



Content and Language Integrated Learning Implementation Through Team Teaching in Biology Lessons: A Quasi-Experimental Design With University Students

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Can engaging university students in Content and Language Integrated Learning (CLIL) increase their achievement in Biology and English language? The current study explored the effectiveness of team teaching enhanced CLIL on student achievement. Framed in interdisciplinary/cross-curricular teaching, we examined the effect of CLIL strategy on student achievement in a quasi-experimental study with a sample of Biology education students ($N = 25$) assigned to control and experimental groups. The topic taught through CLIL was the digestive system, and this subject knowledge was used to test the students' achievement in Biology. Along with t -test and Mann-Whitney U -test a non-parametric ANCOVA was carried out to reveal group differences. We found that engaging in CLIL significantly improved student achievement both in Biology subject knowledge and English language. We highlight the critical role of CLIL in teaching content and language for science subjects such as Biology at university level.

Keywords: biology education, CLIL, digestive system, team teaching, university students

INTRODUCTION

Content and language integrated learning (CLIL) is an educational approach that integrates learning content along with a foreign language (Mehisto et al., 2008). Despite the above statement, the last decade has witnessed quite a large amount of CLIL research hinging on the effect of CLIL on language achievement (Admiraal et al., 2006; Dalton-Puffer, 2008; Roquet and Pérez-Vidal, 2017). CLIL research so far has primarily pursued L1 (first language) and L2 (second language). Meanwhile, in investigations involving CLIL contexts, content-subjects have been largely ignored (Fernández-Sanjurjo et al., 2019). Research has not yet developed sufficient methods for CLIL to be implemented within content-subjects. The large body of research on CLIL has focused on problems associated with CLIL implementation, and perspectives on CLIL and teachers' CLIL

conceptualization. Researchers have also mentioned the vagueness of CLIL and stressed the need for further essential study beyond analyzing language acquisition (Cenoz et al., 2014).

The English as Foreign Language teacher, EFL, is best placed, in terms of language pedagogy, to implement CLIL, but the likelihood that she/he has fully mastered the necessary content knowledge, especially at university level, is low (Maldonado-García, 2018). Language teachers' lack of confidence in their own expertise in content knowledge hinders their incorporate valuable language insights to a lesson, is an additional rationale for keeping the division between content and language instruction ability.

While a subject-content teacher might be proficient in the specific foreign language themselves, she/he may not have been equipped within the appropriate methodology to include language objectives in the CLIL course (Pladevall-Ballester, 2016). One of the concerns in content teachers is that students might learn less content, as they are exposed to a language other than their mother tongue, that is, English (Skinnari and Bovellan, 2016). According to Dalton-Puffer (2007) teachers' concerns are due to the fact that they consider that a foreign language may slow down the lesson and reduce content input. That is why, in this study our investigations focused on the combination of content and language implementation together through team teaching.

One should not expect the CLIL to increase students' content and language proficiencies more than when content and language are taught independently. The beauty (subjective—major advantage) of CLIL is the time gain. In other words, students/teachers do not need to allocate separate time for content learning and language learning, both take place at the same time (Marsh et al., 2009). However, CLIL teaching may have superiority on language-alone teaching for reading comprehension (Admiraal et al., 2006; Jiménez-Catálan et al., 2006) and word learning.

Research on content is “extremely limited,” an argument seconded by Pérez-Cañado (2016), who posits “there is still a well-documented paucity of research in this area.” Even though there is a shortage of studies matching CLIL with subject-content relevance, some of them have flourished from Kazakh authors, who have released various studies in the previous decade (Nurzhan and Ashirimbetova, 2017; Issabekova et al., 2020). Therefore, the aim of this research is to supplement current thinking by providing evidence on, not only language learning, but also content in Biology through both CLIL and team teaching. This study uses a quasi-experimental design, which allows the contrasting of students' achievement in English and Biology in CLIL teaching with regular subject teaching.

