL students. In response to Bruton's (2013) critique of CLIL for fostering elitism, Hüttner and Smit (2014) argue that the discrimination against some social groups stems from other system-inherent factors, such as school-fees or early division of learners into different school types (e.g., in Austria and Germany) and thus are not inherently more elitist than others. Moreover, increasingly more CLIL programmes are mandatory and thus no selection occurs. Furthermore, Pérez Cañado (2020: 15) address the issue of elitism pointing out the significance of socio-economic status. They analysed the effectiveness of CLIL in a socio-economically disadvantaged context and found it effective, thus prompting them to question the elitism charge. Furthermore, Dalton-Puffer et al. (2021) point out that the implementation of mandatory CLIL instruction in Austria's HTLs, a school type where foreign languages classes are not taught extensively, is worth mentioning in light of Bruton's claims of elitism.

Another aspect that is often criticised about CLIL is its inability to achieve the often-lauded aim of fostering a multilingual Europe because of the clear dominance of English as target language in most CLIL programmes. While the European Union encourages CLIL in the hopes to achieve multilingualism, several researchers doubt if CLIL can achieve this aim. Nikula and her colleagues estimate that approximately 95 percent of all cases of CLIL provision adopt English as the language of instruction (2013: 71), while Coyle and colleagues, working in a British context, find it necessary to emphasise that CLIL is not a synonym for *English* language teaching and learning even though English is the predominant CLIL language (2010: 9). This trend might be attributed to the role of English as a global lingua franca and the accompanying high status it receives in non-English-speaking areas. As many parents and students would not approve any other language being used as the medium of instruction (Rymarczyk 2003: 276-

277), some think that this diminishes CLIL's suitability to obtain multilingualism within the European Union (Lasagabaster & Sierra 2009: 372). Another issue with the implementation of CLIL to promote language learning is raised by Morton (2016: 253), who observes that even though the European Union has actively promoted CLIL since the 1990s, its availability across the continent has not spread uniformly. Hence, some countries devoted more effort to the realisation of CLIL by managing it on a national level while other countries decided to leave the issue to local actions.

Other possibly problematic aspects of CLIL can be found with teacher training and the lack of ready-made materials. Most of the time, CLIL teachers are content and not language experts (Hüttner et al. 2013: 276). Many CLIL teachers do not receive formal instruction to prepare them for the demanding task of teaching through a foreign language and even if they are qualified to teach both the CLIL language and a content subject, they might not be prepared to properly integrate them (Mehisto et al. 2008: 21). Therefore, the teachers' lacking language proficiency might have inconvenient consequences on CLIL lessons. For instance, if teachers do not have the necessary fluency to spontaneously react to possible questions of their students, they might dominate the lessons through teacher-talk by sticking too closely to their preparation or overly relying on textbooks without facilitating active student engagement (Klippel 2003: 76). On the other hand, Nikula (2010: 199) analysed the classroom discourse in CLIL and non-CLIL biology lessons taught by the same teacher and found that the limited linguistic resources of the teacher in the CLIL lesson led to more student engagement as the students seemed to view the teacher as a fellow L2 learner and thus on a more equal level with them. However, she also found that the teacher's language in the CLIL lessons was less varied and thus the language input for the CLIL learners was less rich. Moreover, Mehisto et al. (2008: 22) point out that the workload for CLIL teachers is much higher because CLIL instruction requires more preparation to ensure that the lessons consider content as well as language objectives and the activities are appropriately scaffolded. To make matters worse, CLIL textbooks that comply with the national curricula and fit the content and language level of the learners are rare; thus, CLIL teachers often need to develop their own material by adapting existing resources. To reduce the workload for CLIL teacher to a manageable extent, better cooperation between CLIL teacher and between CLIL and language teachers would be necessary.

This section provided a comprehensive discussion of the characteristics of CLIL, its influence on content as well as language learning, its limitations and critiques. The next section will consider CLIL's suitability in connection with biology, the subject of analysis of this thesis.

3. CLIL and biology

This thesis will now discuss CLIL in connection with the subject biology. The following subsections will deal with subject- and language-specific reasons for CLIL in biology, relevant features of scientific language that need to be considered and the Austrian competence model for natural sciences.

3.1. Reasons for CLIL in biology

Gierlinger (2007: 100) shows biology to be one of the three most popular CLIL subjects in Austria alongside with history and geography. The subject, does, indeed have many aspects that make it a good candidate for instruction in a foreign language, especially English. These will be explored in this section.

One of the most important reasons for this suitability is that English is used as a lingua franca in the science community around the world. Thus, to be able to take part in scientific discourse, one must have an appropriate understanding of English as nearly the entire research is conducted in English. The goal of science education, and therefore of biology, is to prepare students to acquire scientific literacy and to be able to participate in situations outside the classroom which are related to science (Vollmer 2010: 8). These situations are diverse but include such issues as climate change, sustainability and biodiversity. The students must be able to make informed decisions about these issues and be able to take part in their global discussion. Therefore, learning about these subjects in the lingua franca English can be seen as beneficial.

Moreover, in their article on bilingual biology, Bohn and Doff (2010) provide several reasons why biology instruction in English can be advantageous to the learners. First, they argue for CLIL biology from a subject-specific standpoint:

1. Biological concepts are often presented through visual elements, such as pictures or diagrams. Most biology textbooks include much visual input which can also be used for revising already learned content by presenting the students with a graph and letting them verbalise the depicted concept. This preference for multimodality makes biology a perfect subject for CLIL instruction.
2. In many cases biological subject matter is perceptible to the senses, for example sensory physiology. This tangibility can aid concept learning even in a foreign language.

3. Biology deals with many topics that are relevant to the students' everyday lives, such as recent medical issues, genetics, ecology, neurobiology or evolutionary research. By discussing these relevant issues, authentic reasons for using the target language are created.
4. Through use of experiments for acquiring knowledge, authentic speaking contexts are established. By conducting experiments, students practice work techniques, such as observing, measuring, demonstrating and modelling, which have to be verbalised. This connects language and performing scientific activities in diverse ways.
5. The didactic potential of biology for CLIL is high because asking the learners to translate data from one form into another (e.g., instructions for an experiment into a sketch or results into a graph) forces the learners to verbalise the procedure and helps integrate content and language learning (Bohn & Doff 2010 78-79, Leisen 2005: 10).

In addition to subject-specific reasons, Bohn and Doff also mention linguistic reasons that speak for CLIL biology:

1. While scientific language is straightforward, objective and lacks emotive elements, this can also be a benefit because it simplifies the integration of content and language through strongly standardised terminology and simple and precise syntax.
2. Scientific vocabulary is easily transferable from the biology context to the learners' everyday life and to other subjects. Many of the predominantly used verbs and nouns originate in Latin or Greek and are the same or similar in English and the academic language, for instance for verbs *observe, inhibit, cause, elicit, increase, decrease*. Many terms can be translated one-to-one into other languages such as German. An example for this would be the English word *photosynthesis* and the German word *Photosynthese*. Moreover, modern biology already uses many English nouns also in non-English speaking contexts, for example *splicing* or *primer* in genetics.
3. Unlike German, in English the technical terms are mostly the same as in colloquial speech (e.g., German *Pneumonie* (tech.) = *Lungenentzündung* (colloq.); English *pneumonia* (tech. + colloq.).
4. While some other subjects, such as history, are often influenced by national or cultural perceptions, biology strives to achieve objectivity. Thus, the biological concepts that are taught should be the same around the world (Bohn & Doff 2010: 79-80).

All the above-mentioned subject-specific aspects such as multimodality, tangibility and relevance to everyday life; and language-specific aspects such as standardised terminology, transferable scientific vocabulary and objectivity of language; illustrate why biology is an appropriate subject for CLIL instruction in English.

3.2. The language of science

It is widely accepted that apart from everyday language and general academic language each school subject uses subject-specific language that the learners are expected to acquire. As one of the natural science subjects, Biology employs scientific language. Scientific language has characteristic language features the learners need to master to successfully take part in the scientific community. Apart from the obvious specific terminology, other aspects include the technicality and abstraction of the language (Reeves 2005), the various genres that are unique to natural sciences (Llinares et al. 2012) and subject- and language-specific thinking skills (Vollmer 2010). Lemke claims that “Learning science means learning to talk science” (1990: 1) which implies that special linguistic knowledge is necessary to acquire scientific knowledge. Furthermore, he argues that it should be the aim of science education to teach speaking, writing and reasoning in this specialised language to enable the learners to establish themselves in the scientific community (1990: 167).

3.2.1. Definitions

In order to talk about the language specific to science subjects, a general understanding of the concept of genre and subject specific terminology is necessary. A genre is “a staged, goal-oriented social process” (Martin & Rose 2003: 8). It is social because it takes place within a specific community, such as the scientific community, goal-oriented as it tries to achieve a certain purpose and staged as it usually follows certain steps to achieve its purpose. An example for a scientific genre would be the experiential lab report. Moreover, subject-specific vocabulary, or technical vocabulary, are lexical items that have a specific meaning in a certain discipline (Nation 2016). Rieder-Bünemann, Hüttner and Smit (2019: 6) point out that some items, called semi-technical vocabulary, might have a different specialised meaning in certain subject areas than they have in everyday language. The next section will analyse the specialised lexical and grammatical conventions of scientific subjects learners will have to acquire to successfully take part in the scientific community.

3.2.2. Characteristics of scientific language

The language used in subjects across the curriculum is influenced by the explored topics and subject-specific ways of constructing meaning. A corpus-based analysis of lower secondary textbooks of six school subjects in Ireland revealed clearly different language features depending on the subject (Kostopoulou 2013). These findings point towards the existence of different genres across subjects. In their book *The roles of language in CLIL*, Llinares et al. (2012: 112) derive three basic genres from scientific activities, namely procedures, reports and explanations. These genres follow certain conventions that members of the community need to adhere to in order to communicate successfully. For example, the procedure serves as a means for an expert to introduce a learner to the activities of the community and usually includes the aim, equipment and materials as well as the method of the activity (Llinares et al. 2012: 113). Reeves (2012: 112) identifies the experimental report as another example for a science genre, whose "form and style [...] has solidified" over time into the fixed pattern of abstract, introduction, methods, findings, discussion with each section adhering to complex rules. Nikula (2015) stresses the importance of teachers possessing explicit subject-specific language knowledge as a prerequisite for them being able to make this knowledge accessible to their learners.

Other important aspects of scientific language are specialised lexis and grammatical conventions. The above-mentioned genres require different lexis and grammar that together represent the register (Llinares et al. 2012: 14). As for lexis, Kostopoulou's (2013: 152) corpus-based analysis revealed that the most common content words in science textbooks are informed by substances and materials (e.g., *water, energy, oxygen*) and scientific practices (e.g., *test, experiment, method*). According to Reeves, the use of "identifiable features of scientific grammar [...] accommodate[s] theory building as well as the need for efficient and economical communication" (2005: 37-38) that prevails in the natural sciences. One example for such a grammatical feature in science is the nominalisation. Through the process of nominalisation, verbs or adjectives are transformed into objects creating an abstractness and technicality. This supports the principle of objectiveness in scientific language and thus aids the development of scientific theories. The ability to use these lexical and grammatical resources attests to the membership in the scientific discourse community.

Moreover, scientific language is also characterised by subject- and language-specific thinking skills. Vollmer (2010: 17) argues that

> [science education] cannot be restricted to command of specialised terminology or the ability to piece together elements of scientific knowledge [...]. The necessary linguistic competences involved in science education, also involve complex thinking and discourse skills and ways of relating the two via lexical, grammatical and textual choices.

With regards to these thinking skills, he mentions the concept of discourse functions, recurring conventionalised spelling, morphology and syntax in types of discourse that can act as link between cognitive skills and their verbalisations. Vollmer (2010: 23) mentions the following examples for the science context: *reporting* (on an experiment), *classifying* (phenomena), *defining* (a concept) or *interpreting* (data). Each of these cognitive processes is characterised by the linguistic resources that are necessary to perform them. Discourse functions will be discussed in greater detail in section 4.

To summarize, learners of science subjects need to become familiar not only with the concepts but also with the unique linguistic features of representing such scientific content. The language of science is characterised by its own unique genres, such as procedures, reports or explanations, and the specialised lexis and grammar that make up their register. Moreover, linguistic resources are necessary to verbalise science-specific thinking skills, such as reporting on a conducted experiment or analysing the collected data. Science learners acquire scientific language by engaging with someone who has already mastered it, their teacher. By being aware of these special features of language in science, teachers can make them explicit for their learners and aid them in acquiring them.

3.3. The competence model for natural sciences

The competence model (Kompetenzmodell) for natural sciences is a didactic model that was developed in 2011 by the Federal Institute for Educational Research, Innovation and Development of the Austrian School System (BIFIE), an institution that was founded by the Austrian National Council with the purpose to innovatively develop the school system and ensure the quality of education in Austria. The competence model was originally developed for lower secondary schools (BIFIE 2011) but was later adapted to academic upper secondary schools (Bundesministerium für Bildung und Forschung 2012). Since the introduction of the new curriculum for academic upper secondary schools, the competence model is a component of the curriculum and therefore the basis for science education in this school type (BMBWF 2018). Its aim is to help promote scientific literacy in science education. The OECD defines scientific literacy as “the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen" (2017: 22) which requires our learners to be able to "[e]xplain phenomena scientifically [...], [e]valuate and design scientific enquiry [...], [i]nterpret data and evidence scientifically" (OECD 2017: 22).

The competence model of natural sciences consists of three axes that together create a three-dimensional space (Figure 4). The first axis is called competence of action (Handlungskompetenz) and is divided into three subdimensions that describe the skills and competences the learners should acquire. These competences are based on the characteristics of natural science research work and will be the focus of this thesis. The first subdimension is referred to in this thesis as *reproduction competence* (W – Wissen organisieren) encompasses skills for acquiring, organising and communicating content knowledge.

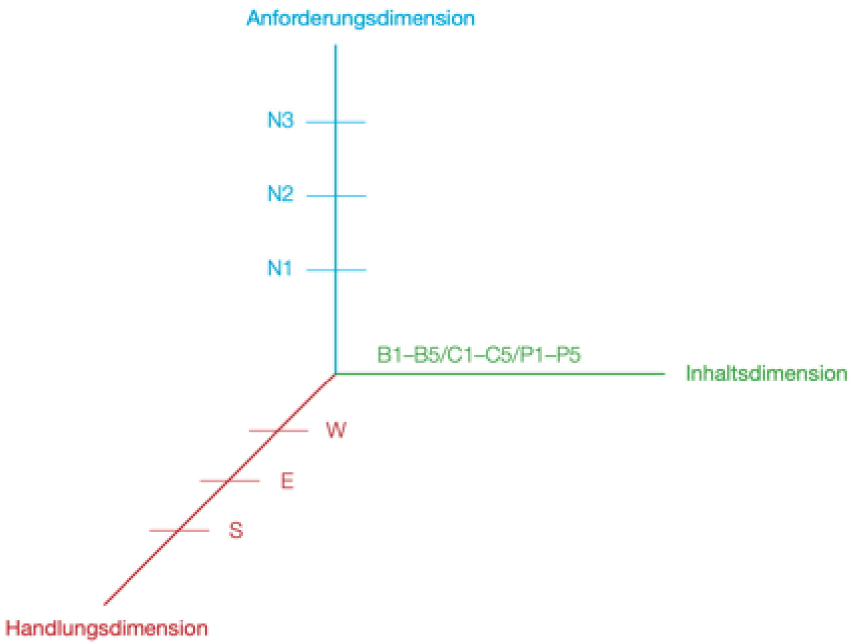

Figure 4. *Competence model for natural sciences (BIFIE 2011: 1).*

This involves skills such as naming and describing processes and phenomena of nature and being able to illustrate them in different forms (e.g., graphs, tables etc.) or extracting information from different types of media (BIFIE 2011: 2). The second subdimension referred to as *empirical competence* (E – Erkenntnisse gewinnen) involves gaining knowledge and insights through observation and experiments. The students should learn to formulate questions and hypotheses regarding processes and phenomena of nature, to observe and measure them, to conduct experiments and to analyse the results (BIFIE 2011: 2). The last subdimension referred to as *evaluation competence* (S – Schlüsse ziehen) is the most demanding one and includes evaluating results and facts from a scientific perspective and drawing conclusions from them. Moreover, the learners should be able to acknowledge and understand the importance of science for individuals and society and act accordingly (BIFIE 2011: 2). The second axis of the competence model is the dimension of requirements (Anforderungsdimension) and consists of three levels of difficulty (BIFIE 2011: 2-3). The lowest level (N1) is shaped by tasks that are mostly teacher-led and focus on describing and reproducing biological topics. At this level mostly everyday language is used. The next level (N2) already uses a limited number of technical terms and biological models, and the learners are supposed to work partly autonomously. On the highest level of difficulty (N3) the learners have to make complex connections between scientific topics and insights and requires them to use complex scientific terminology and act independently most of the time. Lastly, the third axis, the dimension of content (Inhaltsdimension), specifies the conceptual content for the scientific subjects biology, physics and chemistry. For biology the content dimension includes the "planet earth" (B1), "ecosystems" (B2), "organisms" (B3), "organs" (B4) and "the cell" (B5) (BIFIE 2011: 3).

In the light of the implementation of the competence model as well as the competences-oriented school leaving exam, Reichstädter and Müllner (2021) compiled a catalogue of operators for the formulation of competence-oriented examination tasks. These operators are action verbs that help the learners in developing or demonstrating competences. For each of the operators in the catalogue, the authors indicate the competences of action from the competence model it is most likely to be connected with. These operators resemble Dalton-Puffer's CDF construct (4.4) for L1 biology lessons. Therefore, the results of the compatibility of CDFs and the competences will be compared to these authors' considerations.

The competence model should be used as the basis for lesson planning, especially in the upper secondary where it is part of the curriculum. In the standardised school leaving exam, a task for each of the three competences of action needs to be included (BMBF 2012: 9). Thus, there must be an exam question focusing on communicating scientific knowledge, one for transferring their knowledge to new topics gaining new insights as well as one question that requires them to critically reflect on a topic or solve a problem. Thus, to optimally prepare the learners for this exam, lessons and tests in science subjects should be based on this model

(BMBF 2012: 7) and should use the proposed operators that need to be performed at the exam.

In conclusion, section 3 discussed in detail the reasons for the suitability of CLIL in biology not only due to the use of English as a lingua franca in the science community but also due to several subject-specific and linguistic reasons (3.1). Moreover, the specific features of the language of science were presented to highlight aspects that need to be taken into account to ensure successful provision of bilingual biology instruction. Lastly, a description of the Austrian competences model for natural sciences was given in section 3.3 to specify the part of the framework for the undertaken analysis of this study. The next section will discuss the other construct, cognitive discourse functions, that will inform the analysis.

4. Dalton-Puffer's construct of cognitive discourse functions (CDFs)

The following sections introduce Dalton-Puffer's construct of cognitive discourse functions (CDFs) which she first presented in 2013 as a tool for conceptualizing the integration of content and language in CLIL lessons. The chapter is structured into three parts: firstly, the rationale for developing the concept, secondly, an overview of the theoretical background and lastly, a description of the concept itself with detailed deliberations of the seven individual CDFs.

4.1. The rationale for the CDFs

The main purpose of the development of the CDF construct is to aid research into the integration of content and language pedagogies in multilingual classrooms as well as support practitioners. Much CLIL research has focused either on investigating the development of language skills or, to a lesser extent, the acquisition of content knowledge. At the same time, most European CLIL programmes follow the curriculum of the content subject without any explicit language objectives (Dalton-Puffer 2013: 219). In the light of this contradiction, the CDF construct caters to the "need to link up the pedagogies of the different subjects like mathematics, history or economics with the pedagogy of language teaching" (2013: 219). To achieve this aim, the construct is based on linguistic as well as subject-specific educational theory (Dalton-Puffer 2013: 232). In this manner, Dalton-Puffer addresses the question of "how to equip learners with the linguistic competences that are required for educational success" (Dalton-Puffer 2013: 218). The response to this question is to attempt to link subject-specific thought processes in classrooms to their linguistic verbalisations through the CDFs, which are considered "to be observable analogs of thought processes" (Dalton-Puffer 2013: 231). By doing so "the CDFs can function as a kind of lingua franca that may enable educators to communicate across subject boundaries" (Dalton-Puffer 2013: 242).

4.2. Theoretical background

To establish a theoretical foundation for her construct, Dalton-Puffer (2013) draws on several different theories from both the subject-specific field and applied linguistics.

