MASTERARBEIT | MASTER'S THESIS

Titel | Title

The Pea Project: Implementation of a CLIL project in lower secondary biology classes

verfasst von | submitted by

Valentin Reisenauer BEd

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

Master of Education (MEd)

Wien | Vienna, 2024

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) Unterrichtsfach Biologie und Umweltbildung Unterrichtsfach Englisch
Betreut von | Supervisor:	Univ.-Prof. Mag. Dr. Christiane Dalton-Puffer

Abstract

This thesis explores a Content and Language Integrated Learning (CLIL) teaching project designed to integrate Biology and English instruction through the use of Cognitive Discourse Functions (CDFs). The widespread adoption of CLIL as a teaching methodology through local and transnational initiatives across Europe, including Austrian schools, has led to advancements in various content subjects. However, the suitability of Biology as a CLIL subject has not yet been thoroughly investigated, proven by the lack of accessible teaching materials. Thus, a teaching project centred on the topic of inheritance has been conducted in a 4th grade lower secondary classroom in Vienna. Four lessons were designed to provide insights into CLIL in science education, evaluated from the perspectives of the teacher, the quality of the students' work, and the students themselves. The project aims to enhance both content and language proficiency, as well as promote pluriliteracy among students. For this purpose, after devising and implementing the teaching project, a questionnaire was administered to the participating students to gather feedback and insights. The subsequent evaluation of the responses revealed the effectiveness of the approach and highlighted areas for future improvement. The findings suggest that integrating digital tools within the CLIL framework can significantly benefit both language acquisition and subject matter understanding, making it a promising strategy for educators seeking to combine language learning with other disciplines. As an initial foray into this topic, this thesis aims to inspire and guide readers interested in implementing this teaching methodology.

Zusammenfassung

In dieser Arbeit wird ein CLIL-Unterrichtsprojekt zum integrativen Lernen von Inhalten und Sprachen untersucht, das den Biologie- und Englischunterricht durch den Einsatz von `Cognitive Discourse Functions` (CDFs) ergänzt. Die weit verbreitete Anwendung von CLIL als Unterrichtsmethode durch regionale und transnationale Initiativen in ganz Europa, einschließlich österreichischer Schulen, hat zu Fortschritten in diversen pädagogischen und Inhaltsbereichen geführt. Die Eignung von Biologie als CLIL-Fach wurde bislang jedoch noch nicht umfassend untersucht, was durch den Mangel an zugänglichen Unterrichtsmaterialien deutlich wird. Daher wurde ein Unterrichtsprojekt zum Thema Vererbung in einer 4. Klasse der Sekundarstufe I in Wien durchgeführt. Vier Unterrichtsstunden wurden konzipiert, um Einblicke in CLIL im naturwissenschaftlichen Unterricht zu geben, die aus der Sicht der Lehrenden, und anhand der Qualität der Arbeit der SchülerInnen und der SchülerInnen selbst evaluiert wurden. Ziel dieser Arbeit ist es, sowohl die inhaltliche als auch die sprachliche Kompetenz und die Fähigkeit im Umgang mit fachspezifischen Genres der SchülerInnen zu fördern. Zu diesem Zweck wurde nach der Ausarbeitung und Durchführung des Unterrichtsprojekts ein Fragebogen an die teilnehmenden Lernenden ausgegeben, um Rückmeldungen und Erkenntnisse zu sammeln. Die anschließende Auswertung der Antworten offenbarte die Wirksamkeit des Ansatzes und zeigte mögliche Bereiche für zukünftige Verbesserungen auf. Die Ergebnisse deuten darauf hin, dass die Einbindung digitaler Hilfsmittel in den CLIL- Kontext sowohl für den Spracherwerb als auch für das Verständnis des jeweiligen Fachgebiets von großem Nutzen sein kann und somit eine vielversprechende Strategie für Pädagog:innen darstellt, die das Sprachenlernen mit anderen Disziplinen verbinden möchten. Diese Arbeit bietet einen ersten Einblick in dieses Thema und soll Leser:innen, die an der Umsetzung dieser Lehrmethode interessiert sind, inspirieren und anleiten.

Table of Contents

List of Figures and Tables:

1. Introduction

Content and Language Integrated Learning (CLIL) has been defined as an educational setting "where a language other than the students' mother tongue is used as a medium of instruction" (Dalton-Puffer 2007: 1). Due to the exponential increase of CLIL programmes all over the globe, a plethora of different interpretations, theoretical underpinnings, and frameworks of what 'doing CLIL' entails have emerged across national curricula. In an attempt to bridge the gap between the numerous pedagogies, Dalton-Puffer (2013: 231) introduced the concept of Cognitive Discourse Functions (CDFs) which are defined as recurrent language patterns that are used to express and communicate thinking processes. These labels are, however, not only meant to provide an intersection between different cultural applications of CLIL but rather aim to "fulfill the requirement of conceptualizing content and language integration for education in a non-trivial way." (Dalton-Puffer 2013: 232) While CLIL programmes over the past years have struggled to effectively invoke language and content goals alike, something described by Lin (2016: 59) as "intercurricular disconnect", CDFs attempt to bridge this gap by both integrating the communicative and conceptual dimensions of learning. Furthermore, they enable teachers to design more output-oriented lessons by providing educators with operationalised learning goals that assist students in building knowledge and, crucially, function as building blocks for subject specific genres (Coyle & Meyer 2021: 78).

When considering contributions of scholars and practitioners in the field, it becomes evident that the interest to come up with such operationalised labels has spread across multiple fields of study. Due to the competency-based curricula that have captured European classrooms over the last decade (BIFIE 2011, 2012, 2019; BMBWF 2023 a, b) the need for addressing newly formulated learning goals has been met in domains such as science (Reichstädter & Müllner 2021) via the introduction of operators. Similarly to CDFs, they ought to bridge the gap between the formulated learning outcomes as prescribed by the local education system and the needs of language learners situated within the classrooms. Moreover, language sensitivity in scientific contexts is being recognized as an increasingly important concern and is being tackled by a wide range of researchers in their studies (Kramer 2009, Leisen 2010, Tajmel 2010, Kattmann 2016). The fact that both linguists and scientists in their respective domains have dedicated their research to the issue, means that there are plenty of resources to navigate for practitioners who seek to apply these findings in their teaching.

My initial interest in CLIL was piqued when I experienced a similar method of teaching during my time as a student and subsequently by lecturers when I was pursuing my studies at the University of Vienna. I encountered the numerous advantages of this approach from both viewpoints; as a curious pupil and in various seminars and lectures. Given that my primary subjects are English and Biology, I swiftly became an advocate for this innovative method. However, as I embarked on the design and delivery of a CLIL lesson in one of my seminars for the first time, I came to realize the considerable challenges associated with CLIL. Conversations with experienced CLIL instructors further underscored the difficulties, particularly in terms of developing materials suitable for students, obtaining the right balance between language and content, all while creating an engaging and student-friendly learning environment. Therefore, this thesis aims to investigate the feasibility of implementing CLIL in Biology, with a specific focus on the Austrian educational context. To achieve this, I conducted a teaching project in a 4th grade lower secondary MS in Vienna titled "The pea project". The chosen topic for this project was heredity, as it is well suited for theoretical and practical enquiry and addresses a research-gap, seeing as few to none appropriate resources on the subject area exist.

Furthermore, this study posits that the majority of students participating in the study enjoy Content and Language Integrated Learning. To test this hypothesis, this thesis delves into the viewpoints and attitudes of students concerning CLIL, with the aim of uncovering potential factors that could impact students' learning encounters in CLIL classrooms. The teaching project underwent evaluation from multiple perspectives, encompassing an assessment of the practical work produced by the students, the students' feedback through a questionnaire and the author's self-reflection. The findings have the potential to enhance existing methodologies as well as the overall effectiveness of CLIL.

This thesis commences with a concise overview of CLIL's aims, objectives, and limitations, devoting attention to its historical background, and its more recent entanglement with pluriliteracies. Subsequently, the fundamental learning theories and frameworks upon which this teaching method is constructed on are illuminated. In this context, particular attention is paid to the CDF-construct, which not only constitutes an essential milestone in the evolution of CLIL, but also serves as an important instrument in the practical application of this paper. Following this broad exploration, the paper will narrow its focus to CLIL in the domain of Biology. Here, the discussion revolves around the development of Biology as a subject in Austria and the principles guiding Biology pedagogy. Additionally, an examination of the nuances of scientific literacy and the language use in CLIL Biology lessons will ensue, encompassing the competency-model in natural sciences as well as language-sensitive Biology teaching. Subsequent to this theoretical exploration, the paper transitions to a detailed examination of a CLIL project conducted within a lower secondary school in Austria. The principal chapters in this segment revolve around project design, evaluation methodology, and practical implementation. Conclusively, the results section presents empirical findings, employing SPSS for quantitative analysis while also providing a descriptive narrative for aspects beyond the software's analytical scope. A comprehensive discussion of these findings ensues, followed by a concluding section that encapsulates the most significant outcomes and their potential implications for CLIL pedagogy.

2. Content and Language Integrated Learning

Dale, van der Es and Tanner (2011: 1) define Content and Language Integrated Learning (CLIL) as:

> a dual-focused educational approach in which an additional language is used for the learning and teaching of both content and language. That is, in the teaching and learning process, there is a focus not only on content and not only on language. Each is interwoven even if the emphasis is greater on one or the other at a given time.

As this quotation foreshadows, the major challenge of CLIL is one of implementing a foreign language, in this case English, into an independent content-classroom setting. While this approach undoubtedly bears many challenges for students and teachers alike, a number of core principles specified by Richards and Rodgers (2014) justify its growing popularity. Most importantly, "[p]eople learn a second language more successfully when they use the language as a means of understanding content, rather than as an end in itself." (Richards & Rodgers 2014: 118) This can be identified as the main advantage CLIL has over conventional language teaching methods, notwithstanding that teaching the pupils basic rules of grammar and helping them acquire proficiency in the fundamental skills cannot be omitted. Therefore, CLIL in its present form is not meant to serve as a substitution for traditional English teaching, but rather as a complementary approach to enhance students' communicative abilities in a foreign language.

The ongoing interest this mode of teaching has received over the past decades can partially be explained by "a trend towards internationalization and globalization, putting pressure on education systems to provide skills which will allow students to stand their ground in international contexts." (Dalton-Puffer 2007: 1) Thus, an increasing number of countries have implemented such programs in order to stay competitive within an international market. With English being the most widely used lingua franca, education systems that invest in CLIL programs are expected to have an edge over other competitors. Overall, these linguistic competences serve to cater for the needs of knowledge-driven societies and economies (Richards & Rodgers 2014: 118). Other arguments brought forward by proponents of CLIL accentuate its focus on "real communication and the exchange of information" (Richards & Rodgers 2014: 117), a key component of Communicative Language Teaching (CLT), meaning that language proficiency is acquired as a by-product of authentic discourse among students and teachers. This authentic discourse is bound to revolve around a certain subject area, meaning that virtually any kind of content taught in English may become a basis for CLT. Furthermore, CLIL serves as a tool to promote bilingualism. If employed from an early stage onwards, students are encouraged to include a foreign language into their linguistic repertoire.

CLIL originated in Europe and is therefore characterized by a wide range of sociolinguistic and political conditions. The ever-growing trend of using English to convey knowledge, not of the language structure itself, but of a different subject, has established itself world-wide and is known under different names, representing different focuses. While Content-Based Instruction (CBI) is inherently concerned with language learning goals, for CLIL both language as well as content driven variants have developed in different parts of the world and. Although CLIL exhibits certain similarities to various approaches, it may be distinguished through its integrated methodology, where language and content are perceived as interconnected without favouring one over the other (Coyle 2007: 545). Evidently, the main goal of these concepts, including bilingual education and immersion programs, is to incorporate both content and language learning, while assuring that the latter is being taught both explicitly and implicitly in an authentic environment.

Although a classroom can never fully resemble a naturalistic setting in which a foreign language is being spoken voluntarily and informally, Content and Language Integrated Learning still tries to facilitate opportunities for pupils to practice the L2 without having to fear constant criticism and assessment of their language proficiency. The role of the teacher is of particular importance in this context, since they contribute tremendously to the students' learning experiences. Consequently, the pupils are encouraged to communicate under as few constraints as possible. They should be prone to risk-taking, which is proven to be an indispensable skill when it comes to achieving communicative competence (Hedge 2000: 47), arguably, the topmost goal of today's language teaching philosophies.

2.1. Aims, objectives and limitations

Concerning the aims and objectives pursued by CLIL programmes, one must first differentiate between what is politically desirable and what are realistic educational goals for CLIL. According to García (2009: 6), the overarching goal of not only Content and Language Integrated Learning, but bilingual programmes in general, is to guide and provide learners with experiences to become "global and responsible citizens as they learn to function across cultures and worlds, that is beyond the cultural borders in which traditional schooling often operates." This includes greater flexibility and fluency in foreign languages, the promotion of employability and to anticipate different aspects of professional reality in an increasingly globalised labour market. In addition, CLIL contributes to increasing the motivation of all those involved in teaching through methodological and didactic diversity and a shift in the role of the teacher. It offers learners the opportunity to use and extend language skills they have already acquired. Furthermore, CLIL aims to enhance students' critical thinking skills by engaging them in interdisciplinary learning and promoting problem-solving abilities (Coyle 2007: 548).

The educational goals for CLIL are multifaceted and encompass various aspects, however, it is important to acknowledge that CLIL also has its limitations. Arguably, the greatest issue with CLIL pedagogies nowadays is the overwhelming prevalence of English as the vehicular language, which is why the approach has also been referred to as “Content and English Integrated Learning (CEIL)” (Dalton-Puffer 2011: 183). This particularly holds true for the European context, where English has a monopoly on the language of instruction, even though one of its self-declared main objectives is concerned with spreading multilingualism (Merino & Lasagabaster 2018: 79). Seeing as English has established itself as the most commonly taught L2 among European countries, this should not come as a surprise. However, it has arguably led to the marginalisation of languages other than English (LOTE) who are hardly ever mentioned in CLIL contexts and who deserve more attention, especially when learners should be able to ultimately perform as global and not merely anglophone citizens.

Another point of criticism that has attracted the attention of scholars is what has been described as “intercurricular disconnect” (Lin 2016: 59) and refers to the problems arising from the necessity of CLIL to be contextually embedded. CLIL is necessarily interlocked with the demands of regional curricula which predominantly dictate the contents discussed in the classroom. This of course makes it harder to implement universally valid frameworks and materials for practitioners, seeing as they are restricted by their respective department of education. In addition to these regional restrictions, one must also consider the differences among the varying domains in which CLIL is applied. The contents taught in these diverse settings are inherently situated within their subject specific disciplines, which, in accordance with a broader sense of educational values and purposes, are wrapped up in the language of education (Coyle & Meyer 2021: 17). Biesta (2015: 76) points out that the latter “tends to prevent people from asking the key educational questions of content, purpose and relationships” meaning that the ambiguity of language of learning can be what stands in the way of “good” education. For educators this means that they are faced with both the challenge of conveying their contents in a language most likely different from their L1 while adhering to the linguistic and genre specific conventions inherent to the subject matter. This becomes particularly important for STEM subjects such as Biology, which is the focal point of this study. Reeves (2005: 2) describes the language used in poetry and politics, religion and business as biased or arbitrary, and while the language of science is neither perfectly objective, it attempts to be less emotional or overtly persuasive than speech used in other realms. This again entails that CLIL practitioners must aim to be as precise as possible in their language use and at the same time meet the curricular and genre specific requirement set for them.

2.2. The evolution of CLIL

The evolution of CLIL refers to the gradual development of pedagogic frameworks and teaching practices on the basis of empirical research. As such they have been influenced by various factors, including political and language ideological underpinnings, educational policies and teacher education and training. CLIL can be considered as an essential part of the bilingual movement which has led to shifts in education philosophies for the past decades. After its first mention in the 1990s, CLIL programmes have exponentially expanded, serving different purposes, pursuing political and economic interests, as well as addressing social demands such as providing equitable pathways for diverse learners across curricula (Coyle & Meyer 2021: 3). This introduction was not an invention, but rather an integration of good practices from different educational models, including Content-Based Instruction, Immersion, and Bilingual Education. The ever-heterogenous classrooms across the globe were an important impetus to overcome the former, prevailing monolingualism in education. The initial period after the introduction of CLIL saw a rapid diffusion across Europe, notably gaining traction in countries such as Finland, Sweden, and the Netherlands. The European Commission played a crucial role in supporting the evolution of CLIL by recognising its potential in promoting multilingualism and intercultural knowledge in response to the challenges of globalisation (Dalton-Puffer et al. 2014: 214). For the benefit of its residents, the European Union quickly acknowledged that bilingual and immersion programmes were in need of serious revision, as was recorded in the Eurydice report (2006: 8). Due to the fact that the following evolution of CLIL has not been a linear one but rather a plethora of different interpretations of what "doing CLIL" entails have emerged, a greater emphasis has been put on how this mode of teaching can be interpreted. This has resulted in the outcome, that the core characteristics of CLIL are interpreted differently in terms of:

- the relationship between language and content instruction,
- the chosen medium of instruction,
- instructional goals,
- the shared characteristics of participants,
- and the underlying pedagogical approaches (Cenoz, Genesee & Gorter 2013: 255).

The educational programme continues to evolve and today CLIL can be perceived as a broad spectrum of different practices and approaches, with varied implementations across different contexts. Discussions today revolve around the pedagogical principles and models that can optimise CLIL's educational outcomes, considerations of appropriateness for different age groups, and the balance between language and content instruction. The widespread application of CLIL over the past years is, on the one hand, due to pioneer teachers and headmasters who have taken it onto themselves to implement bilingual teaching programmes in their schools and on the other hand as a result of transnational initiatives, which are frequently funded by the European Union or the Council of Europe for the advancement of its professionalisation (Dalton-Puffer 2007: 4). Austria is in an almost unique position within the European CLIL community, as in many other European countries CLIL is still mostly used as part of bilingual courses that can be chosen by students on a voluntary basis. Whereas with the implementation of the new HTL curricula in 2011 for example, CLIL had been established as a mandatory element of teaching and learning, albeit only in technical schools.

The growing ambition to standardise and make learning outcomes comparable, which has been one of the main concerns of our education system for the past years, stands diametrically opposed to the dynamic pedagogical developments within schooling, driven by socio-cultural and political shifts. Hence, even if the future goal is to find a common denominator on how CLIL can be implemented in schools, one must remember the following:

> CLIL is not and cannot be formulaic, with pre-defined procedures and learning outcomes, but is a multifaceted, theoretically sound, contextually embedded phenomenon, which has to address the complementary and at times conflicting pedagogies associated with language learning and subject or thematic learning. (Coyle & Meyer 2021: 4)

This means, there neither is a single approach to CLIL, nor does it entail that any bilingual teaching methodology falls under the umbrella term. CLIL must continue to be subject to empirical research and consequently should be applied, critiqued, and refined. Similar to the scientific understanding of what evolution entails, this should be understood as an incremental process in which something changes into a different and usually more complex or better adapted form.

2.3. CLIL and Pluriliteracies

The definition of literacy in the Australian curriculum encompasses the following key aspects:

> Students become literate as they develop the knowledge, skills, and dispositions to interpret and use language confidently for learning and communicating in and out of school and for participating effectively in society. Literacy involves students listening to, reading, viewing, speaking, writing and creating oral, print, visual and digital texts and using and modifying language for different purposes in a range of contexts. (Australian Curriculum, Assessment and Reporting authority 2014: 16)

The concept of "pluriliteracies" seeks to broaden the aforementioned definition in order to encompass and acknowledge the sociolinguistic complexities that exist within our increasingly diverse and multilingual societies. The eponymous approach first introduced by García, Bartlett and Kleifgen (2007) aims to recognize and embrace the mixed nature of plurilingual literacy practices. It emphasizes equal value for all types of plurilingual practices, such as cultural, digital, critical, and multimodal literacy. In doing so, it encourages the interaction and integration of multiple languages, discourses, dialects, and registers. The approach also highlights the importance of multilingual literacies that rely on various modes and channels of communication as well as semiotic systems (García, Bartlett and Kleifgen 2007

12-13). Indeed, the concept of pluriliteracies is constantly evolving and adaptable. It aims to empower learners by helping them comprehend and cultivate approaches that recognize how cultural and linguistic contexts, as well as social interactions, shape and influence literacy practices both within and beyond formal educational settings.

In the context of a school environment, subject-specific literacies play a crucial role. For instance, in the case of Geographical literacy, they entail the capacity to comprehend and effectively utilize spatial information. However, there is a notable discrepancy in science instruction, where the emphasis primarily lies on teaching and learning scientific concepts and principles. Unfortunately, competencies related to science inquiry and perspectives on the nature of science are often overlooked or neglected (Coyle & Meyer 2021: 38). CLIL aligns with the concept of pluriliteracies, which emphasizes the development of multiple literacies in addition to language or content proficiency. While subject-specific knowledge is essential, it is equally important to foster students' abilities to engage in scientific inquiry, develop critical thinking skills, and understand the underlying principles and assumptions that guide scientific investigation. By integrating both content knowledge and the skills necessary to engage with and think critically about the subject matter, educators can create a more comprehensive and well-rounded approach to teaching and learning in various subjects, including geography and science. It is evident that the challenge of the project, which forms the foundation of this thesis, lies in addressing the imbalance between subject-specific knowledge and the development of essential competencies in the educational context. This imbalance can hinder the comprehensive growth of students, particularly in subjects such as science and Biology. By acknowledging and addressing this challenge, the thesis aims to propose solutions that foster a more holistic and effective approach to education, where both subject-specific literacies and broader cognitive skills are given due attention and integration.

The necessity for educational systems to foster pedagogies that enable individuals to construct, critically analyse, and effectively communicate knowledge across diverse cultures, languages, and fields is evident. (Coyle & Meyer 2021: 36) By integrating content and language learning, CLIL provides opportunities for students to develop these pluriliteracies. Additionally, there is an urgent call to embrace diversity and hybridity in our schools, fostering inclusive learning environments that cater to all learners, regardless of their backgrounds. In this context, the multilingual and inclusive aspect of literacy assumes paramount importance. Pedagogic approaches aimed at enhancing literacy skills for all students within regular classroom settings are indispensable for cultivating a fair and equitable society. To fulfil this requirement, however, researchers and practitioners will have to ask themselves, whether or not their understanding and implementation of CLIL can meet these demands.

3. CLIL Methodology

The success of Content and Language Integrated Learning can be attributed to its strong theoretical foundation, which draws upon several ground-breaking learning theories. Two of the most important cornerstones that have significantly influenced the emergence of CLIL are discussed below:

Krashen's Monitor Model (1985): Krashen's work in Second Language Acquisition (SLA) research has had a profound impact on how foreign languages are taught. He proposed five hypotheses, including the Input Hypothesis, which emphasizes the importance of comprehensible input in language learning. Transferred to CLIL, this would entail that both content and language input should be slightly above the students' current language and content proficiency, challenging them to progress further. Krashen also introduced the concept of the Affective Filter, suggesting that reducing negative emotions like anxiety positively affects language acquisition, which is taken into consideration in CLIL classrooms by mitigating language correction measures.

Swain's Output Hypothesis (1985): Swain argued that output, or the act of producing language, is as crucial as input in language learning, if not more important. According to her hypothesis, students truly comprehend and consolidate knowledge when they are engaged in negotiating meaning actively, rather than passively absorbing information. This "monitor effect" is essential for both content and language learning in a CLIL setting, where practical tasks are integrated to encourage students to apply knowledge in practice (Coyle, Hood & Marsh 2010: 91).

By integrating and building on these influential learning theories, CLIL provides a well-rounded and effective approach to education, fostering language proficiency as well as content knowledge.

3.1. Learning theories and frameworks

3.1.1. The 4Cs-framework

The effective implementation of CLIL in classroom practices relies on a well-established pedagogic tool known as the 4Cs-framework, as introduced by Coyle (2008). This framework emerged from collaborative efforts between educators and researchers during the early stages of CLIL, offering a principled planning heuristic to support the conceptualization of CLIL classroom practices. The detailed exploration of the 4Cs-framework is documented in the work of Coyle, Hood and Marsh (2010). Over the past decade, this pedagogic tool has played a vital role in stimulating adaptability and fostering critical debates about key components of CLIL.

The 4Cs-framework (Fig. 1) comprises four essential dimensions: Content, Cognition, Communication, and Culture, each requiring explicit attention in the design of integrated learning experiences within the CLIL context. While these dimensions are inherently interconnected, their initial separation during planning highlights the unique considerations accounting for each aspect.

By breaking down the curriculum into these distinct dimensions, teachers can more effectively address the diverse challenges and opportunities presented by CLIL instruction (Coyle & Meyer 2021: 18).

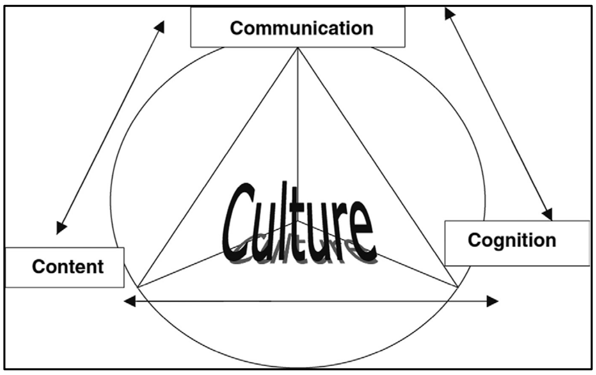


Figure 1: The 4Cs-framework (Bower et al. 2020: 10)

Various scholars have emphasized the significance of the 4Cs-framework and its contribution to CLIL's success as an educational approach that fosters language and content development in an integrated manner. Dalton-Puffer (2011) highlights how the 4Cs-framework encourages teachers to create engaging and meaningful learning experiences for students, promoting language learning while engaging with subject matter. Similarly, Mehisto, Marsh and Frigols (2008) elaborate on how the 4Cs-framework supports teachers in planning and implementing CLIL lessons that promote cognitive engagement, effective communication, and cultural awareness.

As educators continue to analyse and evaluate CLIL practices, a growing recognition of the interconnectedness of the 4Cs becomes evident. The framework has sparked ongoing discussions about the need to integrate subject-specific and language-specific considerations, leading to a shift towards a more inclusive and pluricultural curriculum development. By transcending disciplinary boundaries, Coyle and Meyer (2021: 19) argue that CLIL not only enhances language proficiency but also nurtures a deeper understanding of cultural diversity and global perspectives among students As CLIL continues to evolve, it is essential for educators to acknowledge the interconnected nature of these dimensions, thus facilitating the development of inclusive and culturally enriching learning experiences for students. Through a comprehensive integration of the 4Cs, CLIL can prepare learners to thrive in an increasingly interconnected and multilingual world.

3.1.2. The CLIL-pyramid

In 2013, Meyer argued that despite CLIL gaining traction throughout Europe, “there is still a lack of appropriate teaching materials and a comprehensive and integrative CLIL methodology” (Meyer 2013: 265). While the previously discussed 4Cs-framework provides the groundwork for such investigations, the CLIL-pyramid aims to tackle this issue by defining criteria for effective and enduring CLIL instruction and by offering a versatile planning tool that empowers teachers to create innovative teaching materials.

The CLIL-Pyramid was created to visually illustrate that achieving high-quality CLIL, based on the principles of the 4Cs-Framework, necessitates considering all four Cs in lesson planning and material development. These four Cs serve as the foundation of the CLIL-Pyramid, emerging when lines originating from each corner converge (Fig. 2) and is intended to serve as a tool that aids teachers in planning lessons and constructing/adapting materials (Meyer 2013: 308).

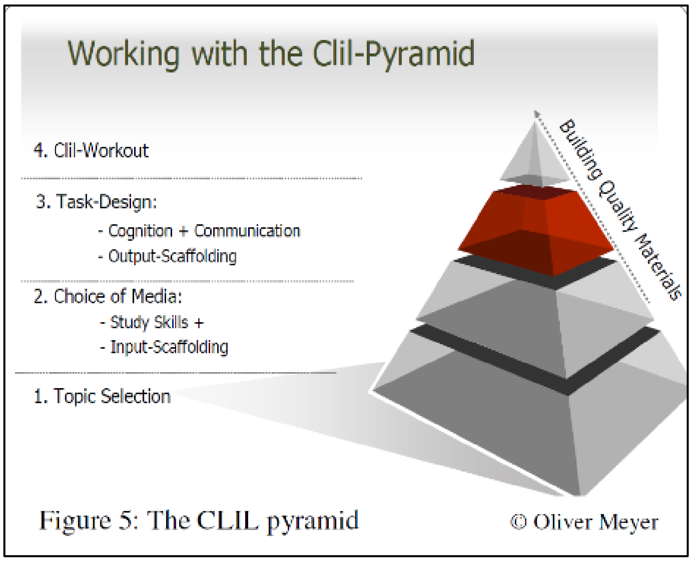


Figure 2: The CLIL-Pyramid (Meyer 2013: 308)

The CLIL-Pyramid proposes a systematic and proven sequence for planning CLIL units and materials, beginning with topic selection and concluding with a comprehensive review of key content and language elements, referred to as the CLIL workout. In practice, this would entail following the four steps displayed in the pyramid (see Meyer 2013: 308):

1. The foundation of planning a CLIL unit lies in selecting content that aligns with the specific needs of the subject, serving as a crucial starting point for material development.
2. Creating multimodal input and evenly distributing it throughout the new CLIL unit results in adaptable materials, catering to diverse learning styles and engaging various language skills. Multimodal input also fosters the development of new literacies.
3. The type of selected input and students' familiarity with it, dictate the amount and type of scaffolding required. It also indicates which subject-specific study skills should be practiced helping students effectively comprehend and engage with the input.
4. Tasks should be strategically designed to stimulate higher order thinking skills (HOTS) and encourage authentic communication and interaction in different formats.

3.1.3. From BICS to CALP

In order to answer the question as to how language proficiency can be conceptualised in connection with academic development, Cummins (2000: 58) suggested a fundamental distinction between conversational and academic aspects of language proficiency which he distinguished into *BICS* (Basic Interpersonal Communicative Skills) and *CALPS* (Cognitive Academic Language Proficiency). In an educational context, BICS include everyday language and the numerous contextual clues that facilitate comprehension such as situations where learners can use visual cues, gestures, or facial expressions to communicate with each other (Dale, van der Es & Tanner 2011: 46). This conversational proficiency is achieved relatively early by language learners, as opposed to the more formal, academic language proficiency which is acquired at a later stage. CALP thus requires higher thinking skills, following Bloom's taxonomy (1956), and clues that aid understanding are reduced or omitted entirely. It is part of the teacher's job to guide the students from BICS to CALP and finally be able to understand and produce more complex language. Dale, van der Es and Tanner (2011: 125) suggest that learners have two needs:

- being able to showcase what they know about a subject (with or without language).
- to be pushed to use more complex language to express complex ideas.

These two basic needs, exemplifying the continuum between BICS and CALP, need to be carefully balanced by teachers and moving from one end of the spectrum towards the other requires substantial amount of scaffolding.

In practice educators must choose an appropriate approach depending on the learning goals, especially when it comes to the use of complex linguistical structures which characterise scientific discourse. Therefore, two approaches concerned with technical language in the scientific domain are presented below. Both have in common the concern to make scientific language commonplace for pupils, so that they can identify with its ideas and contents.

1. The pupils are first taught the biological content in familiar everyday language, which they then translate into technical language. Brown and Ryoo (2008: 530) illustrate that learning complex languages is not a problem for most people, using the example of communicating rules and procedures in American football. As in technical languages, sports are about understanding symbols, technical terms and concepts that are not found in everyday language. So, as in sports, when students learn a new language, they need to embrace the idiosyncrasies of what it expresses. Therefore, Brown and Ryo (2008: 533) call for a "content-first approach", in which scientific ideas are first taught in everyday language and with the use of illustrative material, and only then should technical language be introduced.

2. The second approach assumes that the meaning of words is revealed through their use in the corresponding situation, i.e. in the context of learning technical concepts. Rincke (2010: 245) questions the extent to which learning a technical language is comparable to learning a foreign language. In contrast to learning a foreign language, where pupils at first merely have to express familiar thoughts and ideas in another language, in subject lessons they have to master phenomena that are not yet familiar in a language that is still largely foreign. On the other hand, in the case of abstract terms or terms that have a more restricted or different meaning in the technical language, these can only be developed in the corresponding context. Rincke (2010: 247), for example, mentions the concept of force, the core of which is to be grasped by the statement "exerting force on ...". In addition to physics, there are also a great number of concepts in Biology that are abstract and not easily understood (for example, terms such as fitness, species, territory, meiosis, enzyme reaction, etc.). Their disciplinary dimension can only be developed by using them in a disciplinary context.

Depending on how accessible a biological phenomenon is to experience, the science classroom will mostly follow the content-first approach or learn a concept by using it, and even use a combination of both models. Furthermore, teaching experience shows that students often develop a separate linguistic system described by Selinker (1972: 214) as "interlanguage" in the struggle for appropriate, fluent representation. This becomes especially important when dealing with abstract, scientific concepts as discussed above. The dilemma of using a language that is not yet familiar correctly seems to lead to neglect of either technical or linguistic accuracy. This erroneous learner language, however, may be joyfully welcomed as an expression of the learner's language learning process to meet both linguistic and subject requirements.

3.1.4. Cummins´ Quadrants

In line with best practice, educators should ensure that their teaching is appropriate to the relevant subject- and language-level. Teachers play a crucial role in providing academically challenging content while also ensuring that the linguistic complexity is manageable for the students. Cummins' model of four quadrants (2000: 68) helps to describe and discern the cognitive and language levels of lesson input, differentiating between the previously mentioned Basic Interpersonal Communication Skills (BICS) and Cognitive Academic Language Proficiency (CALP) levels. Figure 3 has been adapted from Dale, van der Es and Tanner (2011: 47) and considers the following quadrants, which illustrate varying degrees of difficulty for a Biology lesson about genetics:

<table>
<tr><td colspan="5">COGNITIVELY UNDEMANDING</td></tr>
<tr><td rowspan="2">CONTEXT EMBEDDED</td><td>Quadrant 1
Picture-Book designed for students telling the story of Mendel the scientist</td><td>Quadrant 3
Podcast for students consisting of a fictitious interview with Mendel</td><td rowspan="2">CONTEXT REDUCED</td><td>BICS</td></tr>
<tr><td>Quadrant 2
Nature documentary on inheritance</td><td>Quadrant 4
Scientific article on inheritance</td><td>CALPS</td></tr>
<tr><td colspan="5">COGNITIVELY DEMANDING</td></tr>
</table>

Figure 3: Cummin's Quadrants (Dale, van der Es & Tanner 2011: 47)

In Quadrant 1, the lesson input is relatively straightforward both in terms of cognitive complexity and language proficiency. The content is presented in everyday language and supported by visual cues so that students can grasp the key concepts easily. This level is suitable for introducing basic ideas or providing simple explanations, such as familiarising the pupils with a prominent figure in hereditary sciences.

Quadrant 2 involves academically challenging content presented in more abstract language. The concepts discussed might be more advanced, requiring higher cognitive processing, but the contextual cues make them accessible to the students. Teachers might use visuals or context-rich examples to make the subject matter more approachable.

Conversely, in Quadrant 3, the lesson input presents content that is conceptually easier, but there is little surrounding context to support the learners. Teachers might provide language support, such as scaffolding and vocabulary explanations, to help students comprehend the subject matter effectively.