This study is significant in several aspects and allows: (i) a focus on both content and language equally where previous research is dominantly on language; (ii) content teachers to teach the content and language teachers teach language through a team-teaching process at university level; (iii) an empirical approach to reveal the potential effects of CLIL; (iv) an insight into a Biology-based science subject where there is little existing research in CLIL.

The purpose of this study is to explore the effectiveness of team-teaching enhanced CLIL on student achievement. The following research question led to this study. Can engaging

university students in CLIL increase their achievement in Biology and English language?

LITERATURE REVIEW

What Is Content and Language Integrated Learning? Language and Content Teaching

The origins of CLIL can be traced back to the immersion programs of the 50 s in Canada. In that decade, thousands of Canadian families moved from the English-speaking area to the French-speaking region of Quebec and Montreal. Many studies which explored these types of bilingual programs (Pérez-Vidal, 2011) showed their success from the linguistic and content point of view. In fact, Pérez-Vidal (2011) underscored the influence of these programs in the implementation of CLIL in Europe and in many ways can be considered the precursors of CLIL education. Nowadays, CLIL is implemented in and out of Europe and is experiencing success globally, specifically in Canada and more recently in United States due to immigration. Both CLIL and immersion, together with other models of bilingual education seem to evidence that L2 instruction integrated with content matter is more effective than L2 instruction in isolation (Badertscher and Bieri, 2009).

Nonetheless, it is important to highlight that the European context cannot be directly compared to the North American one despite their similarities and the influence of the latter over the former. Consequently, not all content-based or immersion principles can be transferred to the CLIL approach. As Gallardo del Puerto et al. (2009) pointed out, “most of the immersion conditions bear little resemblance to the study of English through CLIL programs in Europe, particularly in terms of the sociolinguistic and sociocultural context in which the L2 is learned and the authenticity of the input” (p. 65). In fact, the L2 adopts a secondary role in content-based teaching contexts even though it is the language of instruction. On the contrary, CLIL pursues a balance between the L2 and content in terms of their weight in instruction. Thus, language and content are intertwined without a preference of one over the other (Coyle, 2007).

The CLIL approach aims at the creation of a learning context where the L2 acquisition takes place in a naturalized way (Juan-Garau and Salazar-Noguera, 2015). In addition to the integration of language and content, Mehisto et al. (2008) adds that CLIL must also pursue the development of learning skills, as they are essential to reach the linguistic and content matter aims. CLIL is characterized by its flexibility, dynamism, and versatility (Papaja, 2014). Yet, the 4C framework suggested by Coyle (2006) constitutes a reference for researchers and teachers. These four Cs stand for content, communication, cognition, and culture. As for content, it refers to non-linguistic content or subject matter. Any subject may adopt the CLIL approach. Meyer et al. (2015) affirm that CLIL is not only a question of acquiring knowledge, but that the learner is expected to take ownership of his/her own knowledge. In this line, content is closely related to cognition and learn to learn, which encompasses a cognitive challenge. The

concept of culture is also relevant for understanding CLIL. The student must develop intercultural awareness, which is at the core of CLIL (Coyle, 2006). CLIL provides an opportunity for students to understand and tolerate different perspectives and ways to conceive reality.

From the standpoint of communication, language in CLIL plays a complex role. Authors such as Coyle et al. (2010) and Llinares et al. (2012) distinguish between language of learning, language for learning and language through learning. Language of learning entails the words, phrases and expressions which are key to access the subject content. The language for learning is needed by students to carry out classroom tasks such as debating or presenting information. The third role of language in CLIL is related to the new language that emerges from the cognitive process in which students are immersed.

The 4C framework introduced has evolved and some scholars have recently considered adding a fifth C to Coyle's proposal. For instance, Agolli (2013) suggests the C for context should also be considered as, that which determines instruction and at the same time enriches the framework. Others such as Renau and Mas (2019) suggest that the new C should refer to competence: "the can-do statements [. . .] students are able to make after the lesson, either about the lesson content or about the language that is being learnt" (p. 1113).