Regarding subject-specific theory, every content subject adheres to its own traditions of thinking and the culture-specific education systems in which they occur. However, what they have in common is that many current curricula are based on standards or competences which use the same constructs as their foundation. In this context, Dalton-Puffer mentions

Bloom et al.'s *Taxonomy of educational objectives* (1956), and especially the more recent revision of the taxonomy by Anderson et al. (2001), as important predecessors of the CDF construct. While the original taxonomy by Bloom had a hierarchical structure, the revised taxonomy conceives of thinking skills as positioned on a two-dimensional matrix (Figure 5) with four knowledge dimensions (factual, conceptual, procedural, meta-cognitive) as well as six cognitive process dimensions (remember, understand, apply, analyse, evaluate, create).

The knowledge dimension	**The cognitive process dimension**					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual knowledge						
Conceptual knowledge						
Procedural knowledge						
Meta-cognitive knowledge						

Figure 5. *Revised taxonomy of cognitive educational objectives (Anderson et al. 2001: 28)*

According to Anderson et al. (2001: 27), objectives of every subject include both knowledge and cognitive processes and can therefore be classified via this taxonomy by putting them into cells in the table. Moreover, Anderson et al. (2001: 31) assign concrete examples of cognitive processes for each of the six dimensions which are described using verb forms (Figure 6).

Cognitive process category	**Concrete cognitive processes**
Remember	recognising, recalling
Understand	interpreting, exemplifying, classifying, summarising, inferring, comparing, explaining
Apply	executing, implementing
Analyse	differentiating, organising, attributing
Evaluate	checking, critiquing
Create	generating, planning, producing

Figure 6. *Concrete cognitive processes for the six process categories of the cognitive process dimension (Anderson et al. 2001: 31).*

Dalton-Puffer (2013) agrees with this view of thinking skills as a matrix and argues that in multilingual classrooms the focus often lies on the factual knowledge dimension (Hüttner, Dalton-Puffer & Smit 2013). Consequently, the dimension of the cognitive processes, which is characterized by understanding and actively applying the knowledge, was of particular relevance for the development of the CDF construct (Dalton-Puffer 2013: 222).

Even though the (revised) taxonomy of educational objectives is a highly influential model in this field of research, Dalton-Puffer (2013) finds it worth mentioning several other works with similar intentions of establishing educational goals. For instance, Briggs and Tang (2011) proposed a hierarchy of verbs that can be used for formulating learning outcomes.

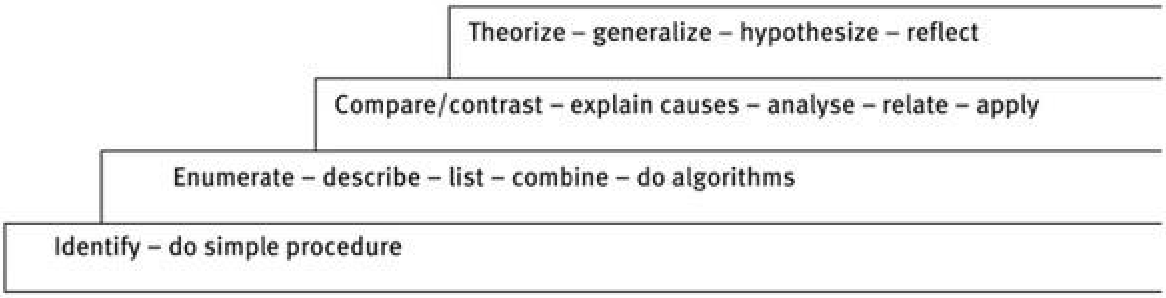

Figure 7. *Verbs for formulating learning outcomes (based on Briggs and Tang 2011: 9; simplified by Dalton-Puffer 2013: 222).*

A simplified version of this hierarchy by Dalton-Puffer (2013: 222) can be seen in Figure 7. The simplification of the complex hierarchy allows for a better comparison to Anderson et al.'s (2001) cognitive process dimension. Moreover, Dalton-Puffer (2013: 223) integrates research on verbs that represent linguistic behaviours that can be used to verbalise content knowledge (e.g., Bailey & Butler 2003). Lastly, the platform *Language in other Subjects* by the Council of Europe impacted the construction of the CDFs. On this platform, a multilingual team of subject and language educators provide a variety of documents that analyse language and subject-specific competences that occur in these subject areas. The reference text most relevant to this thesis is the one on science education by Vollmer (2010); some of the ideas presented in this publication have already been discussed in section 3.2.

Apart from these conceptualisations, theories from applied linguistic have influenced CDF construct. Firstly, Dalton-Puffer (2013: 225) mentions Halliday's *Systemic Functional Linguistics* (Halliday 1978, 1993), which is a meaning-based theory of language which regards language as a system of choices which are shaped by the social activities it occurs in (Llinares et al. 2012: 10). Another significant influence from the linguistics' perspective is Cummins' (2000) binary of Basic Interpersonal Communication Skills (BICS) and Cognitive Academic Language Proficiency (CALP). This concept is widely acknowledged in response to the phenomenon that many L2 learners seem to be proficient in the L2 without achieving academic success. It postulates that the progression of academic language is three to four times slower than that of BICS. Dalton-Puffer (2013: 225-226) points out that there is no set sequence in which BICS or CALP are acquired; given enough exposure to academic language, e.g., through CLIL instruction, CALP may progress faster than BICS. However, even though BICS and CALP are seen as conceptually separate, they have in common that they are shaped by the context of their acquisition as they "develop within a matrix of social interaction" (Cummins 2000: 74). Thus, classroom interaction is central to the development of both and should provide the opportunity for "juxtaposing different oral and literate uses of language, with teachers guiding students in extending their repertoires towards the literate end" (Dalton-Puffer 2013: 227). However, how teachers and learners navigate this process in classroom interaction still needs some more research and the proposed CDF construct attempts to serve as a tool for this purpose.

This section provided an overview of the extensive list of theory on general subject education as well as language learning that constitute the theoretical foundation for the CDF construct. Through the combination of concepts from these two disciplines, the CDF construct aims to serve as a tool for researching integration of content and language in classroom interaction.

4.3. The CDF construct

As can be seen through the extensive analysis of background literature, Dalton-Puffer wants to create "a zone of convergence" (2013: 216) with her CDF construct acting as a bridge between the subject-specific cognitive processes and their verbalisations within classroom interactions.

Through her extensive literature review, Dalton-Puffer (2013: 233) derived a list of about 50 academic language functions that can be used to describe disciplinary thought processes. Her goal for the construction of the CDF construct is to condense this rather long list of functions and impose a logical structure on them. In doing so, she wants to achieve a balance between the whole unstructured alphabetical list (see Dalton-Puffer 2013: 251-253) and previously used knowledge frameworks that used a three-part structure (Classification – Principles – Evaluation) to classify thinking skills (e.g., Mohan 1986).

The starting point for Dalton-Puffer's (2013: 233) structure is the notion of speech acts that are verbal actions reflecting on cognitive processes. These speech acts create communicative patterns that derive from "the needs humans have when they deal with cognitive content for the purposes of learning, representing and exchanging knowledge"

(Dalton-Puffer 2016: 31) and serve the same prototypical communicative intentions for dealing with content knowledge (Dalton-Puffer 2013: 233). Dalton-Puffer (2013: 234) then grouped the derived academic language functions into seven types, each with a prototypical communicative intention at its core. Table 1 provides an overview of these types with their communicative intention as well as a label (*CLASSIFY, DEFINE, DESCRIBE, EVALUATE, EXPLAIN, EXPLORE, REPORT*) to quickly address each type.

Table 1*. List of CDF types and underlying communicative intentions (Dalton-Puffer 2013: 234).*

Function type	Communicative intention	Label
Type 1	I tell you how we can cut up the world according to certain ideas.	CLASSIFY
Type 2	I tell you about the extension of this object of specialist knowledge	DEFINE
Type 3	I tell you details of what can be seen (also metaphorically)	DESCRIBE
Type 4	I tell you what my position is vis a vis X	EVALUATE
Type 5	I give you reasons for and tell you cause/s of X	EXPLAIN
Type 6	I tell you something that is potential	EXPLORE
Type 7	I tell you about sth. external to our immediate context on which I have a legitimate knowledge claim	REPORT

However, given that these labels are English words, they often possess more than one meaning depending on the context, therefore, they cannot be seen as a fixed terminology and must be treated with caution (Dalton-Puffer 2013: 235).

Another characteristic of the CDF construct is that the different categories contain several realisations in the form of action words. Even though each category has more than one realisation, the precise number can vary, as can be seen in Table 2, making the categories unequally extensive.

Table 2. *List of CDF categories and their members (Dalton-Puffer 2013: 235).*

CLASSIFY	Classify, compare, contrast, match, structure, categorize, subsume
DEFINE	Define, identify, characterize
DESCRIBE	Describe, label, identify, name, specify
EVALUATE	Evaluate, judge, argue, justify, take a stance, critique, recommend, comment, reflect, appreciate
EXPLAIN	Explain, reason, express cause/effect, draw conclusions, deduce
EXPLORE	Explore, hypothesize, speculate, predict, guess, estimate, simulate, take other perspectives
REPORT	Report, inform, recount, narrate, present, summarize, relate

The inequal distribution of realisations can be seen by comparing *DEFINE*, which has only three realisations, with *EVALUATE's* ten realisations.

The internal structure of the categories exhibits two characteristics, namely their prototypical communicative function as well as fuzzy borders. Regarding the former, as some of the realisations are more central to the CDF type than others, there is a similarity to prototype theory (e.g., Rosch and Mervis 1975). According to this theory, the blackbird, for example, is the prototypical bird for North America. However, CDFs do not have a "best exemplar" (Dalton-Puffer 2013: 236). On the contrary, the prototypical aspect of each category is its communicative function. The members within the categories are more or less similar to each other or even overlap in their semantic meaning. Thus, different labels may correspond to the same meaning or communicative function but are typically used in specific contexts by different communities of practice. For example, *to comment* on something is a common task in social science subjects while *to evaluate* occurs in natural sciences. However, they share the same underlying prototypical core, namely stance-taking (Dalton-Puffer 2013: 236).

The second characteristic is that the CDFs have fuzzy borders; therefore, they are not mutually exclusive. On the contrary, Dalton-Puffer (2013: 236) argues that the seven types might even include each other. To illustrate this point, she explains that *DEFINE* always includes some aspect of classifying (e.g., comparing and contrasting) but not all realisations of *CLASSIFY* have to be used to define something.

Dalton-Puffer argues that the construct is not essentialist, but the underlying functions can be perceived as cultural models. The construct was designed to be applicable to a broad context and might need adaptation depending on the context, for example the school subject, it is applied in. Based on these contextual variations, the aim of the construct is to serve as a model for further research into these differences (2013: 237).

After having presented the rationale, the theoretical foundation and a general description of the main features of the CDF construct, the next sections explore the individual CDF categories in greater detail.

4.4. The seven CDF types

As a basis for the analysis of the CDFs in the empirical part of this thesis, the following sections will discuss the concrete realisations and characteristics of each CDF type. For this purpose, relevant literature on the functions will be discussed. Moreover, findings from previously conducted empirical research on the implementation of CDFs in CLIL classrooms will be analysed.

4.4.1. CLASSIFY

The first CDF to be introduced is CLASSIFY. Due to its importance in the construction of knowledge, Dalton-Puffer declares CLASSIFY as "a key CDF" (2016: 34). This importance is also acknowledged by others such as Mohan (1986). Moreover, Anderson et al. point out the vital nature of the classification process to developing expertise in academic subjects as "[e]ach subject matter has a set of categories that are used to discover new elements as well as to deal with them once they are discovered" by connecting specific information with each other (2001: 49). Thus, CLASSIFY aids in organising (and ultimately retaining) new information by connecting it to already existing knowledge. Furthermore, in his paper on cognitive functions in science education, Vollmer (2010) also acknowledges the significance of classifying as a microfunction.

While Dalton-Puffer defines the communicative intention behind CLASSIFY as "I tell you how we can cut up the world according to certain ideas" (2013: 234), other researchers (Kröss 2014, Dobner 2020) also found it useful to look at the dictionary definition of the words itself. Even though Dalton-Puffer (2013: 235) stresses that the labels of CDFs cannot form an exact terminology, consulting the definition in the Oxford English dictionary (OED) seems helpful to determine the meaning of the label CLASSIFY for this thesis:

to classify

1. To arrange in or analyse into classes according to shared qualities or characteristics; to make a formal or systematic classification of.
2. To place in a particular class, esp. to assign to a position within a formal system of classification. (OED online)

This definition determines the main function of classifying as analysing and structuring concepts by establishing similarities and differences as well as sorting them into categories of an already existing system. This function is also reflected in the above stated communicative intention.

Two different classification types can be distinguished depending on the directions of the classification approach: from specific to general or from general to specific (Trimble 1985: 85, Widdowson et al. 1979a: 72). Trimble (1985: 85) states that the former is a classification in the true sense where one starts with one or more related items (or members) and searches for a shared class they belong to. For the latter type, on the other hand, one starts with a given class and searches for its members (e.g., Widdowson et al. 1979a: 75) provides a visual representation of these two classification types (Figure 8).

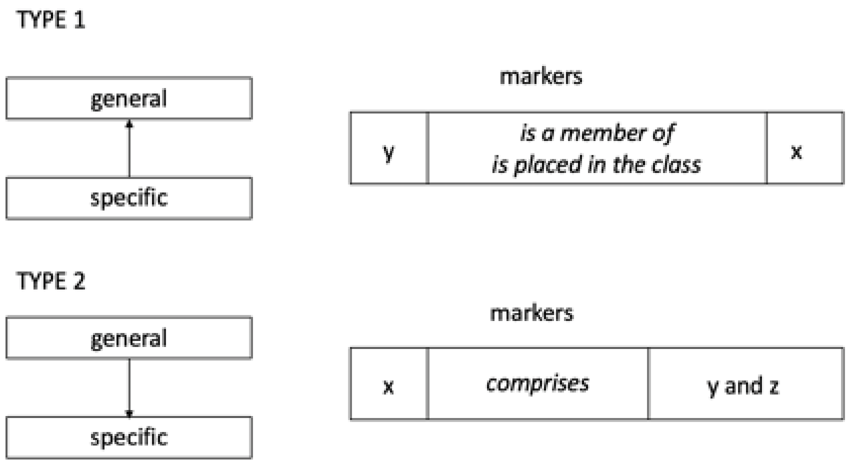

Figure 8*. Types of classification according to directions (Widdowson 1979a: 75).*

Another option of distinguishing between classification types depending on the given information is presented by Trimble (1985: 86-93): complete, partial, and implicit classification. A complete classification includes (1) the item or items that are classified, (2) the class to which they belong, and (3) the basis for classification meaning similarities and distinguishing features of the members of a class (Trimble 1985: 86). In comparison, the partial classification "leaves out the basis for classifying" (Trimble 1985: 89). Lastly, in an implicit classification all the information is present, but it is not explicitly stated as a classification because the overarching rhetorical function is not to classify (Trimble 1985: 90).

Even though classification is a vital process in the acquisition of knowledge, it is not an easy cognitive function to acquire. Dalton-Puffer (2016: 34) ascribes the difficulty for learners to perform classifications to the fact classifying is an abstract and complex process. Through classification one moves from knowledge about specific items to knowledge of abstract categories which are often arbitrary to non-experts (Anderson et al. 2001: 50). Therefore, the knowledge of classes and categories as well as the skill to make connections between concepts must be learned with the help of experts to acquire expertise in a subject domain (Dalton-Puffer 2016: 34). Nevertheless, teaching classifications is important as misclassifications can hinder learning (Anderson et al. 2001: 49-50). Moreover, students struggle to understand that that there can be several levels of generality: an item that is the generalisation in one case can be the specific item in another instance (Trimble 1985: 85).

As already stated in the previous section, different CDFs might overlap with each other. Regarding CLASSIFY, Dalton-Puffer proposes a link to DEFINE as "[c]lassifying is always part of DEFINE, but not all instances of CLASSIFY are" (2013: 236). Similarly, Trimble highlights the close relationship between these two functions" (1985: 85).

4.4.2. DEFINE

Similarly to classifying, defining can be regarded as a core activity in the creation of knowledge. According to Dalton-Puffer, this importance arises from the fact that "all academic disciplines require definition for the proper identification of their subject in order to determine what is and is not part of the field" (2016: 36). This notion is also reflected in Dalton-Puffer's proposed communicative intention for DEFINE, namely "I tell you about the extensions of this object of specialist knowledge" (2013: 234). The relevance of defining for science and academic writing is also acknowledged by Trimble (1985) in his analysis of English for science and technology and by Vollmer (2010) in his work on academic discourse functions in science education. While definitions vary significantly in their extensiveness "from single words to entire books" (Trimble 1985: 75), the definitions in oral classroom discourse are mostly on the shorter side consisting of one or several clauses. As DEFINE is a broad CDF with links to others such as

CLASSIFY, it is important to specify precisely the function of DEFINE in the context of the present study.

According to Dalton-Puffer (2016: 36), a formal definition consists of three necessary elements: *definiendum, definiens,* and *differences*. The *definiendum* is the term or concept that is the subject of the definition; it is set in relation to a superordinate class, the *definiens*. In addition to the concept and the class, a definition states specific differences and features that identify the concept within the class. Thus, the structure of DEFINE can be described as *Definiendum = Definiens + differences*. Trimble ascribes the same features to defining, however, he uses slightly different terminology that reflects the biological concept of a species: "*Species = Genus + Differentia*" (1985: 75-76).

As definitions can vary significantly in their length and complexity, Trimble (1985: 75-84) suggests two broad categories of definitions that can be further divided into subtypes: simple and complex definitions. Simple definitions are usually no longer than a sentence and can be further divided, depending on the number of features they contain and their precision, into formal, semi-formal and non-formal definitions. Formal definitions include all the necessary information (concept, class, differences) and therefore are highly precise in defining a term (Trimble 1985: 75-76). Semi-formal definitions are incomplete definitions as they give no information about the superordinate class. This omission of the class might occur in situations where the class is obvious from the context or where it is too broad to add any meaningful information (Trimble 1985: 77). The simple definition that offers the least amount of information is the non-formal definition. Its function is to provide the reader with a general sense of the concept by connecting it to familiar terminology. Examples of non-formal definitions are the use of synonyms or antonyms as well as naming common members of the class or common characteristics of the members (Trimble 1985: 78-79). Trimble uses the example of "An arachnid is a spider" to show that this type of definition is rather imprecise as synonyms usually do not hold the exact same meaning. In this case, while it holds true that spiders are arachnids, they are not the only type of arachnid and therefore the definition only covers part of the term's meaning (Trimble 1985: 78).

Moreover, Trimble identifies complex definitions as ones that are more extensive in length but usually have a simple definition at their core (1985: 75). Complex definitions are mostly found in written discourse, which is why for the present study, which analyses oral classroom discourse, not many complex definitions are expected. Therefore, they will not be discussed in detail. The three complex definitions presented by Trimble (1985: 81-82) are definitions by stipulation, by explication and by operation.

Another approach to classifying definitions is according to the order the key elements are provided in which relates to the concept of theme. Within this approach, Widdowson et al. (1979a: 56) differentiate between "real" und "nominal" definitions. Whether a definition is real or nominal depends largely on the context. On the one hand, a real definition first names the concept followed by the class and the specific characteristics.

Table 3. *Real and nominal definitions (Widdowson et al. 1979a: 57, adapted).*

	theme		new information
Real definition	name of concept	*is defined as* *may be defined as*	class + characteristics
Nominal definition	class + characteristics	*is known as* *is called*	name of concept

In this type, the concept is the theme of the sentence and is further specified by the class and characteristics. On the other hand, a nominal definition first "states the nature of the concept [through its class and features] and then identifies it by giving its name" (Widdowson et al. 1979a: 56). In this case, the name of the concept is the new information (see Table 3).

In her study of CDFs in classroom discourse, Kröss (2014: 14) raises the question whether translations can be regarded as another type of definition as they serve the same function of clarifying what an expression means. This issue is of relevance to the present study as translations into the learners' L1 occur in the collected data. Kröss (2014) ultimately finds that translations do not usually fulfil the above established conventions and therefore should not be treated the same. Therefore, she introduced the new label DEFINE-TRANSLATION to her analysis which was also adopted by Dobner (2020). In contrast, in their in-depth analysis of CDFs in biology lessons, Hofmann and Hopf (2015: 29) regard translation as a sub-category of non-formal definitions. However, this thesis will not investigate CDFs in that much detail and therefore adheres to Kröss' approach.