The 4th Quadrant involves both academically challenging content and sophisticated language use. The lesson input is at a high cognitive and language level, presenting complex ideas and using domain-specific terminology while at the same time often abstaining from helpful illustrations or visual cues to support the text. Students may need significant language support and explicit instruction to navigate through this level of difficulty.

By employing Cummins' Quadrants, CLIL teachers can strategically design their lesson input, ensuring an appropriate balance between academic rigor and linguistic accessibility. This approach enhances students' content learning while simultaneously developing their language proficiency within the subject context (Dale, van der Es & Tanner 2011: 48). Furthermore, this model can also enable the teacher to assess pupils’ productions differently in different situations by estimating the exercise’s demands in correspondence to the Quadrant’s axes.

3.2. Assessment in CLIL

Evaluation and feedback play a pivotal role in the learning process. In the context of CLIL, how teachers assess their students and provide feedback directly impacts their learning experiences, both within and outside the classroom. Assessment and feedback have the potential to motivate learners to enhance their comprehension of subject matter and to foster appropriate and precise language usage (Dale, van der Es & Tanner 2011: 171). However, specifically in CLIL assessment it is common to emphasize content-subject aspects while minimizing, or even excluding, the language dimension in evaluation (Wolff, 2013: 23). Coyle, Hood and Marsh (2010: 117) advocate for directly testing content-subject related competencies through tasks that require minimal language use. However, this approach has limitations and may not be entirely practical. As Dale, van der Es and Tanner (2011: 176) highlight, thinking and language are intertwined, making appropriate language use unavoidable. Integrating language assessment in CLIL becomes relevant for every teacher, focusing on subject-specific linguistic competencies rather than language competence testing itself (Coyle, Hood & Marsh 2010: 120). This means setting up classroom activities that help learners achieve the lesson aims regarding both content and language (Dale, van der Es & Tanner 2011: 176).

Aligning tasks to assess both content and related language competencies is desirable, and descriptors and rubrics prove to be valuable tools in this regard. A rubric is an evaluation instrument presented as a matrix that assesses a learner's advancement according to multiple criteria, rather than a single score (Davis 2015: 238). Such rubrics can take on a variety of different forms and can be tailored to suit various forms of assessment to further promote the learning process. The impact of assessment on this process, often referred to as the backwash effect, has led to a distinction between two types of assessment: assessment of learning and assessment for learning (Dale, van der Es & Tanner 2011: 177).

These terms are also known as summative and formative assessment, respectively, and the distinction lies in the purpose of the assessment. Assessment of learning aims to provide a summary of what learners have already acquired. It measures and reports their progress to both themselves and teachers or parents. Learners prepare for this type of assessment by, for instance, acquiring the necessary knowledge items and reproducing them during a test. On the other hand, assessment for learning is employed in the classroom to enhance learners' achievements rather than solely measuring them. It is rooted in the idea that students make the most progress when they understand the learning objectives, their current position in relation to these objectives, and the strategies to bridge the gap in their knowledge or skills. To achieve this, assessment tasks are designed to clearly identify gaps in learners' understanding and knowledge, creating a need to address and close these gaps effectively (Dale, van der Es & Tanner 2011: 177).

Another crucial step in effective assessment is sharing objectives and providing success, as they allow learners to understand not only what they will be learning but also how their work will be evaluated throughout the process and upon completion (Coyle, Hood & Marsh 2010: 121). It is essential to express these intentions with concrete statements, not only due to potential linguistic constraints in a CLIL context but also because it aligns with best assessment practices. The complexity of this stage can be tailored to match the cognitive abilities of older and more advanced learners, allowing for a more comprehensive reference to their previous knowledge if their language proficiency permits. Visual support, such as pictures, maps, key vocabulary, or diagrams, can aid in ensuring all learners comprehend the content of the goals set by the teacher.

Lastly, enabling learners to express their responses to tasks in a straightforward manner is crucial to ensure that language does not hinder their ability to demonstrate comprehension of the content. Utilizing uncomplicated assessment formats offers several advantages: it requires minimal language proficiency to trigger content recall and facilitates cognitive engagement and organization of thoughts, ultimately leading to an optimal display of knowledge (Coyle, Hood & Marsh 2010: 123). Exploring less commonly used methods, such as self- and peer-assessment, presentations, or even an adaptation of Cummin's Quadrants, can further enrich the assessment process. However, teachers should consider testing content using the language of instruction to avoid creating a barrier hindering students' performance due to limited terminology in the respective L1 (Coyle, Hood & Marsh 2010: 118).

4. Cognitive Discourse Functions in education

4.1. Theoretical background

Content and Language Integrated Learning (CLIL) has been defined as an educational setting "where a language other than the students' mother tongue is used as a medium of instruction" (Dalton-Puffer 2007: 1). Due to the exponential increase of CLIL programmes all over the globe, a plethora of different interpretations, theoretical underpinnings, and frameworks of what "doing CLIL" entails have emerged across national curricula and across different school subjects and disciplines In an attempt to bridge the gap between the numerous pedagogies, Dalton-Puffer (2013: 231) introduced seven Cognitive Discourse Functions (CDFs) which are defined as recurrent language patterns that are used to express and communicate thinking processes. These labels are, however, not only meant to provide an intersection between different cultural applications of CLIL but rather aim to "fulfil the requirement of conceptualizing content and language integration for education in a non-trivial way." (Dalton-Puffer 2013: 232) While CLIL programmes over the past years have struggled to effectively invoke language and content goals alike, something described by Lin (2016: 59) as "intercurricular disconnect", CDFs both integrate the communicative and conceptual dimensions of learning. As such, CDFs highlight how language is "a natural concern of non-language educators […], commensurate with the educational goals they want to reach in their respective subjects […], formulated in terms that are accessible to them from within the ambit of their own disciplines" (Dalton-Puffer & Bauer-Marschallinger 2019: 33). Furthermore, they enable teachers to design more output-oriented lessons by providing educators with operationalised learning goals that assist students in building knowledge and, crucially, function as building blocks for subject specific genres (Coyle & Meyer 2021: 78). The following Table 1. Illustrates the seven elements, which again comprise several constituents, differing in size and scope:

CDF Type	Label	Communicative Intention	Members
1	*Categorize*	I tell you how we can cut up the world according to certain ideas	Categorize, classify, compare, contrast, match, structure, subsume
2	*Define*	I tell you about the extension of this object of specialist knowledge	Define, identify, characterize
3	*Describe*	I tell you details of what can be seen (also metaphorically)	Describe, label, identify, name, specify
4	*Evaluate*	I tell you what my position is vis a vis X	Evaluate, judge, argue, justify, take a stance, critique, recommend, comment, reflect, appreciate
5	*Explain*	I give you reasons for and tell you cause/s of X	Explain, reason, express cause/effect, draw conclusions, deduce
6	*Explore*	I tell you something that is potential	Explore, hypothesize, speculate, predict, guess, estimate, simulate, take other perspectives
7	*Report*	I tell you about sth. external to our immediate context on which I have a legitimate knowledge claim	Report, inform, recount, narrate, present, summarize, relate

Table 1: CDF types, intentions, and members, based on Dalton-Puffer (2013) and remodelled after Coyle and Meyer (2021)

The seven elements of the construct depicted above serve as a quasi-umbrella term for its numerous members which are not less important and possess no inherent hierarchical structure. However, one can observe that not all designations are equally populated, as *Evaluate* consists of nine members, while *Define* merely holds three (see Table 1). Consequently, the scope of the different categories does vary significantly seeing as they are neither equally populated, nor equally extensive (Dalton-Puffer 2013: 235).

The scarce amount of criticism voiced in connection with CDFs is not necessarily directed towards the construct itself but its appropriate implementation in classrooms. As with any other lexemes of any other language, the labels themselves possess no unitary meaning, however, they function as "networks which are activated differently in different contexts" (Dalton-Puffer 2013: 235). This means that regardless of the content subject being taught in connection with CDFs, they ought to elicit a meaningful response from the student in terms of subject and language knowledge. "As such, they are a bridge between content learning objectives, the specific types of communication (literacies) associated with academic subjects, and the language used to express knowledge and thinking." (Morton 2020: 8) Dating back to Bloom's taxonomy (1956) teachers have always used operations such as *define*, *describe*, or *explain* in their classrooms for instruction-giving. Today there is still an observable emphasis placed on the teachers using CDFs instead of learners' mastery of skills (Coyle & Meyer 2021: 80). To facilitate the latter, educators must provide their students with appropriate scaffolding and opportunities to practice newly acquired content and language knowledge. After all, only in assessment will "the extent to which students are able to language their understanding […] [become] visible and reveal[s] their level of understanding." (Coyle & Meyer 2021: 80)

4.2. CDFs and Biology-teaching

Linguistic patterns of action such as descriptions, explanations and argumentations are commonly used in scientific education, i.e. Biology classes (Erduran & Jimenéz-Aleixandre 2007: 5). These roughly correspond to the CDF labels *Describe*, *Explain,* and *Explore*. Although the theoretical basis for these operators is a different one (see Chapter 5.3.) they fulfil a similar task in the classroom.

Descriptions can serve different purposes in Biology lessons. Depending on whether one wants to classify living organisms taxonomically or place them in an ecological category, one will label them differently. Descriptions are an indispensable prerequisite for understanding structure-function relationships, when it comes to evaluating bioethical problems, pupils describing sentiments, or in finding possible solutions to conflicts.

Explanations extend this search for possible solutions by clarifying states of affairs, placing them in a larger context, presenting reasons and rationales, and thus making things comprehensible. Through explanations, descriptions of phenomena become meaningful and lead to applicable knowledge. The ability to explain is also indispensable in the context of participation in social discourses (Toulmin 2003: 96). In both classroom and extracurricular contexts, explanations are very often given orally. Explanations are not a finished product but are created interactively in a process in which the addressee of an explanation indicates through verbal and non-verbal signals to what extent he or she can and wants to follow an explanation.

There are five reasons why argumentation plays a central role in science education (Erduran & Jimenéz-Aleixandre 2007: 6):

1) Making cognitive and metacognitive processes visible,
2) Developing critical thinking skills and communicative competences,
3) Building an understanding of science,
4) Scientific socialisation and
5) Development of logical rationality and reasoning strategies.

In arguments, a distinction can be made between "adversarial argumentation" and "collaborative argumentation". The former, similar to political debates, aim at winning an argument, whereas the latter serve the joint negotiation of facts (Nussbaum 2011: 85). Argumentation also involves drawing each other's attention to difficulties or jointly exploring, constructing, and assessing difficult situations (Osborne 2010: 463). In his work "The Uses of Argument", Toulmin (2003) describes the basic components of argumentative debate and presents a model of argument structure. Each argument consists of an assertion that is linked to data via rules of inference. In more sophisticated arguments, this basic structure can be extended and consolidated by evidence, support, limitations, and counterarguments (Toulmin 2003: 97).

5. Biology and CLIL

The inclusion of Biology in a CLIL curriculum provides students with the opportunity to develop their knowledge and understanding of the contents of Biology, the language used to communicate scientific concepts as well as become scientifically-literate. Through the previously discussed CLIL methodologies, students not only acquire the necessary academic insights in Biology but also develop their cognitive abilities and language skills. This integration of content and language learning in Biology CLIL classrooms enhances students' overall understanding and promotes deeper engagement with the subject matter.

5.1. Biology as a subject in Austria

Curricula have always served as a foundation for teaching, providing educators with essential tools for lesson planning, design, and development. They also serve as a guide, offering direction regarding the intended learning objectives. Additionally, curricula serve as a fundamental source for creating teaching materials such as textbooks and resources, as well as for the initial and ongoing training of teachers. While curricula play a pivotal role in successful teaching and learning processes, it is equally crucial that they adapt to a rapidly evolving society. Therefore, they should prioritize the acquisition of competencies that hold significance in the future and can be applied to real-life situations. In pursuit of this objective, the Ministry of Education (BMBWF 2023a) has endeavoured to prepare Austria's school with updated curricula for primary and lower secondary levels.

Especially the Biology subject curriculum establishes connections between real-life phenomena accessible to students and subject-specific contents presented in practical applications. Through engaging with this content, students are expected to develop an understanding of the “key technical concepts” (Basiskonzepte) in Biology and environmental education (Müllner et al. 2023: 2). These fundamental ideas and principles in Biology play a crucial role in content selection and identifying the foundational expertise the pupils ought to acquire.

These concepts are rooted in the understanding that Biology encompasses recurring principles that manifest at various levels of organisation, connecting diverse phenomena across different levels (BMBWF 2023b: 1). There are a total of five key technical concepts which allow for the explanation and classification of a range of phenomena, providing support in organizing and interconnecting content from different areas (BMBWF 2023b: 2):

1. Structure and function (Struktur und Funktion)

Functional traits of organisms provide insights into their purposes. Throughout evolution, structures can emerge, change, or even disappear.

2. Reproduction (Reproduktion)

The passing on of genetic material occurs through sexual and vegetative reproductive processes. Sexual reproduction contributes to the diversity of organisms and serves as a foundation for evolutionary adaptability.

3. Evolution and kinship (Evolution und Verwandtschaft)

The variety of living organisms, both within a species and beyond, results from genetic recombination through sexual reproduction and mutations. Diversity drives evolutionary processes, and selection plays a vital role in shaping the relationships among all living beings.

4. Control and regulation, information and communication (Steuerung und Regelung, Information und Kommunikation)

At all levels of biological systems, there are mechanisms for control and regulation to sustain the system. These systems respond to internal and external changes. Living organisms have the capability to generate, process, transmit, store, utilize information, and communicate with other systems.

5. Substance and energy conversion (Stoff- und Energieumwandlung)

Living beings are intricately involved in the transformation of matter and energy. Plants predominantly construct organic compounds. Within ecological systems, building materials and energy sources mostly undergo closed cycles. Human activities can alter these cycles.

These key technical concepts serve as core ideas in Biology lessons, aiding students in identifying the interconnections among different lesson contents throughout their academic journey. The goal is to equip students with the ability to apply their comprehension of these principles to unfamiliar phenomena. By grasping the central subject-related concepts pupils can effectively organize the vast array of biological phenomena (Müllner et al. 2023: 3). The teaching activities and tasks devised for that purpose should enable students to acquire these subject-specific competences. The ultimate goal is for students to possess a foundational grasp of concepts and competencies that will serve them in their future academic and professional endeavours, fostering a reflective approach to handling information and opinions on socially relevant topics pertaining to Biology beyond lower secondary school (Müllner et al. 2023: 2). Furthermore, the ongoing advancements in communication technologies should be incorporated into the teaching of Biology and environmental education. This involves giving students opportunities to engage with simulations, digital measurement techniques, and other computer-aided methods within digitally supported Biology and environmental education lessons (as elaborated in section 6).

5.2. Scientific language vs. Scientific literacy

Having talked about the importance of pluriliteracies in the CLIL classroom before, one must consider the arguably most crucial aim in natural sciences, namely the development of "scientific literacy" defined by the OECD (2013: 7) as follows:

> Scientific literacy is the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen. A scientifically literate person, therefore, is willing to engage in reasoned discourse about science and technology which requires the competencies to:
>
> 1. Explain phenomena scientifically [...]
>
> 2. Evaluate and design scientific enquiry [...]
>
> 3. Interpret data and evidence scientifically [...]

Hence it refers to the ability to apply scientific knowledge, to recognise scientific questions and to draw conclusions from evidence in order to understand and make decisions concerning the environment and the changes made to it by human activity. In addition, the OECD (2013: 9-10) makes a distinction between "knowledge of science" and "knowledge about science" both of which pertain to the utilization of scientific knowledge for comprehending and making informed choices concerning the natural world. "Knowledge about science" can be viewed as subject-specific, meaning it is necessary or at least beneficial to enhance comprehension of factual Biology knowledge and to classify it within the methods and theories of the science. In this context, Kattmann (2003: 117) defines scientific literacy as an approach aimed at reinforcing cumulative learning and understanding processes in Biology, rather than merely acquiring knowledge in an additive manner.

Coming back to the three competencies required for scientific literacy and the contexts in which they may be used, the following statements can be made:

<u>C1: Explain Phenomena Scientifically</u>

The mission of science lies in its development of explanatory theories that have revolutionised our comprehension of the natural world. This knowledge has facilitated the creation of technologies that enhance human life. Proficiency in explaining scientific and technological phenomena, therefore, hinges on a thorough understanding of these fundamental scientific explanations. However, explaining scientific phenomena goes beyond merely recalling and utilizing theories, explanatory ideas, information, and facts, it also entails an awareness of how such knowledge is derived and the level of certainty we can attribute to scientific claims (OECD 2013: 8). To possess this competence, one needs to be acquainted with the standard methods and procedures employed in scientific inquiry to acquire knowledge. Additionally, understanding their role and function in substantiating scientific knowledge is essential in providing scientific explanations (OECD 2013: 8).

When looking into scientific phenomena, one can find information and different perspectives through various media outlets. Additionally, students may receive information from professional sources, like medical doctors or scientists themselves. The ability to comprehend, connect, and interpret this diverse information from multiple sources forms the foundation for the first competency in question (Vollmer 2010: 8).

C2: Evaluate and Design Scientific Enquiry

In order to produce reliable knowledge about the natural world, scientists collect and analyse data through observation and experimentation, both in laboratories and field settings, which leads to the creation of models and explanatory hypotheses (OECD 2013: 8). Scientific progress often builds upon existing knowledge, and researchers frequently collaborate with colleagues nationally and internationally. Furthermore, scientific knowledge is always considered tentative and subject to critical peer review. It must permit replication and verification of results and embrace its uncertainty by allowing for the repetition of measurements, increases in sample sizes or the development of more accurate instruments and statistical techniques to assess confidence in its findings (OECD 2013: 8).

Scientific literacy thus stands for both learning about a content and for students to ask questions and follow empirical modes of operation. With this approach, the emancipatory goals of science education and the interest in qualifying to study science are promoted, as pupils work as a "community of inquiry" (Sprod 2014: 1544). Students learn that the core of scientific working methods is to argue, discuss and look and listen carefully.

C3: Interpret Data and Evidence Scientifically

Interpreting data is a fundamental part of all scientists' professions, and a basic understanding of this process is crucial for scientific literacy. Data interpretation involves anything from identifying patterns and constructing basic visualizations to handling complex data sets using spreadsheets and statistical packages (OECD 2013: 9). In order to make informed choices about how to interpret data, however, learners require a significant amount of knowledge to draw from (C1). A scientifically literate individual should also grasp that uncertainty is inherent in all measurements, and the likelihood of a finding occurring by chance is one criterion for expressing confidence in it (OECD 2013: 9). Biology lessons therefore have the central task of enabling pupils to use and reflect on texts, pictures, diagrams and symbolic representations with scientific content to understand such concepts and processes and to be able to interpret them correctly from a subject-specific point of view (Nerdel, Nitz & Prechtl 2019: 150). Moreover, a scientifically literate individual must possess the ability to assess the appropriateness of these procedures and the validity of resulting claims. For instance, various datasets can be open to multiple interpretations, making argumentation and critique crucial in determining the most appropriate conclusion (OECD 2013: 9).

5.3. The Competency-Model in Natural Sciences

One way to integrate the concept of scientific literacy into everyday school life would be via the so-called "Kompetenzmodell Naturwissenschaften" presented by the BIFIE (2011) on behalf of the Ministry of Education. Merely acquiring and reproducing subject knowledge is no longer sufficient for successful completion of school. Instead, students should develop competencies, which refer to learnable cognitive skills and abilities (Weinert 2001). These competencies enable students to apply their acquired knowledge effectively in relevant and complex problem-solving situations.

The model is structured into three branches, thus creating a three-dimensional framework. Each of the three branches is further divided into different levels encompassing specific skills that students should develop.

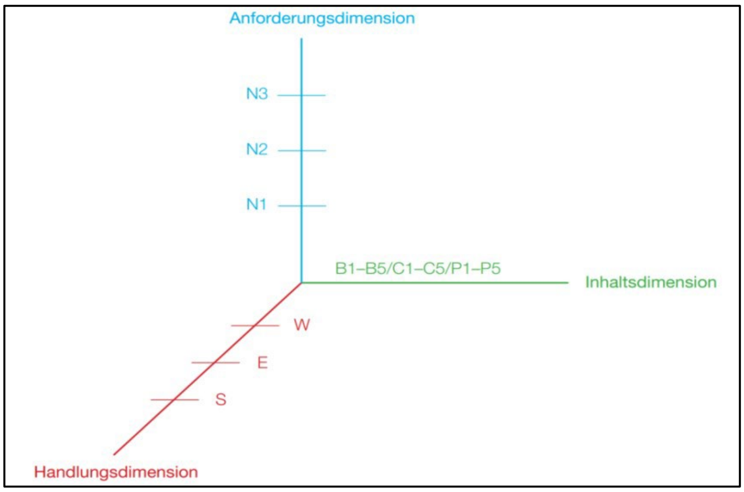


Figure 4: Competency-model in Natural Sciences (BIFIE 2011: 1)

The first one comprises the "Handlungsdimension" (BIFIE 2011: 2) which can again be subdivided into three competencies of action that include organising knowledge (W), gaining insights (E) and drawing conclusions (S). At this point it is important to notice that contrary to the other branches, the different levels do not necessarily entail a varying degree of difficulty. Similar to the previously discussed competencies of scientific literacy (C1-3), however, the competencies of action (W,E,S) are interdependent and often not clearly separable from each other.

In organising, acquiring, representing, and communicating knowledge (W 1-4), students should be capable of describing and naming natural processes and phenomena and extract subject-specific information from different media sources. Furthermore, they must be able to present that information in different forms to effectively communicate their findings and understand and describe the effects of processes in nature, environment and technology on the environment and the living world. Competency "E" is about gaining knowledge and therefore structured as the empirical working method (E 1-4). Firstly, students make observations and carry out measurements of processes and phenomena in nature, the environment and technology, to then ask questions and make assumptions about them. Subsequently they ought to plan, carry out and record a suitable investigation or experiment and analyse and interpret its results. Finally, learners draw conclusions from the knowledge they have gained and organised (S 1-4). They are expected to evaluate varying data from a scientific point of view and draw conclusions from it. At the same time, they ought to recognise the significance, opportunities and risks of the applications of scientific knowledge for themselves, society and various occupational fields. Finally, they should argue in a technically correct and logical manner and distinguish scientific from non-scientific arguments and questions.

The second axis represents the "Anforderungsdimension" (BIFIE 2011: 2-3) or requirement-dimension, comprising three levels of increasing difficulty. The first level (N1) involves tasks heavily reliant on teacher support, primarily focusing on reproducing and describing biological topics using everyday language. The second level (N2) demands students to utilize a limited number of learned technical terms and models, and they should be partially self-directed in their work. The final level (N3) emphasizes students' autonomy in solving tasks and requires them to make connections between and use complex scientific concepts. At this level, students should also be capable of employing a broader range of technical terms and models.

The third axis, known as the "Inhaltsdimension" (BIFIE 2011: 3) or content-dimension, covers some topic areas to be addressed in lower and upper secondary Austrian Biology classes (B1-5), along with physics and chemistry subjects. Again, there is no observable hierarchy among the subject areas, since they mostly address different topics anchored in the curriculum and to be dealt with in the classroom: "Planet Earth (B1), Ecosystems (B2), Organisms (B3), Organs (B4) and The Cell (B5)" (BIFIE 2011: 3).

The model's classifications and detailed explanations for each level make it a valuable tool for lesson planning and creating teaching materials, serving as a supplement to the curriculum. The competency descriptions within the areas of competence W, E, and S should be connected to relevant application areas that correspond to specific school levels. These descriptions facilitate the acquisition and utilization of competencies while enhancing the comprehension of essential subject-related concepts. The application areas are subject-specific, representative, and obligatory, with the possibility of expanding them based on actual teaching settings (BMBWF 2023b: 3). In addition, the competency-model is applied in the Matura exams where students receive a task that prompts all sub-competencies cited within the action-dimension (W,E,S). The content-dimension, in this case, represents the subject pool of the topics from upper secondary and the requirement-dimension of the tasks (N1-3) cannot be directly transferred to the competence-based Matura, seeing as the model was originally devised for lower secondary (BIFIE 2012: 10).

5.4. Competency-based operators in Biology teaching

Starting from the academic year 2014/2015, both the written and oral Matura-exams in Austria have adopted a competence-oriented approach. To align with the competence-oriented approach, appropriate linguistic formulation of tasks is essential, and is achieved via the use of "operators." Operators are action-initiating verbs in the imperative form, specifically designed to promote action-oriented task formulation (Reichstädter & Müllner 2021: 1). Their purpose is to precisely instruct students on what actions they need to perform, providing clear guidance for their responses. Operators serve the goal of achieving a transparent structure and ensuring the clarity of examination tasks, indicating which activities are expected to be performed when working on them. Since 2013, teachers have been supported in the development of Matura examination tasks on the initiative of the Austrian Educational Competence Centre for Biology (AECC), with the aim of jointly creating a task pool with competence-oriented Matura examination tasks (Wenzl et al. 2016). The aim of competence-oriented examination tasks is to make the competencies acquired by the students visible and to enable the assessment of their level of competence reached (Wenzl et al. 2016: 462). In addition to the action-dimension introduced by the competency-model (BIFIE 2011), the Matura-examination tasks are complemented by competence-oriented subtasks from the performance dimensions “Reproduction” (Rp), “Transfer” (Tr) and “Reflexion and Problem solving” (Rf).

	Rp	Tr	Rf
W			
E			
S			

Figure 5: Competency-grid (Reichstädter & Müllner 2021: 3)

Similar to the previously discussed CDF construct (Dalton-Puffer 2013) the operators used for such competence-oriented tasks are recurrent language patterns people use to express and share their thought processes. In an educational or academic context, they tell the learners what is expected of them, and they can aid teachers in posing more than merely knowledge-reproduction tasks by providing them with a “conceptual base for language-aware pedagogical planning and pedagogical action that speaks to subject educators in terms they can accept as 'theirs' and thus has a chance of being translated into practice" (Dalton-Puffer & Bauer-Marschallinger 2019: 32–33).

Although all these language patterns have their lowest common denominator and origin in Bloom's highly influential taxonomy (1956), they differ in a number of ways. Arguably the greatest difference between the CDF-construct and the operators devised for Biology teaching, is that the former has been established for the purpose of CLIL-teaching and thus exhibits a transdisciplinary status and claims to remain unaffected by field-specific requirements (Dalton-Puffer 2013: 232). While neither of the frameworks use exclusive, subject-specific linguistic patterns, the Biology-operators are tightly linked to the competency-model (BIFIE 2011) as to how they are defined. This becomes discernible when juxtaposing the CDF category *evaluate* and the operator *argumentieren*. Without further context one might assume that the two words serve the same linguistic purpose, especially since the verbatim translation of the operator, *argue*, is a member of the CDF category. Nonetheless, the communicative intention of the cognitive discourse function is formulated much more generally ("I tell you what my position is vis a vis X" (Dalton-Puffer 2013: 234)) as opposed to the definition of the operator ("Behauptungen, Einschätzungen oder Wertungen durch naturwissenschaftlich fundierte Belege, Beispiele oder Vergleiche stützen." (Reichstädter & Müllner 2021:3)). Special attention should be paid to the use of the word "naturwissenschaftlich" in this context, as it is directly related to scientific subjects such as Biology and can therefore not be regarded as interdisciplinary. That being said, a differentiation along field-specific requirements is desirable due to the fact that diverse educational goals demand a diverse taxonomy of educational objectives. In order to meet these demands, CDFs must embody an intermediate level of generality, which is why the first criterion that the construct must meet is that it "should be differentiated to such a degree that it reflects conceptual distinctions made in subject-specific educational goals." (Dalton-Puffer 2013: 232)

Another difference between the competency-based operators in Biology teaching and CDFs is that the former include language functions that are explicitly applied to written production. Operators such as *zeichnen* (draw), that is defined as sketching observable or given structures, *darstellen* (illustrate) which entails transferring contexts, facts or similar into a pictorial form of representation and *beschriften* (label), where learners must assign a name to elements in a sketch, drawing or illustration, can hardly be applied in a non-written format (Reichstädter & Müllner 2021: 3-7). In contrast, some of the members of the relatively neutral CDF categories, such as *name, comment* or *narrate* can more commonly be associated with oral rather than written practice. Furthermore, one could argue that the operators are framed in more concrete terms and encompassed by ample context. This might not come as a surprise, since their application is aimed towards the competency-based Matura which demands precise assignments of tasks with the goal to enable comparability across schools and subjects. However, no matter how precise they ought to be, these labels are still lexemes and, as such, exhibit the characteristics of ordinary words: their meanings are not singular and fixed but rather form networks that activate differently in various contexts (Dalton-Puffer 2013: 235). However, to enable a more precise field of application, related operators, i.e. those whose meaning appears very similar at first glance, can be distinguished from one another. Particular challenges arise when distinguishing between *erklären* (explain) and *erläutern* (describe and explain) in German. These two operators can be viewed as a continuum with increasing cognitive requirements (Reichstädter & Müllner 2021: 5). *Erklären* is employed when integrating facts into a broader biological context to make them understandable. The broader biological context refers to theories, models, laws, rules, and functional relationships. *Erläutern* represents a higher level of cognitive demand, where a fact or illustration must be both described and clarified. The emphasis here lies on clarity and comprehensibility. The boundary between *erklären* and *erläutern* is fluid, and the teacher's choice of which operator to use depends on the expectations and demands of the task (Reichstädter & Müllner 2021: 8).

Both CDFs and the introduced operators can serve as a tool to meet the demands of today's competency-based curricula. The utilisation of competency-based operators plays a crucial role in classroom teaching as it helps students become acquainted with this novel approach to posing questions and empowers them to demonstrate their competencies effectively during the Matura-exam. The strong reference to the Matura is visible in the labelling of the competence grid (Fig. 5), which combines elements of the written (W,E,S) and oral (Rp,Tr,RF) competence areas of the Matura examination in Biology. Hence, it is advisable that pupils are exposed to this method of task-setting early on to familiarise themselves with the operators, effectively avoiding misunderstandings. Making the operator catalogue and the associated assessment criteria transparent to students is fair, as it allows them to clearly understand which standards have been applied to which task. It further helps teachers to ensure the most accurate and fair assessment possible, supported by definitions of the individual operators and examples that illustrate their appropriate use (Reichstädter & Müllner 2021: 3-7). Most importantly, the competency-grid also enables teachers to formulate exam questions that cover various areas of competence. All operators cover one to two boxes that are composed of the competence areas of the written and oral maturity-examination. For example, *beschreiben* (describe) in this context involves presenting processes, facts, contexts, or related issues in a structured and precise manner using technical language. As illustrated in Figure 6, this requires the student to reproduce (Rp) subject knowledge by previously acquiring it and now communicating it (W). This is a relatively concrete task that is usually completed in a short period of time. In contrast, the operator *begründe* (justify) in Figure 7 represents an instruction that occupies two areas in the competence-grid and thus places a higher cognitive demand on the pupil. The candidate must be provided with material with the help of which they are to trace a fact, an analysis result, a judgement, an assessment or evaluation back to causal connections (Reichstädter & Müllner 2021: 3).

	Rp	Tr	Rf
W			
E			
S			

Figure 6: beschreiben (describe)
(Reichstädter & Müllner 2021: 3)

	Rp	Tr	Rf
W			
E			
S			

Figure 7: begründen (justify)
(Reichstädter & Müllner 2021: 3)

Ultimately, this comparison draws attention to another common feature of the competence-oriented operators and the CDFs. Depending on their cognitive demand, both can be divided into micro- and macro-functions which means that the categories are not all equally extensive (Dalton-Puffer 2013: 235). While for the former this primarily holds significance when it comes to the compilation of questions for the Matura-exam, one must also pay attention to this asymmetry, specifically when designing CLIL lessons and material.

For the teaching project, which is to be discussed in more detail in the following chapters, the CDF construct has been chosen over the operators. Seeing as this teaching project is concerned with CLIL, and CDFs have been particularly devised for a CLIL context, the choice was not a difficult one. However, the divergences that ought to arise from the actual implementation of the project in the classroom are perhaps greater than the inherent differences between the two approaches.

5.5. Language-Sensitive Biology Teaching

The two sentences "The egg cell migrates to the uterus" and "The egg cell is transported to the uterus by the ciliated epithelium" ought to evoke different images in the mind. While the first statement makes the ovum move purposefully, the passive voice in the second sentence supports the scientifically appropriate idea of the transport of an ovum incapable of active locomotion. Being, or becoming aware of these linguistically conditioned differences in meaning is one facet of language-sensitive subject teaching. After all, the teaching and understanding of Biology are linguistically bound processes, and language generates and influences our ideas.

The idea of language-sensitive subject teaching (Leisen 2010) follows the premise that a promotion of linguistic skills should not be understood as an additional task. In every subject, language plays a central and subject-specific role. This is reflected in the use of technical terms ("uterus", "ciliated epithelium") or in the linguistic presentation of subject-specific working methods (descriptions of experiments, presentation of findings). Language sensitivity thus stands for the approach of consciously using the linguistic dimension of subject-specific teaching and learning processes and, based on the teaching content and working methods of a subject, developing strategies and methods that support the learners' linguistic abilities (Bleichenbacher et al. 2024). Language-sensitive action is taken when one is aware of the ideas that can be created with language and reflects on them together with the students. In the spirit of science teaching, which also strengthens the communication skills of pupils, it is important to make conceptual work and work on linguistic forms of representation an integral part of the subject lessons. However, language sensitivity in particular also means being aware of the possible linguistic difficulties of learners and planning and implementing targeted measures to strengthen linguistic skills in the context of the subject lessons. A major challenge, however, is that science subjects are often juxtaposed with language or social-science subjects from the perspective of both students and teachers, and Biology teachers with their presupposed self-conception as scientists may well find themselves in an identity conflict since they do not consider themselves sufficiently competent in the area of language promotion and language didactics (Tajmel 2010: 167). It is an important first step to understand language education or language support as a concern of the subject.

Science is based on communication and therefore it is not surprising that communication is one of the four basic competence areas for educational standards for science teaching, along with subject knowledge, insight acquisition and evaluation (KMK 2010). The emphasis on communication competence in the educational standards is not least due to the results of international comparative studies, which exhibit shortcomings in the appropriate and professional use of language in science teaching (Kramer 2009: 5). Thus, the task of educating students linguistically cannot be the sole responsibility of language teaching, the reason being that the specific, extended, cognitive and linguistic requirements of a subject cannot be easily met by teachers from outside the subject due to a lack of subject-specific competence (Becker-Mrotzek 2013: 7). The implementation of a language-sensitive Biology lesson, however, does not necessarily require linguistic didactic expertise, but demands conscious promotion of the oral and written language skills of the students, since the study of evolution, ecology and organisms, as well as the implementation of scientific work-methods require such competencies as of themselves (Kramer 2009: 6).