An important portion of the CLIL research hinges on exploring this approach in terms of motivation, analyzing the attitudes of teachers, students and even families. Most of the studies reveal that there is a positive attitude toward CLIL, although there is a certain degree of concern about the challenges involved in its proper implementation (Dafouz, 2009; Alcaraz-Mármol, 2018). For instance, Issabekova et al. (2020) remarks on the success of the implementation of CLIL programs in Kazakhstan, although the authors warn that there is a need for both teachers and students to rethink some traditional language and subject concepts in the teaching and learning process. Likewise, Nurzhan and Ashirimbetova (2017) observed that the CLIL approach increased students' motivation in subjects such as Math. In this sense, Pladevall-Ballester (2016) states that we should take into account the subject CLIL will be implemented for, requiring willing, prepared and involved teachers. These teachers are in charge of choosing appropriate materials and deal with parents' expectations and concerns.

Another research line for CLIL concerns the development of the L2 communicative competence in general, and each of the communicative skills and linguistic aspects in particular. On this basis, research strongly supports the benefits of CLIL in the mastery of a L2 in comparison to non-CLIL contexts (Lorenzo, 2010; Várkuti, 2010; Navés, 2011; Goris et al., 2013; Yang, 2015; Coral et al., 2018). Comparisons of L2 vocabulary acquisition in CLIL vs. non-CLIL contexts is one of the aspects where more literature can be found in this respect. Agustín-Llach (2016) carried out a longitudinal study where she measures and compares the receptive vocabulary size and lexical growth of one group of CLIL learners and another group of traditional EFL learners. Her results show significantly higher vocabulary size in the CLIL learners, which increased in the last years of the study. A significant effect

of CLIL on L2 vocabulary knowledge was also observed in Xanthou (2011), and Sylven and Ohlander (2015) when the CLIL group outpaced the non-CLIL one. When considering morphosyntactic elements of a lesson, Ruíz de Zarobe (2008) and Lázaro (2012) indicate a clear advantage of CLIL learners over traditional EFL students.

Focusing on skills, Nieto (2016, p. 83) concludes that "although there is a growing body of research that shows the many benefits of the CLIL approach, there are still some aspects that require further investigation, such as the most and least benefited skills in the target language" (p. 83), and deems further research is necessary to confirm those benefits. For instance, Hüttner and Smit (2014) and Pérez-Cañado and Lancaster (2017) argue that it is oral communicative skills, particularly speaking, which are most benefited by CLIL in the medium and long term as communicative interaction in the L2 is clearly promoted. Likewise, Gené-Gil et al. (2015) found that writing skills were better among CLIL peers than among EFL students, the former outperforming the latter in all aspects except for lexical complexity.

Nonetheless, Dalton-Puffer (2008) affirms that listening and reading are the most positively affected by CLIL, even though they have usually received less attention than production. Aguilar and Muñoz (2014) showed that there was a significant improvement in students' listening skills within a CLIL context, in comparison with EFL contexts, especially regarding less proficient students. In terms of reading, Ruíz de Zarobe and Zenotz (2018) observed how reading strategies and awareness were enhanced in the CLIL classroom, imparting a positive impact in L2 reading comprehension. In this line, Prieto-Arranz et al. (2015) highlighted a remarkable development in reading comprehension in secondary education learners immersed in CLIL programs.

Content and Language Integrated Learning Through Team Teaching

CLIL has adopted several models, as it is a versatile approach which can be implemented from elementary to higher education (Coyle et al., 2010). One of the educational approaches involves team teaching. No matter which model is used, CLIL aligns with team teaching in which the content and language teacher collaborate (Coyle et al., 2010; Chocholatá and Gahurová, 2018). During a lesson two teachers are in the class (a language teacher and a subject content teacher) and these teachers cooperate not only during planning the lesson but also during the lesson. This approach demands methodological preparation of both teachers (Hanusová and Vojtková, 2011). Content teachers usually keep the balance between teaching the subject content and helping language understanding (Coyle et al., 2009).

Team teaching provides each teacher with his/her own role in the lesson and be a part of the whole message transmitted to students. In fact, it is important to consider not only the content but also the language structure used for this message which, in some cases, would not be analyzed when the topic is covered in the mother tongue (Elorza and Guinda, 2015). The teacher of the content subject sets out subject aims and subsequently on their

basis, set out the language aims in cooperation with a language teacher (Hanusová and Vojtková, 2011).