Even though the various types of definitions can seem rather complex, their linguistic realisation is usually simple. The basic structure of definitions is established by Dalton-Puffer as the copula construction "an X is a Y" accompanied by the specific characteristics. These characteristics can be realised through "adjectives, relative clauses or reduced relatives" (2016: 36). The same construction can be seen in Widdowson et al.'s (1979a) representation of real and nominal definitions with the concept being X and the class and characteristics being

Y. Similarly, Gillet et al. suggest the construction "A Y that ... is X" (2009: 115) for nominal definitions.

4.4.3. DESCRIBE

The next discourse function Dalton-Puffer (2013, 2016) introduces for her CDF construct is DESCRIBE. She identifies the nature of this CDF as "an activity where a speaker/writer informs a listener/reader about the observable features, qualities or external and sometimes also internal characteristics of something in third-person position" (2016: 38) and further specifies that this something can be objects, entities, persons, situations, events or processes. This definition implies that descriptions should be objective, as they focus on observable features, and should not primarily be a response to a comprehension problem. Dalton-Puffer (2016: 38) claims that describing is a key feature of academic knowledge construction that serves the purpose of drawing attention to something that is not immediately obvious by "telling you what I see" (Lackner 2012: 50). The form and purpose of descriptions can vary depending on the discipline and context (Widdowson et al. 1979a: 34); descriptions in science, and therefore biology, are usually timeless and generic and do not include any references to oneself or the addressee as the focus is on the described item or process (Schleppegrell 1998: 187).

Through reviewing of previous literature in the English for specific purposes (ESP) context, researchers have identified four main types of descriptions (e.g., Gillet et al. 2009, Kröss 2014, Lackner 2012, Trimble 1985, Widdowson et al. 1979a). These types are (1) physical, (2) structural, (3) functional and (4) process descriptions. Each of the types includes different kinds of information and has specific realisations; however, they are not mutually exclusive, and combinations of different description types are possible (Trimble 1985: 71).

Physical descriptions "give the physical characteristics of an object and the spatial relations of the parts of the object to one another and to the whole, and of the whole to other objects concerned, if any" (Trimble 1985: 71). Trimble names "dimension, shape, weight, material, volume, colour, and texture" (1985: 71) as the most frequently described characteristics.

Lackner views structural descriptions as closely related to physical descriptions; however, they "always express a part-whole relationship" (2012: 51). Therefore, their realisation is characterised by statements that express this part-whole relationship, for example, by using verbs such as *consists of*, *contains* or *make up* (Lackner 2012: 52).

Widdowson et al. (1979b) and Gillett et al. (2009) suggest typical realisation patterns for structural descriptions that are summarised by Lackner (2012: 52) in Figure 9.

Structural description Type 1

Whole	*consists of*	parts
	is divided into	
	is made up of	
	includes	

Structural description Type 2

Parts	*make up*	whole
	form	

Figure 9. *Structural description types 1 and 2 adopted from Lackner (2012: 52).*

It should be noted that the realisation pattern of the two types of structural description and the realisation of classifications (Figure 8) show similarities. However, Lackner points out the differences between these closely related discourse functions as "*structural description* can be said to express a relationship of meronymy (*x is part of y*) in contrast to *classifying* and *defining*, which have been conceptualized as expressing the relationship of hyponymy (*x is a kind of y*)" (2012: 52).

Functional descriptions are concerned with functional aspects of some device. Generally, functional descriptions give information on devices' use or purpose and/or the function of the main parts of the device (Trimble 1985: 72). The functions of the individual parts combined causes the functioning of the whole device (Widdowson et al. 1979b: 39). Figure 10 shows possible realisations as summarised by Lackner (2012: 53).

Functional description Type 1

Whole/part	*serves to*	function
	is responsible for	
	performs the function of	
	enables	
	controls	
	regulates	

Functional description Type 2

The A One	*function*	of the	whole/part	is to	function
	purpose				
	aim				
	objective				
	role				

***Figure 10**. Functional description types 1 and 2 adopted from Lackner (2012: 53).*

The fourth sub-category of DESCRIBE is the process description. According to Trimble (1985: 72), process descriptions involve a series of steps or stages of a procedure that lead towards a common goal. Moreover, each step (except the first) is dependent on the preceding one. Lackner (2012: 54) states that process descriptions can vary significantly in their level of complexity from rather simple "step-by-step" processes to highly complex ones. The realisation of process descriptions is characterised by the use of sequential discourse markers (Lackner 2012: 54). Moreover, the use of passive voice is typical as the focus is not on the actor but the process itself (cf. Gillett et al. 2009, Lackner 2012). Gillett et al. (2009: 123) mention typical expressions that are used in process descriptions which Lackner (2012: 54) assembles into a general structure (Figure 11).

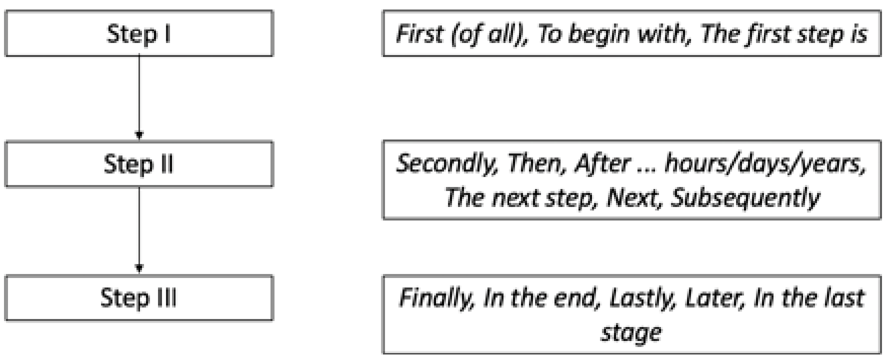

***Figure 11**. Process description adopted from Lackner (2012).*

According to Trimble (1985: 72), process descriptions often occur as a series of instructions. In the context of biology lessons, process descriptions might take place during sequences dealing with experiments. In these cases, they might include the equipment or material used, the purpose of each stage and occurring changes between stages (Widdowson et al. 1979a: 41).

DESCRIBE is closely connected to other CDF types. Firstly, functional descriptions are similar to EXPLAIN; the linguistic realisation helps distinguish between them as explaining includes causality and therefore an element of reasoning which describing lacks (Kröss 2014: 19, Trimble 1985: 72). Moreover, there is another similarity to CLASSIFY and Mohan (1979: 179) even categorises classifying as a part of describing. Dalton-Puffer (2013: 236) connects DESCRIBE to EXPLAIN or REPORT; however, she also emphasises that DESCRIBE will also occur on its own.

4.4.4. EVALUATE

The next CDF type to be discussed is EVALUTE. EVALUATE is the CDF type with the most members, namely *evaluate, judge, argue, justify, take a stance, critique, recommend, comment, reflect* and *appreciate* (Dalton-Puffer 2013: 234). To determine the nature of EVALUATE, Kröss (2014: 21) refers to the OED entry which shows a mathematical understanding of the verb, namely, "[t]o work out the 'value' of [...]; to find a numerical expression for" (OED). As this definition does not match the communicative intention "I tell you what my position is vis a vis X", which Dalton-Puffer (2013: 234) intended for this CDF, Kröss (2014: 21) turns to the closely related member *judge* for a definition. According to the OED, to *judge* is "[t]o form an opinion or conclusion about (a person or thing), esp. following careful consideration or deliberation; to assess, evaluate, or appraise". This definition matches the communicative intention of EVALUATE. Moreover, her a later work, Dalton-Puffer clarifies that evaluations in academic contexts needs to explicitly express "the evidence, criteria, standards or reasons which support the evaluation that is being made" (2016: 42).

As can be seen from the list of members as well as the communicative intention of EVALUATE, this CDF involves an element of subjectivity as the realiser passes personal judgement on something. Kröss (2014: 22) argues that this subjective nature distinguishes EVALUATE from other CDFs as subjectivity is unique to this type. Given that biology belongs to the hard sciences which value objectivity, it can be assumed that EVALUATE does not occur frequently in the biology classroom. However, Mautner (2019: 156) states possible applications of EVALUATE in the science classroom, such as the careful consideration of advantages and disadvantages of models and methods, criticising interpretations and outlining/judging the relevance of practical applications.

In her book on scientific English, Mautner describes four relevant dimensions for classifying evaluations: positive vs. negative, certain vs. uncertain, important vs. unimportant and direct vs. indirect (2019: 140 translated by Kröss 2014: 22). The word pairs of these four dimensions are endpoints of a continuum with evaluations located along these axes (Mautner 2019: 141). However, Mautner made these considerations in the context of academic written language. As the present thesis analyses spoken language, the applicability of these dimensions to my data might not entirely be given and a detailed investigation according to these dimensions goes beyond the scope of this thesis.

Although evaluations have not been extensively discussed in the ESP literature, there is consensus on the importance of this cognitive thinking process (Dalton-Puffer 2016). In the above-described competence model for natural sciences (3.3), EVALUATE is part of the S-dimension of the model (*evaluation competence*). Even though this CDF is part of the Austrian biology curriculum, it is part of the cognitively most challenging competences (e.g., evaluating the significance, opportunities and risks of the application of scientific findings or arguing one's opinion on ethical issues – for full list of competences see appendix). Consequently, instances of EVALUATE are rather rare in biology and science classrooms. Kröss' (2014: 45-48) study of CDFs in physics lessons showed that EVALUATE was extremely rare with only one occurrence in six analysed lessons. While Hofmann and Hopf (2015: 83-85) found several instances of EVALUATE in their data analysing biology lessons, the CDF is still among the least frequent CDFs.

Lastly, the issue of the power imbalance between teachers and learners in the classroom needs to be addressed and its implications for evaluations as this might shed light on the reasons for the infrequent occurrence of this CDF. In most classrooms, teachers' ask the most questions even though they are the ones with the extensive content knowledge. Learners, on the other hand, typically respond to the questions but very rarely ask questions themselves. According to Dalton-Puffer (2016: 43) and Hofmann and Hopf (2015: 45), this inherent inequality in the classroom discourages instances of EVALUTE which require evaluative judgements. As teachers are also responsible for grading, many pupils are tentative to voice their opinions to avoid negative consequences. Also Wells (2009: 4) addresses the negative impact of the power imbalance on stance taking in the classroom:

> And, once this pattern of inequality has been established as the norm in school, older children accept [...] it, becoming unwilling either to ask the sort of questions that might lead to a genuine instructional conversation or to go beyond giving minimal answers, even when a teacher's question calls for an expression of their own opinions or an account of their personal experience.

Taking these considerations into account, the present study expects only few occurrences of EVALUATE in the data.

4.4.5. EXPLAIN

In order to arrive at an understanding of the extent of EXPLAIN for her construct, Dalton-Puffer refers to the general definition of the verb in the OED, which highlights three main uses of the word (2016: 44):

> *Explain 1*: To make sth. plain or intelligible; to clear of obscurity or difficulty; to give details of or to unfold (a matter).
>
> *Explain 2*: To give an account of one's intentions or motives.
>
> *Explain 3*: To make clear the cause, origin, or reason of."

As the very general nature of *Explain 1* is not conducive to defining the scope of this CDF type, Dalton-Puffer (2016: 44) excludes it from the CDF construct. While this first understanding of *explain* may not be suitable to serve as a specific function, Dalton-Puffer argues that all CDFs taken together contribute to this understanding of *explaining* in this first sense. *Explain 2* and *Explain 3* together form the understanding of EXPLAIN for the CDF construct although they are mostly used in different contexts (Dalton-Puffer 2016: 44-45). On the one hand, *Explain 2* highlights the human involvement in causing an event or effect by specifying intentions and motives. This kind of thought process is typical for social science subjects, such as history (Dalton-Puffer 2016: 44, Lackner 2012: 45). On the other hand, *Explain 3* is typical for natural science subjects, which usually arrive at explanations on the basis of deduction (Dalton-Puffer 2016, Hofmann & Hopf 2015, Vollmer 2010). Explanations in the sense of the CDF construct, therefore, always deal with causal relations by trying to answer the question *why?* (Dalton-Puffer 2016: 45). This notion of causality in EXPLAIN is also reflected in its communicative intention: "I give you reasons for and tell you cause/s of X" (Dalton-Puffer 2013: 234).

Natural sciences, in particular, use a process of deduction to explain the reason, cause or origin of natural phenomena and processes as well as their consequences. Many of these phenomena are the end product of processes that themselves triggered further processes. Widdowson et al. (1979b: 108) suggests the structure of this type of *explaining* of causes and consequences as a chain of reaction (Figure 12).

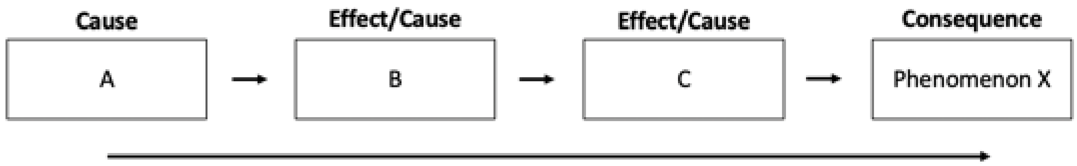

Figure 12. Cause and effect *adapted from Widdowson et al. (1979b) by Hofmann and Hopf (2015: 49).*

A consequence, *Phenomenon X,* can be caused by several factors that are interconnected as some of them are themselves effects of previous phenomena. Figure 12 shows the explanation of this phenomenon as a step-by-step process of deduction. Even though the structure presented in Figure 12 suggests a chronological direction, Hofmann and Hopf stress that "[t]he explanatory process is not required to run chronologically; it can also begin with the final consequence and work its way backwards to the primary cause" (2015: 49),

According to Widdowson et al. (1979b: 118), explanations can take two forms: explanations of causality and of consequence. They both highlight one of the two aspects of the cause/consequence relation and, therefore, take a different syntactic structure. Explanations of causality focus on the reason for the phenomenon while the effect is secondary. Thus, the cause is put into the main clause of the sentence with the effect being introduced by conjunctions, such as *because, as* and *since* (Lose 2007: 99). In contrast, explanations of consequence make the consequence the focus of the utterance and introduce it with conjunctions, such as *therefore, for this reason, that is why, consequently, so* or *as a result of this* (Lose 2007: 99).

Table 4. *Explanation of* causality *and* consequence *adapted from Hofmann and Hopf (2015: 51, 164-165).*

Causality	Consequence
conjunctions	
as because since the reason is is caused by	therefore for this reason consequently so (that) if-clauses that's why the ... the causes/makes
syntactic realisation	
'X because Y.' 'Because X, Y.'	'X. As a result/consequently/That's why, Y.' 'If X, then Y.' 'The X, the Y.' 'X causes/makes Y.'

Table 4, summarises the main conjunctions and syntactic realisations of cause and explanations of consequence based on Hofmann and Hopf's (2015: 51) adaptation of Lose (2007) and Widdowson et al. (1979b) and now includes the results of Hofmann and Hopf's (2015: 164-165) own data.

While EXPLAIN occurs rather frequently in the CLIL classroom, student realisations are rare (Hofmann & Hopf 2015: 174, Kröss 2014: 56). A closer look at the rare explanations realised by students shows that they are usually minimalistic (Dalton-Puffer 2007: 151) and use a narrow range of lexico-grammatical structures that are below the students' overall language proficiency (Lose 2007: 106). Dalton-Puffer (2007: 150-151) argues that the minimalistic nature of students' explanations can be explained by the fact that students assume the teacher is already in possession of the knowledge and therefore minimal information suffices to unlock the concept in the teacher's mind.

EXPLAIN, more than any other CDF in the construct, overlaps with other functions such as DEFINE and DESCRIBE. In the case of DEFINE and EXPLAIN, Dalton-Puffer (2007: 139) argues that looking at the definitions of both terms, they clearly overlap in some aspects. Therefore, she suggests that EXPLAIN is the broader function which might include elements of DEFINE. This is also observed by Dobner (2020: 43) who concludes that "*EXPLAIN* gives significantly more information than *DEFINE*" and therefore is the encompassing function. Moreover, researchers point out the similarity between EXPLAIN and DESCRIBE, especially process descriptions might be part of explanations of certain procedures (Dobner 2020: 42, Hofmann & Hopf 2015: 50).

4.4.6. EXPLORE

Before Dalton-Puffer established her CDF construct, she had already investigated this discourse function albeit under the term *hypothesise* (Dalton-Puffer 2007). Within the later established construct, *hypothesise* can be found among others as one of the members of EXPLORE (Dalton-Puffer 2013). The CDF type EXPLORE functions as a label for several closely related members, *hypothesise, speculate, predict, guess, estimate, simulate*, *take other perspectives, assume, suppose, presume* and *conjecture* (Dalton-Puffer 2013: 235, Dalton-Puffer 2016: 46). All the mentioned verbs share a similar core idea, namely "talking about that which is not in the here and now, and which is not firmly established past fact either" (Dalton-Puffer 2016: 46). Thus, they talk about possible future outcomes or possible past events respectively. Dalton-Puffer summarises the overall meaning of these members in her updated communicative intention for EXPLORE: "I'm talking about something which is not in the here and now, and which is not past fact either. I do not have conclusive evidence for what I say but it can serve me/us as a basis for further reasoning" (2016: 46). Moreover, she stresses that for the purpose of the construct, which is meant to be applied in an educational context, she does not use the technical meaning of *hypothesis* and *prediction* but sees these words in a more general notion. Therefore, when formulating a *hypothesis* in the CLIL classroom, it does not have to be based on scientific theory as part of the research process; rather one assumes what will or will not happen under certain circumstances (Dalton-Puffer 2016: 46-47).

A closer look at EXPLORE reveals that it does not only involve complex cognitive thought processes, but its verbalisation is also characterised by complex lexico-grammatical features. As the function of EXPLORE is to talk about that which is not in the here and now but could possibly be in the future or in the past, verbalisations need to make use of modality. Dalton-Puffer provides grammatical structures needed to realise EXPLORE "including modal verbs (*can, will, may* etc.), adverbs (*probably, perhaps, possibly*), conditional conjunctions (*if*)" (2007: 160). Moreover, Dalton-Puffer (2007: 160-161) supplies a list of lexical verbs and phrases that introduce episodes of hypothesising (Table 5, Table 6).

Table 5. *Lexical verbs introducing hypothesising episodes (Dalton-Puffer 2007: 160).*

assume	propose
guess	speculate
hypothesize	suggest
imagine	suppose
predict	

Table 6. *Phrases introducing hypothesising episodes (Dalton-Puffer 2007: 161).*

let's think/say/assume/imagine	what would your prediction be?
(so) what would happen (if)	what would you propose
what will happen if	what would you do if
what happens if	anyone wanna take a guess?
can you predict	

Even though the complexity of the realisation of EXPLORE can pose a challenge for many learners, this function should not be neglected in the biology classroom. In Austrian biology lessons, exploring is covered by competence *E2* of the above introduced competence model of natural sciences and therefore part of the curriculum (BMBWF 2018). This competence constitutes the following abilities:

> "Ich kann einzeln oder im Team zu Vorgängen und Phänomenen in Natur, Umwelt und Technik Fragen stellen und Vermutungen aufstellen [I can ask questions and make assumptions individually or in a team about processes and phenomena in nature, the environment and technology]" (BIFIE 2011: 2)

Therefore, exploring can be seen as a crucial part of science education. Kröss argues that EXPLORE is especially important in the context of experiments in the physics classroom where the learners need to be "able to predict outcomes, hypothesise about potential explanations, make guesses and estimations, simulate phenomena, etc." (2014: 26). The same can be assumed for the biology classroom as there are also numerous possibilities for conducting experiments.

Even though EXPLORE is an essential part of acquiring knowledge in the science context, the function does not occur frequently within classrooms. One reason for the lack of, especially student-realised, instances of EXPLORE could be the linguistic complexity of the function (Dalton-Puffer 2016: 48). Hofmann and Hopf's (2015: 175) results are slightly more hopeful with 9 percent of occurrences attributed to students.

4.4.7. REPORT

The final of the seven CDFs REPORT covers "what happened, when, who did it and to whom and under what circumstances" (Dalton-Puffer 2016: 49). It encompasses various members such as *report, inform, recount, narrate, present, summarize* and *relate* (Dalton-Puffer 2013: 235). These members share the common main function of informing as well as the fact that they refer to something external which the speaker has either experienced themselves (e.g., an event) or has heard or read about (e.g., newspaper articles, documentaries) (Kröss 2014: 28). These shared features are found in Dalton-Puffer's proposed communicative intention for REPORT: "I tell you about something external to our immediate context on which I have a legitimate knowledge claim" (2013: 234).