Those who can express themselves appropriately and participate in this context are in possession of so-called “educational language” (Gogolin & Lange 2011: 107). According to Vollmer and Thürmann (2013: 44), it is the ability to make a well-founded selection of linguistic and textual strategies and resources from available inventories that are appropriate for a specific situation and given tasks. Educational language is crucial for school and educational success and for the life chances that depend on it. This ability to communicate in a way that is appropriate to the subject and the addressee is particularly important with regard to students with a migration background, learning difficulties, and from so-called educationally disadvantaged families. The interconnection of education and language is expressed metaphorically in the term scientific literacy (Ratcliffe & Grace 2003: 38), which refers to the ability to recognize, understand and communicate scientific references in everyday contexts (PISA Consortium 2001). The guiding principle of such a communication competence related to scientific education emphasizes the social and everyday relevance of the natural sciences and aims to strengthen young people in their development and to enable social participation (Schmölzer-Eibinger 2013: 25). Through the application of language-promoting methods, concrete classroom actions can be identified within Biology lessons to which abstract educational goals, such as the promotion of critical thinking skills or the promotion of democratic citizenship, can be related. These are contents and activities in which students, for example, practice argumentation, present their methodological approach in writing or orally, interpret data and presentations, lead discussions about Biology and environmental ethics issues, or critically engage with technical texts and terms in class (Erduran & Jiménez-Aleixandre 2007: 3-5). The language of instruction, in the sense of the language used in teaching and learning in a non-technical context, can strengthen the educational language competencies of the learners, because everyday language and technical language expressions are used and related to each other in the teaching context. While everyday language is characterised by the fact that it is linked to everyday experiences and uses familiar vocabulary, technical language is characterised by a high density of technical terms and special sentence and text constructions.

Finally, language-sensitive teaching is a competency that has recently found entry into Austrian curricula. The seventh of the general didactic principles within the revised curriculum for lower secondary schools states that language-sensitive subject teaching ought to take place in all subjects (BMBWF 2023a: 10). Unfortunately, however, this does not hold true for the Biology curriculum, meaning that educators are left to their own devices when it comes to implementing this principle in their teaching. Proficient language skills in education are crucial for academic success, future prospects in the job market, and active engagement in political, economic, cultural, and social aspects of life. Students must possess the ability to use specialized language, articulate thoughts and reflections, pose inquiries, label, depict, and describe objects, as well as comprehend, justify, debate, and interpret facts. Apart from subject knowledge, educational language competencies are essential for executing these language actions. These competencies are gradually, age-appropriately, and consistently taught across all subjects and school levels (BMBWF 2023a: 10). Language-sensitive teaching aims to develop competences in everyday, educational, and technical language. It allows students to recognize the various registers of language and use them appropriately in different situations. According to the curriculum, teachers ought to actively support the acquisition of subject-specific vocabulary and language used in various subjects for which classroom lessons create language-stimulating scenarios and provide students with opportunities to experiment and practice language within an encouraging environment (BMBWF 2023a: 10).

6. The teaching project

6.1. Study design

The aim of this thesis is to create and evaluate suitable materials for CLIL classrooms following the CDF construct introduced by Dalton-Puffer (2013). While a larger amount of research has focused on the presence or absence of Cognitive Discourse Functions in CLIL classrooms (e.g., Bauer-Marschallinger et al. 2021), fewer scholars have dedicated their resources to designing appropriate classroom materials and making them available for teachers. The goal of this thesis is to address this research gap by means of producing CLIL materials for the content subject Biology on the topic of inheritance. The appropriate literature consulted and briefly summarised in the previous chapter aided the process of development based on the recommended course of action advocated in Dale, van der Es and Tanner's "CLIL Skills" (2011). However, the propagated modus operandum was expanded by the CDF model which lend itself superbly to be integrated into the planning.

Date	Class	Teacher	Topic
10.03.2022	4b	Mentor/ Language assistant	Cardiovascular system
15.03.2022	4c	Mentor	Endocrine system
17.03.2022	4b	Mentor/ Language assistant	Endocrine system
24.03.2022	4b	Mentor/ Language assistant	Endocrine system
25.03.2022	4a	Mentor	Reproductive biology
25.03.2022	4b	Reisenauer	Endocrine system
31.03.2022	4b	Reisenauer/ Language assistant	Reproductive biology
01.04.2022	4b	Reisenauer	Reproductive biology
22.04.2022	4b	Reisenauer	Reproductive biology
29.04.2022	4b	Reisenauer	Reproductive biology
05.05.2022	4b	Reisenauer	Reproductive biology
06.05.2022	4b	Reisenauer	Reproductive biology
12.05.2022	4b	Reisenauer	Reproductive biology
02.06.2022	4b	Reisenauer	**CLIL-project**
03.06.2022	4b	Reisenauer	**CLIL-project**
09.06.2022	4b	Reisenauer	**CLIL-project**
10.06.2022	4b	Reisenauer	**CLIL-project**
17.06.2022	4b	Reisenauer	**CLIL-project**

Table 2: Timetable of the teaching project

The table above depicts the timeline of the project, which was part of the practical phase of the Master's degree. Observations which are not relevant to the subject matter have been omitted. Furthermore, instances of teaching prior to the actual project in the involved classroom have been provided and labelled accordingly. The lessons of the teaching project were then either scheduled on Thursday morning from 8:00 to 8:50 (lessons 1 and 3) or Friday noon 10:55 to 11:45/ 11:50 to 12:40 (lessons 2, 4 and 5). Naturally, this led to differences in student engagement and influenced the role of the teacher significantly. The resulting implications and considerations for future teaching will be discussed in chapter 8.3. Personal Reflection. As can be deduced from the table, the author and executor of the teaching project had already spent considerable time observing and teaching the involved pupils. However, this did not affect the study design or the compilation of classroom material, seeing as the resources should be available for anyone who chooses to implement them in their teaching.

The resulting project was conducted by the author over the course of two weeks and comprised a total of five lessons. These were scheduled from 8:00-8:50 on Thursdays and from 10:55-11:45 on Fridays which had a significant impact on the learning outcomes and will be discussed in more detail with the corresponding lesson plans. In order to evaluate the project, the very last segment included a questionnaire consisting of both attitudinal and factual questions of different formats to be answered by the pupils. As a means of triangulating the data, various student productions, collected during the project, aim to give insight into the effectiveness of the preparatory tasks and comprehension of content as well as language. The classes original biology teacher took on the role of the observer for the duration of the project and did not intervene in any significant way. Finally, excerpts of a reflective journal kept by the teacher-researcher complement the collected quantitative and qualitative data by complementing and contrasting the opinions voiced by students with the impressions and intentions of the author.

6.2. Design of the didactic unit and lesson plans

This chapter includes the corresponding lesson plans which were compiled for the purpose of this project. Among other things, the guidelines for successful CLIL projects by Dale, van der Es and Tanner (2011) have been consulted to create the following teaching resources which are to be discussed in more detail below. The authors provide useful guidelines for practitioners who want to devise CLIL lesson plans or even teaching projects. The application for this thesis involved mostly getting a general idea of what CLIL projects entail, their (dis)advantages for bilingual learners as well as teachers and the role of the latter during the project. While most of the materials were created from scratch, some of the resources have been adapted from acknowledged publishers and are cited accordingly. Any deviations from the originals which occurred during the intervention stage will be mentioned under the corresponding tables alongside a detailed explanation of the intention behind the planning.

With the most recent curricular changes for Austrian Secondary schools, CLIL has found an honorable mention within the newest version (BMBWF 2023a: 24) if not within the subject specific ones. The latter have also undergone substantial adaptations towards more competency-orientated didactics. The core subject-specific concepts in biology (Basiskonzepte), for example, assist in identifying relevant content and understanding fundamental principles. They are founded on the idea that certain recurring patterns in biology appear consistently across various levels of organization, connecting distinct phenomena across these levels. The lesson plans of the Pea Project are arguably focused on the concepts of “Evolution and kinship” and “Reproduction” (see chapter 5.1.). The overarching goals in terms of content knowledge were to develop knowledge on the laws governing the transmission of genetic material and DNA as the structural basis for genetic information (BMBWF 2023b: 4). On the language-side of things to highlight grammatical structures and technical vocabulary used in scientific discourse and furthermore to introduce new genres, according to the pluriliteracy-approach. Table 3 hence gives a short overview of the contents covered in the five lessons, as well as the relevant competences mentioned in the current biology curriculum that were focused on in the five lessons. Considerations on the didactic makeup of the contents are discussed in more detail under the corresponding lesson plans throughout the next chapters.

<table>
<tr><th>Lessons</th><th>Contents & learning goals
S can…</th><th>Competences (BMBWF 2023b)
S can…</th></tr>
<tr><td>Lesson 1
(W1, W3)</td><td>… acquire basic processes and vocabulary on the topic of inheritance.
…apply their newly gained knowledge on a variety of guided tasks.
… reiterate and apply the rules for the passive voice.</td><td rowspan="5">… name, describe, explain and put into context biological phenomena and principles. (W1)
… develop information from different media and sources in a subject-related way and present and communicate it in different forms appropriate to the target group and situation. (W2)
… use and create models to describe and explain biological facts/ processes/ relationships and discuss their areas of validity and limitations. (W3)
… ask scientific questions about biological processes and phenomena and develop and formulate hypotheses. (E1)
… Plan, carry out and record observations and experiments on scientific issues. (E2)
… distinguish between scientific and non-scientific arguments and argue in a technically correct and logical manner. (S1)</td></tr>
<tr><td>Lesson 2
(W1, S1)</td><td>… (dis-)prove misconceptions about inheritance.
… deepen their knowledge on the topic/ vocabulary.
… realise the importance of passive speech in scientific discourse.</td></tr>
<tr><td>Lesson 3
(W1, W2, W3)</td><td>… adopt the genre of the scientific diary entry.
… identify and distinguish the Mendelian laws.
… organise the setting for station learning.</td></tr>
<tr><td>Lesson 4
(W2, W3, E1, E2)</td><td>… maintain station learning independently.
… deepen their knowledge on the Mendelian laws.
… cooperate in heterogenous groups.</td></tr>
<tr><td>Lesson 5
(W1, E1, S1)</td><td>… solve a mystery on inheritance
… present their findings both visually and orally.
… complete an attitudinal questionnaire.</td></tr>
</table>

Table 3: Overview of contents, goals & competences

6.2.1. Lesson 1: The Fundamentals of Inheritance

Time	Procedure	Skills	Materials
3’	T introduces the CLIL project to S and lists the aims of the following lessons.		Presentation: *The Pea Project* (sl.1)
12’	T presents the fundamentals of inheritance (theoretical input & pre-reading).	listening, speaking	Presentation: *The Pea Project* (sl.2-17)
15’	S complete cloze exercise in pairs.	reading, writing, speaking	Handout: *The Fundamentals of Inheritance* (p.1)
	The exercise is discussed in plenary and remaining questions are clarified.		
10’	T highlights the relevance of the passive voice in scientific discourse and reiterates the grammatical rules together with S on the blackboard.	speaking	Presentation: *The Pea Project* (sl.18), blackboard & chalk
20’	S complete passive voice exercise. If necessary, S receive a complimentary info-sheet (p.3).	reading, writing, speaking	Handout: *The Fundamentals of Inheritance* (p.2-3)
	The exercise is discussed in plenary and remaining questions are clarified.		

Table 4: Lesson Plan 1

Since the pupils were neither familiar with the concept of Content and Language Integrated Learning, nor the discussed topic area of inheritance, the first lesson of the project served as an introduction to both the setting and the contents. In order to familiarise the students with the format as well as the most important scientific concepts, terms and definitions, a conventional approach was chosen as to not overwhelm the recipients and induce initial resignation. Preparatory observations in the classroom by the author have yielded crucial insights into the mentor’s style of teaching and the respective student-side acceptance and adoption of learning contents. While pervasive front-of-class teaching has been demonised by educators and scholars alike, a concise theoretical input provided by the teacher in alternation with interactive elements can provide students with the necessary background knowledge for further learning and serve as a well guided and structured introductory steppingstone. This was implemented in the first quarter of the lesson, when the teacher held a short talk using *Canva*, a mostly free online-Tool for designing presentations and worksheets alike, which has been used for various purposes in the course of this project. The Presentation also served as a tool to visualise grammatical key elements throughout the project and was used for instruction-giving purposes. The relevant slides have been numbered in the corresponding lesson plans and can be reviewed in the Appendix. At this point, it should also be mentioned that during the implementation of the project and due to time constraints, some of the slides in the presentation had to be omitted or skipped during the actual teaching. However, for the sake of completeness they have been retained and marked accordingly.

Firstly, the students were instructed about what was expected of them in the following lessons, by making the goals of the individual segments transparent to them in a simplified manner. By being made aware of what is expected of them, the pupils are more likely to commit to the agreed upon learning goals and they furthermore reach a shared understanding of the assessment criteria they must fulfil (Dale, van der Es & Tanner 2011: 177). In order to engage the audience and activate pre-existing background knowledge for the upcoming intake, the students were asked to look at a comic strip and infer from it the underlying message. The cartoon in question depicts a boy presumably arriving home from school, lamenting to his parents (Figure 8).

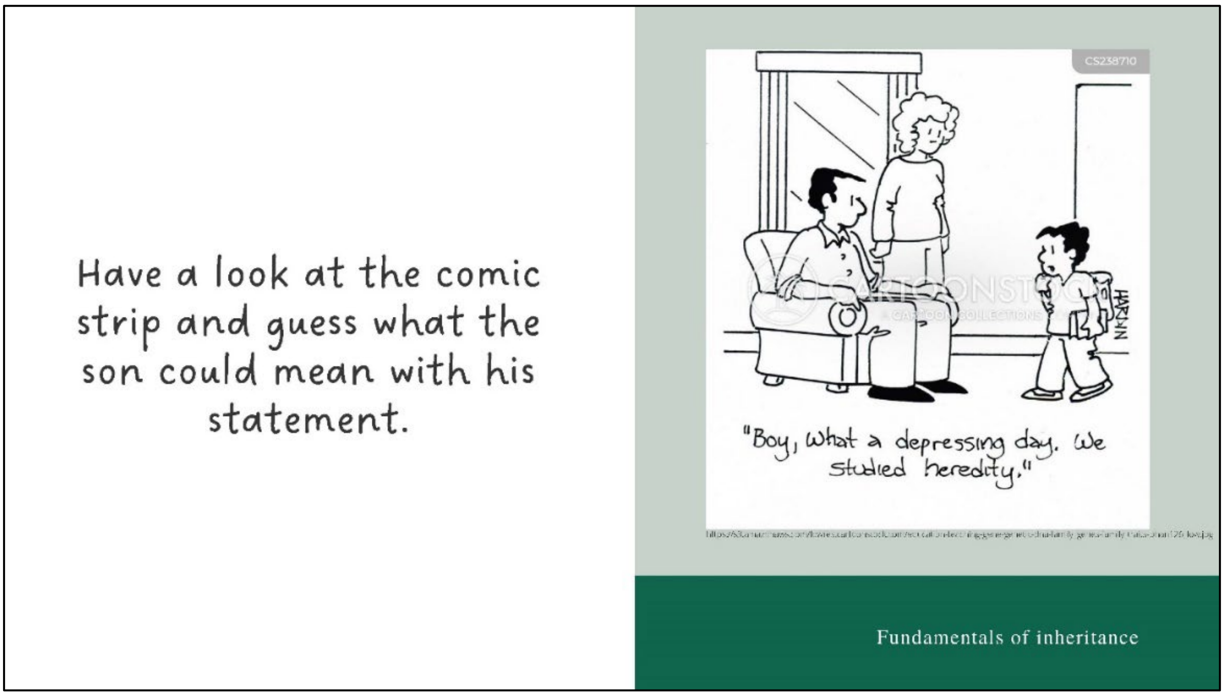


Figure 8: Comic Strip

Guess is a member of the CDF category *Explore* with the underlying communicative intention of telling the recipient something that is potential (Dalton-Puffer 2012: 234). *Guess*, however, expresses a slightly higher degree of hypotheticality (Bauer-Marschallinger 2018: 23) and thus lends itself to let pupils speculate about a topic they are not yet familiar with in much detail. The goal of this introductory task was to elicit, that children look similar to their parents because hereditary traits, also called genes, are passed on from one generation to the next. This ties in closely with the elementary core idea, that "Offspring are very much, but not exactly, like their parents and like one another" as introduced in the *Atlas of Science Literacy* (AAAS 2001: K-2). The reason for why there are still observable differences between parents and their children was clarified during the remainder of the presentation, where, first and foremost, the differences between genes and alleles were outlined. Especially the blueprint-metaphor has proven to be one of the major misconceptions among students in the understanding of inheritance (Kattmann 2016: 115). It supports the idea that genes rigidly determine the expression of hereditary traits among organisms. However, a shift in perspective was effectuated by picking up the ill-conceived metaphor and modifying it. By putting the focus on development processes and emphasising that genes are rather like ingredients in a recipe, students were made aware, that the outcome (our observable characteristics) may vary significantly among individuals (sl. 12-16).

The second segment of the first lesson had a self-made cloze exercise (*The Fundamentals of Inheritance*) in its focus, slowly paving the way from a focus on receptive skills to guided production. The first task of the handout demanded students to match the gaps in a text with the words from a box. The member *Match* belongs to the CDF type *Classify* which primarily involves structuring field-specific information (Dalton-Puffer 2012: 235). In the case of this exercise, the pupils must recognise the word class and/or deduce the meaning of the given items from context. For example, by realising that the word *blueprint* is in fact a noun, the gaps 1,2,3,4,6,7 and 8 are viable options to choose from. If one can furthermore spot that *blueprint* is a singular noun, gaps 1,2,3 and 6 remain as possible answers. Consequently, the students must infer the meaning of the term from context or can rely on the knowledge they have gained from the presentation at the beginning of class. By strategically comparing and contrasting, the cognitive process of *Classifying* is about the recognition of patterns and detecting relevant characteristics in a text (Anderson & Krathwohl 2001: 72).

In selecting appropriate lesson input, words from the previous segment were chosen for the learners to understand and eventually use themselves in the upcoming lessons. As suggested by Dale, van der Es and Tanner (2011: 66), the gaps in the text were numbered for later reference and not too close together, so that learners could actually guess the meaning from the context. While providing extra words which do not fit the text was abstained from, *recessive* and *dominant* were deliberately not discussed before and had to be inferred implicitly, to amplify the difficulty of the last two words. In order to also target this implicit knowledge, the students might possess over the subject area, inference requires them to "combine their literal understanding with their own knowledge, taking information from the [text] and relating it to what they know." (Day 2020: 28) This is done by asking for information not particularly mentioned in the passage but that can still be deduced from context. The last sentence on the first page of the handout: *The Fundamentals of Inheritance* reads:

Alleles are usually described with abbreviations, often only with single upper- or lower-case letters. _______________(9) alleles are usually capitalised, _______________(10) alleles lowercased.

The students might be able to deduce from the trivial meaning of the word *dominant* (= strong), that the latter needs to be abbreviated using uppercase letters. This is no content specific information but rather general background knowledge a majority of pupils are expected to possess, especially when considering that the German lexeme is identical to its English counterpart.

After discussing the answers to the questions in plenary and clarifying any remaining uncertainties, the teacher highlights the relevance of the passive voice in scientific discourse, highlights examples of it in the cloze exercise and reiterates the grammatical rules together with the pupils on the blackboard (sl. 18-21). Broderick and Chadwick (2015: 124) highlight the importance of passive sentences in scientific discourse, which focuses on the action itself, rather than who is performing it. Scientists are constantly looking for ways of finding the most precise and effective language to convey experience (Reeves 2005: 7) and are hence using this specific grammatical structure in order to describe processes, experiments, and more general statements of fact. It should be stated at this point, however, that students are still encouraged to think about who the omitted agent in passive is, seeing as vast significance is attributed to the scientist Gregor Mendel at a later stage in the project. Therefore, the second part of the handout *The Fundamentals of Inheritance* requires students to come up with suitable sentence subjects in turning passive sentences from the text to active ones. Beforehand, however, the students are asked to complete a noticing activity, recycling the previously completed text and identifying and marking all instances of the passive voice in the text. *Identify* belongs to the relatively small CDF category of *Define* which has also been described as a micro-function (Dalton-Puffer 2012: 235). Similarly to *Classify*, it is about organising knowledge though it serves to "present determinative features and the scope of an item of specialist knowledge." (Bauer-Marschallinger 2018: 20). While *identifying* does not require students to actively propose definitions for specific scientific concepts, they must recognise reoccurring linguistic patterns through a series of examples and by scanning the text's internal characteristics. Noticing and awareness activities, with a focus on form, explicitly address particular language structures which are usually disregarded when focusing on the contents of a text (Dale, van der Es & Tanner 2011: 80). Lyster (2007: 44) adds that drawing learner's attention to how language is used in a certain genre can, at a later stage, help them write texts in which language is used in a similar way. This way, the task can also be regarded as somewhat of a pre-reading exercise for the writing task in the following lesson, equipping the students with the necessary tools.

6.2.2. Lesson 2: *Mendel's Laws of Inheritance*

Time	Procedure	Skills	Materials
5'	T presents the roadmap for today's lesson. T provides S with a glossary to look up unfamiliar vocabulary throughout the project.		Presentation: *The Pea Project* (sl.23), Handout: *Glossary*
12'	S speculate about the validity of statements in a Concept Cartoon and give answers/ justifications.	speaking, reading	Presentation: *The Pea Project* (sl.24-26)
	The exercise is discussed in plenary and remaining questions are clarified.		
13'	S watch a TED-Ed video on the Mendelian rules twice and answer vocabulary/comprehension questions during the second time.	listening, speaking	Presentation: *The Pea Project* (sl.27), YouTube, Handout: *How Mendel's pea plants helped us understand genetics*
	The exercise is discussed in plenary and remaining questions are clarified.		
5'	T introduces the historical figure Gregor Mendel and shortly reiterates his findings. (pre-reading)	listening	Presentation: *The Pea Project* (sl.28-31)
15'	In plenary, S read about the 1st Mendelian rule aloud and complete the corresponding comprehension questions with the help of T.	reading, speaking	Handout: *Mendel's Laws of Inheritance* (p.1)

Table 5: Lesson Plan 2

Similar to the first lesson, the teacher starts off by shortly outlining the contents of the lesson to the students and making its goals transparent to them. Since the pupils have been confronted with a relatively large amount of information, as well as an unfamiliar teaching mode, they receive a digital *Glossary*-file containing the most important terms and definitions already dealt with and to be discussed in the following segments of the project. While a Personal Idiom File (PIF) co-constructed between students and teacher would have been preferable, due to time constraints the glossary was compiled beforehand. It includes words and definitions in English as well as an exemplary phrase of the word with context and other related words such as derivations. After careful consideration, the German translations were added to the glossary, seeing as although many of the technical terms in question are virtually identical, it does enable the students to transfer their knowledge to Biology lessons outside of the project which are mostly held in German. Other than that, the beginning of the second lesson is dedicated to recapitulating some of the most important concepts and ideas discussed in the previous one. In the classroom, this is achieved by means of implementing Concept Cartoons (Figure 9) which are a useful tool for taking up preconceptions of students on different scientific areas.

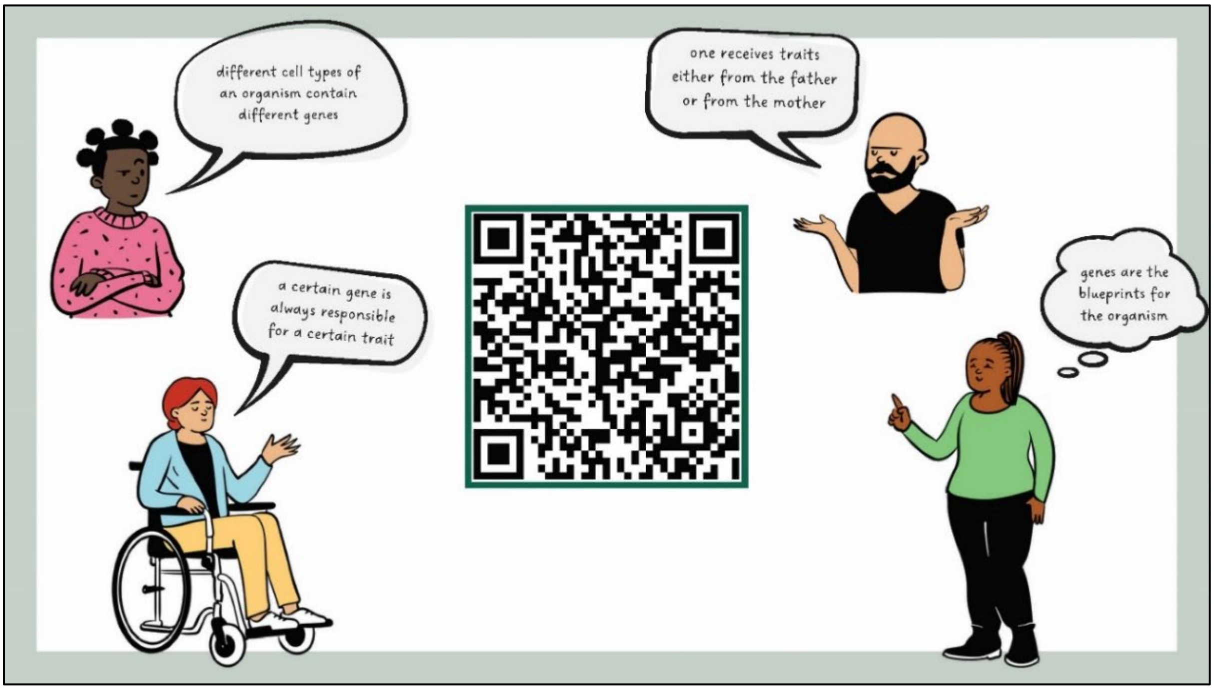


Figure 9: Concept Cartoons

Concept Cartoons represent a visual argument among fictional interlocutors who express their views and beliefs about a specific topic. While they can also be applied individually, Concept Cartoons unfold their full potential when used as a group activity, seeing as they rapidly generate discussion and argument about the expressed viewpoints (Naylor, Keogh & Goldsworthy 2007: 31). The way this is handled in the second lesson is by raising one's hands whenever the students (dis-)agree with the statements. Pupils that object the propositions must then argue why they believe the cartoon character is wrong and how the statement could be rectified. Therefore, both CDF types of *Explore* and *Explain* find application in this exercise (Dalton-Puffer 2012: 234). *Explain*, which has already found mention in the thinking skills taxonomy by Bloom et al. (1956) asks students to give reasons for their discontent with the Concept Cartoons. What makes this didactic tool even more valuable for teaching CLIL is that, besides combining more than one CDF type, it integrates both learning and assessment. As Naylor, Keogh and Goldsworthy (2007: 32) put it, "Elicitation of the learners' ideas through discussion provides a context and a purpose for finding out more about those ideas. In this way elicitation (i.e. assessment) becomes a normal and purposeful part of the whole activity rather than being separated from learning." In the case of this project, the assumptions revolve around the subject areas of genetics and inheritance and were selected from relevant literature (Kattmann 2016: 115-120) according to the contents of the first lesson while also incorporating popular misconceptions investigated by scholars in the field (Marbach-Ad & Stavy 2000, Kattmann 2016, Hammann & Asshoff 2019). For example, one of the statements chosen for the Concept Cartoon reads: "A certain gene is always responsible for a certain trait." According to Sadava et al. (2019: 495), this corresponds to the idea that the phenotype of a human being is determined by its genotype and that one can therefore extract almost all necessary information about the human being from the genotype. This naive genetic determinism ignores the fact that even though genes do influence traits, the genetic code does not directly contribute to trait expression. Rather, proteins interact at the levels of cellular organisation above the nucleus and influence trait development. In nature, polygenically inherited traits are more common than traits that are inherited monogenetically (sl. 25).

The second part of the lesson consists of both a listening and a reading activity which ought to offer multimodal input via various channels (Dale, van der Es & Tanner 2011: 61) and connect the students' general understanding of inheritance with its practical implications on the Mendelian rules. Therefore, a short YouTube video published by the channel "TED-Ed" (2013) serves as a pre-reading exercise by giving the pupils a concise overview of the three Mendelian rules and Gregor Mendel as a historical figure. This listening activity is accompanied by a worksheet (Handout: *How Mendel's pea plants helped us understand genetics*) which requires the listeners to complete both comprehension and vocabulary related exercises while watching the video for the second time, thus activating both linguistic schemata and content schemata. Linguistic schemata refer to the language proficiency in vocabulary, grammar, and idioms a reader possesses including the decoding features necessary to recognise words and their arrangement in a sentence (Al Salmi 2011: 701). This kind of knowledge is being activated by pre-teaching and pre-questioning vocabulary which has proven to encourage surface-level processing and positively impacts participants' comprehension, regardless of their proficiency (Rondon & Tomich 2020: 723). In the case of this exercise, the students must complete a table consisting of technical vocabulary and the corresponding definitions of the terms. The first two being *dominant* and *recessive,* both of which the students should be already familiar with, granting them an easier start. The second type of schema, the content schema, refers to the "background knowledge of the content area of a text, or the topic a text talks about […] including topic familiarity, cultural knowledge and previous experience with a field." (Al Salmi 2011: 702) This has been done by providing the students with the aforementioned video and by activating what they already know about the topic orally.

What follows is a short presentation (see sl. 27-30) to recapitulate what has been said about the scientist Gregor Mendel and to additionally familiarise the students with the "Punnett square" as a visualisation tool for the transfer of genes (Figure 10).

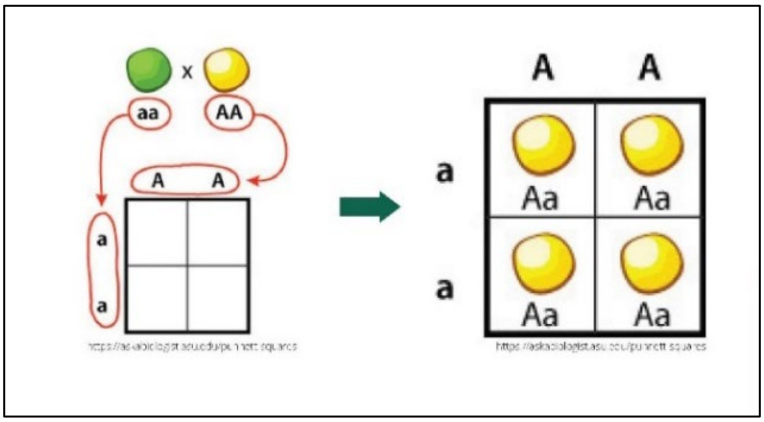


Figure 10: Punnet square

The latter becomes indispensable for the comprehensive reading task about Mendel's laws, the first segment of which constitutes the last chapter of the second lesson. The exercise is called *Mendel's laws of inheritance* and discusses the three Mendelian rules in three short texts, followed by both comprehension exercises and opportunities for the pupils to apply their acquired knowledge. By having them read out the text aloud, some students may practice pronouncing some of the technical terms from the text and the teacher is granted the opportunity to spot potential insecurities when it comes to a remaining lack of vocabulary knowledge. Guiding them through the first part of the reading also helps familiarising the students with the format to enable them to complete the remaining segments individually at a later stage. The answer for question 1.3. in the handout is not explicitly mentioned in the reading which again lets the students *Hypothesise* about a potential explanation.

6.2.3. Lesson 3: The Scientific Diary Entry

Time	Procedure	Skills	Materials
17'	S brainstorm genre characteristics of a diary entry and hypothesise about its scientific relevance.	writing, speaking	Padlet Brainstorming: Diary Entry
5'	T informs S about homework writing task and discusses assessment criteria.		Handout: *Scientific Diary Entry*
8'	In plenary, the 1st Mendelian rule is repeated and visualised using a "Punnett square".	speaking	Blackboard & chalk
15'	S continue to work on the reading exercise about the 2nd Mendelian rule in pairs.	reading, speaking	Handout: *Mendel's Laws of Inheritance* (p.2)
	The exercise is discussed in plenary and remaining questions are clarified.		
5'	T explains organisation for station learning in the next lesson for S to group and prepare classroom accordingly.	listening	Canva Presentation: *The Pea Project* (sl.33-35)

Table 6: Lesson Plan 3

The third lesson starts off with the preparation for a writing task and has the students brainstorm characteristics of a scientific diary entry using the online tool "Padlet". Brainstorming is arguably one of the more popular tools to help learners generate ideas during the pre-writing stage. This type of graphic organiser ensures that features can be depicted in a meaningful and well-structured manner (Dale, van der Es & Tanner 2011: 144). Naylor, Keogh and Goldsworthy (2007: 59) define the sub-genre at hand as "a record of the outcomes of a scientific enquiry, written up in the form of diary entries by a scientist." This corresponds with the third most important function of contemporary Content and Language Integrated Learning, namely, to foster subject specific literacy. This is done by demonstrating to learners how scientists record their speculations about new ideas and theories. In the previous lesson, the students have been provided with the relevant biographical background of the historical figure Gregor Mendel to help them set the scene for their writings. Although diary entries are hardly ever discussed in Austrian EFL classrooms and there is no mention of them in the domestic curricula, it can be presumed that most students are somewhat familiar with the genre, therefore making it easier for them to extend their knowledge of the text type. In terms of genre-specific differences, the sub-genre of scientific diary entries diverges in a number of features. Within a regular diary entry, the addresser and the addressee are usually one and the same person, whereas a scientific diary entry or protocol is subject to publication at some indefinite future date. In addition to differences in audience, the contents of a scientific diary entry will most likely revolve around speculations about scientific ideas rather than a stream-of-consciousness-like enumeration of everyday events. Vocabulary, grammar, and syntax also differ substantially, however, to promote coherence and encourage students to implement different grammatical structures (such as the previously discussed passive voice) in their productions, compromises should be agreed upon. For example, students must use (semi-)technical vocabulary in their writings, however, are also allowed to use informal language in order to express emotions, such as astonishment or frustration. The collective brainstorming also serves the purpose to conjointly develop and discuss the assessment criteria, some of which have already been predetermined by the teacher in the form of rubrics and some that are left open for change, in order to encourage and reward student participation. While all ideas are accepted and written down at this stage to encourage participation, not all of them can be considered for the assessment criteria. The writing task in itself is devised to be completed as homework and requires students to write a scientific diary entry, taking on the perspective of Gregor Mendel's fictitious assistant, who is helping him conduct the experiments on pea plants. The diary format invites them to be creative both in their thinking as well as their writing. Furthermore, it helps them to recognise that science is not always entirely certain, especially when new discoveries in the field are being made (Naylor, Keogh & Goldsworthy 2007: 60). Since the first Mendelian rule, the Law of Uniformity has already been discussed in class, the pupils are expected to specify the findings which have aided them in proving the theory by *describing* them using the Passive Voice. A further CDF-type that is introduced in this activity is *Report* which requires students to inform the readers about something external to the immediate context on which the former have a legitimate knowledge claim (Dalton-Puffer 2012: 234). This is achieved by the second bullet-point provided in the prompt (Handout: *Scientific Diary Entry)* which reads: "Report on your experience in the monastery". Although Bauer-Marschallinger (2018: 24) points out that *reporting* involves recounting events from a more objective point of view, whereas *narrating* would entail a more subjective and personal perspective, the former Cognitive Discourse Function has been chosen for this task, since students are more likely to be familiar with reporting on certain events rather than narrating them. The third CDF in the writing prompt asks pupils to *predict* what other discoveries they expect to make and draws a direct connection to the second and third Mendelian rule, the former of which is subject to more detailed discussion for the remainder of the third lesson.

Prior to that, however, Mendel's first law, The Law of Uniformity, which was subject to discussion in the week before, is shortly repeated in plenary. Furthermore, the importance of the Punnett Square for adequate visualisation of the Mendelian rules is reiterated by the teacher. What follows is the second part of the reading exercise concerned with Mendel's second law, The Law of Segregation. Again, the students must demonstrate the second Mendelian rule on the basis of the following generation, using a Punnett Square. However, this time the pupils are asked to complete the tasks in pairs, granting them more autonomy and accrediting them with enough schematic knowledge to successfully handle the task without the immediate assistance of the teacher. While there is no distinct CDF concerned with visualising data, the catalogue of operators assembled by Reichstädter and Müllner (2021: 4) lists *Illustrate* as an operator in order to also meet competence-oriented assignments linguistically. Hence, *Illustrate* serves to transfer interrelationships, facts or the like into a pictorial form of representation. Exercise 2.3. (see Handout: *Mendel's Laws of Inheritance*) lets the students estimate the amount of peas exhibiting a green phenotype by means of a practical example. *Estimate* in this context possesses a relatively low degree of hypotheticality, since the students should be able to calculate the correct ratio using the information from the text as well as their results from the Punnett Square.