In the CLIL context, the first debatable issue is “what” to assess. Should teachers assess language or content or both (Coyle et al., 2010). Teachers should bear in mind that when assessing their students, the focus should first be on the content, then on the language (Coyle et al., 2010).

Content and Language Integrated Learning in Science Subjects

Experiences of CLIL with science subjects have been widely documented due, perhaps, to the prominent role of English in the scientific community. In non-English speaking countries, various types of English communication skills are being incorporated in higher education to help students reach a reasonable English level after graduating from universities. As a result, STEM and English education are becoming closer to each other in these countries (Capone et al., 2017; Mutseekwa, 2021). Nonetheless, as far as we know, despite the dual focus of CLIL, most of the reported results pay attention only to language learning, or to content (Capone et al., 2017) no matter the stage of education (Beas Catena, 2020). One study from the literature, developed in a multicultural context, reports that content results improve after CLIL biology lessons. It is this author's opinion that this is the weakest conclusion for the study considering the evidence provided from the research as it exhibits a weak experimental design that lacks a control group (Schieltroma, 2019). Among the rest of literature reviewed, the focus is on language. Thus, for instance, in the work of Pérez-Mirón (2016) for Primary, Compulsory Secondary Education and High School students in Spain, by using macro-activities like races and external contests in chemistry, physics, biology and mathematics through cooperative learning, the author reports that students feel more confident regarding science subjects, and improve their communication skills in English, but no results about content learning are presented.

Also, in preuniversity levels, in the study of Tagnin and Ni Ríordáin (2021), biology is taught to upper secondary education students through CLIL with the use of inquiry. They proved that the use of inquiry can help students to develop the argumentation and discourse creation in English. These authors recommended to Science, Technology, Engineering and Mathematics, STEM, teachers not to oversimplify the discipline language aiming to a better understanding of contents and language structure.

When considering Higher Education, there are few studies about STEM subjects taught through CLIL at university level and also there are few that report results regarding content knowledge. For instance, Aiba and Izumi (2019) analyzed how effective CLIL is in teaching STEM subjects to STEM major students when using input or output skills by focusing on cause-effect language structure, highly present in scientific contexts, but without paying attention to any content. They find that students learn no matter which skills are involved or promoted, provided that neither the input nor the output skills can exist in an isolated manner in any teaching activity, and both are combined in teaching practices in the reported CLIL environment. The

perceptions of teachers are captured by Block and Moncada-Comas (2019), who studied science teachers using English-medium instruction, and find that they are acting as English as foreign language teachers, without their realization.

Therefore, the reviewed literature provides evidence on the gap that there are few studies that use a quasi-experimental design and assess content learning of CLIL. This study is aiming to fill this gap to any extent.

Content and Language Integrated Learning in Kazakhstan

CLIL has gained importance over the last decade, especially in some Asian countries. The government of some countries are seriously considering this approach and take action for its promotion (LaPrairie, 2014). Ministry of Education and Science of the Republic of Kazakhstan [MoES] (2014) states that Kazakhstan is one of the first Central Asian countries, and it is among the first post-Soviet countries, to adopt CLIL as a pedagogical approach through which content subjects are taught in three languages.

Different training programs have been designed since 2016 with the aim to prepare STEM teachers so that they can be able to deliver instruction in English. Thus, extensive teacher training programs in Kazakhstan have incorporated CLIL among their contents (Goodman and Karabassova, 2018). Through interviews and observations Karabassova (2018) found that many of the teachers were not familiar with the educational goals behind CLIL and conceptualized CLIL simply as teaching in a new language. More recently Nuranova (2020) used interviews with teachers teaching science subjects and discovered that science teachers experienced numerous challenges when teaching with CLIL, specifically, increased class preparation, curriculum design, and low competence in English on the part of teachers and students. However, teachers participating in the study who exhibited greater experience felt that it only influenced their daily teaching routine.