As REPORT involves relaying external information, the use of reporting verbs is necessary. In his review of written academic language, Hyland (2004: 27) classified reporting verbs according to the activity they refer to as research acts, cognition acts or discourse acts. Moreover, Hyland also points out the most frequently used reporting verbs for biology as *describe, find, report, show, suggest, observe* (Hyland 2004: 27). As Hyland refers to the written context, Hofmann and Hopf (2015: 58) argue that these are unlikely to occur in oral classroom use where more informal alternatives, such as *say* or *find out,* are more common. In their extensive analysis of CDF types and subtypes in the biology classroom, Hofmann and Hopf (2015: 197-198) distinguished seven different types of reports: research report, discourse report, personal report, case report, summary report, introduction report and input report.

Nonetheless, more general important types must be mentioned. Dalton-Puffer (2016: 50) suggests three types of oral reports in classrooms: (1) students summarising (results of) activities, (2) extended oral presentations by students and (3) short teacher monologues. All three of these types are expected to occur in biology lessons; however, extended oral presentations by students are expected to be less frequent than the other types. Similarly to what Kröss (2014: 29) suggested for physics lessons, reporting on processes and results of experiments should be a common occurrence in the biology classroom. This activity is also well established in the written genre of lab report (cf. Vollmer & Thürmann 2010: 118).

As with the other CDFs, REPORT has the tendency to overlap with other CDF types such as DESCRIBE (Dalton-Puffer 2013: 236). Kröss argues that REPORT can include any other CDF type due to its referential nature "since it might be referring to something someone else has said, which can involve any CDF type" (2014: 30).

4.4.8. Previous findings

While some results of previous research regarding the individual CDFs have already been discussed in the respective sections above, this section gives a brief overview of some general tendencies as well as modifications to the construct. The reviewed research is a series of small-scale studies on classroom discourse that were conducted within the context of diploma and master's theses at the university of Vienna. The studies were mostly supervised by Dalton-Puffer (Brückl 2016, Hofmann & Hopf 2015, Kröss 2014) except for the investigation by Dobner (2020) which was supervised by Hüttner. These theses analysed the use of CDFs in physics (Kröss 2014), biology (Hofmann & Hopf 2015), economics (Brückl 2016), and mathematics (Dobner 2020) classrooms. Their results and insights show general tendencies and trends in the use of CDFs in Austrian schools. As biology lessons have already been analysed by Hofmann and Hopf's (2015), the present thesis aims to expand their insights on CDF use in biology classrooms.

The reviewed studies are among the first empirical investigations on the use of Dalton-Puffer's CDF construct; thus, the researchers proposed some modifications to the theoretical framework to ensure the best results in practice. The first modification acknowledges the fact that CDFs have fuzzy borders which leads to possible overlaps. For this reason (Kröss 2014: 36) applied the concept of "moves" from genre studies to describe the occurrence of smaller CDFs within longer passages of another overarching CDF. Similarly, Hofmann & Hopf (2015: 79) talked about "real" CDFs within larger "episodes" and Brückl (2016: 49) called CDFs within another CDF passage "embedded". The second modification that was adapted in different degrees by all the studies is the introduction of a code for translations and German passages. As already mentioned above (4.4.2), Kröss (2014: 35) established the new label DEFINE-TRANSLATION as a sub-category of DEFINE. Due to the frequent occurrence of German passages that were not definitions, Brückl (2016: 47-48) expanded this notion by adding codes for all realisations of CDFs that occurred in German.

Comparing the results of these studies provides general tendencies for the frequency and distribution of individual CDFs within different subjects. Dalton-Puffer et al. (2018: 16) reviewed the results of the above-mentioned studies as well as two more on CDFs in EFL (Lechner 2016) and history (Bauer-Marschallinger 2016) classrooms. Table 7 gives a general overview of the distribution of the CDF types showing the percentage within the overall data expanded with the results of Dobner (2020).

Table 7. *Overview of individual CDFs as percentages per subject adapted from Dalton-Puffer et al. (2018: 16).*

CDF	**Physics** (2014)	**Biology** (2015)	**Economics** (2016)	**History** (2016)	**EFL** (2016)	**Maths** (2020)
CLASSIFY	0.6 %	12 %	4.4 %	11 %	11 %	7 %
DEFINE	15 %	19 %	18 %	17 %	20 %	34 %
DESCRIBE	35 %	21 %	12.5 %	29 %	32 %	19 %
EVALUATE	0.2 %	5 %	12.5 %	13 %	12 %	5 %
EXPLAIN	20 %	17 %	18.5 %	21 %	14 %	32 %
EXPLORE	15 %	17 %	9 %	2 %	3 %	2 %
REPORT	14 %	9 %	25 %	7 %	8 %	1 %

The highlighted fields in the table show the most frequent CDF type for the respective subject. As can be seen, DESCRIBE is the most frequent CDF in four out of six studies. Besides DESCRIBE, EXPLAIN and DEFINE are the most common CDFs across all researched subjects while other CDFs such as CLASSIFY or EVALUATE do not occur frequently in the classroom settings and vary more substantially across the different subjects (e.g., EVALUATE in physics compared to history). Dalton-Puffer et al. (2018: 17) attribute the frequent occurrence of instances of descriptions to the communicative nature of "lessons" in the classroom wherein descriptions are used by teachers and students to establish a common frame of reference for further activities.

Furthermore, the distribution of CDFs according to realisers in the analysed studies show variations that might be due to the different nature of the subjects. An overview of the distribution as percentages can be found in Table 8. Kröss (2014: 52) found that CDFs are predominantly realised by teachers and students collaboratively (59 %) while student realisations are relatively rare (6 %). Hofmann and Hopf's (2015: 89) data show a similar trend for the infrequent student realisations (7 %), the vast majority of realisations are executed by the teacher without the help of the students.

Table 8. *CDF types as percentages according to the realisers.*

Realisations	**Physics** (2014)	**Biology** (2015)	**Economics** (2016)	**Maths** (2020)
T	35 %	67 %	45 %	14 %
S	6 %	7 %	37 %	84 %
T-S	59 %	26 %	18 %	1 %

In contrast, CDFs in the lessons analysed by Brückl (2016: 55) are relatively evenly distributed between teachers and students. Dalton-Puffer et al. (2018: 20) point out that hard sciences, such as physics and biology, are traditionally more teacher-centred and therefore might feature less student-realised CDFs. On the other hand, social sciences give students more opportunities to actively participate which might results in more CDF realisation.

To summarize, the reviewed studies provide the empirical basis on which the research of my thesis will be based. The presented findings show the applicability of the CDF construct as a research tool for classroom discourse, as well as some general tendencies regarding the distribution of CDF types and realisers. The question arises if the current data will show a similar pattern as the already conducted research, especially regarding the previous findings for biology lessons.

In conclusion, the theory section of the thesis introduced the concept of CLIL with its unique characteristics, isolating it from other bilingual programmes, and its potential for content and language learning outcomes. Moreover, the reasons for using a CLIL approach in biology lessons were explored and the unique features of scientific language were surveyed. Then the Austrian competence model for natural sciences was introduced and its importance as part of the biology curriculum was established. Furthermore, a comprehensive discussion of the CDF construct and an overview of the seven discourse functions was given. The most relevant studies analysing CDFs were reviewed to receive general tendencies on the CDF use in Austrian CLIL classrooms. Based on this comprehensive theoretical framework, the following sections will present the empirical part, an analysis of classroom discourse, of this thesis.

5. Study design

Having provided a detailed discussion of the theoretical background of the competence model for natural science education as well as the CDF construct, the next section will investigate their compatibility in naturalistic CLIL biology lessons.

5.1. Research questions

The aim of this thesis is to investigate the use of CDFs in CLIL biology lessons and how they correspond to the dimensions of the competence model of natural sciences. To achieve this, the following overarching research question will be investigated:

1. How are the scientific competences of the curricular competence model for natural sciences and Dalton-Puffer's CDF concept interrelated in the lessons observed?

In order to reach a substantiated conclusion to this investigation, the following sub-questions will also be discussed:

2. How frequently do the individual CDFs occur during the lessons?

3. How are the individual CDFs usually realised in terms of lexico-grammar?

4. Which CDF types tend to be used to work on each of the competences in the competence model for natural sciences?

The expected results to these questions shall expand the data on CLIL classroom discourse in general as well as the CLIL biology classroom in particular. Moreover, results will help evaluate the compatibility of the competence model and the CDF construct by analysing possible overlaps. Based on this analysis, the present thesis will try to conclude if and how CDFs can be used to practise the curricular competences for biology lessons by helping teachers to integrate explicit language learning aspects into their teaching.

5.2. Methodology and data collection

To answer the above-mentioned research questions, a qualitative analysis of audio recordings of six naturalistic CLIL biology lessons was performed. As the present thesis aims to expand on the already existing research into the CDF construct (4.4.8), the research design and coding process was informed by it (cf. Bauer-Marschallinger 2016, Brückl 2016, Dobner 2020, Hofmann & Hopf 2015, Kröss 2014).

First, the audio recordings for the analysis needed to be obtained. For this reason, schools that offer CLIL in biology were found and willing teachers were contacted. Overall, three teachers from two different schools in Lower Austria were willing to participate in the study. Consent forms for all participating parties were prepared by adapting the ones used by Dobner (2020). They were used to obtain consent from the head teachers of the participating schools, the teachers as well as the parents of the learners. In addition, as the schools were in Lower Austria, permission for the study had to be obtained by the directorate of education (Bildungsdirektion) of Lower Austria. Permission was granted by all participating parties. The consent forms are included in the appendix (9.5).

The data collection process faced some difficulties due to the COVID-19 pandemic. Shortly after the permission for the study was granted by the directorate of education, all schools closed for external visitors in November 2021 which meant that the data collection had to be postponed. In consultation with the head teacher, the data could be collected at school A in January of 2022. However, for school B this was not possible. Therefore, it was decided that the teachers from school B (T2, T3) would record their own lessons in February of 2022 using recording devices provided by the researcher. The fact that the researcher was not present during these lessons (L3-L6) made the transcription process more difficult. The lessons were recorded using three recording devices overall, one *Zoom H4N Handy Recorder* to be placed at the front of the classroom and two smaller devices that could be placed with groups during group work. All the devices were provided by the Department of English and American Studies of the University of Vienna.

After the data collection, the data was imported to the data analysis software *MAXQDA 2022* (VERBI Software 2021). With the help of this software, it was transcribed according to the *VOICE* (Vienna Oxford International Corpus of English) conventions [2.1] with small modifications. As aspects such as intonation, emphasis and the length of pauses were irrelevant to the present analysis, they were left out. Pronunciation aspects were only transcribed where necessary, for example when T1 and the native speaker discussed the pronunciation of *species* as /spiːsiːz/ or /spiːʃiːz/. An overview of the most important conventions with examples can be found in the appendix. To ensure anonymity of the participating students, names were replaced by a placeholder (e.g., *Sm1, Sf1, Sx*).

Some difficulties had to be overcome during the transcription process. Firstly, there was considerable background noise in Lesson 1 such as, children playing noisily in the courtyard outside the classroom, the crinkle of a plastic bag for the used COVID-19 tests as well as the students talking among themselves. Luckily, I was present for this lesson and the observational notes aided in reconstructing the lesson. Secondly, another difficulty stemmed from the fact that I could not be present for four of the six recordings due to restrictions imposed by the ministry of education as well as the head teacher of school B. Not having any observational notes and hearing the lessons for the first time while transcribing was challenging. However, after familiarising myself with the covered topics and their English technical terms, the transcription became more manageable. Thirdly, some of the recorded lessons took place during first period on days that COVID-19 antibody test had to be administered, thus reducing the length of the lessons. Finally, due to the noise levels during some group work episodes and the impractical placement of the recording devices, group work sometimes could only be partially transcribed. Moreover, private conversations between students during these episodes were not transcribed as they were deemed irrelevant to the purposes of the study.

Once the lessons were transcribed, the data was coded three-fold using *MAXQDA 2022*. In the first round of coding, the data was analysed according to the established framework for CDFs, i.e., by using the individual CDFs as codes. For passages that were inconclusive, the "assumed underlying communicative intention and cognitive function and not the occurrence of any specific keyword" (Dalton-Puffer & Bauer-Marschallinger 2019: 42) were used to decide on the categorisation of the CDF. In a second and third round, the data was categorised depending on the realiser of the CDF and the competences that are performed in the passage. A more detailed overview of the coding framework is provided in section 5.4. Throughout the coding process, comments were added to inconclusive or interesting passages to ease further analysis.

Moreover, semi-structured interviews were conducted and transcribed with the three participating teachers. However, due to problems staying within the scope of this thesis, this data could not be included in the analysis.

5.3. Research context

This section will give a brief overview of the context of the collected data. Overall, six lessons were recorded in January and February of 2022. The lessons were taught by three teachers and the students were either in 5th or 6th grade (year 9 and 10) of one of the two participating AHS. Both schools offer eight years of education from 1st grade to 8th grade (year 5 to year 12) after which the students take their school leaving exam ("Matura"). For this study, only classes from the upper secondary were selected because at the time of the study only the curriculum for the upper secondary included the competence model for natural sciences. In general, in the Austrian school system lessons last for 50 minutes; however, due to administrative issues (e.g., administering COVID-19 tests, teacher arriving late etc.) in some of the lessons, lesson length and teaching time varied from 31:42 min (L6) to 47:59 min (L4).

School A is an academic secondary school (AHS) located in Lower Austria that offers a bilingual programme from the third grade onwards. As the interest is high and resources are limited, mostly the students with good grades get accepted into this programme, which might lead to elitism (2.3.4). However, for the last few years, students from all programmes (languages, natural sciences, information technology) have received bilingual instructions in biology in 5th and 6th grade. One of the participating classes is from a 5th grade IT programme (Lesson 1 – L1), while the other class is a 6th grade from the bilingual programme (Lesson 2 – L2). In L1 a reluctance to speak English is detectable in the IT students which might stem from the fact that they did not choose the bilingual programme. At this school, one of the two lessons per week in bilingual classes is accompanied by a native speaker (NS). The teacher (T1) is a trained biology teacher who has been teaching bilingually for about 15 years after having attended a seminar on teaching biology in English. A general overview of the lessons and lesson topics can be seen in Table 9.

School B is also an AHS located in Lower Austria which offers English as language of instruction from 5th grade onwards in some subjects in the language programme. The two teachers who participated in the study are both trained in biology, as well as English, making them good candidates for CLIL instruction as they are familiar with language teaching pedagogy. T2 had five years of experience teaching biology in English while it was T3's first year. Each teacher participated with one class: T2 with a 6th grade and T3 with a 5th grade. School B does not have native speakers in their CLIL lessons. For a general overview see Table **9**.

Table 9. *Overview of analysed lessons.*

Lesson code	Teacher code	Grade	Topic	Comments
L1	T1	5	Revision of photosynthesis, limiting factors of photosynthesis (light, temperature, CO_2)	IT programme, NS
L2	T1	6	Revision of nerve cell, action potential	Bilingual programme, NS
L3	T2	6	Mitosis – reasons for and stages of mitosis	Bilingual programme
L4	T2	6	Meiosis – stages of meiosis, similarities and differences to mitosis	Bilingual programme
L5	T3	5	Plant-like protists (algae), ecological & commercial uses of algae, examining products for algae components	Bilingual programme, student presentation
L6	T3	5	Fungi-like protists, discussion of findings of examination for algae components, functions of algae in food/cosmetics	Bilingual programme, student presentation

5.4. Coding framework

Since this thesis aims to investigate the applicability of Dalton-Puffer's (2013) CDF construct, this construct and her later detailed discussion of the individual CDFs (2016) serve as a basis for the investigation (4). However, the modification made by previous researchers as discussed above (4.4.8) were considered.

5.4.1. Modifications to Dalton-Puffer's framework

The first modification to the original framework was introduced by Kröss (2014) who creates a new subcode for translations. Thus, instances where words were translated into German were coded with the label DEFINE-TRANSLATION. This distinction was widely adopted (Hofmann & Hopf 2015, Brückl 2016, Dobner 2020) and was also used in the present thesis. Biology lessons tend to have a high density of technical terms that might be translated for the learners to ensure comprehension.

The next modification deals with the occurrence of German passages within the data. During her data coding, Kröss (2014: 35) noticed that some passages of DESCRIBE, EXPLAIN and REPORT were completely realised in German; therefore, she introduced new labels for these CDFs to make the language of realisation visible. However, individual German utterances within longer English CDF episodes were still treated as English realisations. Brückl (2016: 47) then decided to add these subcodes to all CDF types. Thus, all CDF types that were realised solely in German were coded with this new set of codes to differentiate between the use of the target language and the L1. CDF episodes that were partially realised in English and German were considered to be English CDFs and were coded as such. In the present study, this modification was adopted. However, the data revealed several instances where a CDF passage was realised in German with only the technical term given in English. It was decided that these instances would also be treated as German CDFs. The following table presents an overview of the codes for English and German CDFs:

***Table 10**. Codes for English and German CDF types adapted from Brückl (2016).*

CDF type	CDF type exclusively or partially realised in English	CDF type realised exclusively in German
CLASSIFY	CL	CLG
DEFINE	DF	DFG
DEFINE-TRANSLATION	DFt	-
DESCRIBE	DS	DSG
EVALUATE	EV	EVG
EXPLAIN	EA	EAG
EXPLORE	EO	EOG
REPORT	RE	REG

Brückl (2016: 48) notes that no German label for DEFINE-TRANSLATION was added as these passages always include English and therefore are considered English CDFs. For the present study, only CDFs that were coded as English CDFs were considered in the results as the focus is on the use of English in biology lessons.

Moreover, a differentiation between longer passages of CDFs and individual CDFs that might occur within these passages was made. This adaptation to the framework was adopted using differing terminology by all the previously mentioned studies (4.4.8). The present study adopted Brückl's (2016) terminology of "embedded CDFs" for CDFs occurring within the main CDFs (Table 11).

Table 11. *Codes for main and embedded CDF types adapted from Brückl (2016: 49).*

CDF type	CDF code	Embedded CDF code
CLASSIFY	CL	CLe
DEFINE	DF	DFe
DEFINE-TRANSLATION	DFt	DFte
DESCRIBE	DS	DSe
EVALUATE	EV	EVe
EXPLAIN	EA	EAe
EXPLORE	EO	EOe
REPORT	RE	REe

Example 1 shows an embedded realisation of DEFINE using the code DF with the added suffix -e, thus DFe. In this passage, two learners perform an extended oral presentation which is considered an instance of REPORT with various embedded CDF types, in this instance DEFINE.

Example 1. *Passage showing an embedded CDF (L5).*

Sf1: dear professor [last name], dear class, today we wanna talk about plant-like protists also called algae. First we want to tell you a little bit more about protoctists which we already learned in the lessons. [...] and at the end we talk about the uses of algae.	RE - **S**
Sf2: so what are protoctists? protoctists are all eukaryotes that aren't plants, animals or fungi. their cells have a nucleus containing the dna and other membrane bound organelles. most protoctists are unicellular but some are multicellular. they prefer moist and aquatic environment.	DFe - **S**

Another aspect considered during the coding process was the realiser. The review of previous studies (4.4.8) suggests that hard sciences, including biology, exhibit fewer student-only realised CDFs as they are more teacher-centred in nature. Thus, all CDF realisations were also coded using the following codes as shown in Table 12.

Table 12. *Codes for realisers (Brückl 2016: 51).*

Realiser	Code
Teacher	T
Student	S
Teacher-Student	TS

To maintain consistency, also utterances by the native speaker teacher (only L1, L2) were coded as teacher-realised. CDF realisations that were performed by one or more students were categorised with an S. If a passage was co-constructed interactionally between the teacher and one or more students, it was coded as TS. During the coding a few passages were detected where a student realised the CDF function with the teacher only contributing sounds of confirmation (see Example 2), encouragement or corrections of pronunciation. These passages were coded as student-realised as all the relevant information was provided by the student.

Example 2. *Student-realised passage of DESCRIBE (L3).*

Sm1: and that is actually when the cytoplasm that filled up in erm G1 I think - T: yes. Sm1: - separates and in animal cells there is the cell membrane getting built up again and in plant cells it's the cell wall that is newly created between the two daughter cells.	DS - S

To summarise, modifications to the original CDF construct include new codes for translations, passages realised in German, embedded CDFs and distribution among the realisers.

5.4.2. Coding according to the competence model & compatibility with CDFs

In addition to the implemented modifications, new codes for the analysis of the occurring competences during the lessons had to be established. This section gives a brief overview of what considerations and decisions were taken to obtain the best results.

First, codes were created for the three dimensions of the competence model as discussed above (3.3): W, E and S. Furthermore, the three dimensions were also divided according to the individual competences they encompass. For example, the code W1 was used for the W1 competence from the W-dimension which states, "Biologische Vorgänge und

Phänomene beschreiben und benennen [Describe and name biological processes and phenomena]" (BMBWF 2018). A complete list of all the competences including translations can be found in the appendix.