Finally, the last segment of the lesson is dedicated to the station learning, scheduled for the following day. The pupils are filled in on the ground rules, including the number of stations to complete and the designated amount of time per station. They are instructed on what materials to bring and how to organise the desks before the beginning of the lesson (see sl. 33-34).

6.2.4. Lesson 4: Station Learning

Time	Procedure	Skills	Materials
5'	T prepares materials for station learning and shortly reiterates instructions.	listening	Canva Presentation: *The Pea Project* (sl.33-35)
15'	Learning Station 1: S must arrange triangles with terms/definitions of heredity to form a star-shaped construct.	speaking, reading, writing	Handout: *The Triangles of Genetics*
15'	Learning Station 2: S must (dis-)prove the 2nd Mendelian rule by repeatedly flipping a coin in order to simulate gamete fusion.	speaking, reading, writing	Handout: *Coinflip of Segregation*
15'	Learning Station 3: S must complete a complex Punnett square by familiarising themselves with the 3rd Mendelian rule.	speaking, reading, writing	Handout: *The Law of Independent Assortment*

Table 7: Lesson Plan 4

The fourth lesson of the project revolves around three distinct learning stations designed for the purpose of revising the contents discussed in the previous three lessons, as well as expand students' knowledge on the subject on inheritance. Over the past weeks, students have been gradually directed towards working more autonomously and being less dependent on instruction from the teacher while partaking in a so far unfamiliar learning setting (CLIL). Thus, the teacher takes on the role of both moderator and timekeeper, while the students must become acquainted with the contents presented in the learning stations autonomously. Despite demanding a considerable amount of preparation beforehand, learning stations have proven to be a sustainable lesson practice enhancing both student collaboration as well as classroom immersion by requiring pupils to meaningfully organise the workload amongst themselves and supplying multimodal lesson input (Miles, Deuel & Marlatt 2020, Eickholt, Johnson & Seeling 2021).

In addition to the five minutes allocated towards the end of the previous lesson, another five minutes are being utilised to finally prepare the three distinct learning stations for six collaborating groups of three to four students (see sl. 34). At this point, the issue of group formation should be discussed seeing as opinions on the proper way of doing it correctly seem to diverge tremendously among practitioners. Primarily, the tasks for the station learning were structured so that learners of different aptitude could play an equally important role in the completion of the stations. As suggested by Dale, van der Es and Tanner (2011: 229) groups of three to four learners were chosen as they are relatively easy to organise and allow each group member to contribute a reasonable amount of work. In order to shape the co-operation as productive and rewarding as possible, students were advised to meaningfully share work among their group while accounting for their individual strengths they bring to the table. This ties in with the five requirements that improve co-operation in groups (Marzano, Gaddy & Dean 2000) that have been considered alongside the project design, namely simultaneous interaction, positive interdependence, individual accountability, reflection and equal participation (SPIRE). Observation previous to the implementation of the project and consultation with the mentor teacher have shaped the process of group formation and finally lead to the group appointment as decided by the teacher. While Dale, van der Es and Tanner (2011: 230) point out that this proceeding might negatively revert to learner autonomy by not giving them a say in the matter, it does allow the teacher to consider influential factors such as level of English, interpersonal relationships and behaviour marks to finally come up with equally fair and effective groupings for learners.

The first learning station is named *The Triangles of Genetics* and aims to foster the pupils' vocabulary knowledge on the topic of inheritance in a playful manner. A similar exercise has been devised by Skiba and Spieler (2016: 12) which has been revised and adapted to better suit the CLIL setting. The students are asked to cut out triangles with technical terms and corresponding definitions and meaningfully rearrange them to come up with a star-shaped structure that has the matching terms and definitions on its adjacent arms. Quicker learners are encouraged to also come up with their own definitions for the terms remaining on the outer arms of the star. If necessary, students are allowed to use the *Glossary* they have received at the beginning of the second lesson to look up definitions for words they cannot assign. While all of the terms included in the exercise have been discussed during the previous lesson in differing degrees of detail, it can be expected that even when working as a group, the relatively large number of technical vocabulary items constituting the exercise demands students to check their glossaries from time to time. This could be encouraged by the teacher in order to ensure students can finish the arguably time extensive exercise in the allocated frame.

Coinflip of Segregation is the name of the second learning station and, as the name foreshadows, is concerned with the second Mendelian rule, "The Law of Segregation". This exercise has also been adapted, inspired by a similar learning task distributed by the "Qualitäts- und Unterstützungs-Agentur - Landesinstitut für Schule NRW" (QUA-LiS NRW 2019). The students are asked to simulate the allele distribution resulting from pollination using coins. Firstly, however, context is provided by the fictitious school gardening group, which has re-enacted Mendel's experiments and stumbles over the atypical ratio of 138:102 in the F2 generation. This cognitive conflict triggered by the seemingly wrong numerical ratio is clarified by means of a model experiment with coins and makes it possible to recognize in a concrete way and in a haptic engagement with the learning object that the combination of hereditary dispositions takes place according to a statistical pattern. Thus, the misconception that a 3:1 ratio means that with four offspring, three must have one phenotype and one the other can be countered. By collecting the results in the whole class, it becomes clear that a high sample number is necessary for the statistical ratio of 3:1. With a class size of 24 children working in pairs, one still ends up with roughly 300 results for the F2 generation, but Mendel counted out 8,023 seeds. This context is cognitively quite challenging, but nevertheless the material is suitable for all learners since the sensory dimension is addressed by tossing and looking at the coins. When conducting the model experiment, it is not expected that the students are able to present the statistics underlying Mendel's rules. Rather, participation results from the division of labour (tossing the coins, recording the results) which addresses the enactive level and supports the perception of the crossing process and the emergence of a new generation (QUA-LiS NRW 2019: 2).

The third and last learning station is titled after Mendel's third law, *The Law of Independent Assortment*, and is likely to be the most challenging for students. Unlike the other learning stations, this one follows the same, familiar format as the two reading exercises covered in lessons two and three. The three Mendelian rules are meant to be introduced on three different occasions as to not overwhelm the learners and provide them with enough time and opportunities for practice. As a final assignment they must master the third learning station themselves while still receiving ample amounts of scaffolding to help them with their task. Similar to the other rules, they must read a concise text explaining the theoretical background followed by a definition of the law itself. The complexity of the Punnett square to be completed by them is expected to present itself as the biggest obstacle which is why parts of it have been filled in beforehand. However, this exercise is still an indispensable piece contributing to the completeness of the project as it provides the learners with the final of the three laws and gives an outlook for further genetic discoveries.

Although all of the learning stations have been carefully designed to approximately take up the same amount of time by adding optional supplementary tasks, a separate bonus task has been prepared to ensure as little idle time as possible. It is concerned with a “Botanical Illustration”, another important scientific genre which, before the invention of photography, was the only way of visually recording the plant species and is still a frequently taught skill at universities. While this work would require a great deal of artistic skill, attention to detail and expert knowledge in the field of botany, a simple sketch can also be drawn by novices in the field and by providing necessary vocabulary for appropriate labelling on the instruction sheet.

6.2.5. Lesson 5: Mystery & Evaluation

Time	Procedure	Skills	Materials
5’	T prepares materials for concluding Mystery and instructs S on familiar format.	listening	Mystery prompt & cards, empty poster
35’	In groups, S complete the Mystery on the rules of inheritance by reading out and arranging cards on a poster.	reading, speaking, writing	Mystery prompt & cards, empty poster
	The exercise is discussed in plenary and remaining questions are clarified.		
10’	S fill out attitudinal questionnaire on the project to provide T with anonymous feedback.		Handout: *Questionnaire*

Table 8: Lesson Plan 5

The fifth and final lesson of the CLIL project is dedicated to a teaching method that has recently gained popularity, the Mystery. According to Pütz and Mülhausen (2020: 147), a Mystery describes a riddle or secret that has to be solved with the intention of visualising the participants thinking processes and to promote networked thinking in general. Vollmer (2010: 8) states that

> “It is the obligation of education to develop in learners a scientific mind and outlook on life and to prepare them to cope effectively with situations and social activities in which science is involved, being a subject area with highly significant relevance to human engineering, to technological innovation, to health and security and to ideologies of man-made progress concerning productivity, efficiency, quality of everyday life as well as increasing mastery of the environment.”

Mysteries meet this demand by confronting students with societal issues and phenomena whose solution requires scientific understanding. Initially, learners are faced with a puzzling statement or question and must consequently collect clues and facts in the form of note cards containing short sequences of written text, images, or graphs. With each additional clue gathered, cross connections between them are established and previous knowledge gets activated. Individual components are sorted, as important things are separated from unimportant ones while the pupils must keep in mind that it is not a question of "right" or "wrong" but rather of meaningful linkage which will help them draw conclusions to solve the Mystery. A Mystery can be used at any stage of a teaching unit and in the case of this study, was designed to secure knowledge towards the end of the project. Similar to station learning, the students work conjointly in small groups and the teacher's main responsibility is shaped by preparing the materials beforehand diligently for there to be no hiccups during the execution phase. However, as opposed to station learning, all students start with the same initial material, although they will most definitely come to different results. The groups of students receive an envelope with 27 unordered cards, these are taken out individually and read out to each other. Then the cards are placed on a poster. The information on the cards is necessary to answer the central question around which the puzzle is built. However, there are also cards with biological information that fits the context but is not exactly necessary in answering the question. The pupils arrange the cards on a large sheet of paper and thereby connect the information of the protagonists and the biological topic with each other. The cards are moved and reorganised again and again, until all group members are satisfied with the way the mystery is laid out. The cards are then pasted on the background and the contextual relationships between them are indicated by adding arrows or labels.

Content wise, the mystery focuses on the application of Mendel's rules, using the human as a more relatable example (QUA-LiS NRW 2019: 7-10). In the material the students deal with the phenomenon of rolling the tongue and learn that the laws of heredity are not always sufficient to explain certain characteristics. Following the assumption that the inheritance of the tongue rolling is a monogenic, dominant-recessive mode of inheritance, the students must reconstruct missing genotypes and also consequently recognise that the trait of "tongue rolling" cannot be attributed exclusively to heredity, which is why there can also be exceptions in the connection between genotype and phenotype caused by environmental overprinting. The example at hand covers the CDF labels of *Classify* (i.e., *Categorise, Structure), Define* (i.e., *Identify*), Explain, and *Explore* (i.e., *Predict*).

The mystery method is based on the constructivist learning theory which, simply put, suggests that "people remember things more effectively if they spend more time thinking about them, and if their brains have to work harder to complete a task." (Dale, van der Es & Tanner 2011: 20) This also explains the high time expenditure in relation to content covered, however, the main goal of mysteries is to promote complex thinking and problem solving, two fundamental skills independent of subject specific knowledge. Furthermore, mysteries enable learning in multiple contexts and under multiple perspectives guided by instructional support and embedded in an authentic, social context. In addition, by discussing the outcomes of the mystery in plenary, students are required to justify their choices regarding the structuring of the cards which demands them to verbally defend and argue for the choices they have made. An exemplary solution for the mystery is proposed in Figure 11:

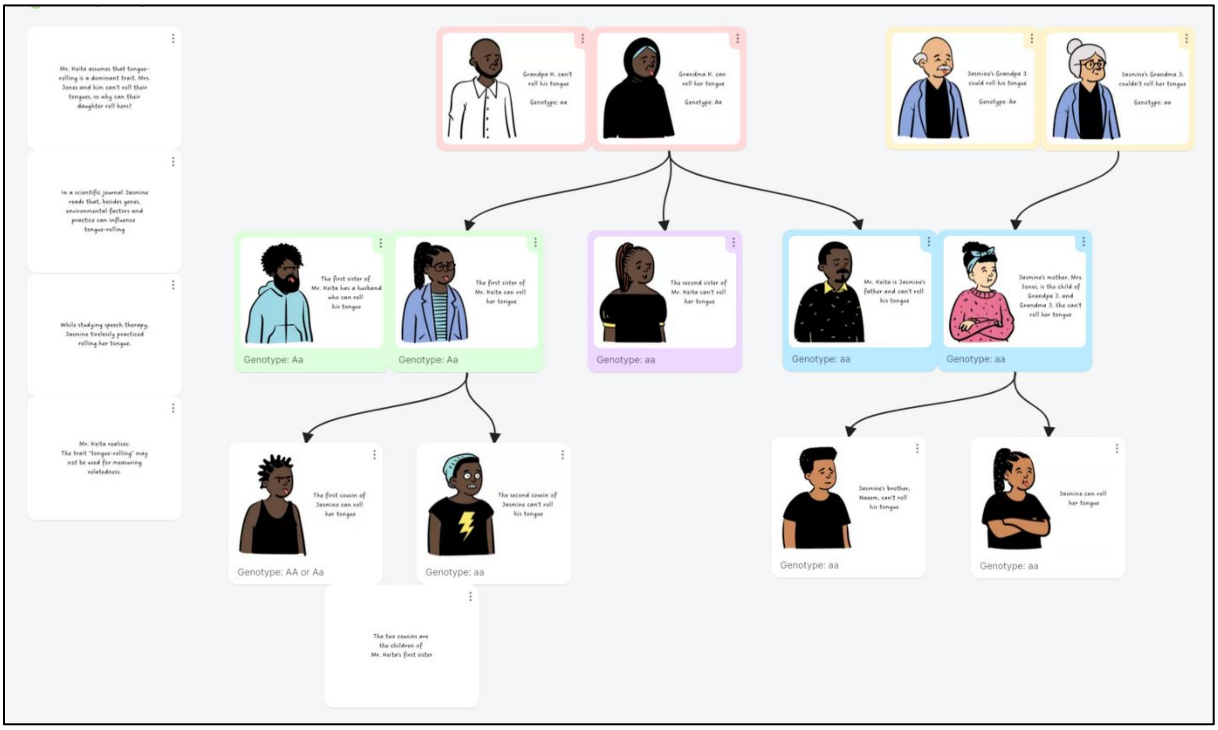


Figure 11: Examplary Mystery solution

Finally, the very last segment of the project consists of the attitudinal questionnaire which is the basis for the evaluation of the project to be discussed in more detail in the following chapter.

6.3. The setting

The study in question was conducted in a 4th grade lower secondary classroom (4b) consisting of 24 students and located in the 16th district of Vienna. The school 2 is part of the "Bildungsgrätzl 'OttakringWest'" whose goals, according to their website, include to increase educational participation in the district, promote equal opportunities, and strengthen democratic culture (Stadt Wien 2020). Furthermore, the school participates in the Vienna Bilingual Schooling (VBS) programme introduced by the Board of Education for Vienna. In cooperation with the Department of Educational Services, their objective is to implement not only German, but also English as a language of instruction in Viennese classrooms in order to meet the needs of pupils who already have a strong command of English more precisely (Board of Education for Vienna 2019: 1). In theory, this would entail classes to be divided into two language groups. One group would receive additional language instruction, whereas the more proficient speakers ought to be challenged appropriately. For the acquisition of mentioned literacy skills, a certain number of lessons is devoted to bilingual teaching in the form of co-teaching (Board of Education for Vienna 2019: 1). In practice, however, judging by the lessons observed as part of this research project, these requirements were hardly ever met. Although only a small number of classes are subscribed to the programme, due to a presumable lack of resources, the teaching in the observed VBS classrooms only slightly differs from the regular mode of instruction. The way this was managed within the classroom at hand was via a language assistant who attended one lesson per week/subject and who, in accordance with the teachers, assisted them or prepared separate, subject specific segments he carried out at some point during the teaching unit. The latter applied to the Biology lessons I observed in preparation for the teaching project.

In accordance with the Common European Framework of Reference (CEFR), the students' language level would correspond with the A2 level (Basic User: Waystage), meaning that they should be able to

> understand sentences and frequently used expressions related to areas of most immediate relevance (e.g. very basic personal and family information, shopping, local geography, employment). Can communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar and routine matters. Can describe in simple terms aspects of his/her background, immediate environment and matters in areas of immediate need. (Council of Europe 2001: 24)

With regard to the necessary lesson planning for the research project, however, the individually differing levels of language aptitude among the pupils needed to be taken into consideration, as will be elaborated on in the following chapters. While some of the students grew up multilingually and are thus highly proficient users of English, the reasons for participating in the VBS programme were manifold. Unfortunately, a smaller margin of students had to join the class involuntarily since from the first grade onwards, students regularly dropped out of class and therefore needed to be replaced without consideration for their language proficiency. Again, due to a lack of resources this undoubtedly suboptimal situation needed to be considered during both the planning stage as well as the execution of the project.

7. Evaluation of the project

Before any data was collected in the first place, the question of consent had to be addressed towards the beginning of the project. Since the participating students were all aged 14, confirmation from the headmaster sufficed as validation for the project to be executed in class. Regardless, the data collected was fully anonymised and students were made aware that they could opt out of their productions being processed at any given time.

Three separate viewpoints from which the teaching project is to be evaluated will be discussed in this, as well as the following chapter. Firstly, the students' written productions as well as the outcomes of the mystery will be subject to a closer analysis by applying appropriate rubrics to the texts. Secondly, the post-teaching questionnaire will deliver insights into the students' perception of the successfulness of the teaching project by having answered a variety of attitudinal questions. Thirdly, every lesson of the project has been thoroughly reflected upon by the teacher upon its implementation and the thoughts were put into writing in note form. Additionally, the memorandum has been complemented with thoughts and impressions voiced by both the attending mentor teacher as well as the occasionally present language assistant who supports the bilingual branches of the school. The obtained data will be analysed and visualised using SPSS Statistics and MS Excel.

7.1. Assessment of student productions

After careful consideration of which student productions should be subject to closer inspection as part of this study and not just to assessment in class, the focus of this chapter lies with the written productions that had to be completed between the third and fifth lesson as part of homework. In order to cover a variety of different forms of performance, the mysteries were also evaluated and assessed applying appropriate rating scales and including a holistic assessment of the short oral presentations. Resulting implications thereof are to be discussed in more detail in the following chapter, after reviewing the final results.

7.1.1. The Scientific Diary Entry

The writing task demanded students to write a scientific diary entry of 150-200 words and included four bullet points for them to elaborate on. Inspired by familiar, competency-oriented writing tasks, a short introductory paragraph provided the students with necessary background information in addition to the contents discussed in class (see lesson 2-3).

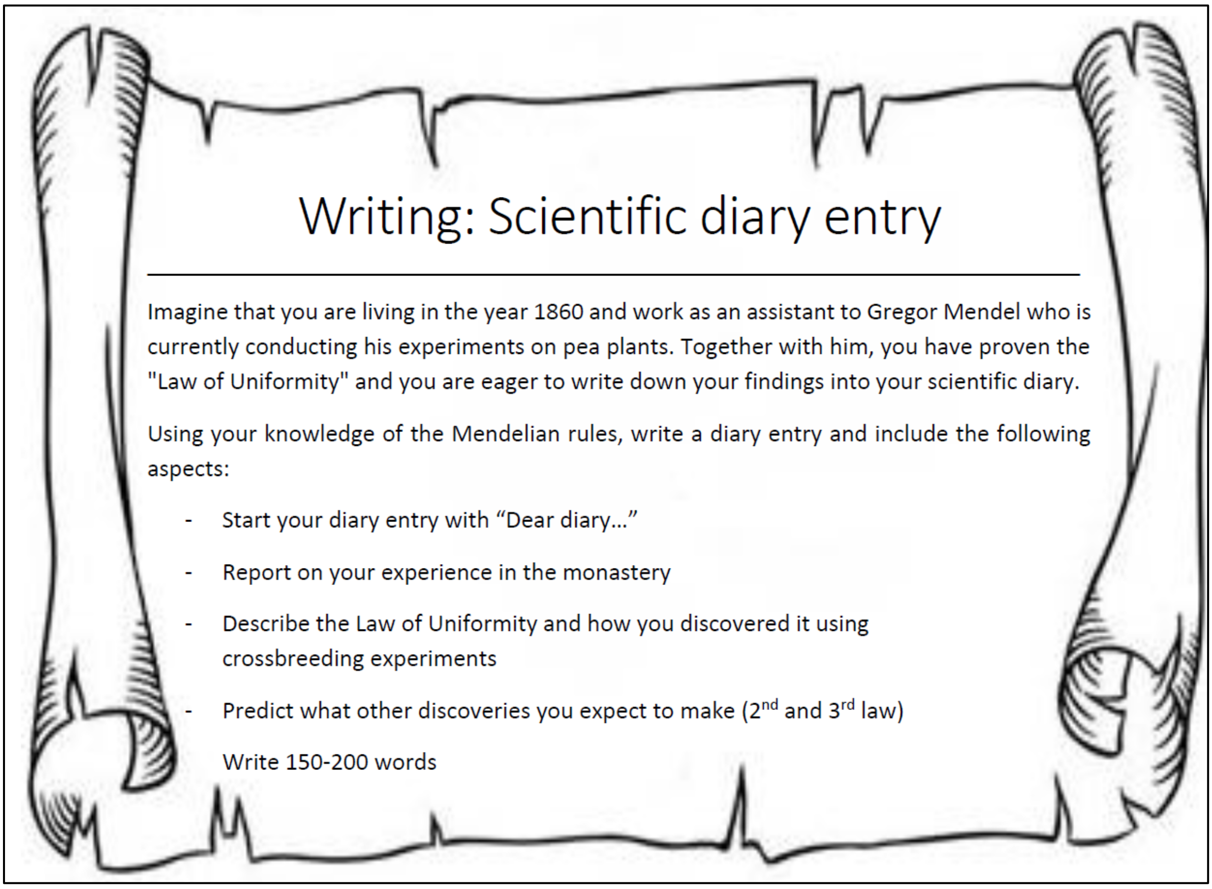


Figure 12: Writing prompt: scientific diary entry

While scholars such as Brown and Abeywickrama (2010: 40) have pointed out that adhering to summative rating scales when assessing writing can be both impractical for teaching purposes as well as restrict beneficial backwash, for the evaluative purposes of this study, clearly defined assessment grids needed to be consulted in order to produce valid and reliable outcomes. The rubrics used for this production are oriented towards the assessment scales published by the Federal Ministry of Education, Science and Research (2024) which focus on the aspects "Task Achievement (TA), Organisation and Layout (OL), Lexical and Structural Range (LSR) and Lexical and Structural Accuracy (LSA)". These rating scales have been chosen as a starting point for the rubrics applied in this study because they were developed for the writing tasks of A2-level pupils (BBWF 2024) in the foreign languages in Austria and thus refer to the Common European Framework of Reference for Languages (CEFR). It is recommended that this assessment grid also be used to assess portfolio work, schoolwork, homework, etc., in order to familiarize students with the assessment criteria and their application to written language production (BIFIE 2019: 1). However, due to the fact that these descriptors are designed to assess writing performance at levels B1 and B2, they have been adjusted accordingly in order to better suit the pupils' level of written production. According to the CEFR Manual (2009) "Lexical and Structural Range" is concerned with descriptions of linguistic and sociolinguistic competence, "Lexical and Structural Accuracy" is focused on semantic competences in connection with language use. However, due to the inert similarity of the two categories as opposed to "Task Achievement" and "Organisation and Layout", and for reasons of simplification they have been subsumed to form one rubric for the purpose of this study (LSAR). Adopting Davis's (2015: 239) view of language as consisting of different and separable parts, rubrics that divide language performance into different components are referred to as "analytic rubrics", as is the case with the writing task at hand. While a successful application of said rubrics is both time consuming and cognitively challenging in their realisation, they do offer more detailed information regarding the student's abilities (Davis 2015: 239).

The first criterion to be distinguished is "Task Achievement" which assesses whether the candidate has completed the task according to the respective assignment. However, the main focus here is not on the linguistic range or language correctness, which are assessed as separate criteria (BIFIE 2019: 2). In the case of the scientific diary entry, the points to be covered are communicated clearly on the prompt in the form of bullet points. The students are asked to report on their experience in the monastery, drawing from the historical background knowledge on Gregor Mendel (see Figure 12). Here, creativity is valued above historical correctness, inviting the students to immerse themselves into the everyday life at a monastery in the 19^{th} century. Contrary to that, the second bullet point asks for specific information from the field of heredity, as students must describe the Law of Uniformity and how they discovered it using crossbreeding experiments. At this stage, the first Mendelian rule has been extensively discussed in class and the students have received a plethora of sources from which to draw relevant information. Thirdly, the students are asked to make predictions about what other discoveries they might make in the field. While Mendel's second law is discussed shortly after the students receive their writing tasks, they can only speculate about the contents of the third one in their writings, if they mention it at all. Considering evaluation, the three bullet points have been designed to carry equal weight as assessment criteria and at the same time request various linguistic and factual competencies in their fulfilment.

The assessment criterion “Organisation and Layout” takes into account the structure of the text both as a whole and at the level of individual paragraphs, the comprehensibility of the structure from the reader's point of view, the logical arrangement and linking of own ideas, and the compliance with layout conventions appropriate to the task and text type (BIFIE 2019: 3). Given the text type, students are not asked to form a new paragraph for each bullet point, however, they are to structure their ideas in a meaningful sequence. In addition, they are instructed to start the text with the opening “Dear diary…” and to write as a first-person narrator. Frequent use of cohesive devices is not expected of them, given their language level, however, it is positively highlighted if present.

The third and final rating scale, which can be subsumed under the heading “Lexical and Structural Range and Accuracy”, then considers linguistic structures such as grammar and lexis, spelling and punctuation (BIFIE 2019: 3). Concerning the foremost feature, special attention is paid to the use of the passive voice in connection with the description of findings. Since this grammatical structure has been discussed in great detail and applied to several practical examples, the pupils are expected to meaningfully implement it in their writings. Moreover, they are expected to make use of the appropriate future tense when predicting what discoveries they expect to make, as noted in the fourth bullet point of the writing prompt.

Other than that, points are being deduced for not adhering to the word limit, prompt lifting and plagiarism, the latter of which will play an important role when discussing the findings of the evaluation. The following Table 9 illustrates the final rubrics created for the writing exercise which follow the criteria used in the rating scales introduced by the BIFIE (2019):

Category	Score			
	3	2	1	0
Task Achievement	(1) Adheres to the specified text type (2) Lists all content points and addresses them in as much detail as applicable (3) Brings in creative ideas in writing	(1) Partially adheres to the given text type (2) Lists most content points and addresses them in sufficient detail	(1) Hardly adheres to the given text type (2) Lists some content points but does not address them any further	(1) Does not adhere to the given text type (2) Lists none of the content points whatsoever

Organisation & Layout	(1) Clear overall structure (2) Successfully uses linking devices	(1) Appropriate overall structure	(1) Acceptable overall structure	(1) Inadequate overall structure
Lexical and Structural Accuracy and Range	(1) Expresses him/herself clearly without much sign of having to restrict what he/she wants to say (2) Uses a good variety of structures (3) Has a good command of basic vocabulary as well as common structures and phrases (4) Spelling and punctuation are correct and do not affect comprehension	(1) Expresses him/herself clearly though there may be some signs of restriction (2) Uses some variety of structures (3) Has an appropriate command of basic vocabulary as well as common structures and phrases (4) Spelling and punctuation are mostly correct and hardly affect comprehension	(1) Occasionally unable to express him/herself clearly (2) Uses a limited variety of structures (3) Has a limited command of basic vocabulary as well as common structures and phrases (4) Spelling and punctuation are hardly correct and frequently affect comprehension	(1) Frequently unable to express him/herself clearly (2) Uses little/no variety of structures (3) Has little/no command of basic vocabulary as well as common structures and phrases (4) Spelling and punctuation are so poor that they very often impair comprehension
Prompt-lifting & Plagiarism	-2	-1		
	(1) a considerable number of structures are copied from the prompt (2) a considerable amount of writing is plagiarised from other sources	(1) a small number of structures are copied from the prompt (2) a small amount of writing is plagiarised from other sources		

Table 9: Analytic rubric for Writing task

7.1.2. The Mystery

The second part of students' productions to be evaluated in this paper is constituted by the Mystery and the presentation thereof, which took place in the fifth lesson of the teaching project. As has been briefly mentioned in the previous chapter, a Mystery revolves around a question or statement that demands further investigation to be clarified while visualising the participants thinking processes and promoting networked thinking. The learners work on a problem relevant to the lesson in a multi-perspective way. They puzzle, combine and structure in small groups in order to solve the seemingly incoherent initial question. At this stage, it should be emphasized that Mysteries are not suitable for assessment purposes, seeing as the students are taught that there is no right way to arrange the cards on the poster. However, the learners must justify as to why they have acted the way they did to come up with a possible explanation for the initial statement. Thus, Mysteries can very well be used for evaluative purposes, seeing as the pupils' thinking processes are being made visible on the spot. Even if they are not used for assessment, appropriate rubrics can also serve as a means of evaluation which is why they have been added to this exercise. The two items which are subject to evaluation are the design of the poster itself, as well as the short presentation by the small groups.

Seeing as the presentation of the posters was conducted in a rather informal manner and was assigned a relatively short time frame, a holistic rubric has been applied as a means of evaluation. Holistic rubrics are relatively quick to use and allow for an evaluation of the full complexity of performance (Davis 2015: 240) which is why they have been adopted for this part of the mystery. The oral presentation was to be held by one dedicated group member and reflected upon the amount of effort each group has put into the compilation of their posters as well as whether they have understood the task and could provide an answer for the opening statement. Grammatical errors and slips of the tongue did not contribute to the score of the evaluation since the focus of the task is not on linguistic correctness but rather on whether or not the scientific phenomenon has been understood or not. Therefore, the holistic rating scale for the presentation of the mystery reads as follows in Table 10:

Category	Score			
	3	2	1	0
Oral Presentation	excellent	good	sufficient	insufficient

Table 10: Holistic rubric for Mystery

Concerning the posters themselves, they can be assessed in terms of completeness, since groups put different amounts of effort into the finalisation of the construct. As is often the case in the classroom, this assessment is subject to the teacher's judgement. While it has been emphasised that there is no right or wrong when it comes to the final results of the Mystery, a lack of group participation of course influences the outcome of the assignment and should therefore also be taken into account in terms of evaluation. The latter is reflected in the evaluation criterion *Completeness* which measures how many of the 27 cards included in the envelopes have been added to the posters and if so, whether they have been linked in a meaningful manner. Since the students are familiar with the teaching method and 35 minutes are available for the task, the assignment can easily be completed within the allocated timeframe. The teacher acts as an advisor and observer during the group work which means that questions asked by the students can be addressed immediately and should not hinder progress.

The second category that is subject to evaluation is the *Understanding of the Scientific Concept* which in this case relates to the understanding of the heritability of characteristics. Such understanding is demonstrated by providing an answer to the central question around which the mystery revolves. In addition, students must note the correct genotype of different family members on some of the cards provided. This again reflects how well they can implement the insights gained via the first and second Mendelian rule. Seeing as some of the cards allow for more than one correct answer, both possibilities are counted as correct in the case of this rubric. Furthermore, four of the cards from the envelopes give the participants necessary context in order to correctly answer the central question. The way students arrange them on their posters can also provide insight into how well the core idea has been understood.

Lastly, *Creativity* has been chosen as an evaluation criterion. Although fewer points can be achieved for this exercise, Dale, van der Es and Tanner (2011: 175) emphasise the importance of allowing and appreciating creativity when assessing CLIL projects as a means to engage learners and increase their motivation. While science is a subject that often neglects creative activities due to the empirical pretence under which it operates, the mystery allows for students to bring creative ideas to the table. Hence, an analytic rubric has been devised in order to capture all the different aspects that demonstrate the success of the assignment:

<table>
<tr><th rowspan="2">Category</th><th colspan="4">Score</th></tr>
<tr><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Completeness</td><td>(1) All cards are put on the poster and are linked meaningfully</td><td>(1) All cards are put on the poster but are not linked meaningfully</td><td>(1) All cards are put on the poster but are not linked at all</td><td>(1) Only some cards are put on the poster</td></tr>
<tr><td>Understanding of the Scientific Concept</td><td>(1) The poster reflects full understanding of the concept
(2) All 9 genotype-cards are filled in correctly
(3) The story-cards are arranged meaningfully</td><td>(1) The poster reflects some understanding of the concept
(2) 8-7 genotype-cards are filled in correctly
(3) The story-cards are arranged somewhat meaningfully</td><td>(1) The poster reflects little understanding of the concept
(2) 6-5 genotype-cards are filled in correctly
(3) The story-cards are arranged incomprehensibly</td><td>(1) The poster reflects no understanding of the concept
(2) 4 or less genotype-cards are filled in correctly
(3) The story-cards are not arranged at all</td></tr>
<tr><td rowspan="2">Creativity</td><td>1,5</td><td>1</td><td>0,5</td><td>0</td></tr>
<tr><td>(1) The poster shows a high creative effort</td><td>(1) The poster shows considerable creative effort</td><td>(1) The poster shows some creative effort</td><td>(1) The poster shows no creative effort</td></tr>
</table>

Table 11: Analytic rubrics for Mystery

7.2. The post-teaching questionnaire

The second viewpoint of evaluation adopted in this paper accounts for the learners who participated in the project. Towards the end of the very last lesson, the students were asked to fill out a questionnaire which consists of 17 attitudinal questions of different formats. This assessment method was selected for the purpose of triangulating the data. Questionnaires are deemed appropriate for deployment with homogeneous groups due to their time-efficient nature. (Raab-Steiner 2008: 44). In order to ensure comprehension, the questions are formulated in both English and German. Concerning the structure and design of the questionnaire, most choices are based on the guidelines provided by Burns (2010) and Raab-Steiner (2008). The items used are outlined to be closed-ended and include Likert-like rating scales, with three final questions allowing for open answers so that students can express their opinion more elaborately and accurately. The first twelve items are formulated as closed statements providing the students with five answer options to choose from, ranging from *does not apply* to *fully applies*. Going for a "forced choice" answer format, consisting of only four different options to choose from, has been avoided in order to provide students with more possibilities to express their opinions. Furthermore, as the following chapter will demonstrate, no significant bias towards the middle response option can be observed. For items thirteen and fourteen a bipolar rating scale with verbal designations has been chosen to allow for answers along a continuum and offers the participants the greatest possible freedom of choice (Raab-Steiner 2008: 58). This is desirable for collecting data on the perceived difficulty of the project both content and language wise. The last three questions adopt an open format, allowing students to express themselves freely and potentially provide additional insights beyond what has already been asked. Drawing from a similar study conducted by Stürmer (2018) they ask the students to add something they enjoyed about the project (i.e. *Something I found really interesting/Something I really enjoyed/Something I will remember*), something the students felt negative about (i.e. *Something I did not like/Something I would have preferred*), and offers the chance to give brief general feedback (i.e*. Something else I would like to tell you*). The remaining items, including a justification for choosing them for the questionnaire are listed in Table 12:

Item number	Question/Statement	Justification
1	I liked having biology lessons in English	measures whether S enjoy CLIL regardless of the project
2	I was able to try out new things using English	measures S newly acquires skills in the L2
3	My English skills improved because of the project	measures self-perceived language improvement
4	My biology skills improved because of the project	measures self-perceived content improvement
5	I communicated more than in other biology lessons	measures the project's claim to CLT
6	I would have produced the same work if the project had taken place in German	measures perceived relation between language of instruction and output
6.1	I would have performed better/worse had the project been taught in German	see 6
7	I always knew what I had to do	measures perceived success of instruction giving by T
8	I always knew what was expected of me in terms of content and language goals	measures transparency of learning goals
9	I experienced a variety of teaching methods during the project	measures degree of multimodality
10	I was able to complete all the tasks in the time given	measures success of time management
11	I would have needed more support when working on the tasks	measures success of T role as facilitator
12	I could always ask the teacher for help if necessary	see 11
13	How do you rate the language level used during the project?	measures perceived difficulty of language used
14	How do you rate the biology content of the project?	measures perceived difficulty of contents discussed

Table 12: Questionnaire items: overview & justification

7.2.1. Hypotheses

To empirically evaluate the data gathered by the questionnaire, 5 hypotheses have been generated which are to be discussed in more detail. Out of the 24 students who participated in the project, 20 were present in the last lesson to take the questionnaire and unfortunately, the remaining four students could not be persuaded to fill out the form subsequently. In addition, out of the 20 pupils present, not everybody provided an answer on the open items 15-17 as will be discussed in the next chapter. The questionnaire comprises of 17 attitudinal questions which can be grouped according to the hypotheses they seek to verify. Before conducting the survey, the following assumptions have been established:

Hypothesis 1 (item 1, 15 and 16): The majority of students enjoy the CLIL project.