In the studies conducted in Kazakhstan, it has been emphasized the difficulty of assessment by content teachers in biology lessons taught through CLIL (Abzhanova, 2020). This author realized that balancing content and language was a real challenge for teachers in CLIL environments. In fact, despite familiarity of biology teachers with regards to assessment tools and strategies, they were reluctant to adopt criteria-based assessment, as they felt insecure when evaluating students within a CLIL context; the teachers found difficulty in their use and implementation of L1 and L2 evaluation process as they focused on content goals instead of language goals; they tended to give more relevance to content over language, given their limited knowledge about language assessment.

Therefore, taking into account all the settled arguments and the gaps detected, this study is aimed at analyzing whether both content and language learning are promoted through CLIL by using team teaching at university level into a biology-based science subject. The dependent and independent variables of this study are achievement and CLIL-T, respectively.

The purpose of this study is to explore the effectiveness of team-teaching enhanced CLIL on student achievement. The following research question led to this study. Can engaging university students in CLIL increase their achievement in Biology and English language?

RESEARCH METHODOLOGY

A subject teacher teaching both content and English Language learning is a challenging process. To facilitate CLIL implementation we proposed team teaching during CLIL lessons which we call CLIL-T. Namely, the subject teacher and the language teacher taught together. They planned both content and language learning objectives for each lesson prior to teaching. The focus was again the content (as suggested by CLIL method) however, the language teacher interjected as language related issues raised in the classroom.

In this study, CLIL-T implementation took place for one topic (digestive system) of Biology at the university level. Prior to and after the implementation of CLIL-T both pre-tests and post-tests for both Biology and English language were administered to both control and experimental groups. Thus, this was a quasi-experimental study with a “Pre-test/Post-test control group design” (Dugard and Todman, 1995).

Sample

The study was conducted at the end of the spring semester of 2020–2021 academic year. The sample of this study consisted of trainee teaching students enrolled in introductory Biology course in a university in Kazakhstan. Convenience sampling method was employed to select students. There were 12 and 13 students in the control and experimental groups, respectively. Almost all the participants were female; one student from control group and two from experimental group were male. They all voluntarily participated in the study. Because of students’ voluntariness, they were not arbitrarily assigned to treatment conditions. Instead, each was allowed to select which treatment they would receive.

The university was situated in an economically moderate suburb but was well resourced. After a successful completion of the undergraduate study program, the students are awarded a bachelor’s degree in biology education. The classes on teaching and learning biology, are typically limited to around 25 students. The classes are subjected to teacher education certification program. The 4-year education comprises four curricular elements: biology content, models of teaching and learning, English and Turkish languages, and practical teaching experience. One of the 2 weekly biology class periods concentrates mainly on the study of conventional biology content. The other weekly class session centers on problem solving and theoretical foundations of learning biology. At least once a month, students take part in the laboratory section of the program. The last year of the program is mainly devoted to pedagogical practice both at the university and at schools. The pedagogical practices provide students with useful skills both in biology and in techniques of teaching and learning (Özdemir et al., 2019).

Instruments

The biology achievement test consists of 25 multiple-choice questions to assess students’ four different knowledge areas in human digestive system. These areas are introduction to digestive system, steps in digestion, organs of digestive system, digestive secretions, and diseases of digestive system.

There are two criteria for evaluating a standardized test: validity and reliability. For validity, experts’ validation was used, while for reliability Kuder-Richardson reliability index (KR20) and Ferguson’s delta (δ) for reliability and discriminatory power of tests were used in this study. KR20 reliability index is a measure of internal consistency of a whole test when test items are dichotomous (i.e., correct or incorrect answers). Ferguson’s delta is a measure of the discriminatory power of a test. It considers how broadly students’ total scores are distributed over the possible range (Hankins, 2008). The KR-20 values for the biology post-test were found to be 0.881 for experimental group and 0.835 for control group which are very reasonable values for statistical purposes (Maloney et al., 2001). Similarly, the Ferguson’s delta values for the biology post-test was found to be 0.81 for experimental group and 0.89 for the control group.