The first consideration that shall be mentioned here is that the focus of this study was on which competences are realised in a lesson, not on how many instances occurred. This decision was made because competences are usually realised in longer sequences, for instance when students conduct investigations or experiments. As sometimes these longer sequences featured other competences, overlaps of competences were accepted. An example for this is shown in Example 3 where the teacher explains a task asking the learners to research the ingredients of various products to investigate algae components. During the following group work the competences W2, "Aus unterschiedlichen Medien und Quellen fachspezifische Informationen entnehmen [Extract subject-specific information from different media and sources]" as well as E4, "Untersuchungen oder Experimente zu naturwissenschaftlichen Fragestellungen planen, durchführen und protokollieren [Plan, carry out and record investigations or experiments dealing with scientific questions]" (BMBWF 2018) were realised.

Example 3. *Instructions for investigation practising competences W2 & E4 (L5).*

01 T: yeah research first. so usually you have- we have- if you have a look at the list of ingredients at the back of any product we won't find algae in most cases. so there's other substances which erm are produced by algae and in the first step you are allowed to use your mobile phones then. and research- do some research on that. so what are typical substances that are produced by algae. write them down. because this will make it easier in the next step to find out whether you know some ingredients erm are included erm [...

Moreover, passages were only coded as competences if they were student-realised or co-constructed with a teacher. This decision stems from the fact that the competences in the competence model describe actions the students are able to perform and thus depend on student engagement. While there were passages were the teacher modelled certain competences, they were not coded. Similarly, passages of students only reading aloud were not coded unless they engaged to some extent with the recited information.

After coding for the competences, the compatibility with the CDF construct was investigated by noting down every CDF that occur within the segment of each occurring competence. Through this process frequently occurring patterns could be identified.

5.4.3. Overview of codes

To summarise, Table 13 gives a clear overview of all the possible codes used during the coding process.

Table 13. *Overview of all codes with explanations adapted from Brückl (2016: 53) & Dobner (2020: 58-59).*

	CDF types
	CL – CLASSIFY
CL	classification exclusively or partially realised in English
Cle	embedded classification
CLG	classification performed in German
CLGe	embedded classification performed in German
	DF – DEFINE
DF	definition exclusively or partially realised in English
DFe	embedded definition
DFG	definition performed in German
DFGe	embedded definition performed in German
DFt	translation
DFte	embedded translation
	DS – DESCRIBE
DS	description exclusively or partially realised in English
DSe	embedded description
DSG	description performed in German
DSGe	embedded description performed in German
	EV – EVALUATE
EV	evaluation exclusively or partially realised in English
EVe	embedded evaluation
EVG	evaluation performed in German
EVGe	embedded evaluation performed in German
	EA – EXPLAIN
EA	explanation exclusively or partially realised in English
EAe	embedded explanation
EAG	explanation performed in German
EAGe	embedded explanation performed in German
	EO – EXPLORE
EO	exploration exclusively or partially realised in English
EOe	embedded exploration
EOG	exploration performed in German
EOGe	embedded exploration performed in German
	RE – REPORT
RE	report exclusively or partially realised in English
REe	embedded report
REG	report performed in German
REGe	embedded report performed in German
	REALISERS
T	teacher
S	student
TS	teacher-student
	COMPETENCES
W1, W2, W3, W4, W5	competences 1-5 from W-dimension (reproduction c.)

E1, E2, E3, E4, E5	competences 1-5 from E-dimension (empirical c.)
S1, S2, S3, S4, S5	competences 1-5 from S-dimension (evaluation c.)

A fully coded CDF passage is provided in Example 4. The whole passage is coded as REPORT as the class is revising last lesson's content. There are several other CDFs embedded, such as an explanation of the reasons for mitosis and a description of the different stages of this phenomenon. Moreover, the whole passage can be seen as adhering to competence W1 (5.4.2) as the teacher and students are describing and naming biological phenomena.

Example 4. *Fully coded CDF passage including competences (L4).*

01	T: nice to see you, too. let's revise the process of cell division, cell cycle and mitosis.	RE – **TS**	W1
	so why do we need mitosis? yes?	EA - **TS**	
02	Sxf: reproduction? reproduction?		
03	T: reproduction. asexual reproduction. yeah?		
04	Sxf: cell replacement.		
05	T: cell replacement. very good.		
06	Sxm: and growth?		
07	T: growth. very good. and?		
08	Sxf: I wanted to say that.		
09	T: okay. so. let's take a look at the cell cycle itself. can you name me the three stages of the cell cycle? yes.	DS - **TS**	
10	Sxf: mitosis.		
11	T: so let's start with the first one.		
12	Sxf: interphase.		
13	T: interphase. it always starts with interphase the longest stage.		
14	Sxf: mitosis and cytokinesis.		
15	T: cytokinesis. very good.		
	and now let's take a close look again at mitosis. name three- three or four? stages.	DS - **TS**	
16	{Sx sneezes and T and SS wish them bless you}		
17	Sm1: it starts with prophase, then goes into metaphase, then anaphase and ends with telophase which is kind of already cytokinesis=		
18	T: =simultaneously happening. very good.		
	and what is the result? yes?	EA - **TS**	
19	Sxf: a replicate of the first like cell.		
20	T: yes. so we have=		
21	Sxf: =two cells.		

After having discussed the CDF construct in detail (4) as well as having presented the full coding framework including considerations and modifications to ensure valid results (5.4), the following section will present the findings of the study.

6. Results and interpretation

In this chapter, the results of the conducted analysis will be presented.

6.1. Frequencies and occurrences of CDF types

This section covers the quantitative analysis of the CDFs and answers the second research question “How frequently do the individual CDFs occur during the lessons?”.

In total, 249 minutes of audio were recorded and transcribed which results in an average of 42 minutes per lesson. Within the recorded data, a total number of 440 CDFs were identified and coded. Deduction of the 61 realisations that occurred completely in German leaves 379 fully or partly English-realised CDFs. This equates to an average of 63 CDFs per lesson or approximately 1.5 realisations per recorded minute, a number which is in accordance with the calculated average presented by Dalton-Puffer et al. (2018: 15) which takes into account five different studies. The overall occurrences of CDF types across these studies complemented with data from Dobner (2020) and the present study (highlighted in grey) can be seen in Table 14.

Table 14*. Overall occurrence of CDFs across studies adapted from Dalton-Puffer et al. (2018: 15) & Dobner (2020: 60) and complemented with the data from the present study.*

Study/subject	1 physics	2 biology (2015)	3 econ	4 history	5 EFL	6 maths	7 biology (2023)
Lessons	6	8	6	8	8	7	6
Total CDFs	504	619	480	265 (SS only)	481	486	379
CDFs/lessons	84	77	80	33 (only SS)	60	69	63

The overview in Table 14 shows that the results of this study (63 CDFs/lesson) are within the scope of previous research (60-84 CDFs/lesson). The slightly lower number of CDFs per lesson compared with the other CLIL subjects could result from the shorter average length of the recorded lessons due to administration of COVID tests at the beginning of some lessons or because German-realised CDFs were omitted from the data, which was not the case, for example, in Dobner’s (2020) study.

Regarding the overall distribution of the CDF types throughout the data, it can be said that the CDFs are unevenly distributed (Figure 13).

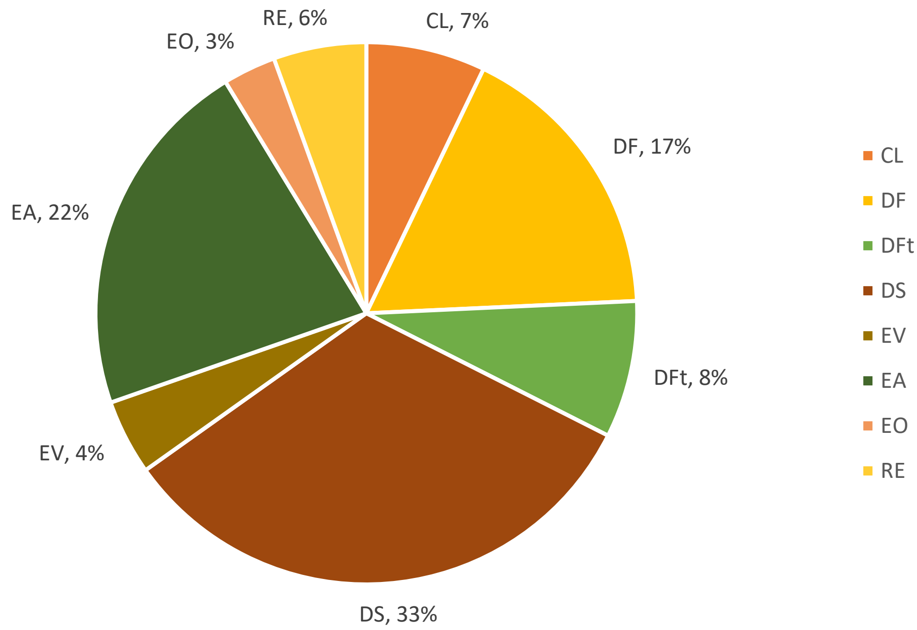

***Figure 13**. Overall occurrence of CDFs.*

As can be seen in the graph, some CDF types are more frequently realised than others. The most frequent CDF type is DESCRIBE followed by EXPLAIN and DEFINE. Together these three CDF types make up nearly two thirds of all CDFs. These findings correspond with previous work as Kröss (2014), Hofmann and Hopf (2015) and Bauer-Marschallinger (2016) also found DESCRIBE to be the most frequent CDF. The fact that descriptions are this prominent not only in science education, but also in Bauer-Marschallinger's (2016) research on history lessons is unsurprising as "DESCRIBE almost seems to be a defining characteristic of the communicative setting of the 'lesson'" (Dalton-Puffer et al. 2018: 17). The nature of this CDF is to create a common base of knowledge by sharing one's perceptions of objects, processes or phaenomena, and on this established common ground one can add further knowledge. Therefore, it is difficult to imagine lessons without descriptions as learning would be impaired without the establishing of common ground. Also the high frequency of EXPLAIN and DEFINE is unsurprising in the context of previous works (cf. Dalton-Puffer et al. 2018: 17).

Other interesting insights can be gained by comparing the present data with Hofmann and Hopf's (2015) study as they both focus on the CLIL biology classroom. The three most frequent CDFs are the same but in a different order. In the present study DESCRIBE (33%), EXPLAIN (22%) and DEFINE (17%) were most frequent. While these three CDFs are also the most frequent in Hofmann and Hopf's (2015: 82) results, the ranking was slightly different:

DESCRIBE (21%), DEFINE (19%) and EXPLAIN (17%). Nevertheless, this consensus underlines the prominence of these cognitive functions in biology education. Dalton-Puffer et al. (2018: 17-18) argue that this status of DEFINE in the CLIL context can be attributed to the use of the target language as this requires the learners to form links between the meaning of concepts in their L1 to the meanings of words in the new language. Therefore, new words are often introduced through definitions in the target language which also often prompts a translation into the L1.

While the above-mentioned CDF types constitute most of the CDF occurrences within the data, the other four CDF types and DEFINE-TRANSLATION occur significantly less often with all their relative frequencies below 10 percent. The least frequent CDF type is EXPLORE which only covers 3 percent of CDF realisations, followed by EVALUATE, REPORT, CLASSIFY and DEFINE-TRANSLATION. Again there is some agreement with Hofmann and Hopf (2015) regarding the least frequent functions. Both studies found EVALUATE, REPORT and CLASSIFY among the least frequent CDFs. However, while in the present study EXPLORE is the CDF that occurred least, it was rather frequent in the previous analysis where it even occurred as often as EXPLAIN (Hofmann & Hopf 2015). The low frequency of EVALUATE in both studies, however, was expected as hard sciences do not leave as much room for subjective views as, for example, humanities.

Furthermore, while the present data shows an uneven distribution with three types making up most of the realisations, Hofmann and Hopf's data is "rather evenly distributed" (2015: 82) with most CDFs ranging between 21 and 12 percent with EVALUATE (5%) and REPORT (9%) being exceptions.

To provide a more balanced overview of the data, Table 15 presents the CDF distribution across the six lessons:

Table 15. *Distribution of CDFs across lessons (L1 to L6).*

	L1	L2	L3	L4	L5	L6	TOTALS
CL	2	1	2	3	8	11	27
DF	4	10	15	6	17	13	65
DFt	4	3	1	2	7	14	31
DS	15	19	27	27	21	15	124
EV	4	1	2	6	3	1	17
EA	11	13	12	24	11	11	82
EO	3	1	2	5	1	0	12
RE	3	3	2	1	2	10	21
TOTALS	46	51	63	74	70	75	379

While most lessons still have the same three most frequent CDF types as established in the overall distribution, some of the less frequent CDF types are more prominently represented in individual lessons. For example, while CLASSIFY only comprises 7 percent of overall CDFs, in L5 and L6 it is more frequent with 11.4 and 14.7 percent respectively. Similarly, L4 includes twice as many instances as the overall score of EVALUATE (8.1%) and the same percentage of DEFINE, which normally belongs to the most frequent CDFs. Only one CDF type, namely EXPLORE, is so infrequently realised that no occurrence was found at all in L6.

Another figure that stands out are the 10 instances (13.3%) of REPORT in L6. On REPORT, it must be mentioned that the numbers both overall and in terms of the distribution across lessons do not justly depict this CDF type. The numbers suggest that REPORT only plays a subordinate role in biology classroom discourse except for L6. However, this CDF occupies more space in biology lessons than it appears as it is often realised in long turns as monologues in the form of extensive oral presentations (e.g., L5, L6) or longer oral revisions of previous content (e.g., L1, L2). Therefore, instances of REPORT have a more prominent part than the numbers might suggest (more in section 6.2.7).

In conclusion, the overall frequency of CDFs is comparable to previous research with DESCRIBE, EXPLAIN and DEFINE being the most frequent CDFs in the biology classroom due to their relevance for establishing common ground and connecting to previous knowledge. The CDFs are unevenly distributed with the most frequent ones making up most of all CDF occurrences. Deviations from this overall tendency are found in the individual lessons where some of the least frequent CDFs play bigger roles (e.g., REPORT in L6).

6.2. Qualitative analysis of CDF types

The next subsections of this thesis aim to provide an in-depth understanding of the CDF types by considering not only the frequencies but also qualitative aspects such as how the CDF types are realised. This analysis investigates and answers the third research questions dealing with the lexico-grammatical realisation of the CDFs.

6.2.1. CLASSIFY

As can be seen in Figure 13 above, CLASSIFY belongs to the less frequent CDFs in the recorded lessons. However, especially L5 and L6 displayed a considerable number of instances. Table 16 shows the distribution of verbalisations of CLASSIFY across realisers.

Table 16. *Realisers of CLASSIFY.*

Realisers	Frequency	Percentage
T	8	29,6%
S	15	55,6%
TS	4	14,8%
TOTAL	**27**	**100%**

Interestingly, more than half of the realisations of CLASSIFY were conducted by students on their own. This can be explained by the fact, that L5 and L6 included extensive oral presentations held by two students in each lesson. These presentations included several instances of classifications to clarify and define the presented topics as well as giving examples of class members. These uses are in accordance with the purposes of classifications suggested by Hofmann and Hopf (2015: 121): structuring, defining and exemplifying.

Example 1*. Specific to general classifications.*

a) Sf: downy mildew and the late blight of potato **are part of** the oomycetes.
b) NS: like a potato exactly. that is a good **example of** starch.

Examples 1a and 1b illustrate classifications from specific to general (Widdowson et al. 1979a: 75). Example 1a is an example for the classic *X is a member of Y* structure of classifications. In Example 1b, the native speaker classifies potatoes as examples of starch.

Examples for the other direction of classifications according to Widdowson et al. (1979a: 75) from general to specific are given in Examples 2a and 2b:

Example 2. *General to specific classifications.*

a) Sf1: today there are more than 60 thousand different protists all over the world. which are **divided into** three groups. can anyone remember how these groups are called? perhaps this image can help you? yeah?
Sf2: there are the animal-like protists, then the plant-like and the fungi-like.

b) T: okay and we talked about we have **two types of** neurons.
Sf: there are sensory neurons <L1de> von der haut ins gehirn.
T: zum beispiel ja.
Sf: und dann haben wir die </L1de> motor neurons <L1de> und die gehen in die andere richtung.

Example 2a is from a student presentation where the presenter is asking the class to provide the different members of protists: animal-like, plant-like and fungi-like. She does not use the rather formal suggested phrase *X comprises of Y & Z* that Widdowson et al. (1979a: 75) use in their conceptualisation of classifying, but rather the more student-friendly expression of dividing the overarching group (protists) into three subgroups (animal-like, plant-like, fungi-like). The other example (2b) is co-constructed by the teacher and a student during an oral revision of previously discussed content. The teacher asks for two types of neurons (class) which the student provides with information on how they differ from each other. Overall, these two examples show classifications that fulfil not only the primary purpose of ordering and structuring, but also of giving examples for certain phenomena.

Lastly, an instance for a classification by the teacher that serves to differentiate between different phenomena is given in Example 3.

Example 3. *Dividing classification.*

T: mitosis and meiosis **are different** cause of- because when mitosis is happening just body cells are created. hair. nails. skin. for the actual cells in our bodies and meiosis is just needed to create sperm cells in the boys and to create egg cells in the girls. **that is the main difference here.**

Example 3 fulfils another of Hofmann and Hopf's (2015: 121) types of purposes of classification, namely the purpose of dividing topics into various sections. In this instance, the teacher differentiates between the two types of cell divisions mitosis and meiosis. This division is important as meiosis (the new concept) includes stages that are similar to mitosis but cannot be labelled as mitosis, as one of the students wrongly tried, because different types of cells are involved in each process: body cells or sex cells. Linguistically, the teacher stresses the difference by using expressions like *are different cause of* and *that is the main difference*.

Concluding, while CLASSIFY is not the most frequent CDF type within the data, there are several circumstances in the biology classroom that require this discourse function, for example to express membership of a new concept to a superordinate group, to provide examples of a new concept or to divide a topic into several parts. For this purpose, structures like *a kind/type of*, *example of*, *X is a Y*, *can be divided into* are most frequently used.

6.2.2. DEFINE

With 17 percent, DEFINE is the third most frequent CDF type in the data. Table 17 indicates that it is most often verbalised by students (38,5%) or teachers (36,9%) in isolation with only a quarter of realisations produced collaboratively. The high number of student-realised occurrences can again be traced to the student presentations in L5 and L6.

Table 17. *Realisers of DEFINE.*

Realisers	Frequency	Percentage
T	24	36,9%
S	25	38,5%
TS	16	24,6%
TOTAL	**65**	**100,0%**

The high frequency of DEFINE in the data shows the importance of definitions in biology where many technical and semi-technical terms occur and therefore need to be defined to create a shared understanding of their meaning. One popular approach of creating this comprehension of subject-specific terms is by using synonyms or antonyms to connect the defined terms to common terminology, so called non-formal definitions (cf. 4.4.2).

Example 5*. Non-formal definitions.*

a) Sf: algae is a **synonym** for plant-like protists.
b) Sf: the **scientific name for** brown algae is phaeophyta.
c) Sm: Na+
NS: which is?
Sm: inside the cell membrane.
T: **another word for** Na.
Sm: <L1de> natrium </L1de>.
T: yeah that is true but in english.
NS: in english.
Sf: sodium.

Examples 5a-c present different types of non-formal definitions from the recordings. While Example 5a explicitly states that algae is a synonym for the defined term plant-like protist, 5b connects the everyday term brown algae to its scientific name and thus also provides a synonym. The last provided example for non-formal definitions, 5c, was collaboratively realised between the teacher, native speaker and two students. While describing a graph, the native speaker asks for a synonym of “Na+” from the student. At the teacher’s explicit prompt for “another word for Na” he resorts to a translation which is not accepted by the native speaker. The expected synonym is then provided by another student.

Another popular type of definition were semi-formal ones. This type includes information on the term to be defined as well as some information on differences, however, the class is not indicated, mostly because it is obvious and therefore redundant. Examples 6a-c provide instances of semi-formal definitions.

Example 6. *Semi-formal definitions.*

a) Sf: [oomycetes] have X branch cell filaments which are called hyphae.
b) Sf1: can anyone remember the difference between haploid and diploid? [Sf3].
Sf2: erm I’m not sure but diploid means that they contain sets of chromosomes and haploid means that they contain one set of chromosomes.
Sf1: that’s correct.
c) Sm: so in the first growth phase erm is when erm protein like gets created and it like comes to protein synthesis?
T: synthesis. yes exactly. and-
Sm: and also cytoplas- yeah cytoplasm increases.