While the first item in the questionnaire directly enquires about the pupils' attitude towards the project, items 15 and 16 allow for open answers and for students to express their opinions on the project more freely. Since the antecedent observations have revealed that the class is predominately taught Biology following a front-of-class teaching style, they are expected to perceive CLIL as refreshing and exciting.

Hypothesis 2 (item 2, 3, 4, 5 and 9): The CLIL project enables students to practice and improve their English and Biology skills.

Although the students are somewhat used to English as a medium of instruction during their Biology lessons, they have never experienced CLIL teaching with an equal focus on content, language, and literacy skills. Thus, it is assumed, that the pupils were able to try out new things using English while at the same time improving their perceived English and Biology skills because of the project. Optimally, the pupils will find that their knowledge in both subject areas has developed equally.

Hypothesis 3 (item 6 and 6.1): The language of instruction does not make any difference to the majority of students.

It is expected that using English as a medium of instruction did not impede comprehensibility throughout the project. Therefore, students are expected to believe they would have produced the same work, had the project been held in German.

Hypothesis 4 (item 7, 8, 10, 11 and 12): The framework of the project allows for successful Content and Language Integrated Learning.

This hypothesis estimates that the students agree with the methods employed by the teacher who has created the appropriate conditions in terms of accuracy of instruction, transparency of learning goals and time management. Furthermore, it is presumed that the pupils have been provided with a sufficient amount of scaffolding and could always ask for further assistance or clarification.

Hypothesis 5 (item 13 and 14): The perceived difficulty of the project was neither too high nor too low.

The desirable outcome for this hypothesis is that students were challenged by the new contents and language input provided during the project, without having felt over- or underwhelmed by the methods employed.

7.3. Personal reflections and teacher comments

"Being reflective assists teachers' lifelong professional development, enabling them to critique teaching and make better informed teaching decisions." (Burton 2009: 298) As is common knowledge among practitioners, reflective practices are a necessary toolkit to improve one's teaching, which is why methodical refection is also at the centre of action research. For the roughly three weeks of the CLIL project, a diary was kept by the teacher for the purpose of reflecting on the success of the project and the appropriateness of the chosen teaching methods. Reflection on one's own actions is most successfully manifested when operating via feedback loops which allow the teacher to repeat his/her teaching, adapting changes gained by the process of reflection. This final step, however, has been partially disregarded in this paper seeing as it would go beyond the scope and the purpose of this study to conduct the project a second time. Nonetheless, the reflective practices adopted in this paper involve most of the same sequences as proposed in Burton (2009: 300), visualised in Figure 13.:

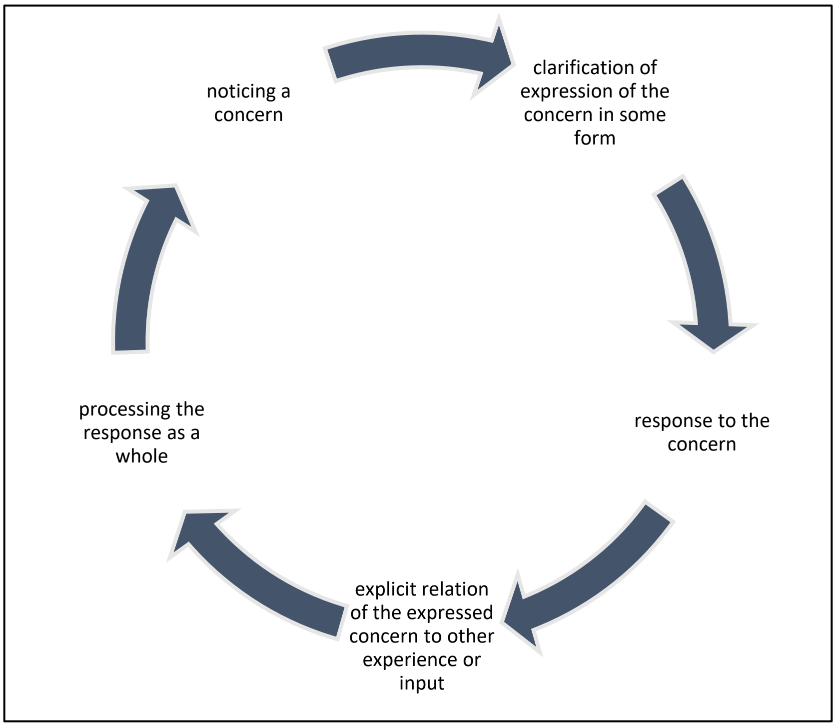


Figure 13: Reflective feedback-loop (Burton 2009: 300)

These thoughts are complemented by the insights of both the English teacher of the class, as well as the language assistant, both of whom were present during most of the teaching project. These informal discussions centred around complications that arose during the project and incidents that have remained unnoticed by the teacher-researcher. Comments have been recorded in note form and will be integrated in the personal reflection to follow in the next chapter.

8. Findings of the evaluation

This chapter will summarise the findings gathered in the course of the teaching project. As has been mentioned in the previous chapter, this is being considered from three different viewpoints. Firstly, the students' performance is being evaluated by considering both their written performance and the results from the mystery. Secondly, the post-teaching questionnaire which has been conducted at the end of the project serves to highlight the pupils' attitude towards the project, including the perceived difficulty and usefulness. Lastly, systematically recorded reflections round off the evaluation by combining both the personal thoughts and assessment of the project and consider the unbiased opinion of the English teacher, as well as the language assistant.

8.1. Student productions

8.1.1. The Scientific Diary Entry

The first part of student performance to be evaluated covers a scientific diary entry that requests the pupils to unite their knowledge of the subject area, their language skills, and the genre-specific conventions of the text type. The following Table 13 illustrates the outcomes of the written productions according to the afore-determined rubrics:

	N	Minimum	Maximum	Mean	Std.-Deviation
Task Achievement	8	1,00	3,00	1,7500	,71686
Organisation and Layout	8	1,00	3,00	1,9500	,59861
Lexical and Structural Accuracy and Range	8	,50	3,00	1,8500	,81820
Prompt-lifting and Plagiarism	7	-2,00	-1,00	-1,7143	,48795

Table 13: Descriptive statistics of writing task

As can be read from the table above (N), out of 24 students only 8 managed to hand in the written assignment which was part of their homework. This unfortunately limits the informative value of the results transferred to the whole class, however, the individual results do provide information on the understanding of the task (and lack thereof). Thus, the results should nonetheless be considered for the qualitative evaluation of the project. The descriptive statistics reveal that a considerable spectrum of scores was attained across all categories, and none of the students scored 0 points on any of the assessment criteria. What immediately catches the eye is that 7 out of 8 students assessed have been caught either lifting sentence fragments directly from the prompt or copying entire paragraphs from some of the teaching materials, as well as the internet. This could be determined by striking discrepancies concerning the "Lexical and Structural Accuracy and Range" in some of the productions, as can be seen in the following excerpt:

> The scientist did many experiments and he found the Law of Uniformity. He called it Laws of inheritance. He said <u>if one crosses a plant that yields purebred yellow peas and one that yields purebred green peas, gametes with the allele A or a are formed</u>. (Text 5)

The underlined segment has been directly quoted from the teaching materials the students were provided with in the previous lessons despite having been instructed to use their own words in the writing. Out of the 7 times prompt-lifting or plagiarising has been detected, 5 times a considerable amount of writing has been wrongfully copied from different sources. The most extreme case of plagiarism was recorded for Text 2 where out of 178 words total, 130 were a direct copy from various internet sources, which amounts to 73% of the entire production.

Concerning the remaining assessment criteria, "Task Achievement" received the lowest overall ratings with a mean value of 1.75, ranging from a minimum of 1 to a maximum rating of 3. This result ties in closely with the previously discussed frequent occurrences of plagiarism, seeing as how many pupils made use of various sources in order to describe the Law of Uniformity, on which they presumably would have found lots of information online. However, this meant that they frequently deviated from the text type and ended up giving a biographical description of the historical figure Gregor Mendel, rather than producing a scientific diary entry:

> Dear diary, today I'll be talking about works of Gregor Mendel. Mendel's work is outstanding, since it constitutes a completely new approach: the concentration on just a single feature. Mendel set great store by evaluation of the plants gained by hybridisation independently. (Text 6)

Assuming that reporting on the experience in the monastery, as well as predicting future discoveries are assessment criteria that demand students to come up with their own ideas, would explain why those who plagiarised the most also received lower ratings in terms of TA:

		Prompt-lifting and Plagiarism		
		a considerable amount of writing is plagiarised from other sources	a small amount of writing is plagiarised from other sources	Total
Task Achievement	Hardly adheres to the given text type	3	0	3
	Partially adheres to the given text type	2	2	4
Total		5	2	7

Table 14: Cross-table examining instances of prompt-lifting and plagiarism in connection with TA

As Table 14 depicts, 3 of the students who hardly adhered to the given text type and only listed some of the bullet points also belonged to the group of students who plagiarised a considerable amount of their writing from other sources.

In terms of creativeness in writing, only one text was able to meet the prerequisites of receiving 3 points for the first assessment criterion. While the student who produced Text 1 could have addressed the bullet points in slightly more detail, as he/she did not manage to make the word limit, the way the diary entry was composed differs from all the other compositions. It includes an enumeration of days in which certain discoveries were made, tells a more personal story rather than simply listing facts and even includes a correctly filled-in Punnett square depicting the first and second Mendelian rule (see Appendix: p.128).

The second criterion of the assessment scale, "Organisation and Layout", had students yield rather positive result with a mean value of 1,95 (see Table 11). All students but one followed the convention of starting their entry with "Dear diary," which is just as mandatory for the respective text type as a proper greeting in a letter. While texts occasionally exhibit use of linking devices, in most of these instances the passages were plagiarised and therefore not considered for further assessment. Thus, only one diary entry met the prerequisites for receiving 3 points on this criterion for successfully implementing linking devices:

> Mendel's law showed that when a true-breeding yellow pea and a true-breeding green pea were cross bred their offspring always produced yellow seeds. However, in the next generation, the green peas reappeared at a ratio of 1 green to 3 yellow. (Text 8)

Apart from the scientific correctness, the author of Text 8 was the only one to use linking words in his/her writing and was therefore assigned a 3rd point for this assessment criterion.

Regarding the "Lexical and Structural Accuracy and Range", assessment according to the predefined rubrics was particularly difficult due to the high occurrence of plagiarised content. Similarly to the other criteria, it was determined that the passages should not be evaluated for any of the categories except for word count. Therefore, some of the texts which exhibit a considerable amount of prompt lifting or plagiarism were particularly difficult to assess, given the limited content. It is hardly surprising, that similar to the correlations with TA, students who plagiarised, produced less accurate and diverse texts (Table 15).

		Prompt-lifting and Plagiarism		
		a considerable amount of writing is plagiarised from other sources	a small amount of writing is plagiarised from other sources	Total
Lexical and Structural Accuracy and Range	Occasionally unable to express him/herself clearly	2	0	2
	Expresses him/herself clearly though there may be some signs of restriction	3	1	4
	Expresses him/herself clearly without much sign of having to restrict what he/she wants to say	0	1	1
Total		5	2	7

Table 15: Cross-table examining instances of prompt-lifting and plagiarism in connection with LSAR

A majority of mistakes can be traced back to insecurities using (semi-)technical vocabulary or phrases common in scientific discourse:

> I report on the scientific experiences in inheritance law. (Text 3)
>
> I think we will do further research into the Law of Seperations as well as Independence. (Text 3)
>
> Mr. Gregor Mendel is a <u>Monch</u> and also a Sienticts. (Text 4)
>
> The scientict did many experiments and he found the Law of Uniformity. (Text 5)
>
> The Mendel's law! (Text 7)
>
> He is also known for creating the science of genetics. (Text 7)
>
> Another law named law of Dominance (Text 7)
>
> The Mendel's law describes the characteristics of a human being/ other breeds. (Text 8)

Furthermore, the example from Text 4 points towards cross-linguistic influence as the cause for the error. The other examples are mostly concerned with mistakes in connection with the Mendelian rules/ Mendel's laws which have either been cited incorrectly or have not been grammatically adapted according to the sentence structure. The remaining mistakes produced by students are not indicative of any particular misunderstandings of the contents but rather common errors occurring at the respective language level. Incorrect uses of pronouns, singular/plural mistakes and inappropriate tenses were found among them, to name a few:

> In the 1st generation all peas was yellow. (Text 4)
>
> He called it Laws of inheritance. (Text 5)
>
> The thing Mendel discovered is called principle of uniformity, or so did he called it. (Text 6)
>
> Me and Gregor work on a project which later got named on him (Text 7)
>
> Gregor Mendel worked on a project which was later on named after him by other biologist. (Text 8)

8.1.2. The Mystery

The results of the mystery, which was conducted in the fifth lesson of the project, were evaluated from two viewpoints. The posters designed by the students were taken into consideration using an analytic rubric, while the consecutive oral presentation was assessed using a holistic rating scale. The outcomes of the latter are illustrated in Table 16 below:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	sufficient	2	20,0	33,3	33,3
	good	3	30,0	50,0	83,3
	excellent	1	10,0	16,7	100,0
	Total	6	60,0	100,0	
Missing	System	4	40,0		
Total		10	100,0		

Table 16: Results of oral presentations using a holistic rating scale

Since every group took the opportunity to present their findings to the rest of the class, none of the presentations have been marked as insufficient. However, the extent to which the various presenters could provide comprehensive and detailed justifications for their work differed significantly. Out of the six presentations, only one group received an excellent rating as they managed to answer both the central question of the mystery and were able to give good reasons for how they arranged the cards on their poster. While the other groups were also able to provide answers to the central question, their explanations were not satisfactory enough or did not line up with the impression gained from the poster, so that they did not receive a better rating.

Regarding the posters themselves, they have been evaluated in terms of Completeness, Understanding of the Scientific Concept and Creativity.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Only some cards are put on the poster	2	20,0	33,3	33,3
	All cards are put on the poster but are not linked at all	1	10,0	16,7	50,0
	All cards are put on the poster but are not linked meaningfully	2	20,0	33,3	83,3
	All cards are put on the poster and are linked meaningfully	1	10,0	16,7	100,0
	Total	6	60,0	100,0	
Missing	System	4	40,0		
Total		10	100,0		

Table 17: Results of completeness using an analytic rating scale

Table 17 illustrates the ratings according to the first criterion on the assessment scale. The assessment of poster completeness considers whether all of the cards have been correctly incorporated into the poster and if there are any discernible, meaningful connections highlighted by lines, arrows, annotations, and so on. Although the students were already familiar with the format as well as the contents, the results still display insecurities on how to organise a mystery. As was briefly mentioned in the previous chapter, time can be ruled out as a determining factor explaining the incompleteness of two of the posters. The only group that achieved a rating of 3 points in terms of completeness is Group 1, whose finished product is depicted in the Appendix (p.136). The reason as to why this group has been awarded the best rating is because it is the only group that managed to successfully illustrate the familial relations of the agents in the mystery in the shape of a family tree. Genealogical trees can be defined as a discrete scientific genre themselves and although they have not been introduced during the project, Group 1 managed to assort the various family members accordingly. In addition, the group cleverly attached the genotype-cards to the corresponding family members which makes the whole arrangement appear well structured.

Thorough understanding of the scientific concept goes hand in hand with linking the cards on the poster in a meaningful manner. However, this evaluation criterion also includes judgement on whether or not the empty genotype-cards have been filled in correctly. The parental generation (P), represented by the grandparents, exhibits the respective genotypes on the cards. Thereby, students are prompted to deduce the remaining genotypes of the two following generations (F1 and F2) using their knowledge of the Mendelian rules. The only group that managed to provide the correct genotypes for all agents was Group 2 (see Fig. 11) who, despite showing a lack of creative effort, managed to consider all possible outcomes for the family's genotypes.

Group 2 was also able to correctly arrange the remaining story cards in chronological order, which most likely assisted them in understanding the central question of the mystery and, despite not being able to justify all of their choices in the oral presentation, rewarded them with a good overall score.

Lastly, the two posters which have been discussed in more detail are exemplary for the range of creative effort the different groups have put into their productions. It goes without saying that apart from using different colours to indicate generational distinctions, Group 1 was able to produce a genealogical tree while Group 2 hardly made use of any other resources than the ones provided for them in the envelopes. Seeing as the focus of this exercise nonetheless lies on the overall completion of the exercise and understanding of the underlying scientific construct, points awarded in terms of creativity did not influence the overall outcomes of the task significantly:

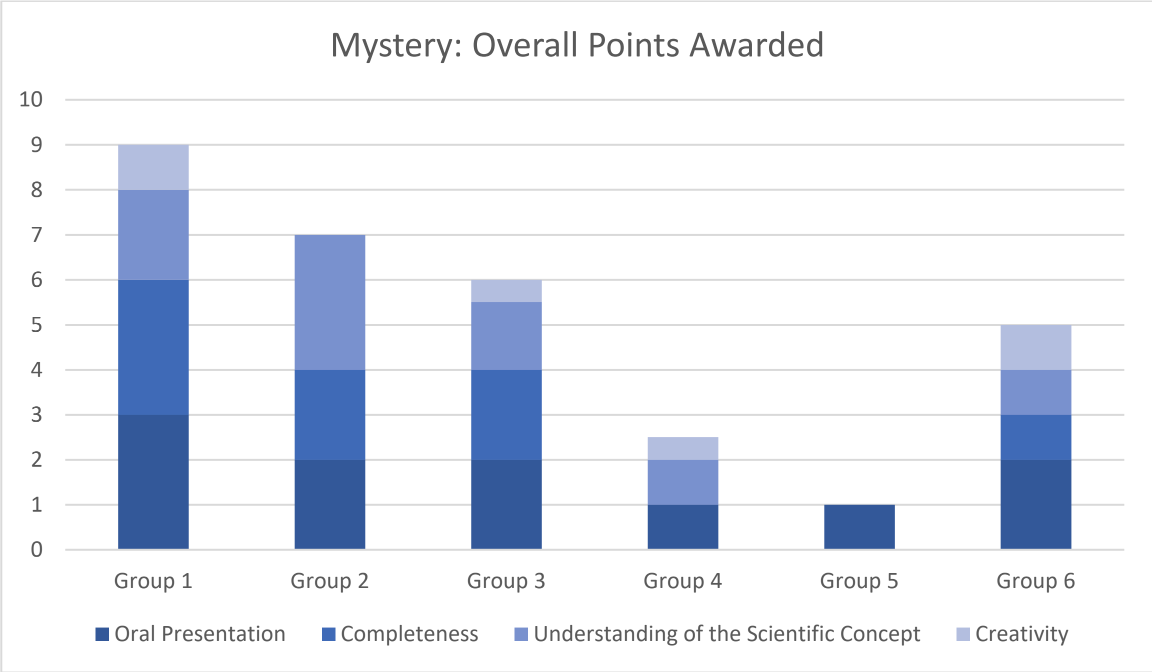


Figure 14: Overall awarded points for the Mystery

Figure 14 summarises the results for the evaluation of the mystery and makes visible a significant performance gap among the different groups. Unfortunately, Group 4 and Group 5 did not manage to complete the exercise in the given time, putting little to no effort into their productions and partially refusing to comply with the task. While the identical groups have been assembled for the station learning in lesson 4, the two groups hardly participated in the last lesson of the project. A classroom is subject to countless environmental influences the teacher has no influence on, such as the time of the day, the cognitive demands of the previous lessons, or the mental state of each individual students, to name a few. A further possible explanation for the lack of engagement could be, that a football tournament had been planned for the very day of the fifth lesson, yet had to be cancelled due to heavy rain, which led to noticeable frustration among many of the pupils. Nonetheless, measures the teacher could have taken to circumvent such an undesirable outcome will be discussed in more detail in the personal reflection.

8.2. Student Questionnaire

As a means of triangulating the data obtained by the student productions, the participants were asked to fill out a questionnaire in order to determine the perceived effectiveness of the project in accordance with the difficulty of the exercises.

The first hypothesis postulates that, overall, the students enjoyed the CLIL project and discusses both a closed as well as open questions measuring the participants' attitude. Figure 15 illustrates the answers collected on the first question on the survey: *I liked having biology lessons in English*.

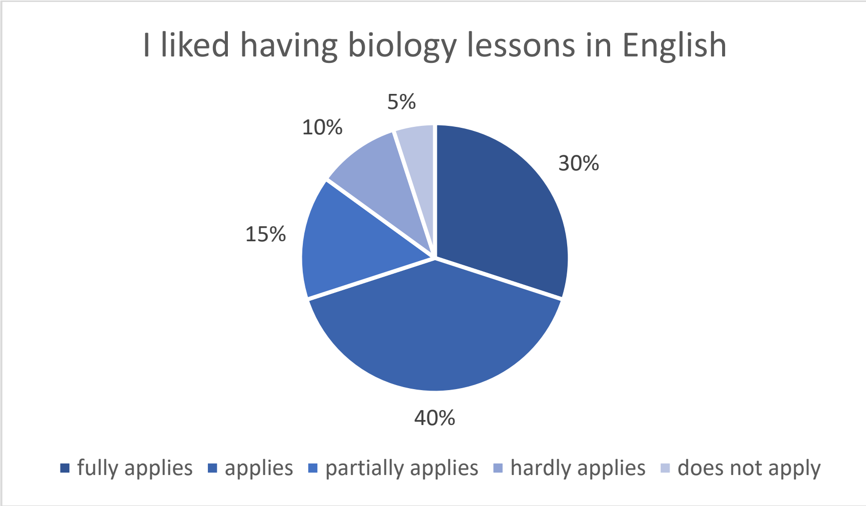


Figure 15: Results of I1: "I liked having biology lessons in English"

As can be read off the pie chart, a total of 70%, equalling 14 students, liked having biology lessons in English, whereas only 15% (3 students) did not enjoy the project and another 15% enjoyed parts of it. The vast majority of pupils gained a positive impression of the project, however, to get further insight on their opinions, the answers to item 1 are compared with those to the open questions 15 and 16 which allowed for a more detail description of what the students (dis-)liked about the project. Therefore, the registered answers are classified into a predefined category system. Concerning item 15, *Something I found really interesting/Something I really enjoyed/Something I will remember*, and item 16, *Something I did not like/ Something I would have preferred*, 3 and 4 distinct the respective categories and results can be viewed in Figures 16 and 17:

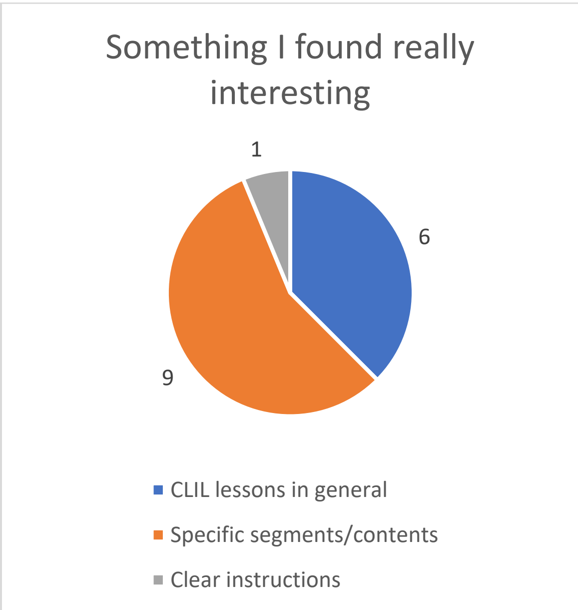


Figure 17: Results of I15: "Something I found really interesting/Something I really enjoyed/Something I will remember"

Figure 16: Results of I16: "Something I did not like/ Something I would have preferred"

Out of the 16 students who gave a valid answer on item 15, 6 reiterated the fact that they enjoyed the CLIL lessons, one student writing “Everything was good, I am going to remember the lessons in English”. A total of 45% referred to specific segments from the project, such as the learning stations, which reinforces the assumption that the pupils are content with the multimodal input they received. Accuracy of instruction was mentioned once both in item 15 and item 16, one student highlighting the fact that they were content with the instruction-giving and one student pointing out that they would have needed additional directions. Concerning item 16, out of the 14 students who gave a valid answer, 10 substantiate that they did enjoy the project, regardless of the question asked. Those 10 pupils, however, were among the 6 who already expressed their satisfaction with the project in item 15. While one student in particular pointed out that the speech rate of the teacher was too fast, which corresponds with the teacher’s impression discussed in the following chapter, two pupils claimed that they would have preferred German as the medium of instruction. This is consistent with the answer both of them gave to question 6.1., asserting that they would have performed better had the project been taught in German.

	N	Minimum	Maximum	Median	Std.-Deviation
I was able to try out new things using English	20	2,00	5,00	4,0500	,88704
My English skills improved because of the project	20	1,00	5,00	3,4000	1,23117
My Biology skills improved because of the project	20	2,00	5,00	4,3000	,80131
I communicated more than in other Biology lessons	20	1,00	5,00	3,4000	1,09545
I always knew what was expected of me in terms of content and language goals	20	2,00	5,00	3,8500	,93330

Table 18: Descriptive statistics of I2,3,4,5,9

Items 2, 3, 4, 5 and 9 are all related to the students’ perceived success of the project in providing them with diversified lesson input and expanding their knowledge in both English and Biology. All students, apart from one, stated that they were able to try out new things using English, suggesting that the project differed substantially from the English instruction they had received up until this point. Preceding observations fortify this claim, seeing as the only segments taught in English were prepared independently by the language assistant and hardly ever connected with the lesson input prepared by the Biology teacher who acknowledged that she does not instruct their students in any language other than German.

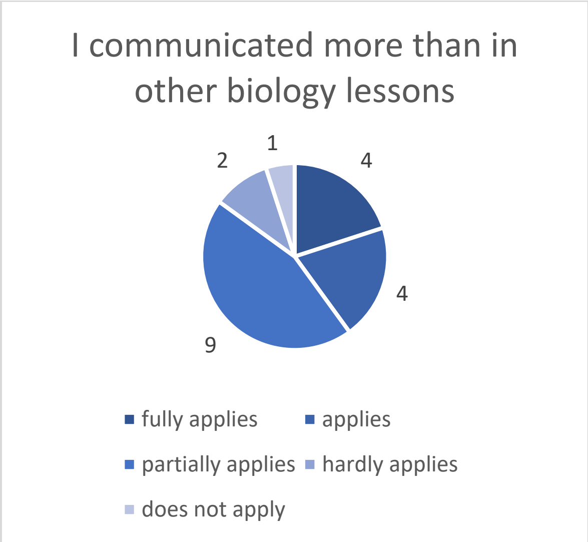


Figure 19: Results of I5: "I communicated more than in other biology lessons"

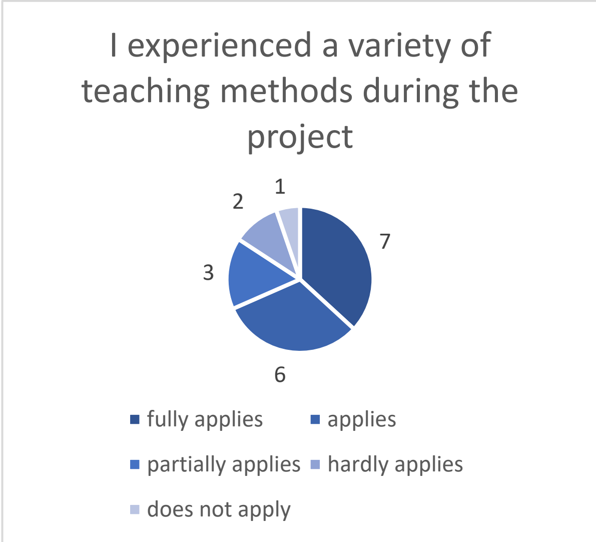


Figure 18: Results of I9: "I experienced a variety of teaching methods during the project"

Figures 18 and 19 present the pupils perceived success in terms of CLT and multimodality. While the majority of participants seem to agree on the fact that a variety of teaching methods has been implemented throughout the project, the results concerning the amount of time devoted to communicating shift towards the answer *partially applies*. Although the results are undeniably positive, the difference between the two items could be explained by the strong emphasis on receptive skills in the first two lessons of the project. While there was a conscious attempt to counteract this approach from the third lesson onward, it seems to have impacted on the students' answers considerably. It could also stem from the fact that although the class is part of a bilingual schooling programme, some would have felt more comfortable and thus contributed more orally, had the lessons been held in German. In addition, seeing as one of the focal points of this project is to successfully implement CDFs in CLIL, whose successful implementation becomes cognisable via communicating, a stronger tendency towards the first two answer options *fully applies* and *applies* would have been desirable.

Since CDFs have been described as a "zone of convergence between content and language pedagogies" (Dalton-Puffer 2013: 216) the perceived improvement of both English and Biology skills should be reasonably balanced. This is what items 3 and 4 ought to illustrate, the results of which are illustrated in Figure 20:

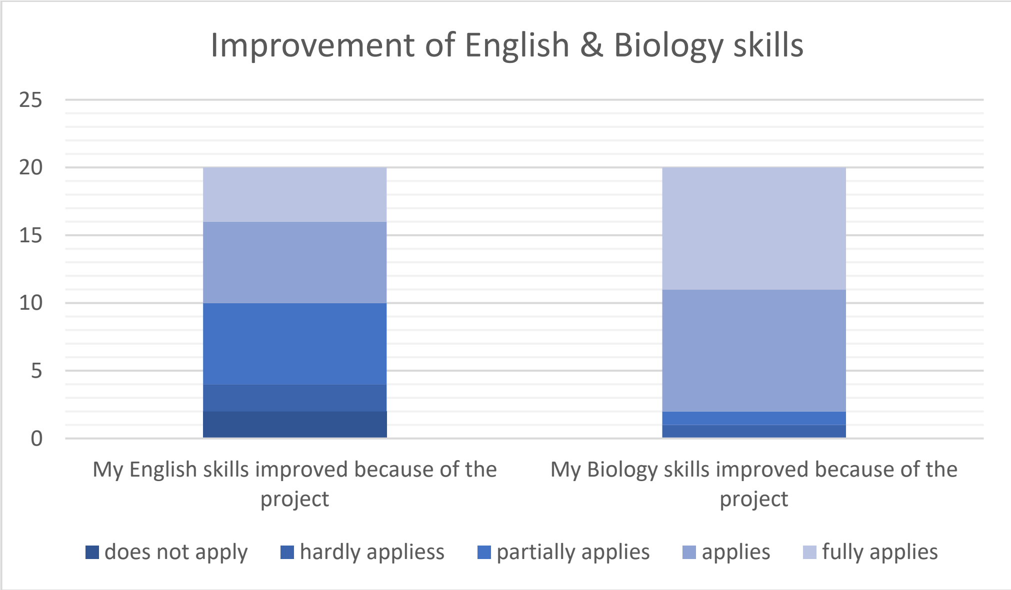


Figure 20: Results of I3,4: "My English/biology skills improved because of the project"

The bar-charts illustrate that in both instances a majority of pupils believe that their competencies have improved due to the project. In accordance with the results gained from items 2 and 9, this confirms the second hypothesis and demonstrates that the CLIL project enabled students to practice and improve their English and Biology skills. However, as previously mentioned, an equal improvement of both English and Biology skills cannot be observed given the results gathered from item 3 and 4. While during the planning stage of the project, detailed attention has been paid to creating a balance between a focus on meaning and a focus on form, this intent unfortunately could not effectively be transferred into practice. The perceived emphasis on content rather than language might originate from the fact that the language assignments have been presented in a more implicit manner than the contents could, thus shifting the pupils' attention towards the latter. Although a variety of materials, such as exercises on the passive voice and a writing activity, have been devised in order to emphasise the importance of language, the students have unwantedly been left with the impression that mostly knowledge about the topic of inheritance was at the centre of the CLIL project. Furthermore, progression in language learning is often more challenging to clearly define and measure than advancements in understanding biology content. While biology topics tend to be structured and can be divided into distinct units or concepts, language learning involves a more fluid and context-dependent process.

Hypothesis number three, *The language of instruction does not make any difference to the majority of the students*, assumes that using English as the medium of instruction did not impede comprehensibility of the contents discussed. In view of the results presented in Figure 22, the vast majority of students believe that they understood the contents regardless of the language of instruction in accordance with the hypothesis. Surprisingly, however, out of the 11 students who also provided an answer to item 6.1., 6 answered that they would have performed better, had the project been taught in German, whereas 5 pupils believe they would have done worse (see Figure 21).

Figure 22: Results of I6: "I would have produced the same work if the project had taken place in German"

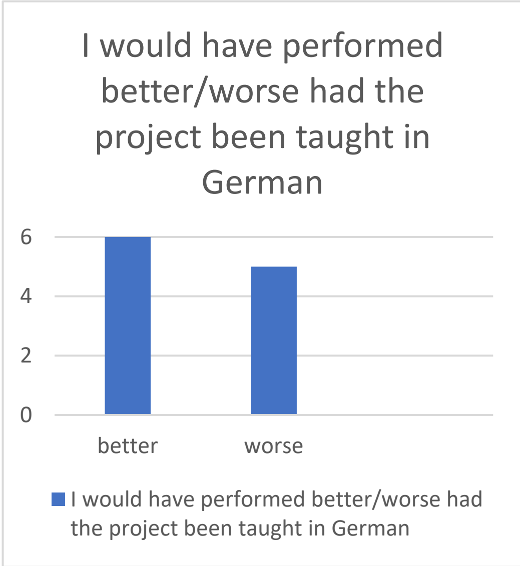


Figure 21: Results of I6.1: "I would have performed better/worse had the project been taught in German"

These results lead the author to believe that some of the pupils misunderstood item 6. This could be due to an ambiguity in meaning concerning the question which has not been considered while compiling the item, since 3 out of the 6 pupils who claimed that they would have performed better with German as the medium of instruction fully agreed with item 6 (see Figure 23). What was really asked of them, however, was whether they understood all of the content, regardless of the language, whereas the question really hinted towards the idea that the medium of instruction played no role whatsoever during the project. Therefore, it is impossible to establish how many of the students understood the item in such a way that does not lead to the verification of the third hypothesis.