The English language achievement test consisted of 17 multiple-choice questions and two constructed response items (for assessing writing skill) to assess students’ four different knowledge areas in language. These areas are vocabulary (4 items), comprehension (5 items), grammar (8 items) and writing (2 items). The KR-20 values of the English language post-test were found to be 0.744 for the experimental group and 0.742 for the control group. Similarly, the Ferguson’s delta values for the English language post-test were found to be 0.80 for the experimental group and 0.85 for the control group.

Procedures

The study was started with a pilot implementation of CLIL-T. The aim of the pilot study was to improve the quality and efficiency of the main study. In addition, it was conducted in order to increase the researchers’ experience with the CLIL-T. A total of 37 students participated in the pilot study who later voluntarily divided into control and experimental groups where 12 students do not accept to participate in the main study. So, the students in this study had already experienced CLIL teaching in “respiratory system” unit.

The main study consisted of a week-long series of meetings (see **Table 1**) wherein students and the researchers came together to discuss the teaching of digestive system. Overall, six 2-h (including 2 h pilot study) online meetings were held with the participation of freshman year biology students from a university. For meetings the online platform Webex¹ was used. During each meeting, students discussed important concepts in digestive system, solved problems, sing songs related to digestive system, “repeat after me” vocabulary exercises, fill in the blanks, spelling biology related terminology, etc. All meetings were led by the first author and an English language teacher.

In the control group biology lessons on digestive system were provided in English language. No team teaching and CLIL were employed in this group.

¹<https://www.webex.com/>

TABLE 1 | Daily schedule for CLIL method.

Day	Presenter	Topics	Date	Duration
1	Teacher 1 and teacher 2	Respiratory system (pilot session)	May 10	2 h
2	Teacher 1 and teacher 2	Introduction to digestive system Types of digestion	June 17	2 h
3	Teacher 1 and teacher 2	Steps in digestion Physiology of digestion	June 18	2 h
4	Teacher 1 and teacher 2	Organs of digestive system Difference between main and accessory organs of digestive system	June 19	2 h
5	Teacher 1 and teacher 2	Digestive secretions Digestion of organic materials	June 19	2 h
6	Teacher 1 and teacher 2	Disease of digestive system (disorders of DS) General diseases in Kazakhstan	June 20	2 h

After the pilot study, some revisions such as increasing the interaction in English exercises, adding some new activities during presenting the topic, include cultural attributes in the presentations to carry out more attractive lessons, and include exercises into the songs presented during the lesson were included on the lesson plans of CLIL-T. Similarly, some revisions such as increasing the interaction between students and teachers, allowing the Biology and English teacher to interject when needed, having students make presentations, and include videos and animations into the lesson were added to the structure of the study.

During the CLIL-T, cultural issues were brought to the agenda and students were invited to attend the class. Below are some of the dialogues that took place during the meetings that exemplify students' participation during this program. These excerpts are the transcriptions of video recordings during the meetings.

Teacher: What do you know about Kazakh national food?
 Student: Beshbarmak, Kuyirdak, Boursak, kurt, kazy, zhal zhaya, irimshik
 Teacher: What do you know about Kazakh national drinks?
 Student: kumys, shubat, ayran
 Teacher: Which proverbs do you know in Kazakh culture?
 Student: Boursak vsemu golova (Bread is head of everything), As -adamnin arkau (food—main thing of people)
 Teacher: Syilap bergen su da tatti (the water becomes sweet if give with respect). Tatu uydin tamagy tatti (in friendly house food is delicious)
 Student: Taspenn urgandy aspen ur (who throw stone throw food)

Similarly, discussions took place about unclear points. Among the many topics taken up in the discussions was the most productive way of stating important concepts like “physical digestion”:

Teacher: Does physical digestion occurs in the stomach?
 Student 1: No, it occurs in our mouth by special substance saliva.

Student 2: I think in the stomach physical digestion occurs because of contraction of muscles.

Teacher: As you see this table (Biology teacher presented a table showing the steps of digestive system) indicates which process takes at which part of the digestive system. As you see the physical digestion occurs in the stomach.