All the examples in 6 leave out the class. For example, to expand 6a to a formal definition, one must add that oomycetes are fungi-like protists; however, this information is obvious as oomycetes are presented as an example for fungi-like protists. Similarly, in 6b-c the classes of organisms or phases of mitosis are implied by the context.

Even though the context often makes the mention of the class unnecessary, several formal definitions including the concept, class and characteristic could be found in the recordings (Examples 7a-c).

Example 7. *Formal definitions.*

a) Sf: parasites are living organisms which feed on the expense of other organisms.

b) T: so [meiosis] is again a type of cell division that is now what you knew, right? anyhow. it reduces the number of chromosomes in the parent cell by half. so at the end you just have a haploid number of chromosomes.

The definitions provided in Example 7 all serve the function of introducing a new key term or concept. These utterances include all the necessary information for a complete definition. While 7a already takes the form of Trimble's (1985: 76) equation of "Term = Class + Differences", 7b can easily be recast to fit this structure: "Meiosis is a type of cell division that reduces the number of chromosomes in the parent cell by half leaving a haploid number of chromosomes".

While many instances of simple definitions (formal, semi-formal and non-formal) could be found in the data, there was an apparent lack of complex definitions (Trimble 1985). However, the rarity of these types of definitions was to be expected as they usually occur in written contexts and require expert knowledge as well as the necessary language skills and many of the definitions were uttered by learners.

In conclusion, while many instances of DEFINE were found in the data, most of them did not adhere to a specific formal structure in their realisations. Non-formal definitions, for example, in most instances, did not state explicitly that they were providing a synonym. Semi-formal definitions used language such as *X means that* or *X is when.* Even though most formal definitions did not make use of Trimble's (1986: 76) proposed structure of "Term = Class + Differences", they could easily be recast to resemble this form. The explicit discussion of the structure of formal definitions or a collaborative recasting of students' definitions to resemble the canonical form, could improve learners' exam performances as definitions are often a part of biology exams.

6.2.2.1. DEFINE-TRANSLATION

DEFINE-TRANSLATION is treated as a subtype of definitions with its own code, and thus will be briefly discussed here. Overall, 31 instances of translations could be found in the data (8%). They are mostly performed by students or in collaboration between students and the teacher (Table 18).

Table 18. *Realisers of DEFINE-TRANSLATION.*

Realisers	Frequency	Percentage
T	8	25,8%
S	13	41,9%

TS	10	32,3%
TOTAL	**31**	**100,0%**

This rather low number of translations suggests a minor role of German in the observed biology lessons. However, it must be mentioned again that completely German CDFs were not included in this analysis. While T2 and T3 are trained Biology and English teachers, T1 who is only trained in Biology does not aim to use English only. The CLIL programme at T1's school aims to fulfil a fifty-fifty quota concerning the use of the L1 and target language. That and the fact that learners in L1 did not choose bilingual instruction is the reason for the rather extensive use of German in T1's lessons, especially in L1.

The translations found in the recordings can be divided into ones from English to German and ones from German to English. The former group is by far more extensive than the latter. Examples 8a-d show instances where English terms were translated into German by the teacher or the students to ensure comprehension.

***Example 8**. Translations from English to German.*

a) Sf: don't forget 2.1 billion is <L1de> 2,1 milliarde </L1de> in german.

b) Sf: in german they are called <L1de> geißeltierchen, wimperntierchen, wurzelfüßer und sporentierchen </L1de>.

c) T: what is fertiliser in german? <L1de> was wäre das auf Deutsch? </L1de> in agriculture erm you know the farmers rely on different types of fertilisers to make the plants grow better. so fertiliser ... [Sm2].
Sm: is like <L1de> dünger?
T: genau ein düngemittel </L1de> yeah. fertiliser <L1de> schreibts euch das vielleicht dazu </L1de> fertiliser erm <L1de> düngemittel </L1de>.

Taking a closer look at the examples above, 8a is an example for translations that serve a, what Hofmann and Hopf (2015: 140) call, contextual function, namely to "clarify the meaning, which has immediate relevance in the lesson". Moreover, this familiarised them with the German term, which the learners might need in their academic future. In contrast, 8b and 8c rather serve an associative function of trying to connect the new terms to previous knowledge by mentioning the German term.

***Example 9.** Translation from German to English.*

T: <L1de> der lebensraum ist auf englisch. der lebensraum... haben wir jetzt schon öfter gehabt. ist? </L1de> [Sm1].
Sm: the habitat.

T: habitat yeah. the habitat.

Example 9 shows the only verbalization of a translation from German to English. In this instance, the teacher reacts to the wrong word choice made by one of the student presenters (cf. competence function, Hofmann & Hopf 2015: 141).

This illustration of the uses of translation in the data shows that while translations are relatively rare in the recorded lessons, they do occur and serve various functions, such as connecting new terms to previous knowledge and preventing immediate comprehension problems.

6.2.3. DESCRIBE

As previously stated, DESCRIBE is the most frequent CDF type with 124 total occurrences, which amounts to 33 percent. Table 19 indicates that this CDF type is produced most often in collaboration between the teacher and one or more students.

Table 19*. Realisers of DESCRIBE.*

Realisers	Frequency	Percentage
T	36	29,0%
S	34	27,4%
TS	54	43,5%
TOTAL	**124**	**100,0%**

In the data, all four of the previously discussed types of DESCRIBE, physical, structural, functional and process descriptions, are included (cf. Trimble 1985, 4.4.3). The strong presence of DESCRIBE shows the high relevance of descriptions in the biology classroom. Due to the high number of DESCRIBE verbalisations, only a select few, which were chosen to be as representative as possible of the data, can be included in this analysis.

Firstly, Example 10 present physical descriptions which were mostly used to refer to visual representations that everyone in the room can see. This makes sense as biology lessons tend to make considerable use of graphs, figures and pictures. For describing the features of these visuals, demonstrative pronouns (*this, these*), adverbs (*here, there*) or phrases referring to the visible features of a picture, for example, *at the end we have*, *on the diagram*, *you can see*, *we have got* or *a visual representation of* are used.

***Example 10**. Physical descriptions.*

a) Sf: in **this** picture you can see an infected potato.

b) T: okay **at the end we have** the=
S2: =axon terminals.
T: axon terminals.

c) T: so again **here** are the homologous chromosomes.

d) Sm: **on the diagram** the K+ is inside. the white things. and outside the natrium plus or sodium- sodium plus the black.

Secondly, Example 11 illustrates structural descriptions, referring to relationships between whole objects and their parts.

***Example 11.** Structural descriptions.*

a) Sf1: the **structure of** erm an algae cell is- **first there are** folded outer membrane that are also called (pellisaw)- pellicle- pellicle. and it **contains** erm a nucleus and in the nucleus also a nucleolus, this is the red-brown spot **in the middle**. there are also chloroplasts that **contain** the chlorophyll that colours them green. and the other green parts that you can see on the picture is the cytoplasm that fills the cell. the blue dot is the contractile vacuole that contains water in the cell. and they- most of them also have a flagellum that is used for movement.

b) T: <L1de> welche richtung fließt jetzt der strom wenn strom fließt?
Sf2: from-
T: <L1de> so oder so?
Sf2: so rum </L1de>.
T: okay. from the cell body to the axon terminals.

In Example 11a, a student provides a structural description of an alga cell by describing the individual parts of the cell. She uses phrases like *structure of*, *there are* and *contains* to make clear the structure of and the relationship between the parts of the cell. The second example (11b) discusses the direction in which electric stimuli travel through a neuron by mentioning parts of the neuron (cell body to axon terminals). The knowledge of the structure of neurons is essential to understand how the nervous system works as a whole.

The data also revealed several functional descriptions (Example 12) that specify the function of objects or processes. While the teacher in 12a, does not use the proposed structure (Lackner 2012: 53, see 4.4.3) or any explicit markers that make obvious the connection to the function, it is still clear that insulating the axon of a neuron is the function of myelin.

Example 12. *Functional descriptions.*

a) T: okay. myelin is insulation. insulation for the X.

b) T: and how do we call these components within algae that are responsible for their colour? not only in algae but also in plants in general. yeah?
Sm: so in german it's <L1de> pigmente </L1de> and in english pigments?
T: it's pigments. yeah. it's basically the same. so the pigments are responsible for the colour.

Example 12b, on the other hand, is more explicit in its purpose and uses the proposed structure of "whole/part (pigments) is/are responsible for function (colour of algae)".

Lastly, Example 13 presents some examples of process descriptions. Process descriptions were mostly realised by teachers with only one occurrence of student involvement (13a) found within the data.

Example 13. *Process descriptions.*

a) T: name three- three or four? stages.
Sm1: it **starts with** prophase, **then** goes into metaphase, **then** anaphase and **ends with** telophase which is kind of already cytokinesis=
T: =simultaneously happening.

b) T: we have the resting potential at **number one**. we have at **number two** the depolarisation. the sodium ions rush in. yeah? we have the erm potassium, the next thing the repolarisation the potassium rush out. and then we have <L1de> diesen kleinen schlenkerer haben wir gesagt. diese hyperpolarisation </L1de>. and number four is the pump. the reset.

As can be seen in 13a, process descriptions tend to make the different stages of the process visible by using simple sequence markers, such as *starts, then* and *ends* or simply numbering the different steps and using *and* as simple coordinating conjunction as can be seen in 13b.

Summarising, most instances of DESCRIBE did not follow a fixed structure. However, the use of demonstrative pronouns, adverbs and phrases for referring to visible features, pointing out parts of a structure and highlighting the sequence of processes could be found.

6.2.4. EVALUATE

As established above, EVALUATE is one of the rarest CDF types with only 17 overall realisations amounting to 4% of the data. This CDF type is predominantly realised by teachers (Table 20). This could be because the realisation of EVALUATE is rather demanding: not only must there be a judgement but also a basis that supports the evaluation (cf. see 4.4.4).

Table 20. *Realisers of EVALUATE.*

Realisers	Frequency	Percentage
T	11	64,7%
S	5	29,4%
TS	1	5,9%
TOTAL	**17**	**100,0%**

In Example 14, instances of evaluations from the recordings are presented. 14a is a student evaluation of laver as the most important food alga and supports this evaluation with the fact that in Japan alone a huge amount of these algae are farmed. Though the student does not use a causal marker to explain her reasoning, it is clear the second sentence is in support of her claim. In 14b the teacher judges the meiosis process as more difficult compared to the previously discussed process of mitosis and supports this claim with the reasoning that meiosis has more stages and is therefore more complex.

Example 14. *Evaluations with supporting details.*

a) Sf: laver (porphyra) is the **most important** commercial food alga. in japan alone approximately 100.000 hectares (247.000 acres) of shallow bays and seas are farmed.

b) T: it’s a bit **more complex**. so the whole process is meiosis. that creates four daughter cells. but it’s a bit more complicated **because** you can divide meiosis into two phases.

c) Sf1: okay. </L1de> but- but **I think** it’s prophase 1.
Sf2: why?
Sf1: **because** there is only one and prophase 2 there must be two.

The student-realised occurrences of EVALUATE in the data mostly occurred during a group work in L4. The students examined different pictures of stages of meiosis, identified them and gave reasons for why they think this picture shows the respective stage. These instances show a similarity to CLASSIFY; however, it was decided to code them as EVALUATE if the learners used markers for giving their subjective opinion, such as *I think* and gave causal support of their opinion (*because*) as can be seen in 14c. This decision was made because the subjectivity in these instances is a key feature of EVALUATE that distinguishes it from other CDF types that are based on objectiveness.

The frequency or lack thereof of EVALUATE in the data is probably at least to an extent influenced by the subject matter of the lessons. Biology, as a hard science, has certain subjects that do not leave much space for expressing evaluations and judgements, such as natural processes like mitosis, meiosis, photosynthesis. However, more opportunities for this type of discourse function can be found with topics, such as genetics, for example in evaluating the use of genetic screening of embryos or genetically modifying food crops.

In conclusion, EVALUATE rarely occurred in the data. In the few instances, the causal support for the given judgement is usually presented with the causal marker *because*. However, there was also an instance where no causal marker was used, but rather the context indicates the supporting evidence for the reasoning. Moreover, most instances did not include any indication of subjectivity, such as *I think* or *in my opinion*.

6.2.5. EXPLAIN

EXPLAIN, with 82 overall occurrences (22%), is the second most frequent CDF type in the analysed lessons. Most realisations were performed by the teacher (42,7%), followed by student realisations (30,5%) and about a quarter of the occurrences were co-constructed (Table 21).

Table 21. *Realisers of EXPLAIN.*

Realisers	Frequency	Percentage
T	35	42,7%
S	25	30,5%
TS	22	26,8%
TOTAL	**82**	**100,0%**

The importance of the logical reasoning that is inherent to EXPLAIN in the biology classroom can be seen in the high number of realisations within the observed lessons. As discussed in the theory (4.4.5), explanations are often introduced by the question word *why* and can occur in two forms, explanation of causality or consequence, which differ in their use of conjunctions.

Cxplanations of causality use conjunctions, such as *because, as, since, the reason is* or *is caused by* (Hofmann & Hopf 2015). Not all of these conjunctions were found in the data, but examples are given in Example 15.

Example 15. *Explanations of causality.*

a) T: no, we start off with 92 **because of** the replication.
b) Sm: erm. label- erm <L1de> nein </L1de>. <reading aloud> what are the **two reasons** the ions will permeate through the cell membrane? </reading aloud>

erm I only got one. and that the flow is always going from high to low concentration.
T: and **the second reason is** the?
Sm: difference in charge?
T: yes of course. of course. the charge.

The most common conjunction to give reasons for a phenomenon was *because* (Example 15a). In Example 15b, the class is comparing a task that asks the learners to give reasons for why ions can permeate the cell membrane. The learner does not explicitly use the above-suggested phrase *the reason is* but rather just answers the question. For the second reason, the teacher provides the conjunction *the second reason is* prompting the student again to provide only the reason without using any specific lexico-syntactical structure himself.

The second type of EXPLAIN, explanations of consequence, uses structures such as *therefore, so (that), if*-clauses, *for this reason, consequently, that's why, the ... the ...* and *causes/makes* (Hofmann & Hopf 2015). Again the data does not include all these phrases, but some examples are given below (Example 16).

Example 16. *Explanations of consequence.*

a) Sf: plant-like protists contain chlorophyll. **therefore** they con- therefore they synthesise like plants.
b) Sf: brown algae are autotrophic **so** they feed on photosynthesis.
c) T: but then afterwards another division is happening and **that is why** we receive four daughter cells.
d) NS: okay so it will die **if** it doesn't have enough light, it can't photosynthesis again.
e) Sf: they **cause** a variety of plant diseases. for example, the fungus that **was caused by** the potato famine in irland in the 19th century.

As the name suggests, all the examples in Example 16a-e provide a consequence of something. In 16a the consequence of plant-like protists containing chlorophyll is that they behave like plants and the consequence of brown algae being autotrophic is that they can perform photosynthesis (16b). The consequential relationship in 16a-c is syntactically realised by giving the phenomenon followed by one of the mentioned conjunctions and the consequence. 16d is a bit different. In 16d an *if-clause* is used to make clear the logical reasoning of a plant not being able to do? photosynthesis without enough light.

Example 16e provides a case of explanation whose classification is not as clear-cut as the prior examples. The first sentence is an explanation of consequence using the structure *to cause*. However, while the second sentence uses the structure *caused by* which indicates an explanation of causality, the content of the sentence is incorrect and should be "the fungus that *caused* the potato famine" (explanation of consequence) or "the potato famine *was caused by* the fungus" (explanations of causality). This example of imprecise use of the conjunctions suggests that some explicit teaching of lexico-grammatical structures could benefit the learner in correctly vocalising this important CDF type.

In conclusion, EXPLAIN is the second most frequent CDF type found in the analysis with many instances of causality as well as explanations of consequence. Regarding their linguistic realisation, a wide variety of markers for causality (e.g., *because, the reason is*) and consequence (e.g., *therefore, so, that is why, if, the x the y, cause, was caused by*) were found. That and the high frequency of this CDF type indicate that learners are used to performing explanations in the biology classroom. However, wrong applications of causal markers show that more teaching could be necessary.

6.2.6. EXPLORE

The rarest CDF type in the present data is EXPLORE with only 12 overall occurrences equating to 3 percent of the data. This CDF types was most often realised by students on their own; however, due to the generally low number of EXPLORE this difference is not significant (see Table 22).

Table 22. *Realisers of EXPLORE.*

Realisers	Frequency	Percentage
T	4	33,3%
S	5	41,7%
TS	3	25,0%
TOTAL	**12**	**100,0%**

The data included several ways in which EXPLORE was expressed by the students, the teacher and in collaboration. Example 17 provides an overview.

Example 17. *Realisations of EXPLORE.*

a) Sm: and then you need like a new parent cell and if the body has like- doesn't have any parent cells anymore **do they produce new ones with like mitosis?**
T: yeah. yeah.

b) T: yeah like like **let's imagine** like I am a microtubule and you are a chocolate, piece of chocolate. so I'm naturally drawn to you. so this is like a good example of explaining how microtubules move towards the chromosomes and attach to them.

c) Sm: this **could** be metaphase 1. but also metaphase 2. we don't have any X yet. so it **could** both be 2 but also 1.

d) NS: what is the three things that is **probably** not right with this plant. can you guys list the things?
Sf: light.
T: **should** have enough light here. but **maybe**.
NS: yeah what what what are the three things when you have a plant at home and it's dying on you or it doesn't look very good or it's barley alive. there are always three factors that you can adjust to maybe help your plant survive and look good.
T: what can you do? [Sm]? [...]

In Example 17a, a student makes an educated guess based on prior knowledge about the topic of cell division indicating uncertainty by casting it as a question. This type of EXPLORE is one of the more common ones (cf. Hofmann & Hopf 2015) as it does not need any complex structure to express possibility like any suggested lexico-grammatical structures by Dalton-Puffer (2007: 160-161, 4.4.6). The teacher triggers an instance of EXPLORE in 17b using the phrase *let's imagine* to highlight the following statements as hypothetical. 17c was realised in the context of pair work were learners had to match stages of meiosis with pictures of these stages. The learners use the modal verb "could" to indicate that he is unsure and only guessing even though he provides some justification for why he thinks it is metaphase. A longer episode of EXPLORE is given in 17d. Here the native speaker and teacher prompt the learners to speculate about the reasons for the bad state of the plant in the classroom. Throughout the episode, the modal verbs *should* and adverbs *maybe* and *probably* are used to indicate the probability of the statements. In this co-constructed episode, the teacher prompts the learners to explore as well as reacts to them by validating them or prompting further explorations.

Even though EXPLORE seems to be rare in CLIL biology classrooms (cf. Hofmann & Hopf 2015), it does occur especially when experiments are conducted, and hypotheses are formulated and tested. However, the present data did not include any experiments therefore lacking information on this part of EXPLORE.

In conclusion, the number of EXPLORE within the data is so low, that no relevant statements can be made on common linguistic structures. The few instances were either realised as statements with rising intonation to indicate uncertainty or made use of modal verbs (*could, should*) and adverbs (*maybe, probably*) to express possibility. The question arises whether more explicit instruction of linguistic phrases and structures, would lower the inhibition threshold for the use of these functions.

6.2.7. REPORT

The last CDF type that needs to be discussed is REPORT. Overall, 21 occurrences of this CDF could be found in the data which equates to 6 percent. Most of the instances were co-realised between the teacher and one or more students (Table 23).

Table 23. *Realisers of REPORT.*

Realisers	Frequency	Percentage
T	5	23,8%
S	2	9,5%
TS	14	66,7%
TOTAL	**21**	**100,00%**

First, though REPORT does not occur that often in absolute numbers, some of the episodes are very extensive. As discussed in the theory, the most common types of reports in the classroom are teacher monologues, student's summarising (results of) activities and extended oral presentations (Dalton-Puffer 2016). All three of these types were found in the data. Especially, the oral presentations conducted at the beginning of L5 and L6 are extensive in nature and solely realised by students; each lasted for five minutes and were coded as one instant of REPORT. This illustrates the difficulty of quantifying this CDF type. Example 18a shows the beginning and end of such an oral presentation. Both presentations displayed clear signposting of the beginning, which included a greeting, the introduction of the topic and a short overview of the presentation, and the ending.

Example 18*. Realisations of REPORT.*

a) Sf1: **good morning,** everyone. today we **want to present** the fungus-like protists. **here's a short overview** of our presentations. **first** we explain what protists are. **then** we describe animal-like protists and plant-like protists in short. and **in the end** we want to focus on fungus-like protists. [...]