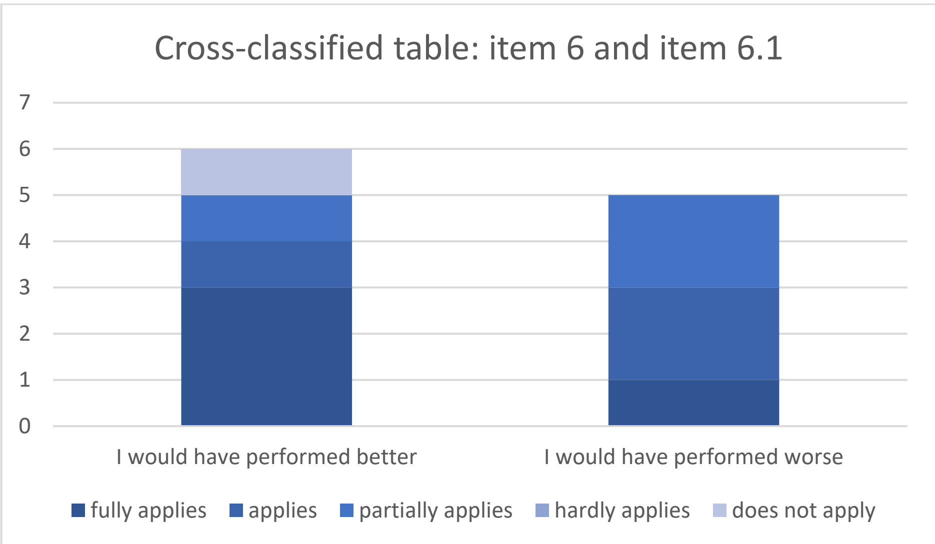


Figure 23: Cross-table examining results of I6,6.1

The fourth hypothesis focuses less on CLIL-specific issues and encompasses more general aspects that are essential for facilitating successful learning. These aspects are equally important and greatly contribute to the project's success.

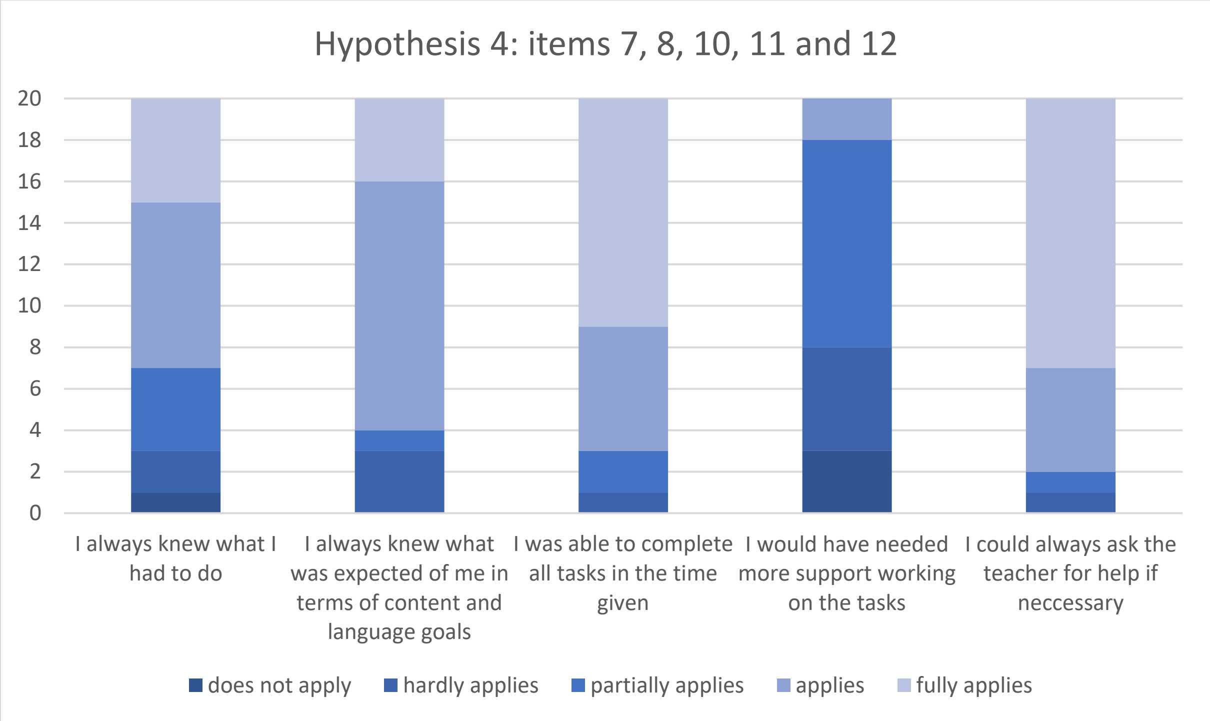


Figure 24: Results of I7,8,10,11,12

Figure 24 summarises the findings concerning the pedagogical framework of the project and paints a clear picture. An overwhelming number of participants felt that they had been instructed clearly and that both content and language outcomes had been made transparent to them beforehand. Since, in addition to oral instructions, all teaching materials are labelled with information on what is expected of the students, this does not come as a surprise. Furthermore, at the beginning of each lesson, the learning goals were briefly discussed, giving the students an outlook of what is to come. In terms of timing, the impression of the pupils is that there was plenty of time provided for all tasks which, interestingly, diverges from the teacher's perception as is discussed in the following chapter. When it comes to the amount of support provided during the course of the project, a larger proportion of students would have wished for more scaffolding in order to complete the exercises. However, all of the participants who partially agreed with the statement responded strongly that they could have always asked the teacher for help if necessary. It goes without saying though, that even more scaffolding could have been provided to help the throughout the project. Unfortunately, however, the questionnaire fails to depict which tasks the students would have needed more assistance with, which is something to keep in mind for the implementation of similar studies in the future.

The final research question investigates the perceived difficulty of the project according to language and content. Following Krashen and Terrell (1983), teachers should aim to provide input which is comprehensible, meaning that the contents' difficulty is slightly higher than the learners' present level. On average, the pupils perceived both language and content input equally easy/difficult as there are no major deviations between the two categories (see Figure 25).

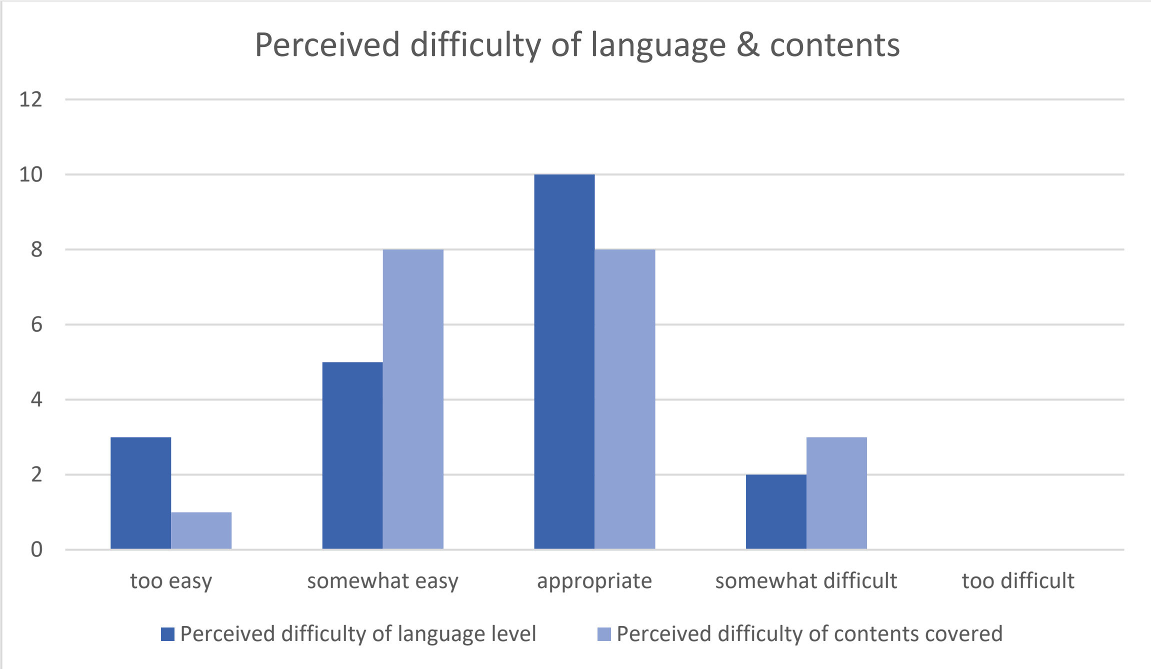


Figure 25: Results of I13,14: "How do you rate the language level/ content used during the project?"

The contents covered during the project were assessed as appropriate and somewhat easy by 8 pupils respectively. In accordance with comprehensible input, the desired outcome should lean towards *somewhat difficult*, however. Interestingly, the students' self-assessment diverges from the external assessment discussed in the previous chapter. Although the results scored by the pupils were not necessarily poor, the productions do not fully reflect the prevailing opinion regarding the difficulty of the contents. Seeing as the questionnaires were plotted anonymously, unfortunately the results of the student productions and the answers on the questionnaire cannot be put in direct connection. Language-wise, the answers lean even further towards the impression, that the lessons were not demanding enough, although, as item 11 has shown, a disproportionate number of pupils would have needed more support. Participant 7, for example, stated that they would have liked more support when working on the tasks (*applies*) yet at the same time considered the language level used *appropriate* and the contents *somewhat easy*. These contradictory results are hard to interpret and would perhaps require interviewing the students as to why they gave the respective answers which, for mentioned reasons, is impossible. What fortunately can be highlighted, however, is the fact that none of the pupils considered both language and contents as too difficult which suggests that the teacher has successfully contributed to the achievement of the learning objectives.

8.3. Personal reflections and teacher comments

Throughout the project, a diary has been kept recording personal reflections on the success of certain teaching segments, as well as the project as a whole. This chapter will deal with the insights gained through the reflective process, underpinned by three central investigative questions after Burton (2009: 301):

- What do I do?
- How do I do it?
- What does this mean for me and those I work with (and for)?

Starting chronologically with the first lesson of the project, a considerable amount of time had to be expended to clarify and reinforce the format and purpose of the project. Although the class in question is subscribed to the Vienna Bilingual Schooling program, despite all efforts, many of the students did seem overwhelmed at first having to focus on both language and content. This impression was strengthened by the fact that, until now, they had mostly been taught in English by the previously mentioned language assistant, who was not present in class at the beginning of the project. Although the preparatory observations gave reason to believe that for a majority of students it feels natural to speak English in class and with their peers, the project was something to get used to regardless, albeit because of the language or the CLIL-setting in general. However, in anticipation to this possibly constituting an issue, the first part of the project included some front-of-class-teaching and focused on the activation of receptive skills. While the Presentation does include several interactive elements for students to participate during the lecture, some of the input could and should have either been omitted at this initial stage. Although 15 minutes of input appear to be within reason, due to the fact that some pupils already felt overburdened with the new format, they were not as susceptive to the contents being presented to them at this stage. Adhering to the suggestions on activating for CLIL by Dale, van der Es and Tanner (2011: 26) more attention could have been paid to appealing to different learning styles or multiple intelligences, hence promoting comprehensibility among all learners. The mentor teacher also voiced her concerns regarding the speaking pace during this segment which, according to her perception, was too fast for some learners. She also suggested making use of paraphrasing and translations into German to a greater extent. Especially when working with ample amounts of (semi-)technical vocabulary, both of these strategies are reasonable approaches to ensure student understanding, however, throughout the project translations were mostly avoided, seeing as the majority of unfamiliar words would have been as difficult to understand in the first language without proper contextualisation.

Reducing the amount of time taken up by the theoretical input would have also allowed for a more extensive examination of the *Cloze exercise*, as well as the following segments. Concerning the former, despite the task essentially including information presented beforehand, it would have made sense to provide the pupils with the prefabricated glossary beforehand. Although this could have decreased the task-difficulty and taken up more time, the students would not have been as dependent on language clues from the text to complete the exercise and rather look for the correct meaning of the missing vocabulary.

The final segment of the first lesson had a clear language focus and demanded students to both look for and produce instances of the passive voice. For this reason, the English teacher of the class had been consulted beforehand to inquire about the group's knowledge of the passive voice and their English proficiency in general. While the teacher reassured that the pupils are familiar with the passive voice, it turned out to be not as anchored in their memory as anticipated. The plan was to re-activate these grammatical structures and provide some students with additional scaffolding to use for the completion of the task. However, the entire class would have needed a closer inspection and reiteration of the passive voice to successfully complete the exercise, which again would have demanded more dedicated time and unfortunately led to some confusion at this stage. Despite the task having been designed to be done individually, most of it was completed in plenary which possibly meant that not all students had the opportunity to properly think about the exercises for themselves.

The second lesson of the project started off with a *Concept Cartoon* that confronted students with various pre-/misconceptions about the subject of inheritance and demanded them to reason for/against the provided statements. While content-wise, most pupils were able to tell what is right from what is wrong, language-wise, they had difficulties articulating their arguments. This could have easily been avoided by providing them with appropriate scaffolding for arguing for/against something in English. While most of the pupils were able to get their points across regardless, they either resorted to switching to German or had a hard time putting their thoughts into words in English. Therefore, they were allowed to also user their L1 to explain themselves, seeing as the understanding of the scientific concept was deemed more important at that point and students should be encouraged to participate, albeit not in English. However, it was also brought to their attention that they should talk in English during the project and that risk taking is actually desirable, even if it entails occasionally making mistakes. This request was positively reinforced by the language assistant who was present for the second lesson of the project.

The following listening exercise consisted of a TED-Ed video which was streamed twice via YouTube, during the second time of which the pupils had to complete an exercise. It was definitely necessary to play the video two times, seeing as the contents were presented in a dense manner. Although the students need not understand all of the mentioned concepts at this point, they should not feel overwhelmed by the amount of input given in a relatively short amount of time. Another way to address this could have been to reduce the video speed to 0.75 times the original, allowing students more time to work on the questions without having to listen to a completely distorted voice, at the expense of one to two minutes. A segment that could have been omitted in order to facilitate more time for other exercises is the short presentation on Gregor Mendel as a historical figure. Seeing as he also finds mentioning in the short video and his biographical information is not necessary for the upcoming exercise, the information mentioned in the presentation could have been provided for the students to look up at home when compiling their diary entries. Alternatively, the writing task, which was introduced in the third lesson, could have lent itself to be done as an in-class writing exercise, which would have entailed several advantages. The pupils would have had someone at their disposal to ask questions while writing and who could have given them further suggestions on what to consider when writing a text. The mediocre outcomes resulting from the writing task indicate that the students could have also made use of (pre-)writing strategies to improve their texts and make them more coherent. In addition, they might have been more likely to implement the passive voice in their productions more frequently, given the chance to ask for assistance at any time. Lastly, in-class writing activities bear the advantage that it is virtually impossible for students to plagiarise from other sources than the prompt itself, which presumably would have also yielded more positive results and fewer points to be deducted as a result of the assessment grid. However, this would have required another full lesson to add to the project which simply was not realisable given the fact that the designated lesson had to be agreed upon beforehand together with the mentor teacher.

The station learning was most time-consuming during the planning stage of the project, seeing as both the contents as well as the timing had to be adjusted meticulously. Nonetheless, there is arguably still room for improvement, beginning with the group formation process. While none of the students appeared to have an issue with their assigned group members themselves, some groups synergised much better than others for no apparent reason. Although a considerable amount of effort was put into the allocation of pupils, the role distribution inside of the groups led to occasional periods of latency. While some groups followed the assignments immediately and meaningfully distributed the workload among themselves, others had to be instructed more thoroughly in order to complete the exercises in time. These frequent teacher interventions unfortunately oppose the intention to let students work as autonomously as possible during the station learning, for the sake of time keeping. On the other hand, the bonus task, which was put in place as a workaround to avoid groups having to wait for each other, claimed too much time to set up and explain in itself. Instead of carrying the necessary items over to the respective group, the teacher's desk could have served as the base for the bonus task for students to come up to, possibly saving time setting it up. Alternatively, an entirely different bonus task that is easier to carry out could have been put in place. Regarding the actual learning stations, no major difficulties occurred in terms of understanding, although sometimes students proceeded to ask questions without having had a proper look at the instruction sheets. Learning station 1, *The Triangles of Genetics*, turned out to consistently be the most challenging task. Students had to match (semi-)technical terms with their corresponding definitions by cutting out and re-arranging triangles. Again, in order to save time, the triangles could have been cut out beforehand by the teacher, seeing as the process itself is hardly beneficial for the students working on the station. Furthermore, the terms and definitions could have been highlighted with distinct colours for pupils to distinguish between them faster and providing them with an additional scaffold. Concerning the latter, the use of the glossary should have been reinforced by the teacher as many groups had difficulties with this learning station.

Despite the fifth day of the project having been the most pleasant one in terms of room temperature (the classroom facing south-side), due to heavy rain an announced football tournament had to be cancelled which led to major frustration among a select group of pupils. The groups were identical to those the day before, and yet the results achieved by them varied immensely. There is not much that could have been done to avoid this situation other than broaching the issue and consoling the visibly upset students who, understandably, made their frustration known. Neither the mentor teacher, not the language assistant could think of a solution to avoid the unfortunate outcome in hindsight, however, fortunately, none of the students gave expression to their displeasure with the ungovernable situation in the questionnaire.

Considering both the student productions as well as the questionnaire, the implementation of the teaching project can be described as successful. The pupils exhibited an overall high level of engagement and due to careful planning, including differentiated task design and ample scaffolding, the majority of learning goals have been realised. However, a critical reflection on the teaching methods used reveals manageable opportunities for improvement in future applications. Firstly, the issue of timing should be addressed, seeing as it has come up at various stages of the reflection and was also commented on by the mentor teacher. During the planning stage, an additional lesson was already adjoined to the original four hours the project was scheduled for. In hindsight, an additional one to two hours would have been needed to complete the project without compromising the achievement of learning outcomes. Alternatively, the mystery is arguably the only exercise that could be deleted / left out in future application of the project, seeing as the other tasks are all building up on each other both content- and language-wise.

9. Conclusion

While the central emphasis of this thesis is placed on the development of appropriate CLIL teaching materials, a thorough empirical evaluation was conducted to assess their reception and quality. After successful implementation of the project and discussion of the results achieved, some concluding remarks shall be made. Concerning the output generated by the pupils throughout the project, it is unfortunate that a relatively small number of students handed in their texts and that many of them lifted sentence fragments or even entire paragraphs from the prompt or the internet. As previously discussed, this could be attributed to the fact that some were overchallenged with the contents of the first lessons. However, in view of the individual assessment criteria, a satisfactory result for the target audience can be recorded. In addition, the self-perceived difficulty of the tasks at hand were mostly deemed appropriate with more participants even arguing they were too easy rather than difficult. The results achieved with the mystery method are also mostly satisfactory. This again strengthens the assumption that the in-class assignments were completed more conscientiously. Although outer factors negatively influenced the pupils' motivation at the time, most of them complied with the set tasks and were able to successfully realise them according to their capabilities. This is further supported by the results of the questionnaire which reinforce a positive reception of the project among the student body. In accordance with the first and central hypothesis of the thesis, a majority of the participants stated that they enjoyed the CLIL setting. Furthermore, the contents aligned with the pupils' fields of interest and while a small proportion of learners would have preferred a conventional setting, a majority of students reinforced their content with the project. Likewise, most participants agreed that the project allowed them to try out new things while being subjected to a variety of different teaching methods. On the other hand, according to the results of the questionnaire, a stronger focus on communication and thus fewer written assignments would have been desirable. Moreover, an unequal self-acclaimed improvement of English and Biology skills was reported, with a stronger tendency towards the content subject. These findings are evident when comparing the last two results, as a greater acquisition of knowledge in English should correlate with increased communication. However, as has been mentioned before, progress in language acquisition, especially over a relatively short period of time, tends not to be noticed by learners, in contrast to content knowledge. In terms of instruction-giving and scaffolding the uttered impressions by the pupils and the teachers' remarks diverge substantially. While the former reported that they always knew what to do and would not have needed more support working on the tasks, the instructors shared the impression that some of the learners could not follow specific segments which was reflected in their output. This also applies to the time allocated. while the students were content with the time available to complete the tasks, the teacher had to accept cutbacks in order to be able to implement the project in a meaningful way.

Finally, it can be stated that the "Pea Project" has been successfully implemented in an authentic classroom setting and can/will be added to an increasing canon of CLIL classroom materials. Like any other project, it can and should always be subject to modifications and potential improvements through practitioners in the future. I, for one, will count myself among them.

10. Bibliography

Al Salmi, Mahfood. 2011. “Schemata (background knowledge) and reading comprehension for EFL students”. *Research Journal Specific Education* 22, 695-708.

American Association for the Advancement of Science. 2001. *Atlas of science: Mapping K-12 science learning.* (Volumes 1 and 2). Washington: AAAS.

Anderson, Lorin W.; Krathwohl, David R. 2001. *A taxonomy for learning, teaching, and assessing: a revision of Bloom's taxonomy of educational objectives*. New York, NY: Longman.

Australian Curriculum Assessment and Reporting Authority. 2014. *National Report on Schooling in Australia 2012.* ACARA.

Bauer-Marschallinger, Silvia; Dalton-Puffer, Christiane; Heaney, Helen; Katzinger, Lena; Smit, Ute. 2021. “CLIL for all? An exploratory study of reported pedagogical practices in Austrian secondary schools”. *International Journal of Bilingual Education and Bilingualism,* 1–16.

Bauer-Marschallinger, Silvia. 2018. “Integration of content and language pedagogies: cognitive discourse functions in the CLIL history classroom”. *CELT Matters* 2, 19-28.

Becker-Mrotzek, Michael. 2013. *Sprache im Fach: Sprachlichkeit und fachliches Lernen*. Münster: Waxmann.

Biesta, Gert. 2015. “What is education for? On good education, teacher judgement, and educational professionalism”. *European Journal of Education* 50(1), 75-87.

BIFIE. 2011. “Kompetenzmodell Naturwissenschaften 8. Schulstufe“. https://bildungsstandards.bifie.at/themen/nationale-kompetenzerhebung/grundlagen-der-nationalen-kompetenzerhebung/grundlagen-der-bildungsstandards (Jul. 2024).

BIFIE. 2012. “Die kompetenzorientierte Reifeprüfung: Biologie und Umweltkunde-Richtlinien und Beispiele für Themenpool und Prüfungsaufgaben”. https://www.bmbwf.gv.at/dam/jcr:6a34b8b5-1bbc-4f66-b80a-5764307b9e8b/reifepruefung_ahs_lfbio_21976.pdf (Jul. 2024).

BIFIE. 2019. „Beurteilungsraster B1 und Begleittext“. https://www.matura.gv.at/index.php?eID=dumpFile&t=f&f=514&token=0b26d6b4145345f27422f696b65cb89cc952da88 (Jul. 2023)

Bleichenbacher, Lukas; Rossner, Richard; Schröder-Sura, Anna; Pirih Svetina, Nataša. 2023. “Building blocks for planning language-sensitive teacher education”. Council of Europe (European Centre for Modern Languages) Graz. www.ecml.at/languagesensitiveteachereducation (Jul. 2024)

Bloom, Benjamin; Engelhart, Max; Furst, Edward; Hill, Walker; Krathwohl, David. 1956. *Taxonomy of educational objectives: cognitive domain.* New York, NY: David McKay.

Board of Education for Vienna. 2019. “VIENNA BILINGUAL SCHOOLING – VBS”. Vienna: FIDS | Specialist Department for Inclusion & Diversity – Language Diversity, Department of Educational Services.

Bower, Kim; Coyle, Do; Cross, Russel; Chambers, Gary N. 2020. *Curriculum Integrated Language Teaching.* Cambridge: Cambridge University Press.

Broderick, Matthew; Chadwick, Timothy. 2015. *Breakthrough to CLIL for Biology*. Cambridge: Cambridge University Press.

Brown, H. Douglas; Abeywickrama, Priyandava. 2010. *Language assessment: Principles and classroom practices.* (2nd ed.). New York, NY: Pearson Longman.

Brown, Bryan A.; Ryoo, Kihyun. 2008. "Teaching science as a language: A "content-first" approach to science teaching". *Journal of Research in Science Teaching* 45(5), 529–553.

Bundesministerium für Bildung, Wissenschaft und Forschung. 2023a. „LEHRPLAN DER ALLGEMEINBILDENDEN HÖHEREN SCHULE (Allgemeiner Teil)". https://www.paedagogikpaket.at/images/Allgemeiner-Teil_AHS.pdf (Jul. 2024).

Bundesministerium für Bildung, Wissenschaft und Forschung. 2023b. „BIOLOGIE UND UMWELTBILDUNG (Sekundarstufe I)". https://www.paedagogikpaket.at/component/edocman/278-lehrplan-2/download.html?Itemid=0 (Jul. 2024).

Bundesministerium für Bildung, Wissenschaft und Forschung. 2024. „Standardisierte, kompetenzorientierte Reifeprüfung an AHS: Modellschularbeiten, Lebende Fremdsprachen – A2-Raster mit Bewertungskriterien". https://www.bmbwf.gv.at/dam/jcr:ec4e3c97-8d45-4c05-a90d-8d9a764eed7e/reifepr_ahs_mslf_bwr.pdf (Jul. 2024).

Burns, Anne. 2010. *Doing Action Research in English Language Teaching: A Guide for Practitioners*. New York, NY: Routledge.

Burton, Jill. 2009. "Reflective Practice". In Burns, Anne; Richards, Jack C. *The Cambridge Guide to Second Language Teacher Education*. New York, NY: Cambridge University Press, 298-307.

Cenoz, Jasone; Genesee, Fred; Gorter, Durk. 2013. "Critical analysis of CLIL: Taking stock and looking forward". *Applied Linguistics* 35, 243-262.

Coyle, Do. 2007. "Content and Language Integrated Learning: towards a connected research agenda for CLIL pedagogies". *International Journal of Bilingual Education and Bilingualism* 10(5), 543-562.

Coyle, Do. 2008. "CLIL - a pedagogical approach from the European perspective". In J. Cenoz & N. H. Hornberger (Eds.). *Encyclopedia of Language and Education.* (2nd edition). Springer Science+Business Media, 97-111.

Coyle, Dorothy; Meyer, Oliver. 2021 *Beyond CLIL: Pluriliteracies Teaching for Deeper Learning*. Cambridge: Cambridge University Press.

Coyle, Dorothy; Hood, Phillip; Marsh, David. 2010. *CLIL: Content and Language Integrated Learning*. Cambridge University Press.

Cummins, Jim. 2000. *Language, power and pedagogy: Bilingual children in the crossfire*. Clevedon: Multilingual Matters.

Dale, Liz; van der Es, Wibo; Tanner, Rosie. 2011. *CLIL Skills*. Leiden: European Platform.

Dalton-Puffer, Christiane. 2007. *Discourse in Content and Language Integrated Learning (CLIL) Classroom*s. Amsterdam: John Benjamins Publishing Company.

Dalton-Puffer, Christiane. 2013. "A construct of cognitive discourse functions for conceptualising content-language integration in CLIL and multilingual education". *European Journal of Applied Linguistics* 1(2), 216-253.

Dalton-Puffer, Christiane; Bauer-Marschallinger, Silvia. 2019. "Cognitive Discourse Functions meet historical competences: Towards an integrated pedagogy in CLIL history education". *Journal of Immersion and Content-Based Language Education* 7(1), 30–60.

Dalton-Puffer, Christiane. 2011. "Content-and-Language Integrated learning: From practice to principles?". *Annual Review of Applied Linguistics* 31, 182–204.

Dalton-Puffer, Christiane; Llinares, Ana; Lorenzo, Francisco; Nikula, Tarja. 2014. "'You can stand under my umbrella'': Immersion, CLIL and bilingual education. A response to Cenoz, Genesee & Gorter (2013)". *Applied Lincuistics* 35(2), 213-218.

Davis, Larry. 2015. "Designing and using rubrics". In Brown, James D. *The Cambridge Guide to Research in Language Teaching and Learning*. Cambridge: Cambridge University Press, 238-246.

Day, Richard R. 2020. *Teaching reading*. Alexandria, VA: TESOL Press.

Eickholt, Jesse; Johnson, Matthew R.; Seeling, Patrick. 2021. "Practical active learning stations to transform existing learning environments into flexible, active learning classrooms". *IEEE Transactions on Education* 64(2), 95–102.

Erduran, Sibel; Jiménez-Aleixandre, María. 2007. *Argumentation in science education. Perspectives from classroom-Based Research*. Dordrecht: Springer.

García, Ofelia; Bartlett, Lora; Kleifgen, Jo Anne. 2007. "From biliteracies to pluriliteracy". In Auer, Peter; Wei, Li. *Handbook of Multilingualism and Multilingual Communication (Vol. 5).* Berlin: Mouton de Gruyter, 207-228.

García, Ofelia. 2009. *Bilingual education in the 21st century: A global perspective.* Wiley: Blackwell.

Gogolin, Ingrid; Lange, Imke. 2011. "Bildungssprache und Durchgängige Sprachbildung". In Fürstenau, Sara; Gomolla, Mechthild. *Migration und schulischer Wandel: Mehrsprachigkeit*. Wiesbaden: VS Verlag für Sozialwissenschaften, 107–127.

Hammann, Marcus; Asshoff, Roman. 2019. *Schülervorstellungen im Biologieunterricht: Ursachen für Lernschwierigkeiten.* (4th edition). Hannover: Klett | Kallmeyer.

Hedge, Tricia. 2000. *Teaching and learning in the language classroom*. Oxford: Oxford University Press.

Kattmann, Ulrich. 2003. „Vom Blatt zum Planeten – Scientific Literacy und kumulatives Lernen im Biologieunterricht und darüber hinaus". In Moschner, B.; Kiper, H.; Kattmann, U. *PISA 2000 als Herausforderung.* Baltmannsweiler: Schneider Hohengehren, 115–138.

Kattmann, Ulrich. 2016. *Schüler besser verstehen: Alltagsvorstellungen im Biologieunterricht*. Hallbergmoos: Aulis Verlag.

Kramer, Gesa. 2009. *Entwicklung und Überprüfung eines Strukturmodells der fachlichen Kommunikationskompetenz im Biologieunterricht*. Kiel: Universität Kiel.

Krashen, Stephen D.; Terrel, T.D. 1983. *The natural approach: Language acquisition in the classroom*. Oxford: Pergamon Press.

Krashen, Stephen D. 1985. *The input hypothesis: issues and implications*. London: Longman.

Kultusministerkonferenz (KMK). 2010. „Bildungsstandards im Fach Biologie für die Allgemeine Hochschulreife". (Beschluss der Kultusministerkonferenz vom 18.06.2020). Institut zur Qualitätsentwicklung im Bildungswesen: Carl Link.

Leisen, Josef. 2010. *Handbuch Sprachförderung im Fach. Sprachsensibler Fachunterricht in der Praxis*. Bonn: Varus.

Lyster, Roy. 2007. *Learning and teaching languages through content: a counterbalanced approach*. Amsterdam: John Benjamins Publishing Company.

Marbach-Ad, Gili; Stavy, Ruth. 2000. "Students' cellular and molecular explanations of genetic phenomena". *Journal of Biological Education* 34(4), 200–205.

Marzano, Robert; Gaddy, Barbara; Dean, Ceri. 2000. *What works in classroom instruction*. Aurora, CO: Mid-continent Research for Education and Learning.

Mehisto, Peeter; Marsh, David; Frigols, María Jesús. 2008. *Uncovering CLIL: Content and Language Integrated Learning in bilingual and multilingual education*. Oxford: Macmillan Education.

Merino, Jon; Lasagabaster, David. 2018. "CLIL as a way to multilingualism". *International Journal of Bilingual Education and Bilingualism* 21(1), 79-92.

Meyer, Oliver. 2013. "Introducing the CLIL-Pyramid: Key Strategies and Principles for CLIL Planning and Teaching". In Eisenmann, Maris; Summer, Theresa. *Basic issues in EFL-teaching*. Heidelberg: Universitätsverlag Winter GmbH, 295-313.

Miles, Harvey; Deuel, Adrianna; Marlatt, Rick. 2020. ""To be, or not to be": Modernizing Shakespeare with multimodal learning stations". *Journal of Adolescent & Adult Literacy* 63(5), 559–568.

Morton, Tom. 2020. "Cognitive Discourse Functions: A bridge between content, literacy and language for teaching and assessment in CLIL". *CLIL Journal of Innovation and Research in Plurilingual and Pluricultural Education* 3(1), 7-17.

Müllner, Bernhard; Nowak, Elisabeth; Wenzl, Ilse. 2023. „Kommentar zum Fachlehrplan Biologie und Umweltbildung (Mittelschule/AHS-Unterstufe)". https://www.paedagogikpaket.at/component/ edocman/455-kommentar-zum-lehrplan-2/download.html?Itemid=0 (Jul. 2024).

Naylor, Stuart; Keogh, Brenda; Goldsworthy, Anne. 2007. *Active Assessment: Thinking Learning and Assessment in Science*. Abingdon: Routledge.

Nerdel, Claudia; Nitz, Sandra; Prechtl, Helmut. 2019. „Kompetenzen beim Umgang mit Abbildungen und Diagrammen". In Groß, Jorge; Hamman, Marcus; Schmiemann, Philipp; Zabel, Jörg. *Biologiedidaktische Forschung: Erträge für die Praxis*. Heidelberg: Springer Spektrum, 147-165.

Nussbaum, E. Michael. 2011. "Argumentation, dialogue theory, and probability modeling: Alternative frameworks for argumentation research in education". *Educational Psychologist* 46(2), 84-106.

OECD. 2013. "PISA 2015 draft science framework". https://www.oecd.org/publications/pisa-2015-assessment-and-analytical-framework-9789264281820-en.htm (Jul. 2024).

Osborne, Jonathan. 2010. "Arguing to learn in science: The role of collaborative, critical discourse". *Science* 328(5977), 463-466.

PISA-Konsortium. 2001. *PISA 2000: Basiskompetenzen von Schülerinnen und Schülern im internationalen Vergleich*. Wiesbaden: VS Verlag für Sozialwissenschaften.

Pütz, Norbert; Mülhausen, Julia. 2020. "Mysterys" In Spörhase-Eichmann, Ulrike; Ruppert, Wolfgang. (eds.). *Biologie Methodik: Handbuch für die Sekundarstufe I und II*. Berlin: Cornelsen Scriptor Verlag, 147-153.

Raab-Steiner, Elisabeth. 2008. *Der Fragebogen: Von der Forschungsidee zur SPSS Auswertung*. Stuttgart: UTB.

Ratcliffe, Mary; Grace, Marcus. 2003. *Science education for citizenship: Teaching socio-scientific issues.* Maidenhead: Open University Press.

Reeves, Carol. 2005. *The language of science.* Florence: Taylor & Francis Group.

Reichstädter, Alexandra; Müllner, Bernhard. 2021. „Operatoren in der mündlichen und schriftlichen kompetenzorientierten Reifeprüfung Biologie & Umweltkunde". Vienna: AECC-Biologie.

Stadt Wien. 2020. “Bildungsgrätzl ‚OttakringWest‘“. *Rathaus, A-1010 Wien*. https://www.wien.gv.at/bildung/schulen/bildungsgraetzl/ottakring-west.html (Jul. 2024).

Richards, Jack C.; Rodgers, Theodore S. 2014. *Approaches and methods in language teaching*. (3rd edition). Cambridge: Cambridge University Press.

Rincke, Karsten. 2010. “Alltagssprache, Fachsprache und ihre besonderen Bedeutungen für das Lernen”. *Zeitschrift für Didaktik der Naturwissenschaften* 16, 235–260.