As decided after the pilot study, the English language teacher interjected when language related issues raised:

Teacher: Let us repeat vocabularies that Mr. Satayev used to in these presentations.

Teacher: CHEW (v)/tʃu:/

Students: CHEW

Teacher: phagocytosis (n)/'fæg·əsal'tou·sIs/

Students: phagocytosis

Teacher: vacuole (n)/'vækjuəʊl/

Student: vacuole

Teacher: saprophytic (bacteria) (n)/sæprəu'fitik/

Student 3: Teacher may I ask the question? Why is the transcription of phagocytosis different in word saprophytic?

Teacher: its concern of their pronunciations, don't confuse them and read it by rule

Along with many language activities “fill in the blanks” was a primary activity. Following is an example of activity led by both teachers.

English Teacher: Everybody look at the text and try to fill in the blanks. You have 3 min.

After 3 min. . .

English Teacher: Ok let's start, open your microphones. First blank?

Students: In this process, food is ingested from the environment.

English Teacher: That's great! Second one?

Students: Hydrolyzed into its subunits and absorbed from the gut into the blood.

English Teacher: It's okey, continue please.

Students: Vitamins, carbohydrates, and minerals may enter the circulatory system without any changes in their composition.

Biology Teacher: Are carbohydrates passed through into the blood without any digestion? Let's remind from the beginning lesson (Teachers showed a slide including the answer).

Students: Oh, okay its water.

Biology Teacher: Thanks.

Data Collection

The data gathered for this study highlight student performance, and in particular assess student knowledge in the digestive system. The assessment of student performance involves pre-tests and post-tests of the basic concepts in the digestive system and their vocabulary, comprehension, grammar and writing skills in English language. The tests were administered to all groups of students online before and after the implementation of the CLIL strategy. Before the testing, the researcher explained the purpose and the importance of the study. The testing was not anonymous. To motivate the students to participate in the study and to take the test seriously, we made three compensations; add incentives to their final grades, to reteach one more biology topic in CLIL method and have a dinner at a restaurant the end of the study.

Data Analysis

For the analysis, Jamovi² was used. The *t*-test was carried out for locating group differences. The Mann-Whitney *U*-test was used to compare differences among two separate groups when the data is ordinal or when the assumptions of the *t*-test are not met (MacFarland and Yates, 2016). Finally, a non-parametric ANCOVA was carried out because parametric test conditions were not met for Biology post test scores. To know the extent of the group differences, the effect size through d-Cohen coefficient was calculated.

RESEARCH RESULTS

Table 2 exhibits the mean and standard deviations, as well as the *p*-values of normality tests applied to the variables in the control and experimental groups.

Table 2 indicates that post test scores for both biology and English language subject are not normally distributed (Shapiro-Wilk *p* < 0.05). For these two variables non-parametric tests will be used.

Control and Experimental Groups Pretest and Posttest Comparisons

During CLIL implementation pre and post tests were carried out for both Biology content and English language skills. Table 3 indicates Independent Samples *t*-test results for both subjects' pretest scores. The pretest score for control and experimental groups were compared to see if the groups are initially equal

TABLE 2 | Mean, standard deviation, SD, and *p*-values of Shapiro-Wilk normality test.

	Group	Pretest-bio	Pretest-eng	Posttest-bio	Posttest-eng
N	Control	12	12	12	12
	Experimental	12	12	13	13
Mean (SD)	Control	10 (4.34)	9.25 (3.02)	16.18 (2.60)	11.3 (3.34)
	Experimental	15.31 (2.21)	10 (2)	20.85 (2.19)	14.1 (2.96)
Shapiro-Wilk W	Control	0.929	0.91	0.956	0.969
	Experimental	0.905	0.929	0.784	0.806
Shapiro-Wilk p	Control	0.371	0.211	0.731	0.903
	Experimental	0.184	0.371	0.004	0.008

Bolds are statistically significant results.

TABLE 3 | Independent samples *t*-test.