Sf2: [...] **that brings us to the end** of our presentation. here you can see our sources. **thank you** for your attention. are there any questions?

b) Sm2: em we had the whipped cream.
T: yeah.
Sm2: <L1de> schlagobers </L1de>.
T: yeah. cream.
Sm2: and the product also also included carrageen.
T: yeah so we have cream. and we have the same component.

c) T: the first one is erm that it is a source of food for almost all marine wild life. so this is the first thing. if we **sum up** the text this is the first important role that algae play in an ecosystem. <L1de> also das ist die erste wichtige funktion von algen in einem ökosystem </L1de>. erm so the function as food erm so as food source for different other species. erm **this is the first part**. and the **second part** if we try to see the bigger picture is that they produce oxygen and you know scientists are not absolutely sure about the amount of oxygen but numbers reach from 73 up to 87 percent of oxygen for the planet.

Example 18b describes an episode where students report on the results of a group work where they had to research the ingredients of different products to see if they included some type of algae. In Example 18c, the teacher summarises a text that was read and reports on the most important insights to ensure students' understanding. Another type of report that occurred within the data were revisions of previously covered content at the beginning of a lesson. These happened in three out of six lessons and usually were co-constructed episodes between the teacher asking questions and one student answering them.

Lastly, though the absolute numbers of REPORT were low, this CDF was rather prominently featured in the data due to the extended length of its episodes. Regarding the language used, the oral presentations included explicit signposting. As REPORT episodes included a multitude of other CDF types, the language used to express those is also found in this CDF type.

In conclusion, this section reported on the results of the lexico-grammatical realisation of all the CDF types individually and therefore answered the third research question "How are the individual CDFs usually realised in terms of lexico-grammar?". Though learners make use of a wide variety of linguistic structures to realise the seven CDF types, there is still potential for more explicit instruction on phrases and structures to ensure a more precise language in the execution of cognitive acts in the CLIL biology classroom. The next section analyses the competence model for natural sciences and how the competences overlap with the CDF types.

6.3. Competences of natural sciences in practice

The following sections provide an overview of the three competences of action, which are outlined in the competence model (3.3), within the collected data and highlights the connections between these competences with the CDF types used to perform them.

Figure 14 tries to quantify the three competence types throughout the data. As can be seen, the *reproduction competence* is by far the most performed of the three competences as about three quarters of all recorded competences were this type. However, quantifying the competences is difficult because they often stretch over extensive episodes (e.g., reading and discussing a technical text) or cannot be observed with the data collected (e.g., students read a text silently and answer questions). Therefore, Figure 14 is not as relevant as the qualitative analysis of the competences that follows.

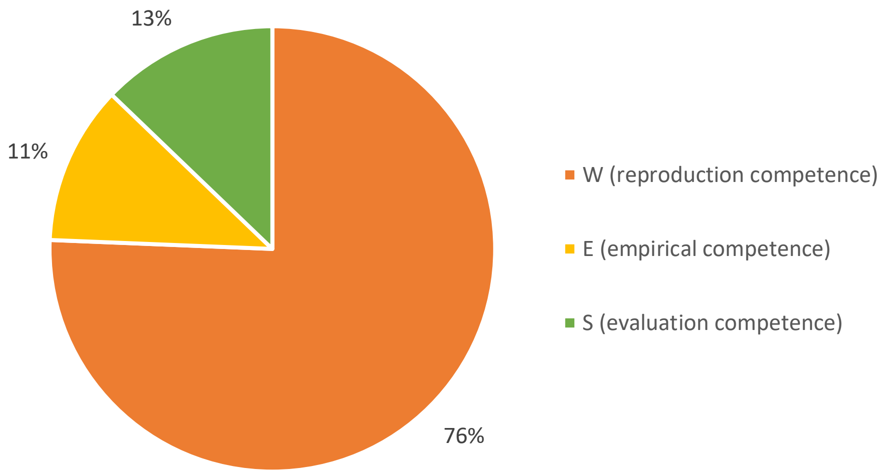

Figure 14. *Relative distribution of competences.*

6.3.1. Overview: Connections between scientific competences and CDFs

The following section gives an overview of the connections that can be found between the competences for natural sciences and the different CDF types. Figure 15 provides a colour-coded visual representation of the connections and their intensity in the form of a heat map. The shade of the colour in the fields indicates the intensity of the co-occurrence with darker shades signalling a more frequent connection than lighter shades. The bottom row provides an overview of the possible shades. Blank fields signify that no connection between the given competence and CDF was found.

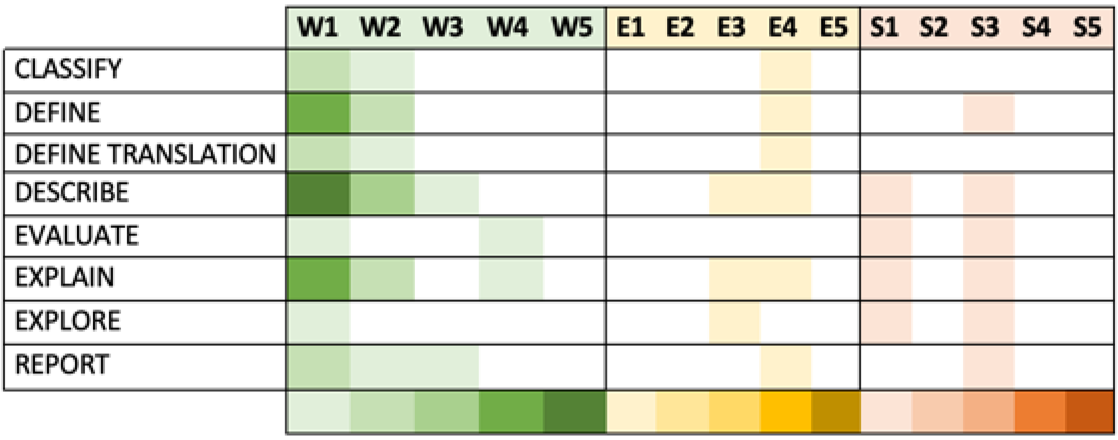

Figure 15. *Interrelation of scientific competences and CDFs.*

Overall, the most dominant competence was the *reproduction competence*. Not only is it the most frequent competence in absolute numbers, but it is also realised with the greatest variety of CDF types. Throughout the five sub-competences, all seven CDF types occurred while W1 was the only sub-competence that correlated with all the CDFs. The most frequent connections were found with DESCRIBE, EXPLAIN and DEFINE.

The most prominent CDFs are DESCRIBE and EXPLAIN, both being realised in connection with seven of the eight sub-competences that were produced overall. Thus, it can be said that these CDF types are most diversely connected to the competences. With regards to the strength of this connection, DESCRIBE shows the strongest relationship with the most cooccurrences. The least overlapping CDF types are CLASSIFY and DEFINE-TRANSLATION as both are restricted to only three sub-competences. Moreover, these two CDFs are the only CDFs that could not be found in correlation with *evaluation competence* at all.

Regarding the intensity of the correlation of competences and CDFs, significant differences could only be found for W1 and W2; where DESCRIBE has strongest connection with 53 overlaps with W1 and 24 with W2, EXPLAIN has 35 and 10 and DEFINE 33 and 10 respectively. On the other hand, EVALUATE and EXPLORE show the weakest connection with W1 with 5 and 4 overlaps, and DEFINE-TRANSLATION, CLASSIFY and REPORT overlap the least with W2 (2 or 3). For the rest of the sub-competences, the overlaps for all CDFs are between one and seven times and thus do not differ significantly from each other.

In conclusion, while not all sub-competences were performed, all CDF types occurred and their connection to the realisations of the competences could be shown. Therefore, the relevance and potential of deliberate use of CDFs to practise the required competences in the biology classroom can be assumed.

The next sections take a closer look at the three competence dimensions and how they were performed identifying the overlapping CDFs and their realisations.

6.3.2. *Reproduction competence* (W) in practice

As already discussed in section 3.3, *reproduction competence* is concerned with organising knowledge by extracting knowledge from different resources and communicating this information to others. Like the other two competences, it can be further divided into five sub-competences (W1 to W5, complete list in appendix).

Overall, *reproduction competence* is the most frequently realised competence within the data, and consequently, the most overlaps with CDFs were found for this competence. In more detail, all sub-competences except for W5 occurred in the data. While W1 is performed most often, followed by W2, there were only few instances of W3 and W4.

The most frequent sub-competence W1, which is concerned with describing and naming biological processes and phenomena, was performed throughout all lessons in different situations. For example, in T1's lessons, the students had to DESCRIBE the structures of the nerve cell or EXPLAIN the phenomenon of resting potential thus communicating their knowledge on these biological phenomena. Moreover, in the lessons by T2, students needed to EXPLAIN the reasons for and DESCRIBE the process of mitosis or name the cell organelles. Other examples of W1 are the oral student presentations about protists. Unsurprisingly, the most frequent CDF types that could be found connected to this competence are DESCRIBE, EXPLAIN and DEFINE. While DEFINE-TRANSLATION, CLASSIFY and REPORT could also be found moderately often in connection with W1, EXPLORE and EVALUATE only occurred sparsely with this competence. For a fully coded example of W1 with CDFs see Example 4 above.

The second most-frequent sub-competence W2 asks the learners to extract subject-specific information from different media and sources. This was done by learners writing down key words during their fellow students' presentations, researching information on the internet, reading technical texts or listening to teacher monologues. The beginning of a prompt for online research on algae components in products is given in Example 19.

Example 19. *Prompt for W2.*

> T: step one. analyse products to find out whether they contain algae or not. algae comes in many forms and its products are identified by different names. so you might want to do some online searches ...

This activity prompted the learners to DESCRIBE the ingredients of certain products, CLASSIFY and DEFINE algae components, and EXPLAIN the function of these algae components in the products. Again, all instances of W2 prompted the learners to mostly use the CDF types DESCRIBE, EXPLAIN and DEFINE. Unsurprisingly, no connections between W2 and EVALUATE EXPLORE was found.

The objective of W3 is to depict processes and phenomena in different forms (graph, table, picture, diagram, ...), explain and communicate them appropriately. Even though this competence was rare, some instances could be identified, for example, after researching algae ingredients, the learners had to report on their results and record them in a table assisted by their teacher. Moreover, T2 made her students do a sketch of the process of meiosis based on information on the process. Thus, the students rendered a written description into a sketch. Overall, the only connections of W3 to the CDF types were the just mentioned instances of DESCRIBE and REPORT. No other interrelations were found.

Only one instance of W4 was found where students had to explain processes and phenomena by means of specialised knowledge with reference to regularities (e.g., models, rules, laws, functional relationships). T1 elicited a scientific explanation for the difficulty of splitting water by drawing on the octet rule from the field of chemistry, thus utilising the learners' specialised knowledge of scientific rules and laws. This episode triggered an instance of EVALUATE, which admittedly was performed by the NS as she judged the question of T1 as good because it was related to chemistry. Moreover, the teacher collaborated with a student on explaining the mentioned phenomenon.

No instances of W5, explaining phenomena in the context of evolution, were found as the analysed lessons did not focus on evolution.

In their catalogue of operators for competence-oriented exam tasks, Reichstädter and Müllner (2021) give examples for operators belonging to CLASSIFY, DESCRIBE, EXPLAIN and REPORT that overlap with the W-dimension. Given the present results with their much greater variety of CDFs, this list must be seen as non-exhaustive. The authors acknowledge that their list mentions the primarily relevant operators but cannot cover all the possible combinations.

6.3.3. *Empirical competence* (E) in practice

Empirical competence deals with gaining scientific knowledge through scientific research processes, such as experiments but also observations. This includes formulating hypotheses and planning research designs as well as recording and interpreting their results (3.3). While *reproduction competence* can be found in most biology lessons due to their objectives overlapping with the inherent nature of education, acquiring and communicating knowledge, *empirical competence* is limited to specific activities in the classroom, such as conducting experiments and therefore occurs less frequently. In the analysed data, this competence was rare and only three of the five sub-competences could be identified (E1, E3, E4).

Firstly, E1 covers observing, measuring and describing biological processes and phenomena. There was only one occurrence in the data which was, however, completely realised in German; therefore, it was not coded for CDFs because only CDFs realised at least partially in English were considered in this analysis.

Secondly, E3 deals with asking questions and formulating hypotheses about biological processes and phenomena. Similarly to E1, this sub-competence occurred only once. In the context of determining limiting factors of photosynthesis, the NS and T1 elicited possible factors plants need to survive. Thus, the learners were asked to speculate and form hypothesis, in the non-technical sense (Dalton-Puffer 2016). The NS prompts an episode of EXPLORE by asking "what is the three things that is probably not right with this plant?" Within this episode the learners and teachers also used instances of DESCRIBE to determine the factors and EXPLAIN to establish the causal relationship between these factors and the plant's current state.

Lastly, L5 and L6 included a long episode that focused on E4, which asks the learners to plan, carry out and record investigations or experiments dealing with scientific questions). The learners carried out an online investigation on the different ingredients of food and cosmetic products to identify algae components and their functions. While the learners were given their research question, they had to carry out the investigation and document their results mostly performing instances of DEFINE, REPORT, EXPLAIN and DEFINE-TRANSLATION. However, also DESCRIBE and CLASSIFY were used. This indicates that this sub-competence requires a wide range of different cognitive functions. The only CDF types that were not found in connection to E4 are EVALUATE and EXPLORE which was to be expected due to the factual nature of the competence that leaves little room for speculations or opinions.

Once more, the present data expands the overlaps Reichstädter and Müllner (2021) propose of CLASSIFY and EVALUATE with the E-dimension as all the CDFs except EVALUATE were found in connection with *empirical competence.*

6.3.4. *Evaluation competence* (S) in practice

The *evaluation competence* is the most complex one and thus expected to be the least frequent competence. This competence requires the learners to evaluate results and facts from a scientific perspective and draw conclusions from them (3.3). They need to be able to argue using scientific reasoning and judge facts and issues based on scientific support. Based on these conclusions they should also be able to recommend courses of action, for example, for environmental issues.

Two different episodes of S1 were found in the lessons of T2 where learners needed to argue in a subject-specific and logical manner and distinguish scientific from non-scientific reasoning. Firstly, in L3 the teacher asked the learners to evaluate the length of interphase compared to the whole process of cell division based on the processes happening during each stage of mitosis. The learner argued that interphase needed to be the longest phase since it involved the duplication of the DNA and cell organelles. This reasoning can be seen as scientific as it uses scientific facts and processes as support. Moreover, learners were asked to identify the different stages of meiosis according to pictures. For this activity they again needed to provide reasons for their evaluations and thus had to draw on scientific knowledge about the different stages to identify them. The most common CDF type connected with this competence is EXPLAIN, but also rare instances of EVALUATE, EXPLORE and DESCRIBE were found. All these CDFs, especially EXPLAIN, can be necessary to describe your perspective and explain the causal thinking behind your opinion by also supporting it with some hypotheticals and evaluations of evidence.

The last competence that was found in the data is S3 which involves recognising the significance, opportunities and risks of the application of scientific findings for the individual and for society in order to act responsibly. As part of an oral presentation, learners gave an overview of the uses of algae in the field of medicine (cancer treatment, heart diseases) as well as the food and cosmetic industries thus outlining the significance of the substances found in algae for the individual and society. The learner described the different applications, defined relevant substances and evaluated them. Furthermore, T1 highlighted the advantages of using additional CO^2 in green houses to increase the rate of photosynthesis leading to better harvests, while also pointing out that this only works to a certain extent. The connected CDFs that were found are DESCRIBE, EXPLAIN, EXPLORE and one instance each of DEFINE, EVALUATE and REPORT.

Reichstädter and Müllner (2021) provided examples for overlaps of CLASSIFY and EVALUATE with the *evaluation competence* while the present data found connections of this competence with all CDFs but CLASSIFY and DEFINE-TRANSLATION.

The low number of *evaluation competences* in the data is likely due to the high demand of these activities and to an extent the nature of the covered topics. Photosynthesis, action potential, mitosis, meiosis and protists are highly based on scientific fact and therefore leave little room for arguing one's point of view. Other topics, such as abortion, animal testing, species extinction, genetic engineering or cloning are more suitable for practising this type of competence as they leave more room for moral judgements. Overall, it must be mentioned that there are few instances of EVALUATE even in the competence dimension that is focused on argumentation and evaluation based on specialised knowledge.

In conclusion, the discussion of the fourth research question suggests that some competences of the competence model for natural sciences require a wide range of CDFs (e.g., W1, W3, E4, S3) while others are more focused on a few elect ones (e.g., W4, E3). Disappointingly, only half of the sub-competences were included in the data leaving room for further investigation of the compatibility of the CDF construct with the competence model in biology.

Furthermore, the main research question, "How are the scientific competences of the curricular competence model for natural sciences and Dalton-Puffer's CDF concept interrelated in the lessons observed?" needs to be answered. As the discussions of the other research questions showed, there are many connections between the CDF concept and the curricular competences in the analysed data. Depending on the nature of the competences some or many CDF types are required to develop the competence. Most of the links found were to be expected considering the nature of the competences, for example REPORT when recording the findings of an investigation or EXPLAIN when discussing the cause of an phenomena based on general rules or laws. Other competences were more open as they related to many if not all the CDF types (W1). Therefore, the data implies that CDFs can be used in the biology classroom to work on the curricular competences as written down in the competence model for natural sciences.

7. Conclusion

The purpose of this study has been to extend the empirical support for the use of the CDF construct in CLIL biology education as well as to investigate the relation of this construct to the curricular competence model for natural sciences to judge its usefulness in acquiring scientific competences. The analysis of the theory behind both constructs implies a certain connection between CDFs and the competences as the CDFs comprise the thinking skills needed to perform the competences.

The empirical findings of the analysis of biology classroom discourse indeed show a connection between the CDF construct and the scientific competences as the acquisition of competences requires a range of CDF types. Instances of all seven CDF types as well as the three competence dimensions, *reproduction competence, empirical competence* and *evaluation competence*, could be found in connection with various CDFs. However, not all sub-competences of the competence model were present in the data, and *empirical competence* and *evaluation competence* played a minor role in the recorded lessons. Therefore, further research into these competences is necessary. Nevertheless, the results indicate that there is a great potential for the explicit use of CDFs and their common linguistic features in CLIL biology lessons to bridge language and content demands.

The most prominent CDF type is undoubtedly DESCRIBE as it was not only the most frequently used CDF but also showed the most overlaps, together with EXPLAIN, with sub-competences in all three dimensions. The prominence of DESCRIBE was also found by previous studies, such as Kröss (2014), Hofmann and Hopf (2015) and Bauer-Marschallinger (2016). The second most frequent CDF is EXPLAIN which has an equal number of overlaps with the competences as DESCRIBE. Moreover, DEFINE is the third frequent CDF and though it overlaps with slightly fewer sub-competences than the beforementioned CDFs, it also has connections to all three competence-dimensions. Though the number of overlaps for the three most frequent CDFs varies, they all share their strongest connection to W1. This is insofar unsurprising as W1 is by far the most frequent sub-competence as it encompasses describing and naming biological phenomena which presupposes the use of DESCRIBE and DEFINE with episodes of EXPLAIN to give reasons for these phenomena. These three CDF types together make up nearly two-thirds of the overall CDF occurrence. Hofmann and Hopf (2015: 204) argue that DESCRIBE and DEFINE are especially important for science education as it mostly deals with fact-based content whereas social sciences place more importance on evaluations.

With the most frequent CDF types adding up to the majority of CDFs in the data, the remaining types are significantly less frequent. The CDFs that occurred least frequently are EXPLORE followed by EVALUATE, REPORT and CLASSIFY. This corresponds with Hofmann and Hopf's (2015) findings who found a low frequency for EVALUATE, REPORT and CLASSIFY. The low status of EXPLORE and EVALUATE might be explained by their strong dependence on the topic area. Instances of EXPLORE will be significantly higher in lessons where experiment are conducted, and lessons on more ethical topics, such as animal testing, leave more room for subjective reasoning inherent to EVALUATE. The low number of REPORT might be a bit misleading, as there were several extensive episodes of this CDF which, however, could only be counted once. Though classifying new information and concepts is an important part of biology education, this CDF played a secondary role in the data.

As for lexico-grammatical realisations of the CDFs, the use of linguistic structures associated with CDFs varied according to the CDF type. While learners made extensive use of these structures for CLASSIFY and EXPLAIN, this cannot be said for DEFINE and DESCRIBE. Other CDFs such as EXPLORE, REPORT and EVALUATE showed some use of linguistic structures though not extensively.

In summary, the findings have expanded the empirical data on the practicality of CDFs in CLIL education of various subjects and further validate the usefulness of Dalton-Puffer's construct. Moreover, a connection between the construct and the curricular competence model for natural sciences was confirmed as the results of the analysis suggest the usefulness of CDFs in the development of scientific competences.