Rondon, Tatiana; Tomitch, Leda. 2020. “The effect of different pre-reading activities on pre-intermediate and advanced EFL students’ reading comprehension”. *Revista (Con)Textos Linguísticos*,14(1), 719-738.

Sadava, David; Hillis, David M.; Heller, H. Craig; Hacker, Sally D. 2019. *Purves Biologie*. (10th edition). Berlin, Heidelberg: Springer.

Selinker, Larry. 1972. “Interlanguage”. *International Review of Applied Linguistics in Language Teaching* 10(1-4), 209–32.

Sprod, Tim. 2014. “Philosophical inquiry and critical thinking in primary and secondary science education.” In Matthews, Michael R. *International handbook of research in history, philosophy and science teaching*. Dordrecht: Springer, 1531–1564.

Schmölzer-Eibinger, Sabine. 2013. "Sprache als Medium des Lernens im Fach". In Becker-Mrotzek, M.; Schramm, K.; Thürmann, E.; Vollmer, H. J. (eds.). *Sprache im Fach: Sprachlichkeit und fachliches Lernen*. Waxmann Verlag, 25-40.

Stürmer, Magdalena. 2018. “‘Take one’: Exploring the art of filmmaking in a CLIL approach to art education”. MA thesis, University of Vienna.

Tajmel, Tanja. 2010. „Daz-Förderung im naturwissenschaftlichen Sprachunterricht“ In Ahrenholz, Bernt. *Fachunterricht und Deutsch als Zweitsprache*. Tübingen: Narr Verlag, 167-184.

Toulmin, Stephen E. 2003. *The uses of argument: Updated edition*. Cambridge: Cambridge University Press.

Vollmer, Helmut Johannes. 2010. “Items for a description of linguistic competence in the language of schooling necessary for learning/teaching sciences (end of compulsory education): An approach with reference points”. *Council of Europe*, 1-28.

Vollmer, Helmut Johannes; Thürmann, Eike. 2013. „Sprachbildung und Bildungssprache als Aufgabe aller Fächer der Regelschule“ In Becker-Mrotzek, M.; Schramm, K.; Thürmann, E.; Vollmer, H. J. (eds.). *Sprache im Fach: Sprachlichkeit und fachliches Lernen*. Waxmann Verlag, 41-57.

Weinert, Franz E. 2001. “Concepts of competence – A conceptual clarification”. In Rychen, Dominique S. *Defining and selecting key competencies*. Göttingen: Hogrefe and Huber, 45-64.

Wenzl, Ilse; Heidinger, Christine; Pany, Peter. 2016. „Participatory development of competence-orientated examination tasks with biology teacher as large scale professional development initiative”. In Pixel (Hrsg.) *Conference Proceedings „New Perspectives in Science Education“.* Limena: Libreria Uni-versitaria, 461-465.

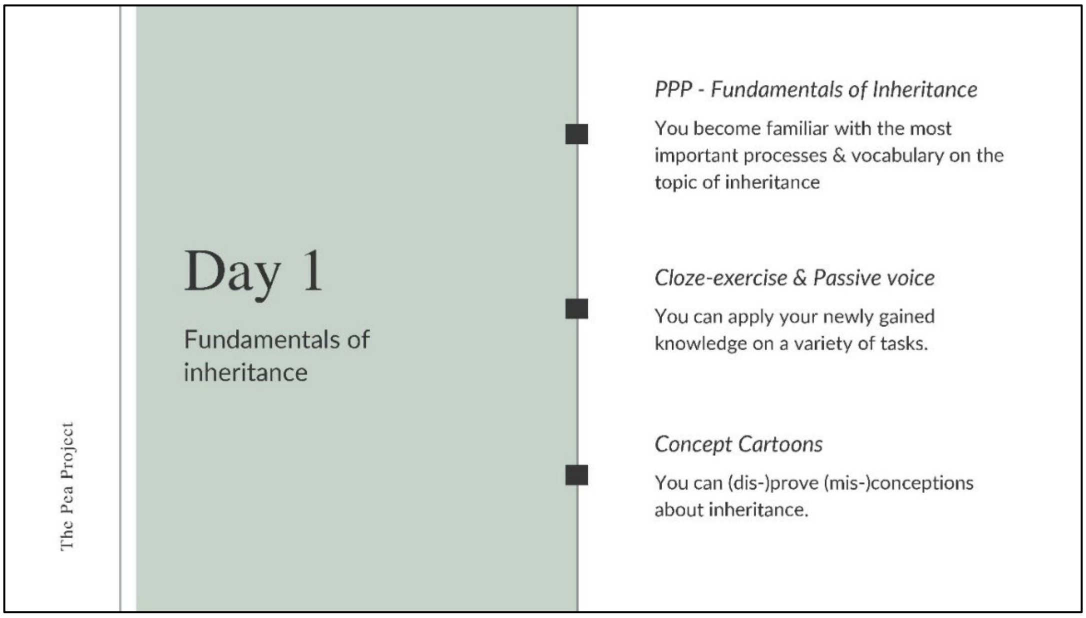
Wolff, Dieter. 2013. “CLIL als europäisches Konzept”. In Hallet, Wolfgang; Königs, Frank G. (eds.). *Handbuch bilingualer Unterricht: Content and Language Integrated Learning*. Seelze: Klett-Kallmeyer, 18-26.

Ich habe mich bemüht, sämtliche Inhaber*innen der Bildrechte ausfindig zu machen und ihre Zustimmung zur Verwendung der Bilder in dieser Arbeit eingeholt. Sollte dennoch eine Urheberrechtsverletzung bekannt werden, ersuche ich um Meldung bei mir.

11. Appendix

11.1. Teaching Materials

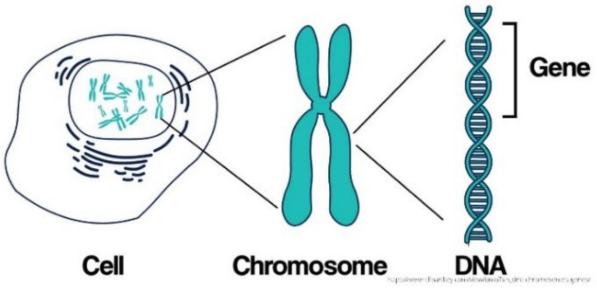
11.1.1. Presentation



Have a look at the comic strip and guess what the son could mean with his statement.

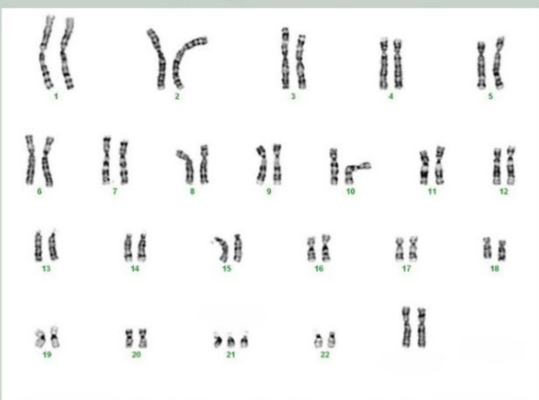
Fundamentals of inheritance

Fundamentals of inheritance



- cell nucleus contains thread-like structures = chromosomes
- chromosomes consist of DNA chains
- a gene is a small section on the DNA
- each gene contains specific hereditary information

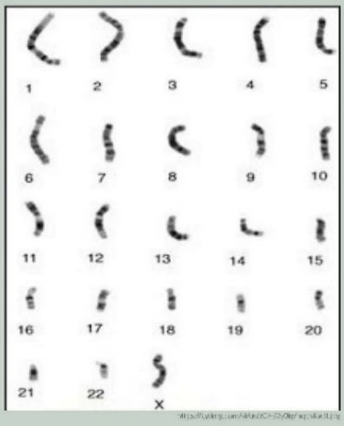
Karyogram (n=2)



Male or female?

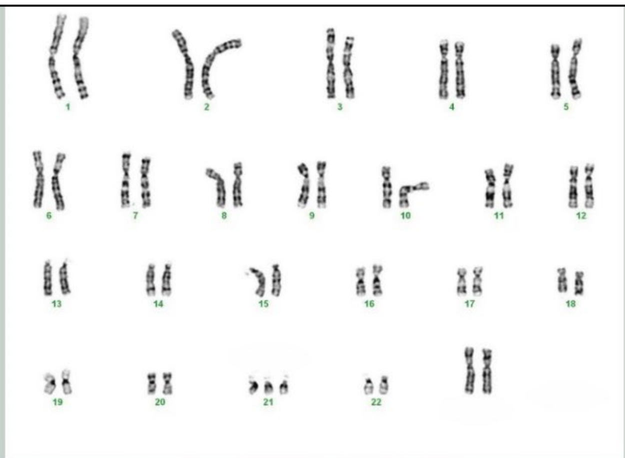
- 46 chromosomes (23 chromosome pairs) in **almost** every human cell (=diploid)
- 23rd pair = sex chromosomes

Karyogram (n=1)



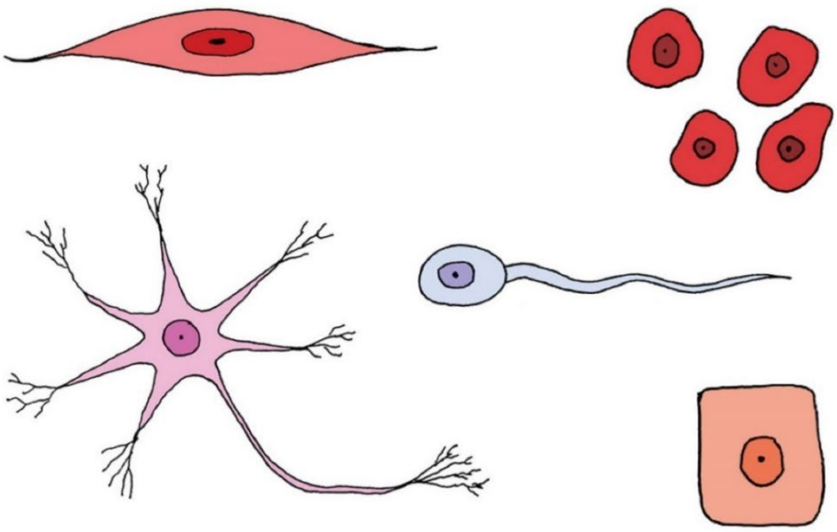
The heredity of sex

- gametes have a single set of chromosomes (= haploid)
- created by a special form of cell division
- after fertilisation, zygote has a double set of chromosomes

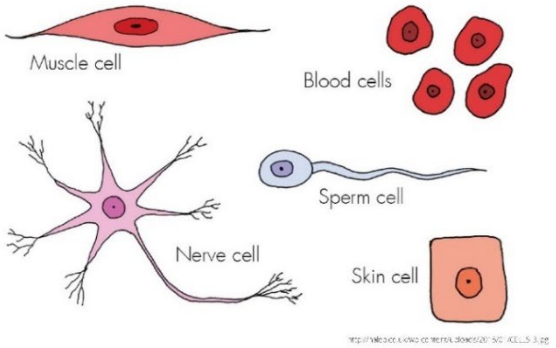


- is this a male or female?
- do you see any abnormality?

Fundamentals of inheritance



Fundamentals of inheritance



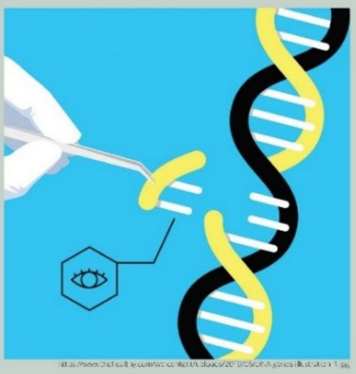
Genes contain the hereditary information

- different body cells contain the same information!
- **BUT** the information is expressed differently
- gene ≠ allele

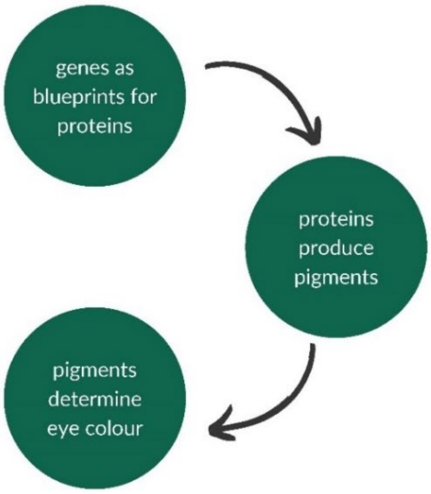
Genes

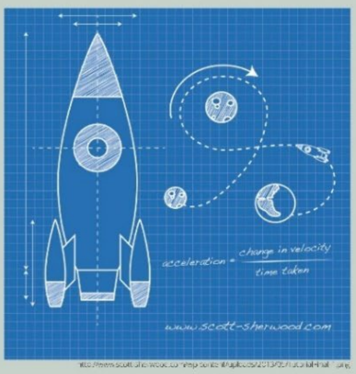
= hereditary traits

- small section of DNA
- responsible for the expression of a certain characteristic (=trait)
- e.g.: hair colour, eye colour, body size, ...



Fundamentals of inheritance





Fundamentals of inheritance

Why don't we all have the same eye colour?

There are different variants of the blueprint (gene).

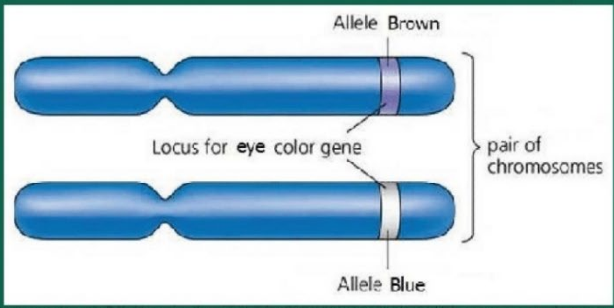
Gene [ˈjēn]

= a segment of DNA that carries the code for specific proteins.
"What"

Allele [ə-ˈlēl]

= Variants of a gene that can express different traits
"How"

Fundamentals of inheritance



- Allele "**Brown**" produces brown eye colour
- Allele "**Blue**" produces blue eye colour

Fundamentals of inheritance

- a **gene** is a small section of DNA
- it is the foundation for a certain characteristic

- an **allele** is a variant of the gene
- it determines how the characteristic is expresses

Fundamentals of inheritance

Now it's your turn!

Check your understanding by completing the cloze exercise

The passive voice

- We use passive sentences when **what** is being done in the sentence is more important than **who** is doing it.
- In science, the passive voice is often used in statements of fact, in describing experiments and in describing **processes:**

"Mass is measured in kilograms"

Fundamentals of inheritance

The passive voice

An active sentence follows the structure:

subject + **verb** + **object** (usually)

Mendel's laws describe the inheritance of biological features.

Fundamentals of inheritance

The passive voice

To make the sentence passive, we follow some simple steps:

1. We start the sentence with the **object** of the sentence. This **object** then becomes the new **subject**.

2. We choose a form of the verb 'to be'. The form of the verb we choose should match the tense of the verb in the active sentence. **Describe** is the present tense and so we need the present form of the verb 'to be', **is** or **are**, depending on whether there is a singular object, or there are plural objects.

3. We use the original verb but in its third form – the past participle.

4. We decide if we need the original **subject** in our sentence or not. If we choose to keep it, then we must use the word 'by' to connect it to the sentence.

Fundamentals of inheritance

The passive voice

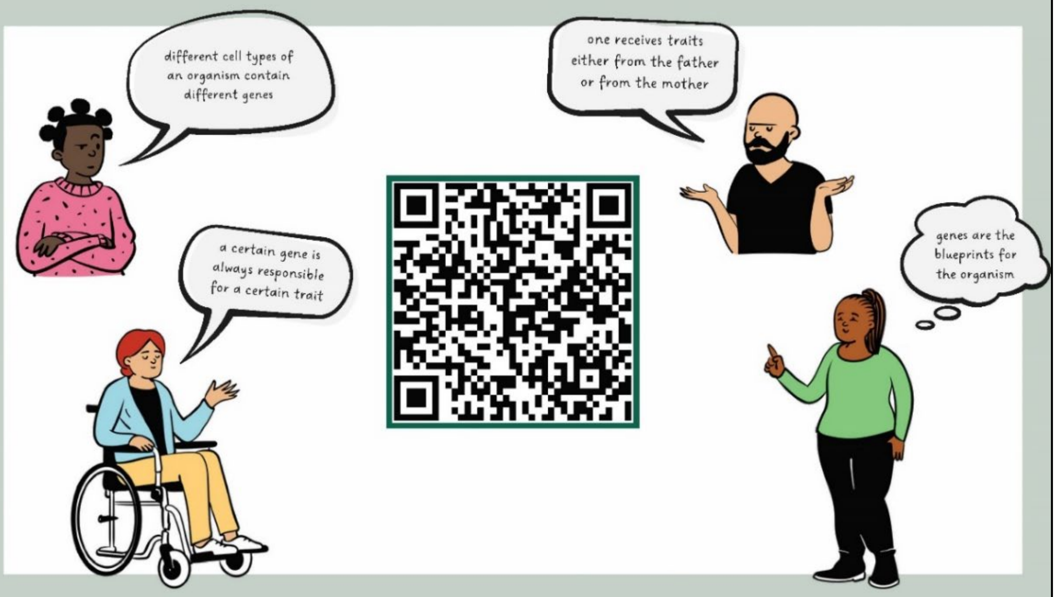
Fundamentals of inheritance

Our passive sentence then is:

subject + **verb** + **object** (usually)

The inheritance of biological features is described by Mendel's laws.

Read the people's statements and think about whether they are right or wrong.



A CERTAIN GENE IS ALWAYS RESPONSIBLE FOR A CERTAIN TRAIT

Genes influence traits, but the genetic code does not directly contribute to trait expression. Rather, proteins interact at the levels of organisation above the nucleus and influence trait development. In nature, polygenically inherited traits are more common than traits that are inherited monogenically.

DIFFERENT CELL TYPES OF AN ORGANISM CONTAIN DIFFERENT GENES

Different cells in our body perform different tasks, such as the transmission of stimuli in nerve cells, or the secretion of saliva by cells of the oral mucosa, but the DNA in their cell nuclei is nevertheless the same. Genes provide information for gene products that contribute to the expression of characteristics. Depending on the cell type, different genes are expressed and other proteins are formed.

ONE RECEIVES TRAITS EITHER FROM THE FATHER OR FROM THE MOTHER

In biology, a distinction is made between genotype and phenotype: the genome is inherited. All genes are present on the chromosomes in different forms (alleles), of which one allele per gene locus is usually inherited from the mother and one from the father.

GENES ARE THE BLUEPRINTS FOR THE ORGANISM

Yes, BUT genes do not determine the expression of characteristics 1:1. An organism is constantly exposed to environmental conditions that can have just as much effect on the expression of characteristics.

Biology 1

Resources

Sources used

Cell Theory: A Core Principle of Biology

by Regina Bailey

Glycolysis

Khan Academy

How to Learn the Krebs Cycle

Sunil Kumar

The Pea Project

Day 2

Mendel's laws

PPP Mendel's laws

You get to know the famous Austrian scientist Johann Gregor Mendel and learn about his accomplishments in genetics.

Reading: Mendel's laws

You will receive an overview of the 3 Mendelian rules.

Writing task

You will write a typical scientific text about what you have learned (HW)

How Mendel's pea plants helped us understand genetics:

https://www.youtube.com/watch?v=Mehz7tCxjSE&ab_channel=TED-Ed

Mendelian Inheritance

Johann Gregor Mendel

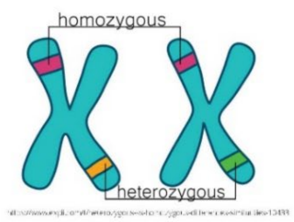
- Austrian monk
- crossbreeding experiments with peas
- Mendel's laws of inheritance

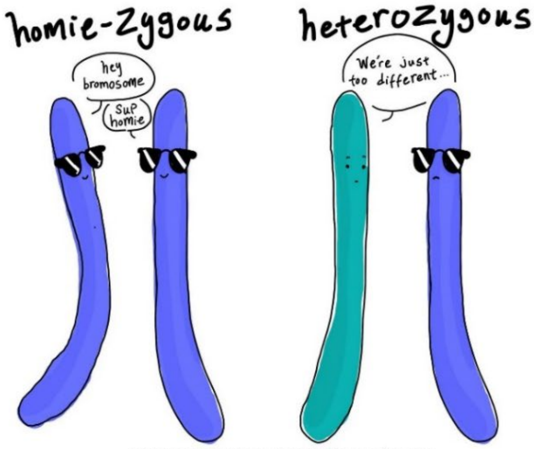
How are hereditary traits passed on?

Mendelian inheritance

- if alleles are the same in two chromosomes = homozygous (e.g. YY, yy)
- if alleles are different in two chromosomes = heterozygous (e.g. Yy)

- 1 parent passes on 1 allele
- if passed-on alleles are different, the stronger one prevails

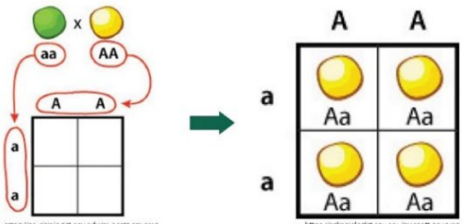




https://www.expii.com/t/heterozygous-vs-homozygous-differences-similarities-10433

Punnett squares

- are a great tool for visualising the transfer of genes from parent to offspring.



https://askabiologist.asu.edu/punnett-squares

https://askabiologist.asu.edu/punnett-squares

Mendelian inheritance

Reading: Mendel's laws of inheritance

Mendelian inheritance

Day 3

Station learning

Biology 1

Station 1
The Triangles of Genetics

Station 2
The Coinflip of Segregation

Station 2
The Mendelian Knot

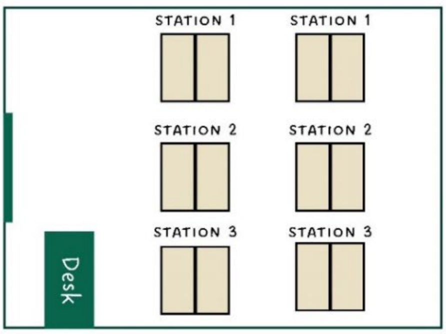
Ground rules:

- You have 10-15min per station to complete the exercises
- You need: a pen, glue and a pair of scissors (1 per group)
- Should you finish a station earlier, come to me for a bonus task until the next station is free

Station learning

Ground rules:

- Remove all your stuff from the tables and arrange them as follows:



Station learning

11.1.2. Cloze-exercise: The Fundamentals Of Inheritance

The Fundamentals of Inheritance

1) *The following text should help you with checking your understanding of the fundamentals of inheritance. Read the text and match the gaps with the words from the box below:*

dominant	blueprint	heredity	expression	recessive	variants	alleles	code	characteristics	nucleus

Children look like their parents because genes are passed on from one generation to the next. This transfer of genes is called inheritance and it is the subject of _______________**(1)** or genetics.

Genes are contained in every _______________**(2)** of our body cells. A gene, also called a hereditary trait, is a small section of DNA. This section of DNA is responsible for the _______________**(3)** of a certain trait. Hair colour, eye colour or body size are easily recognisable examples of such _______________**(4)**.

In fact, it is not just one gene that is responsible for these traits in a human being, but several genes together. For hair colour alone, eleven relevant genes have already been identified. One can also say that these genes _______________**(5)** for hair colour. Genes can be compared to a _______________**(6)** that one can read and then build something from it. In this case, the gene is a blueprint for proteins. These proteins then produce pigments, for example, and these then determine our hair colour.

There are many different hair colours because there are different _______________**(7)** of the blueprint. With one variant, you can make proteins that produce dark-coloured pigments. With other variants, proteins are made that produce light-coloured pigments. Each variant of the gene then produces a different hair colour.

The different variants of the gene are called _______________**(8)**. In the case of hair colour, they would be the genes for black, brown, blonde, and so on. The allele “brown” is then the version of the blueprint that ensures that proteins are made that produce dark dyes. The allele “blonde” would be the version that makes proteins that produce light dyes. Alleles are usually described with abbreviations, often only with single upper- or lower-case letters. _______________**(9)** alleles are usually capitalised, _______________**(10)** alleles lowercased.

2) *Identify and mark all instances of the use of the passive voice in the text. Afterwards, rewrite five of the sentences using the active voice. If there is no suitable subject in the passive sentence, you can use "We" or "Scientists" instead. For example:*

PASSIVE: Alleles *are usually described* with abbreviations, often only with single upper- or lower-case letters (**by scientists**).

ACTIVE: **Scientists** *usually describe* alleles with abbreviations, often only with single upper- or lower-case letters.

1. ____
   ____
   ____

2. ____
   ____
   ____

3. ____
   ____
   ____

4. ____
   ____
   ____

5. ____
   ____
   ____

(The information on the following page should help you with the task)

The Passive Voice:

We use passive sentences when what is being done in the sentence is more important than who is doing it. The passive form focuses on the action, rather than who is performing the action. In science, the passive voice is often used in statements of fact, in describing experiments and in describing processes.

An active sentence follows the structure: **subject** + *verb* + <u>object</u> (usually):

Mendel's laws *describe* <u>the inheritance of biological features</u>

To make the sentence passive, we follow some simple steps:

1. We start the sentence with the <u>object</u> of the sentence. This <u>object</u> then becomes the new **subject.**
2. We choose a form of the verb 'to be'. The form of the verb we choose should match the tense of the verb in the active sentence. *Describe* is the present tense and so we need the present form of the verb 'to be', *is* or *are*, depending on whether there is a singular object, or there are plural objects.
3. We use the original verb but in its third form – the past participle.
4. We decide if we need the original **subject** in our sentence or not. If we choose to keep it, then we must use the word 'by' to connect it to the sentence.

Our passive sentence then is:

The inheritance of biological features *is described* by <u>Mendel's laws</u>.

11.1.3. Glossary

Word	Meaning	Use	Related words	Translation
allele	Variants of a gene that can express different characteristics.	Alleles can either be dominant or recessive.	hereditary trait	das Allel, die Erbanlage
chromosome	A string of DNA that contains all of the genetic information for that cell.	People with 'Down-syndrome' have an extra piece of their 21st chromosome.	chromosomal, chromatid	das Chromosom
code	A rule for converting one type of information into another, either simpler or more complicated.	Strings of DNA code for certain proteins.	code (noun)	codieren
diploid	A cell that contains two sets of chromosomes.	All cells in our body, except for gametes, are diploid.	double	diploid
DNA **(=desoxyribo-nucleic acid)**	A nucleic acid in the shape of a double helix. It is the main component of the chromosomes.	We can study a DNA molecule to see if people are related to each other.	genetic code, hereditary information	die DNS (=Desoxyribonuclein-säure)
dominant	Dominant means strong. A dominant allele overpowers the recessive allele, located on the other pair of chromosomes.	The fold in the ears was caused by a heritable, dominant, mutated gene.	dominantly, strong	dominant
fertilisation	The joining of male and female gametes to form a zygote.	After the egg is fertilised, no more sperm cells can enter.	fertilise, reproduction	die Befruchtung
filial generation	Any generation resulting from a genetically controlled mating, following the parental generation	The first filial generation (F1) shares the same phenotype.	following generation	die Filial-generation, die Folge-generation
gamete	A sex cell that only has half the usual number of chromosomes.	The female gametes, or egg cells, are much larger than the male ones.	germ cell, egg cell, sperm cell	die Keimzelle (Eizelle & Spermium)

gene	The basic unit of genetic material inherited from our parents.	Gene mutations can produce faulty proteins.	genetic, gene pool, genetic code	das Gen
genotype	An individual´s sum of genes.	Identical twins will have the same genotype, but it may be expressed differently (phenotype).	genotypical	der Genotyp
haploid	A sex cell (gamete) that contains one set of chromosomes.	The gametes, or sex cells, are haploid, meaning they only have one set of chromosomes.	single	haploid
heredity	The characteristics we get from our parents and our relatives before them.	Heredity plays no part in the disease.	hereditary, inheritance, heritable	die Vererbung
heterozygous	having different pairs of genes/alleles for any hereditary characteristic.	He has one allele for brown, and one allele for blue eyes, so he is heterozygous.	heterozygote	heterozygot, mischerbig
homozygous	Having identical pairs of genes/alleles for any hereditary characteristic.	She has two alleles for blue eyes, meaning that she is homozygous.	homozygote	homozygot, reinerbig
nucleus	The part in a cell that contains most of its genetic material (DNA).	Animals, plants, and fungi all have eucaryotic cells and therefore nuclei.	nuclei (pl.)	der Zellkern
offspring	A child or children of (a) parent(s).	Some characteristics are passed down from parents to offspring.	children	der Nachwuchs
phenotype	An individual’s observable appearance.	Identical twins will have the same genotype, but it may be expressed differently (phenotype).	phenotypical	der Phänotyp
recessive	Recessive means weak. A dominant allele overpowers the recessive allele, located on the other pair of chromosomes.	A rule for converting one type of information into another, usually simpler or more complicated.	recessively, weak	rezessiv
trait	A genetically determined characteristic or condition.	The trait “eye colour” is inherited from the parents.	characteristic	die Eigenschaft

11.1.4. Listening Exercise: How Mendel’s pea plants helped us understand genetics

How Mendel’s pea plants helped us understand genetics

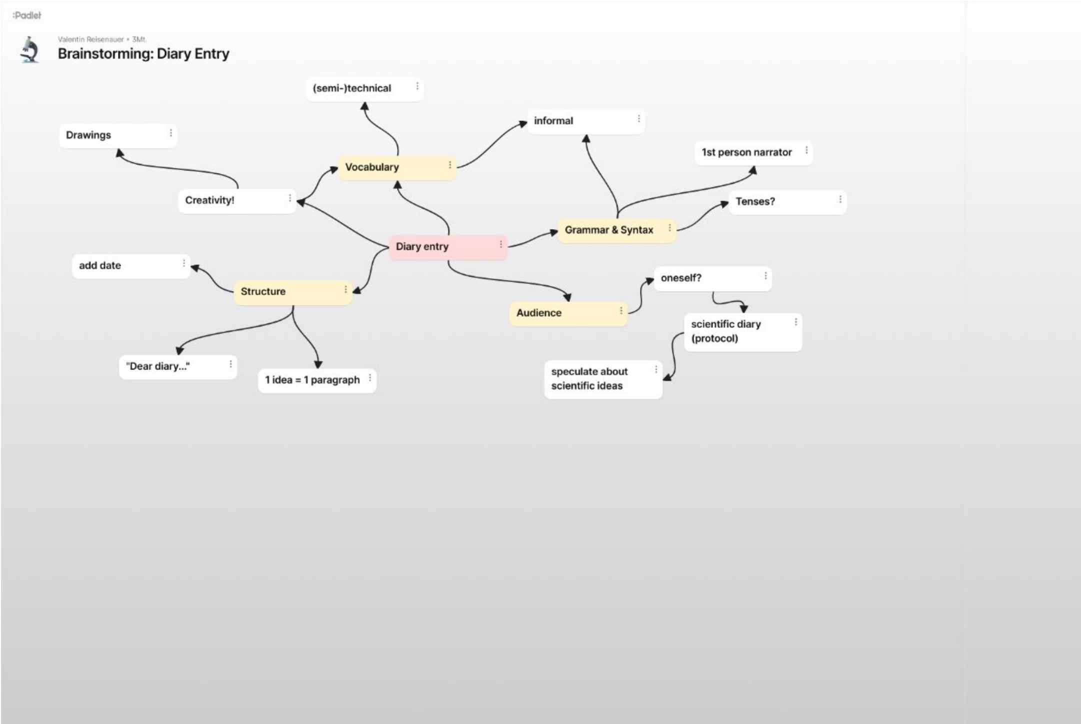
Complete the table below with the correct terms and definitions mentioned in the video:

Word	Definition
dominant	
	an allele hidden by the dominant one
homozygous	
	the two alleles are different
genotype	
	the visible result of the genotype
	a diagram depicting different allele combinations

After having watched the video a 2nd time, think about the following questions and discuss them with your neighbour:

1. Hypothesise what could be meant by dominant-recessive inheritance?
2. Compare the two terms “genotype” and “phenotype”. What is the difference between the two and how do they influence each other?

11.1.5. Padlet: Brainstorming



11.1.6. Writing: Scientific Diary Entry

Writing: Scientific diary entry

Imagine that you are living in the year 1860 and work as an assistant to Gregor Mendel who is currently conducting his experiments on pea plants. Together with him, you have proven the "Law of Uniformity" and you are eager to write down your findings into your scientific diary.

Using your knowledge of the Mendelian rules, write a diary entry and include the following aspects:

- Start your diary entry with “Dear diary…”
- Report on your experience in the monastery
- Describe the Law of Uniformity and how you discovered it using crossbreeding experiments
- Predict what other discoveries you expect to make (2nd and 3rd law)

Write 150-200 words

11.1.7. Reading: Mendel´s laws of Inheritance

Mendel’s laws of inheritance

Read through the paragraphs about the Mendelian laws of inheritance and complete the corresponding comprehension exercises:

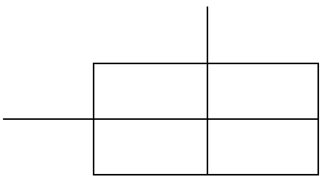
1st Mendelian rule (= *The Law of Uniformity*)

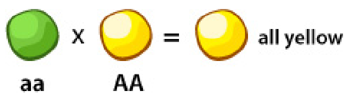
If one crosses a plant that yields purebred yellow peas (AA) and one that yields purebred green peas (aa), gametes with the allele **A** or **a** are formed. Since **A** is dominant and **a** is recessive, only yellow peas with the alleles **Aa** are produced in the following generation (F1). Mendel formulated the 1st Mendelian rule from the realisation that in crossbreeding experiments in the first following generation (F1), all offspring have the same flower colour:

> *If two pure-blooded organisms of one species are crossed, all offspring in the first generation are identical in this characteristic (=uniform).*

Exercise 1:

1.1. Match the Punnett square below with the correct allele combinations for the 1st Mendelian law:





1.2. Which of the Alleles is dominant and what does this mean for the phenotype of the offspring?

____

____

____

1.3. Hypothesise why the 1st Mendelian law is also called ‘The Law of Uniformity”:

____

____

____

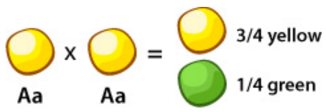
2^{nd} Mendelian rule (= *The Law of Segregation*)

Johann Gregor Mendel continued his experiments. He used heterozygous offspring (Aa) from his first crossbreeding experiments. If one crosses the plants of the 1^{st} following generation (F1) with the alleles **Aa**, it produces yellow peas with the alleles **AA**, yellow peas with the alleles **Aa** and green peas with the alleles **aa**. In the dominant-recessive inheritance, the alleles split in the ratio of 3:1 in the 2^{nd} following generation (F2). Therefore, the 2nd Mendelian rule is:

> *If you cross two heterozygous organisms of the 1st generation, the characteristics split in a certain ratio in the 2nd generation.*

Exercise 2:

2.1. Using the Punnett square, demonstrate the 2^{nd} Mendelian rule and explain why the ratio for the traits of the 2^{nd} following generation is spit 3:1



____

____

2.2. By looking at the Punnett square, we see that there are three possible genotypes that could result from this crossing. How many different phenotypes does this result in? Complete the table below:

Genotype	Phenotype
AA	Yellow

2.3. Let's imagine there were 240 total offspring in Mendel's F2 generation. Estimate how many peas are likely to have the green phenotype? Justify your answer:

____

____

____

Learning Station 1

The Triangles of Genetics:

The priest and natural scientist Gregor Mendel (1822-1884) is considered the "father of genetics" because he was the first to discover the laws of heredity through systematic crossbreeding experiments with peas.

to crossbreed = mixing different species or varieties of animals or plants and produce hybrids

Tasks:

1. Cut out the triangles and match them so that the correct explanation is opposite each technical term. If they are arranged correctly, the result should look like a star.
2. Stick the star in the middle of a piece of A4 paper.
3. Fill in the missing definitions in the empty spaces around the star (if there is time).
4. If you are stuck or cannot figure out the solution, you may check the Glossary or use your tablet to look up the definitions for the words online.

offspring

a cell with one set of chromosomes

the basic unit of genetic material

heterozygous

a weak allele located on one part of a chromosome

phenotype

nucleus

a sex cell with only half the usual number of chromosomess

fertilisation

dominant

both alleles of a gene pair are fully expressed

code (verb)

trait

an individual's sum of genes

zygote

DNA

haploid

phenotype

gene

having identical pairs of genes for a certain trait

recessive

variants of a gene that can express different characteristics

homozygous

gamete

a child/children of a parent/parents

genome

codominance

the traits we get from our (grand)parents

karyogram

allele

heredity

all of an organism's DNA

genotype

diploid

a graphical representation of our chromosomes

chromosome

Learning Station 2

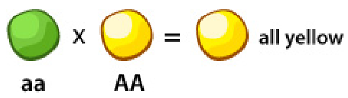
The Coinflip of Segregation:

Read the report from the school garden aloud in your group and complete the tasks:

Report from the school garden:

A long time ago we had the following idea: "We'll plant a vegetable patch and prove the 1st and 2nd Mendelian law!" Our teacher agreed and so, with a lot of effort and the greatest care, we bred a generation of pea plants through targeted pollination that was homozygous in pea colour. Now we were ready to go! We crossed the homozygous pea plants, and the uniformity rule was proven:

	a	a
A	Aa	Aa
A	Aa	Aa



In a next step we crossed the plants of the first daughter generation with each other and waited anxiously for the pea pods to open. Finally, we could count the peas: ***138 yellow*** *and* ***102 green peas****.*

Oh no! The Law of Segregation says that if you cross mix individuals of the first daughter generation, the offspring will split in a ratio of 3:1. Have we made a mistake with the crossings, or are Mendel's rules not always correct after all?

Tasks:

1. Using a model experiment on the Law of Segregation, calculate the ratio of seed colours in the F2 generation. Here is how:

INFORMATION:

- The two sides of a coin represent the two alleles in a heterozygous genotype:

Heads 	allele "**a**" for **green** colour	Tails 	allele "**A**" for **yellow** colour

- The flip of 1 coin simulates the gamete of 1 parent.
- A pollination event is simulated by tossing 2 coins together:

	A	a
A	AA	Aa
a	Aa	aa

Example:

After the toss, the 1st coin shows "tails" and the 2nd coin shows "heads" => genotype "Aa". (see record sheet below)

PROCEDURE:

- Simulate 14 more pollination events by flipping both coins or by dropping them on the table from a low height.
- Write down the result as genotype (AA/ Aa/ aa) on the record sheet.

Record sheet:

1. *Aa*	2.	3.	4.	5.
6.	7.	8.	9.	10.
11.	12.	13.	14.	15.

EVALUATION:

- Count the frequencies of the genotypes: AA: _______ Aa: _______ aa: ______
- Determine the phenotype ratio:
  - yellow seed colour : green seed colour = ____: ____

At the end of the lesson:

- *Determine the phenotype ratio from all trials in the class: (N= _______)*
  - *yellow seed colour : green seed colour = ____: ____*

2. Write an explanation for the result of the school garden and explain why the laws of heredity were not broken in this experiment:

____

____

____

____

____

Learning Station 3

The Mendelian Knot:

If you cross organisms that differ in more than one characteristic, the characteristics are inherited independently of each other. New combinations of traits are created. For example, if you cross a yellow (AA), wrinkled (rr) pea with a green (aa), round (RR) pea, you will only get yellow, round peas in the first generation (F1). <u>Yellow dominates over green</u> and <u>round dominates over wrinkled</u>. These pairs of traits split approximately in a ratio of 9:3:3:1. Hence the 3rd Mendelian rule:

> *If you cross two homozygous organisms of one species that differ in two or more characteristics, they are inherited independently of each other. This leads to new combinations of hereditary traits and therefore also of characteristics.*

Tasks:

1. Complete the Punnett square with the correct genotypes (allele-combinations) and phenotypes (pea shapes & colours):

		Ra		**ra**
RA				
	RRAa			
			rrAA	
ra				

2. Hypothesise why the 3rd Mendelian law is also called 'The Law of Independent Assortment":

____

____

____

11.1.11. Mystery:

MR. KEITA IS CONFUSED – EITHER HE PAID NO ATTENTION IN SCHOOL OR JASMINE ISN'T HIS DAUGHTER?

It is your task to answer the question above

In turns, each group member draws a random card from the envelope and reads it out loud for the others to hear. Then, the card is laid out on the poster. Card by card the clues are read out and laid down.

REMEMBER: ONLY TAKE ONE CARD AT A TIME!

Structure the cards in a meaningful order. Add captions and arrows to illustrate how the information presented in the Mystery is connected.

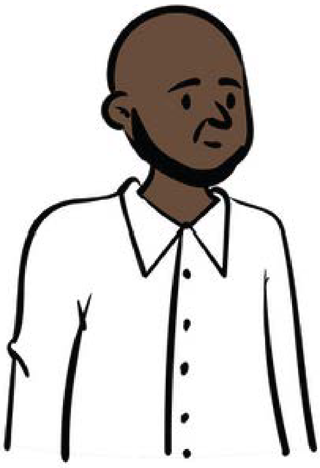
Identify the family members' genotypes by analysing the heredity according to the Mendelian laws. Write down your results on the cards.

Explain why Mr. Keita doesn't have to worry about Jasmine not being his daughter

Jasmine can roll her tongue

Jasmine's brother, Naeem, can't roll his tongue

Mr. Keita is Jasmine's father and can't roll his tongue



Grandpa K. can't roll his tongue

Genotype: aa

The second sister of Mr. Keita can't roll her tongue

Jasmine's Grandpa J. could roll his tongue

Genotype: Aa

Jasmine's mother, Mrs. Jones, is the child of Grandpa J. and Grandma J. She can't roll her tongue

Jasmine's Grandma J. couldn't roll her tongue

Genotype: aa

The first sister of Mr. Keita has a husband who can roll his tongue

The first cousin of Jasmine can roll her tongue

Grandma K. can roll her tongue

Genotype: Aa

The second cousin of Jasmine can't roll his tongue

The first sister of Mr. Keita can roll her tongue

Possible genotype of Mr. Keita's second sister:

Possible genotype of the husband of Mr. Keita's first sister:

Mr. Keita assumes that tongue-rolling is a dominant trait. Mrs. Jones and him can't roll their tongues, so why can their daughter roll hers?

Possible genotype of Mr. Keita's first sister:

Possible genotype of Jasmine's second cousin:

Possible genotype of Jasmine's first cousin:

Possible genotype of Mrs. Jones:

Possible genotype of Mr. Keita:

____

Possible genotype of Naeem:

____

Possible genotype of Jasmine:

____

Mr. Keita realises:
The trait "tongue-rolling" may not be used for measuring relatedness.

In a scientific journal Jasmine reads that, besides genes, environmental factors and practice can influence tongue-rolling

While studying speech therapy, Jasmine tirelessly practiced rolling her tongue.

The two cousins are
the children of
Mr. Keita's first sister

11.2. Questionnaire

Questionnaire: “The Pea Project”

Liebe Schüler*innen,

im Rahmen meines Master-Projekts an der Universität Wien, untersuche ich, wie erfolgreich CLIL (Content and Language Integrated Learning) in eurer Schule umgesetzt werden kann. Um diese Frage beantworten zu können, brauche ich eure Unterstützung und würde euch bitten, den folgenden Fragebogen gewissenhaft auszufüllen. Es gibt dabei kein Richtig oder Falsch und ihr bleibt auch ganz anonym!

Danke für eure Unterstützung 😊

---

1. I liked having Biology lessons in English.

(Ich mochte den BU Unterricht auf Englisch.)

fully applies	applies	partially applies	hardly applies	does not apply
(trifft völlig zu)	*(trifft zu)*	*(trifft teilweise zu)*	*(trifft eher nicht zu)*	*(trifft gar nicht zu)*
◯	◯	◯	◯	◯

---

2. I was able to try out new things using English.

(Ich konnte neue Dinge auf Englisch ausprobieren.)

fully applies	applies	partially applies	hardly applies	does not apply
(trifft völlig zu)	*(trifft zu)*	*(trifft teilweise zu)*	*(trifft eher nicht zu)*	*(trifft gar nicht zu)*
◯	◯	◯	◯	◯

---

3. My English skills improved because of the project.

(Meine Englischkenntnisse haben sich durch das Projekt verbessert.)

fully applies	applies	partially applies	hardly applies	does not apply
(trifft völlig zu)	*(trifft zu)*	*(trifft teilweise zu)*	*(trifft eher nicht zu)*	*(trifft gar nicht zu)*
◯	◯	◯	◯	◯

---

4. My Biology skills improved because of the project.

(Meine Biologiekenntnisse haben sich durch das Projekt verbessert.)

fully applies	applies	partially applies	hardly applies	does not apply
(trifft völlig zu)	*(trifft zu)*	*(trifft teilweise zu)*	*(trifft eher nicht zu)*	*(trifft gar nicht zu)*
◯	◯	◯	◯	◯

5. I communicated more than in other Biology lessons.

(Ich habe mehr kommuniziert als in anderen Biologiestunden.)

fully applies	applies	partially applies	hardly applies	does not apply
(trifft völlig zu)	*(trifft zu)*	*(trifft teilweise zu)*	*(trifft eher nicht zu)*	*(trifft gar nicht zu)*
◯	◯	◯	◯	◯

---

6. I would have produced the same work if the project had taken place in German

(Ich hätte dieselbe Arbeit geleistet, wenn das Projekt auf Deutsch stattgefunden hätte.)

fully applies	applies	partially applies	hardly applies	does not apply
(trifft völlig zu)	*(trifft zu)*	*(trifft teilweise zu)*	*(trifft eher nicht zu)*	*(trifft gar nicht zu)*
◯	◯	◯	◯	◯

6.1. Optional: I would have performed <u>better</u>/<u>worse</u> had the project been taught in German. [Cross one out]

(*Ich hätte <u>besser</u>/<u>schlechter</u> abgeschnitten, wenn das Projekt auf Deutsch unterrichtet worden wäre* [*Eines durchstreichen*])

---

7. I always knew what I had to do.

(Ich wusste immer, was ich machen muss.)

fully applies	applies	partially applies	hardly applies	does not apply
(trifft völlig zu)	*(trifft zu)*	*(trifft teilweise zu)*	*(trifft eher nicht zu)*	*(trifft gar nicht zu)*
◯	◯	◯	◯	◯

---

8. I always knew what was expected of me in terms of content and language goals.

(Ich wusste immer, was von mir bzgl. der inhaltlichen und sprachlichen Ziele erwartet wurde.)

fully applies	applies	partially applies	hardly applies	does not apply
(trifft völlig zu)	*(trifft zu)*	*(trifft teilweise zu)*	*(trifft eher nicht zu)*	*(trifft gar nicht zu)*
◯	◯	◯	◯	◯

---

9. I experienced a variety of teaching methods during the project

(Ich erlebte während dem Projekt eine Vielfalt an Lehr-/Lernmethoden.)

fully applies	applies	partially applies	hardly applies	does not apply
(trifft völlig zu)	*(trifft zu)*	*(trifft teilweise zu)*	*(trifft eher nicht zu)*	*(trifft gar nicht zu)*
◯	◯	◯	◯	◯

10. I was able to complete all the tasks in the time given.

(Ich konnte alle Aufgaben in der vorgegebenen Zeit erledigen.)

fully applies	applies	partially applies	hardly applies	does not apply
(trifft völlig zu)	*(trifft zu)*	*(trifft teilweise zu)*	*(trifft eher nicht zu)*	*(trifft gar nicht zu)*
○	○	○	○	○

---

11. I would have needed more support when working on the tasks.

(Ich hätte bei der Bearbeitung der Aufgaben mehr Unterstützung benötigt.)

fully applies	applies	partially applies	hardly applies	does not apply
(trifft völlig zu)	*(trifft zu)*	*(trifft teilweise zu)*	*(trifft eher nicht zu)*	*(trifft gar nicht zu)*
○	○	○	○	○

---

12. I could always ask the teacher for help if necessary.

(Ich konnte die Lehrperson, wenn nötig, jederzeit um Hilfe bitten.)

fully applies	applies	partially applies	hardly applies	does not apply
(trifft völlig zu)	*(trifft zu)*	*(trifft teilweise zu)*	*(trifft eher nicht zu)*	*(trifft gar nicht zu)*
○	○	○	○	○

---

13. How do you rate the language level used during the project? [Mark with an **X**]

(Wie bewertest du das Sprachlevel des Projekts?)

too easy	somewhat easy	appropriate	somewhat difficult	too difficult
(zu einfach)	*(etwas einfach)*	*(angemessen)*	*(etwas schwierig)*	*(zu schwierig)*
●	●	●	●	●

---

14. How do you rate the Biology content of the project? [Mark with an **X**]

(Wie bewertest du den Biologie Inhalt des Projekts?)

too easy	somewhat easy	appropriate	somewhat difficult	too difficult
(zu einfach)	*(etwas einfach)*	*(angemessen)*	*(etwas schwierig)*	*(zu schwierig)*
●	●	●	●	●

15. Something I found really interesting/Something I really enjoyed/Something I will remember:

(Etwas, das ich sehr interessant fand/Etwas, das mir sehr Spaß gemacht hat/Etwas, an das ich mich erinnern werde:)

16. Something I did not like/Something I would have preferred:

(Etwas, das mir nicht gefallen hat/Etwas, das ich lieber gehabt hätte:)

17. Something else I would like to tell you:

(Etwas, das ich Ihnen noch sagen möchte:)

11.3. Student Production

11.3.1. Scientific diary entries

Dear Diary

Diary

1. Day: Me and Mr. Mendel have began our research today on a project named „The Law of Uniformity.

2. Day: Mr. Mendel went to the garden of the monastery so he could studie y the peas and crossbreed them.

3. Day: The crossbreeding is turning out succesfully and Mr Mendel has given me a Punnett square so I can could observe how the crossbreeding works.

1st Gen

A = green
a = yellow

	A	A
a	Aa	Aa
a	Aa	Aa

4. Day: The first generation of peas are only green, proving that the green pigementation is more dominant than the yellow one.

2nd Gen

	A	a
A	AA	Aa
a	Aa	aa

5. Day: In the second generation there were $\frac{3}{4}$ green peas and $\frac{1}{4}$ one yellow ones. Mr Mendels theory was proven right.

08.06.2022

Scientific diary entry

Dear diary

In 1860 I got recruited ~~as~~ as an assistant to work with Gregor Mendel. Gregor Mendel was a meteorologist. He was born on the 20.th of July 1822 and died on the 6. of ja~~k~~~~n~~nuary. He was also a mathematician, biologist and he is from which is today 48 Czech. Rep. Mendel is a born German speaking family in the Silesian part of the Austrian Empire. Mendel worked with seven characteristics of pea plants: plant height, pod shape and color as an example, Mendel showed that when a true-breeding green pea were cross-bred their offspiring always produced yellow seeds. However, in the next generation, the green peas reappeared at a ratio of 1 green to 3 yellow. To explain this phenomenon, Mendel coined the terms recessive and dominant in reference to certain traits. In the preceding example, the green trait, wich seems to have vanished in the first filial generation, is recessive and the yellow is dominant. He published his work in 1866 demonstrating the actions of invisible factors now called genes in predictably determing the traits of an organism.

430

Scientific diary entry

I report on the scientific experiences 1860
in inheritance Law. I am Mr. Gregor Mendel's
assistant and we/are in the Abbey of
St. Thomas in Alt Brünn. We have
discovered the following thorough the experiments:
Crossing a purebread plant with another
purebred plant that have different
flower Colors, produces gamets with A
and a, so the following generations F1
will have the same flower col.
This is the 1st Medelian rule.
when crossing two purebred organisms,
the first generation offspring are uniform in
this trait.
I think we will do further research into
the Law of seperations segregation as well as
Independence assortment.

8th June 1860

Dear Diary,

Mr. Gregor Mendel is a monk Monch and also a scientist Sientists. He believes in the laws of inheritance so he called his experiment "Law of Uniformity". To prove ~~that was~~ what he thinks do we this experiment. We put ~~a~~ yellow peas with lower AA and ~~a~~ green peas with upper aa. In the ~~F1~~ 1st generation, all peas were ~~was~~ yellow. In the 2nd generation, there were ~~was~~ 3 yellow and 1 green pea~~s~~. That's because the Aa from the 1st generation (the alleles) make many new combinations ~~kompination~~ that make an upper aa so that~~s~~ makes one pea~~s~~ ~~a~~ green and the others yellow. He who? is~~it~~ planning a new experiment for the 3rd law. What will happen~~?~~? Would it be the same or will there be a new color? We don't know what will happen but will see in the 3rd law.

8th June 1860

Dear diary,

The Monk is living in the monastery. He's His name is Gregor Mendel, he H is a monk and a scientict s. The monk is adicctet to god and is living in peace? The scientict did may experiments and he found discovered the law of uniformity. He called it them laws of inheritance. He said i If one crosses a plant that yields purebred yellow peas and one that yields purebred green peas, gametes with the allele A or a are formend. Since A is dominant and a is recessive, only yellow peas with the alleles Aa are produced in the following generation. Mendal formulated the 1st Mendelian rule from the realisation that in crossbreeding experiments in the first following generation, all offspring have the same flowes colour. He is doing experiments and researching on the next law.

130 words

VIII-VI-XXII

Mendelian Genetics

Dear diary, today I'll be talking about works of Gregor Mendel.

Mendel's work is outstanding, since it constitutes a completly new approach: the concentration on just a single feature. Mendel set great store by the evalution of the plants gained by hybridization independently. He found it also essential to work with as great a number as plant as possible in order to outrule chance.

The thing Mendel discovered is called principle of uniformity, or so ~~did~~ he called it.

It says that, if two plants that differ in just one trait are crossed, then uniform feature either one of the parents traits (a dominant-recessive pair of characteristics) or it is intermediate.

This by it-self is a great discovery, I think there is a lots more to be discovered. I thu there will be maybe 2-3 another principles.

Mendel is really a great mind, and I hope I will be able to stay at his side for a long time!

3 March 1840

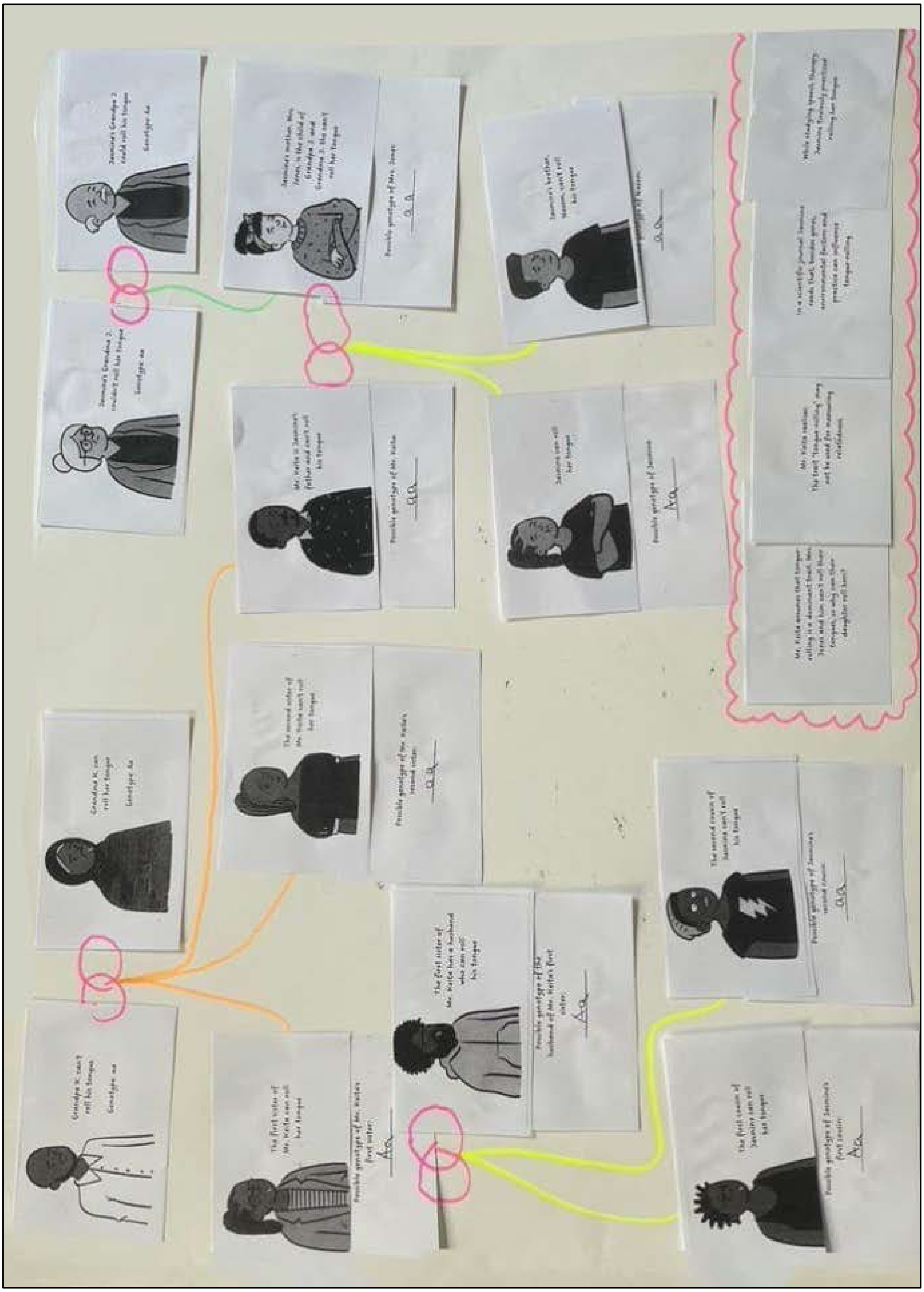
Dear Diary,
Today is 3 March
~~In~~ 1840 i work~~ed~~ as an assistant for Gregor Johann Mendel. Johann
Mendel ~~was~~ is a Meteorologist, Biologist and mathematicst and it ~~was~~ is fun
to work with him. Hence, i ~~enjoyed~~ enjoy it. Me and Gregor ~~worked~~ work on a project
which later got named ~~on~~ after him. ~~The~~ Mendel's laws Also ~~cal~~ defined
as law of segeration. He ~~to~~ is also known for creating the
science of genetics. The law explains that all characters in an
indivisual are controlled by distinct units called factors that occur
in pairs. The pair can be homozygous or heterozygous, and in the
case of heterozygous pairs, one of the factors dominates the other. It was
hard work for both of us. Another law is named ~~f~~ law of Dominance. This
is called Mendel's first law of inheritance. According to the law
of dominance, hybrid offspring will only inherit the dominant
trait in the phenotype. It also tells that we inherit the hormons from our parent to us.
today! Bye for now!. I am pretty tired and its ~~Dr.~~ Dr. Gregor Johann bought us food
I must go work tomonorow. Bye 12 O clock..

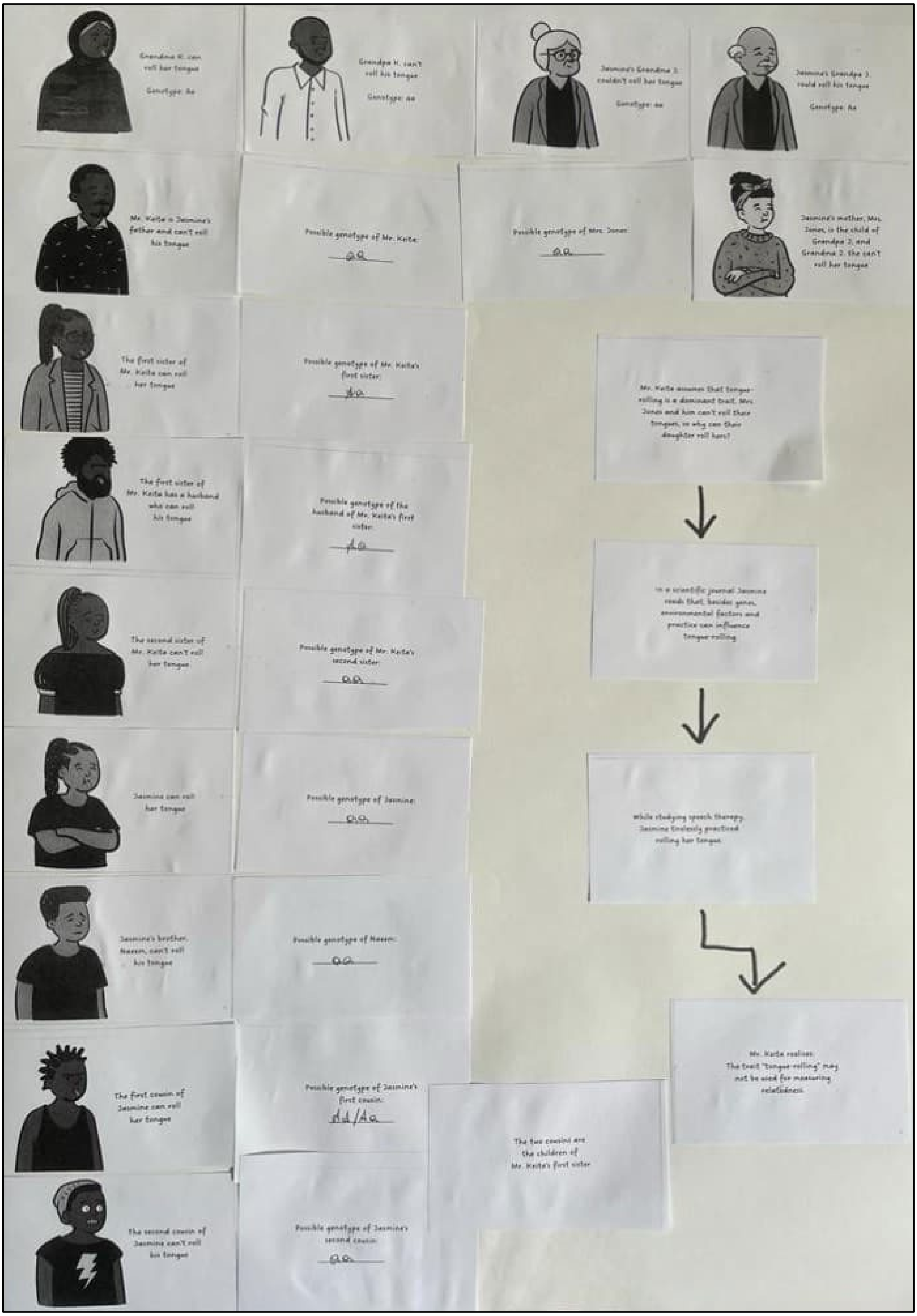
Diary

Dear Diary,

In 1840 I worked as an assistant for Mr. Mendel. Gregor Mendel was a meteorologist, mathematician and a biologist. Gregor Mendel worked on a project, which was ~~later~~ (on) named after him by other biologists. (The) ~~pro~~ Mendel's laws describes the characteristics of a human being / other breeds. The characteristics of a human is inherited from their biological parents. (The child inherits the genes from his/her parents) Mendel started his project by experimenting on pea plants. Mendel's law showed that when a true-breeding yellow pea and a true-breeding green pea were cross bred their offspring always produced yellow seeds. However, in the next generation, the green peas reappeared at a ratio of 1 green to 3 yellow. To explain the change in the 2nd generation, Mendel coined the terms "resessive" and "dominant" to define certain traits. For example, the green trait, which vanished in the first generation, is recessive and the yellow trait is dominant. Gregor Johann Mendel published his work in 1866.

11.3.2. Mystery posters




Grandpa K. can't roll his tongue
Genotype: aa
Jasmine's Grandma J. couldn't roll her tongue
Genotype: aa
Jasmine's Grandpa J. could roll his tongue
Genotype: Aa
Mr. Keita is Jasmine's father and can't roll his tongue
Possible genotype of Mr. Keita:
aa
Possible genotype of Mrs. Jones:
aa
Jasmine's mother, Mrs. Jones, is the child of Grandpa J. and Grandma J. She can't roll her tongue
The first sister of Mr. Keita can roll her tongue
Possible genotype of Mr. Keita's first sister:
The first sister of Mr. Keita has a husband who can roll his tongue
Possible genotype of the husband of Mr. Keita's first sister:
The second sister of Mr. Keita can't roll her tongue
Possible genotype of Mr. Keita's second sister:
aa
Jasmine can roll her tongue
Possible genotype of Jasmine:
aa
Jasmine's brother, Naeem, can't roll his tongue
Possible genotype of Naeem:
aa
The first cousin of Jasmine can roll her tongue
Possible genotype of Jasmine's first cousin:
AA/Aa
The second cousin of Jasmine can't roll his tongue
Possible genotype of Jasmine's second cousin:
aa
The two cousins are the children of Mr. Keita's first sister
Mr. Keita assumes that tongue-rolling is a dominant trait. Mrs. Jones and him can't roll their tongues, so why can their daughter roll hers?
In a scientific journal Jasmine reads that, besides genes, environmental factors and practice can influence tongue-rolling
While studying speech therapy, Jasmine tirelessly practiced rolling her tongue.
Mr. Keita realises:
The trait "tongue-rolling" may not be used for measuring relatedness.

11.4. Raw data sets

11.4.1. Student Productions: Mystery

Descriptive Statistics

	N	Minimum	Maximum	Median	Std.-Deviation
Completeness	6	,00	3,00	1,3333	1,21106
Understanding of the Scientific Concept	6	,00	2,00	1,2500	,75829
Creativity	6	,00	1,00	,5000	,44721
Valid Values	6				

Oral Presentation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	sufficient	2	20,0	33,3	33,3
	good	3	30,0	50,0	83,3
	excellent	1	10,0	16,7	100,0
	Total	6	60,0	100,0	
Missing	System	4	40,0		
Total		10	100,0		

Completeness

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Only some cards are put on the poster	2	20,0	33,3	33,3
	All cards are put on the poster but are not linked at all	1	10,0	16,7	50,0
	All cards are put on the poster but are not linked meaningfully	2	20,0	33,3	83,3
	All cards are put on the poster and are linked meaningfully	1	10,0	16,7	100,0
	Total	6	60,0	100,0	
Missing	System	4	40,0		
Total		10	100,0		

Understanding of the Scientific Concept					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	The poster reflects no understanding of the concept	1	10,0	16,7	16,7
	The poster reflects little understanding of the concept	2	20,0	33,3	50,0
	1,50	1	10,0	16,7	66,7
	The poster reflects some understanding of the concept	1	10,0	16,7	83,3
	The poster reflects full understanding of the concept	1	10,0	16,7	100,0
	Total	6	60,0	100,0	
Missing	System	4	40,0		
Total		10	100,0		

Creativity					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	The poster shows no creative effort	2	20,0	33,3	33,3
	The poster shows some creative effort	2	20,0	33,3	66,7
	The poster shows considerable creative effort	2	20,0	33,3	100,0
	Total	6	60,0	100,0	
Missing	System	4	40,0		
Total		10	100,0		

11.4.2. Student Questionnaire

Descriptive Statistics	N	Minimum	Maximum	Median	Std.-Deviation
I liked having Biology lessons in English	20	1,00	5,00	3,8000	1,15166
I was able to try out new things using English	20	2,00	5,00	4,0500	,88704
My English skills improved because of the project	20	1,00	5,00	3,4000	1,23117
My Biology skills improved because of the project	20	2,00	5,00	4,3000	,80131
I communicated more than in other Biology lessons	20	1,00	5,00	3,4000	1,09545
I would have produced the same work if the project had taken place in German	20	1,00	5,00	3,8000	1,10501
I would have performed better/worse had the project been taught in German	11	,00	1,00	,5455	,52223
I always knew what I had to do	20	1,00	5,00	3,7000	1,12858
I always knew what was expected of me in terms of content and language goals	20	2,00	5,00	3,8500	,93330
I experienced a variety of teaching methods during the project	19	1,00	5,00	3,8421	1,21395
I was able to complete all the tasks in the time given	20	2,00	5,00	4,3500	,87509
I would have needed more support when working on the tasks	20	1,00	4,00	2,5500	,88704
I could always help the teacher for help if necessary	20	2,00	5,00	4,5000	,82717
How do you rate the language level used during the project	20	2,00	5,00	3,4250	,86260
How do you rate the Biology content of the project	20	2,00	5,00	3,3750	,80908
Valid Values	11				

I liked having Biology lessons in English *
Something I found really interesting/ Something I really enjoyed/ Something I will remember
Cross-table

Number

		Something I found really interesting/Something I really enjoyed/ Something I will remember		
		CLIL lessons in general	specific segments/contents	clear instructions
I liked having Biology lessons in English	does not apply	1	0	0
	hardly applies	0	2	0
	partially applies	0	3	0
	applies	1	4	1
	fully applies	4	0	0
Total		6	9	1

I would have produced the same work if the project had taken place in German *
I would have performed better/worse had the project been taught in German
Cross-table

Number

		I would have performed better/worse had the project been taught in German		
		worse	better	Total
I would have produced the same work if the project had taken place in German	does not apply	0	1	1
	partially applies	2	1	3
	applies	2	1	3
	fully applies	1	3	4
Total		5	6	11

I always knew what I had to do

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	does not apply	1	5,0	5,0	5,0
	hardly applies	2	10,0	10,0	15,0
	partially applies	4	20,0	20,0	35,0
	applies	8	40,0	40,0	75,0
	fully applies	5	25,0	25,0	100,0
	Total	20	100,0	100,0	

I always knew what was expected of me in terms of content and language goals					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	hardly applies	3	15,0	15,0	15,0
	partially applies	1	5,0	5,0	20,0
	applies	12	60,0	60,0	80,0
	fully applies	4	20,0	20,0	100,0
	Total	20	100,0	100,0	

I always knew what was expected of me in terms of content and language goals					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	hardly applies	3	15,0	15,0	15,0
	partially applies	1	5,0	5,0	20,0
	applies	12	60,0	60,0	80,0
	fully applies	4	20,0	20,0	100,0
	Total	20	100,0	100,0	

I was able to complete all the tasks in the time given					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	hardly applies	1	5,0	5,0	5,0
	partially applies	2	10,0	10,0	15,0
	applies	6	30,0	30,0	45,0
	fully applies	11	55,0	55,0	100,0
	Total	20	100,0	100,0	

I would have needed more support when working on the tasks					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	does not apply	3	15,0	15,0	15,0
	hardly applies	5	25,0	25,0	40,0
	partially applies	10	50,0	50,0	90,0
	applies	2	10,0	10,0	100,0
	Total	20	100,0	100,0	

I could always help the teacher for help if necessary					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	hardly applies	1	5,0	5,0	5,0
	partially applies	1	5,0	5,0	10,0
	applies	5	25,0	25,0	35,0
	fully applies	13	65,0	65,0	100,0
	Total	20	100,0	100,0	