As the result show a connectedness of CDFs with the curricular competence model used in natural science subjects, this has several implications for CLIL teachers in this field. Firstly, CLIL teachers can explicitly use CDFs as a teaching tool in their lessons to practise the scientific competences. They can and should explicitly address the linguistic structures that are necessary to successfully realise these cognitive functions. In making these language structures visible and accessible for the learners, CLIL teachers can help them in developing not only their language proficiency but also their scientific competences as they learn how to perform vital thinking skills more precisely. For example, when definitions, are addressed during the lesson, the teacher can explain which aspects constitute a full formal definition. This will enable the learners not only to understand the act of defining a biological phenomenon or process better, but it will also enable them to write better definitions in their exams, and thus, they might achieve higher scores. After the introduction of a CDF, encountered realisations of this CDF type in textbooks, on worksheets, or the students' own realisations can be collaboratively analysed and recast if necessary. As could be seen in the data, learners did not make extensive use of the structures for definitions and other CDFs, even though defining new concepts is an important aspect of biology lessons. Therefore, an explicit focus on the lexico-grammatical features of these CDF types could really benefit the learners in CLIL lessons.

Moreover, teachers can actively use the CDFs as a tool for planning their CLIL lessons and preparing their materials. As already established, the competences vary in how extensive they are with some encompassing many different types of CDFs, while other are focused on one or two. When planning a lesson, teachers should start by deciding on the competences that should be the focus of the lesson, then suitable thinking skills can be determined by choosing appropriate CDFs. Through the use of CDFs, the language needs to successfully perform certain tasks can be predicted. This allows teachers to prepare glossaries, phrase boxes or other language support to scaffold the learners' language use for defining, describing, explaining, exploring among others. This not only anticipates the learners' needs to participate successfully in content knowledge creation, but it also empowers the teachers who are often content expert with no formal training in the target language by allowing them to prepare themselves linguistically for the cognitive tasks.

However, it is plausible that several limitations might have influenced the results. To begin with the investigation only focused on two schools with overall four learner groups where three have a strong language background and explicitly chose to receive bilingual instruction. Regrettably the topics of the recorded lessons did not prompt the use of all the sub-competences from the competence model. For more comprehensive insights into the matter, lessons in more diverse topic areas need to be analysed to include instances of experiments prompting *empirical competences* or moral discussions triggering *evaluation competences*. Moreover, the context of this study was limited to oral classroom discourse and how the competences were practised in the lessons observed. However, to truly judge the acquisition of the competences, further data needs to be collected, especially in written form and testing situations. Given these limitations, the results should be treated with considerable caution as more extensive empirical research is necessary for more conclusive findings.

Another useful consideration would be the use of control groups to also research the practicality for mainstream L2 learners that were not elected for the bilingual programme.

Nevertheless, the results of this study showed the interrelatedness of language and scientific competences as overlaps between the competences and the CDF types, which are verbalised cognitive processes (Dalton-Puffer 2013: 216), were found. This has certain implications for the CLIL classroom. First, CDFs play a substantial role in the CLIL classroom and show great potential for integrating content with language learning. As most CLIL teachers in Austria are experts in the content subjects, the explicit focus on language is often lacking from CLIL lessons. The explicit use of CDFs could not only benefit learners' language development, but it could also help them acquire the connected subject-specific competences through the use of CDFs as explicit connectors between language and competences. Moreover, the explicit teaching of CDFs and their linguistic realisations could also benefit minority language learners in multilingual contexts. However, not only learners could benefit from the use of CDFs, but also teachers could gain a higher awareness of form and function which might help them anticipate necessary language structures of certain subject-matters. This would allow better preparation for the language requirements of certain activities and competences and could result in a richer linguistic input for the learners.

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9. Appendix

9.1. Abstract

Since the emergence of content and language integrated learning (CLIL) over two decades ago, researchers have been interested in its potential for foreign language learning and subject-content acquisition. While early research was often only focused on one of these two aspects, in recent years the focus has shifted to the investigation of the integration of content and language. To investigate this integration, Dalton-Puffer (2013, 2016) created the concept of cognitive discourse functions (CDFs) which attempts to provide a framework to ensure the successful integration without neglecting the curricular content aims. She argues that this construct is compatible with content curricula that are based on standards or competences (2013: 242), such as the Austrian upper secondary curriculum for biology. Even though previous work has already focused on CDFs in biology CLIL lessons (Hofmann & Hopf 2015), a comprehensive and detailed analysis of the compatibility of the CDFs with the curricular competence model for natural sciences (BMBWF 2018) is still unaccounted for. Thus, the aim of this thesis is to investigate the use of CDFs in CLIL biology lessons and conduct a detailed analysis of their overlaps with the dimensions of the curricular competence model of natural sciences. For the purpose of this study, six CLIL biology lessons were recorded in two schools in Lower Austria. The collected data was analysed according to the occurring CDF types and their correlation with the scientific competences. The results show a high occurrence of CDFs in naturalistic CLIL biology lessons and thus provide further evidence for the usefulness of the CDF construct for the analysis of CLIL classroom discourse. Moreover, a connection between competences and certain CDF types was found thus suggesting the relevance of CDFs for the development of scientific competence.

9.2. Zusammenfassung

Seit dem Aufkommen des Content and Language Integrated Learning (CLIL) vor mehr als zwei Jahrzehnten haben sich Forscher für dessen Potenzial für das Fremdsprachenlernen und den Erwerb von Fachinhalten interessiert. Während sich die frühe Forschung oft nur auf einen dieser beiden Aspekte konzentrierte, hat sich der Forschungsschwerpunkt in den letzten Jahren auf die Integration von Inhalten und Sprache verlagert. Um diese Integration zu erforschen, hat Dalton-Puffer (2013, 2016) das Konzept der kognitiven Diskursfunktionen (cognitive discourse functions, CDFs) entwickelt, das versucht, ein Rahmenkonzept für eine erfolgreiche Integration zu schaffen, ohne die inhaltlichen Ziele des Lehrplans zu vernachlässigen. Sie argumentiert, dass dieses Konstrukt mit inhaltlichen Lehrplänen kompatibel ist, die auf Standards oder Kompetenzen beruhen (2013: 242), wie z. B. der österreichische Lehrplan für die Sekundarstufe II für das Unterrichtsfach Biologie. Auch wenn sich bereits frühere Arbeiten mit CDFs im CLIL Biologieunterricht beschäftigt haben (Hofmann & Hopf 2015), steht eine umfassende und detaillierte Analyse der Kompatibilität der CDFs mit dem curricularen Kompetenzmodell für Naturwissenschaften (BMBWF 2018) noch aus. Ziel dieser Arbeit ist es daher, den Einsatz von CDFs im CLIL Biologieunterricht zu untersuchen und eine detaillierte Analyse ihrer Überschneidungen mit den Dimensionen des curricularen Kompetenzmodell für Naturwissenschaften durchzuführen. Für diese Studie wurden sechs CLIL Biologiestunden in zwei Schulen in Niederösterreich aufgezeichnet. Die erhobenen Daten wurden hinsichtlich der vorkommenden CDF-Typen und deren Korrelation mit den naturwissenschaftlichen Kompetenzen analysiert. Die Ergebnisse zeigen ein hohes Vorkommen von CDFs im naturalistischen CLIL Biologieunterricht und liefern damit einen weiteren Beleg für die Nützlichkeit des CDF-Konstrukts für die Analyse des CLIL Unterrichtsdiskurses. Darüber hinaus wurde ein Zusammenhang zwischen Kompetenzen und bestimmten CDF-Typen festgestellt, was auf die Relevanz von CDFs für die Entwicklung naturwissenschaftlicher Kompetenzen schließen lässt.

9.3. Transcription conventions

The applied transcription conventions in this study are based on the VOICE conventions [2.0] as well as Bauer-Marschallinger's (2016) proposed modifications. Further modification were made in order to fit the purpose of my study.

Speakers:	
T	Subject teacher
NS	Native speaker
Sf – Sf1, Sf2, ...	Identifiable female student
Sm – Sm1, Sm2, ...	Identifiable male student
Sx	Unidentifiable student
Sxf	Unidentifiable female student
Sxm	Unidentifiable male student
Speech:	
X	Incomprehensible word
XX	Incomprehensible phrase
XXX	Incomprehensible sentence or longer utterance
...	Pause longer than a few moments
[...]	Cut-out phrases
<1> ... </1>	Overlaps
?	Rising intonation
(word)	Uncertain transcription
{}	Translation

Bold: emphasis added to mark words relevant for the analysis

9.4. Full list of competences from the competence model of natural sciences (BMBWF 2018)

The following list presents all of the competences of the three dimensions of the competence model for natural sciences (BMBWF 2018). Moreover, translations into English have been added.

Reproduction competence:
Fachwissen aneignen und kommunizieren [Acquiring and communicating content knowledge]

W1: Biologische Vorgänge und Phänomene beschreiben und benennen.
[Describe and name biological processes and phenomena.]
W2: Aus unterschiedlichen Medien und Quellen fachspezifische Informationen entnehmen.
[Extract subject-specific information from different media and sources.]
W3: Vorgänge und Phänomene in verschiedenen Formen (Grafik, Tabelle, Bild, Diagramm, …) darstellen, erläutern und adressatengerecht kommunizieren.
[Depict processes and phenomena in different forms (graph, table, picture, diagram, ...), explain them and communicate them appropriately to the addressees.]
W4: Vorgänge und Phänomene mittels Fachwissen unter Heranziehung von Gesetzmäßigkeiten (Modelle, Regeln, Gesetze, Funktionszusammenhänge) erklären.
[Explain processes and phenomena by means of specialised knowledge with reference to regularities (models, rules, laws, functional relationships).]
W5: Biologische Vorgänge und Phänomene im Kontext ihres evolutionären Zusammenhangs erläutern.
[Explain biological processes and phenomena in the context of their evolutionary context.]

Empirical competence
Erkenntnisse gewinnen [Gaining insights]

E1: Biologische Vorgänge und Phänomene beobachten, messen und beschreiben.
[Observe, measure and describe biological processes and phenomena.]
E2: Biologische Vorgänge und Phänomene hinsichtlich evolutionsbiologischer Kriterien analysieren und Beziehungen herausarbeiten.
[Analyse biological processes and phenomena with regard to evolutionary criteria and identify relationships.]
E3: Zu biologischen Vorgängen und Phänomenen Fragen stellen und Hypothesen formulieren.
[Ask questions and formulate hypotheses about biological processes and phenomena.]
E4: Untersuchungen oder Experimente zu naturwissenschaftlichen Fragestellungen planen, durchführen und protokollieren.
[Plan, carry out and record investigations or experiments dealing with scientific questions.]
E5: Daten und Ergebnisse von Untersuchungen analysieren (zB ordnen, vergleichen, Abhängigkeiten feststellen) und interpretieren.
[Analyse and interpret data and results of investigations (e.g., order, compare, establish dependencies).]

Evaluation competence

Standpunkte begründen und reflektiert handeln [Justifying positions and acting in a reflective way]

S1: Fachlich korrekt und folgerichtig argumentieren und naturwissenschaftliche von nicht-naturwissenschaftlichen Argumentationen unterscheiden.

[Argue in a subject-specific and logical manner and distinguish scientific from non-scientific reasoning.]

S2: Sachverhalte und Probleme unter Einbeziehung kontroverser Gesichtspunkte reflektiert erörtern und begründet bewerten.

[Discuss facts and problems in a reflective manner, taking into account controversial points of view, and evaluate them in a well-founded manner.]

S3: Bedeutung, Chancen und Risiken der Anwendung naturwissenschaftlicher Erkenntnisse für das Individuum und für die Gesellschaft erkennen, um verantwortungsbewusst zu handeln.

[Recognise the significance, opportunities and risks of the application of scientific findings for the individual and for society in order to act responsibly.]

S4: Menschliche Erlebens- und Verhaltensmuster aus evolutionsbiologischer Sicht reflektieren.

[Reflect on human experience and behaviour patterns from an evolutionary perspective.]

S5: Handlungsempfehlungen erstellen und gestalten (zB Naturschutzstrategien, Gesundheitskonzepte, Ernährungspläne, …).

[Create and design recommendations for action (e.g., nature conservation strategies, health concepts, nutrition plans, ...).]

9.5. Consent forms adapted from Dobner (2020)

Teilnehmerinformation und Einwilligungserklärung Direktion

Teilnehmerinformation „Integration of content and language: Acquisition of scientific competences in the CLIL biology classroom"

[Place], 09. November 2021

Sehr geehrte*r [headmaster's name]!

Im Rahmen meiner Masterarbeitsstudie an der Universität Wien plane ich in englischer Sprache abgehaltenen Biologieunterricht zu untersuchen. Das Ziel der Studie ist es Aufschluss über das Lernen von biologischen Inhalten mit Fokus auf die geförderten Kompetenzen (Kompetenzmodell Nawi) mit Englisch als Arbeitssprache zu gewinnen.

Im Zuge dessen habe ich mich mit [teacher's name] in Kontakt gesetzt, der*die sich bereit erklärt hat seinen*ihren Unterricht für diese Forschungsstudie freizugeben. Im Rahmen dieser Studie werde ich bei zwei Unterrichtsstunden den Sprachgebrauch aufnehmen und anschließend analysieren, um Einsichten in die Funktionen der Sprache im bilingualen Biologieunterricht zu erlangen. Selbstverständlich werde ich darum bemüht sein, dass dabei die Schüler*innen in ihrer gewohnten Lernumgebung möglichst ungestört bleiben. Anschließend werde ich Interviews mit den teilnehmenden Lehrpersonen führen, um mehr über die Wahrnehmung zur Rolle der Sprache im bilingualen Biologieunterricht zu erfahren.

Alle gesammelten Daten werden vertraulich behandelt, anonymisiert und ausschließlich für Forschungszwecke verwendet. Die gesammelten Daten werden auf einem durch ein Passwort geschütztem Laufwerk gespeichert. Die Tonaufnahmen werden nicht veröffentlicht. Nur anonymisierte Ausschnitte der Transkripte werden in der Arbeit verwendet.

Ich möchte Sie auf diesem Wege um Ihre Mithilfe durch Erteilung Ihrer Zustimmung zu diesem Vorhaben bitten und bedanke mich bereits im Voraus sehr herzlich für Ihre Unterstützung.

Für Fragen stehe ich Ihnen jederzeit gerne zur Verfügung.

Mit freundlichen Grüßen

[researcher's name]
Masterstudentin Anglistik Universität Wien

Betreut durch
[supervisor's name]
Institut für Anglistik und Amerikanistik

Teilnehmerinformation und Einwilligungserklärung Eltern

Integration of content and language: Acquisition of scientific competences in the CLIL biology classroom (Die Integration von Fachinhalt und Sprache: Der Erwerb von naturwissenschaftlichen Kompetenzen im CLIL Biologie Unterricht)

[place], 09. November 2021

Liebe Eltern!

Im Rahmen meiner Masterarbeitsstudie an der Universität Wien werde ich in englischer Sprache abgehaltenen Biologieunterricht untersuchen. Das Ziel der Studie ist es Aufschluss über das Lernen von biologischen Inhalten mit Fokus auf die geförderten Kompetenzen (Kompetenzmodell Nawi) mit Englisch als Arbeitssprache zu gewinnen.

Im Zuge dessen wurde die Klasse ihres Kindes ausgewählt, um Informationen über bilingualen Biologieunterricht zu sammeln. Dazu sollen Audioaufnahmen des üblichen Sprachgebrauch im Unterricht aufgenommen und analysiert werden, um Einsichten in die Funktionen der Sprache im bilingualen Biologieunterricht zu erlangen. Selbstverständlich werde ich bemüht sein, dass dabei die Schüler*innen in ihrer gewohnten Lernumgebung möglichst ungestört bleiben.

Alle gesammelten Daten werden vertraulich behandelt und ausschließlich für die genannten Forschungszwecke verwendet. Die Tonaufnahmen werden nicht veröffentlicht und nach der Transkription sicher gelöscht. Im Zuge der Transkription werden alle personenbezogenen Daten entfernt, **somit können Ihrem Kind keine Aussagen zugeordnet werden**. Die erhobenen Daten werden ausschließlich in anonymisierter Form in der Masterarbeit veröffentlicht.

Die Teilnahme an der Erhebung und die Zustimmung zur Verwendung der Daten für den oben beschriebenen Zweck sind freiwillig. Ihrem Kind entstehen keine Nachteile durch eine Nichtteilnahme.

Ich möchte Sie auf diesem Wege um Ihre Mithilfe durch Erteilung Ihrer Zustimmung zu diesem Vorhaben bitten und bedanke mich bereits im Voraus sehr herzlich für Ihre Unterstützung.

Für Fragen stehe ich Ihnen jederzeit gerne zur Verfügung.

Mit freundlichen Grüßen

[researcher's name]
Masterstudentin Anglistik Universität Wien

Betreut durch
[supervisor's name]
Institut für Anglistik und Amerikanistik

Abschnitt bitte bis spätestens [Datum] an [Name der Lehrperson] retournieren

- -

Ich habe die Elterninformation über die Studie der Universität Wien zum englischsprachigen Biologieunterricht zur Kenntnis genommen und bin mit der Durchführung dieser Studie in der Klasse meines Kindes einverstanden.

Name des Kindes: ___________________________ Klasse: _______________

Unterschrift: _______________________________

Bildungsdirektion Niederösterreich:

„Integration of content and language: Acquisition of scientific competences in the CLIL biology classroom"

[place], 09. November 2021

Sehr geehrte Damen und Herren,

Mein Name ist [researcher's name] und ich mache gerade den Master of Education in den Fächern Englisch und Biologie an der Universität Wien. Im Rahmen meiner Masterarbeitsstudie an der Universität Wien plane ich in englischer Sprache abgehaltenen Biologieunterricht zu untersuchen. Das Ziel der Studie ist es Aufschluss über das Lernen von biologischen Inhalten mit Fokus auf die geförderten Kompetenzen (Kompetenzmodell Nawi) mit Englisch als Arbeitssprache zu gewinnen.

Im Zuge dessen habe ich mich mit Lehrer*innen des [school name] bzw. [school name] in Kontakt gesetzt, die sich bereit erklärt haben ihren Unterricht für diese Forschungsstudie freizugeben. Im Rahmen dieser Studie werde ich bei sechs Unterrichtsstunden (zwei Stunden pro teilnehmender Lehrperson) den Sprachgebrauch aufnehmen und anschließend analysieren, um Einsichten in die Funktionen der Sprache im bilingualen Biologieunterricht zu erlangen. Selbstverständlich werde ich bemüht sein, dass dabei die Schüler*innen in ihrer gewohnten Lernumgebung möglichst ungestört bleiben. Weiters werde ich Interviews mit den teilnehmenden Lehrpersonen führen, um mehr über die Wahrnehmung zur Rolle der Sprache im bilingualen Biologieunterricht zu erfahren.

Alle gesammelten Dateien werden selbstverständlich vertraulich behandelt, anonymisiert und nur für die Forschungszwecke dieser Masterarbeit verwendet. Die gesammelten Daten werden auf einem durch ein Passwort geschütztem Laufwerk gespeichert. Die Daten können von der Betreuerin der wissenschaftlichen Arbeit für Zwecke der Leistungsbeurteilung eingesehen werden, ansonsten hat nur die Forschende Zugriff auf die Audiodateien. Die Tonaufnahmen werden nicht veröffentlicht. Alle Aussagen werden anonymisiert transkribiert, d.h. ohne Nennung von Namen (Schule, Lehrpersonen, Schüler*innen), in der Arbeit verwendet.

Die Teilnahme an der Erhebung und die Zustimmung zur Verwendung der Daten für den oben beschriebenen Zweck sind freiwillig. Die Teilnehmer haben jederzeit die Möglichkeit ihre Zustimmung zu widerrufen, ohne dass ihnen dabei Nachteile entstehen.

Ich möchte Sie auf diesem Wege um Ihre Mithilfe durch Erteilung Ihrer Zustimmung zu diesem Vorhaben bitten und bedanke mich bereits im Voraus sehr herzlich für Ihre Unterstützung.

Für Fragen stehe ich Ihnen natürlich jederzeit gerne zur Verfügung.

Mit freundlichen Grüßen

[researcher's name]
Masterstudentin Anglistik Universität Wien

Die Masterarbeit wird betreut durch
[supervisor's name]
Institut für Anglistik und Amerikanistik

Anhang: Projektbeschreibung mit Liste der teilnehmenden Schulen
Interviewleitfaden (Lehrer*innen)
Bestätigung der Betreuung durch die Universität Wien
Elterninformationsblatt mit Einverständniserklärung