		Statistic	df	P
Pretest-bio	Student's t	5.721	22	<0.001
Pretest-eng	Student's t	0.717	22	0.481

in terms of academic achievement both in Biology and in English language.

Table 2 indicates that pretest scores for control and experimental groups in Biology are statistically significantly different while for English language it is not. Since the pretest scores in Biology subject was statistically significantly different, ANCOVA analysis was conducted to adjust students' initial academic achievements. However, since post test scores in Biology are not normally distributed (see Table 2) a non-parametric ANCOVA was carried out (Cangür et al., 2018). Similarly, post test scores in English language are not normally distributed. Thus, a Mann Whitney *U*-test was carried out to analyze scores from English language test. The results are shown in Table 4.

The Mann-Whitney *U*-test showed that there was a significant difference (*p* < 0.05) between the control group compared to the group receiving the CLIL treatment. The median was 11.5 for the control group compared to 15 (see Table 4) for those receiving the CLIL treatment in learning English language suggesting

TABLE 4 | Mann-Whitney *U*-test.

Descriptive statistics					
Group	N	Mean	Median	SD	SE
Control	12	11.3	11.5	3.34	0.964
Experimental	13	14.1	15	2.96	0.82
Inferential statistics					
Statistic	P	Effect size			
40	0.039	0.487			

²<https://www.jamovi.org/>

TABLE 5 | Mean and standard deviation, and SD for non-parametric ANCOVA.

		Pretest	Posttest
Control	N	12	12
	Mean	10	16.18
	SD	4.34	2.60
Experimental	N	12	13
	Mean	13.31	20.85
	SD	2.21	2.19
Adjusted control	N	11	13
	Mean	8.05	16.27
	SD	7.14	4.30
Adjusted experimental	N	11	13
	Mean	7.09	17.08
	SD	4.43	5.34
Residual	N	11	13
	Mean	-2.61	2.21
	SD	4.05	5.64

TABLE 6 | Non-parametric ANCOVA (Quade Method).

Source	SS	df	MS	F	P
Level	137.9	1	137.9	5.56	0.028
Error	545.626	22	24.801		
Total	683.526	23			

that the CLIL treatment is more effective than traditional teaching methods.

Non-parametric ANCOVA for Biology Subject

As seen in **Table 5** the pretest means of the control and experimental groups varied significantly? ($M_{con} = 10.00$, $M_{exp} = 13.31$) while adjusted means are very close to each other ($M_{con} = 8.05$, $M_{exp} = 7.09$). On the other hand, the mean difference between unadjusted posttest scores is 3.31 and that of adjusted scores is only 0.96. There is a substantial effect for the covariate which suggests that including it has changed the apparent group difference on the dependent variable (post test scores). The significance of the group difference after the adjustment is checked by the non-parametric ANCOVA (see **Table 6**).

Non-parametric ANCOVA analysis results (using Quade Method) showed a significant difference among groups, i.e., teaching status, in terms of pretest-adjusted posttest values ($p = 0.028$). According to pretest-adjusted posttest values, control group scores were significantly lower than that of the experimental group. In summary, CLIL teaching was significantly effective in increasing students' scores in Biology.

DISCUSSION

In the current study, the effectiveness of team teaching-enhanced CLIL on student achievement was analyzed. For this purpose, the CLIL lessons were framed in an interdisciplinary/cross-curricular teaching, and we examined the effect of CLIL strategy on student

achievement in a quasi-experimental study with a sample of biology education students ($N = 25$) distributed in control and experimental groups.

The improvement in content learning is also documented in the literature not only for university students but also for the elementary level of education, as shown by Yamano (2013). In the literature review we have emphasized that most of the studies analyze English skills but not content acquisition (Pérez-Mirón, 2016; Aiba and Izumi, 2019; Tagnin and Ní Riordáin, 2021). In this case not only the experimental group but also the control group showed gains, the experimental group results being consistent with Schietroma (2019). Our results are aligned with those of Yamano (2013) who used a similar experimental design but worked with primary education pupils. Therefore, it seems that, no matter the age, the results of using CLIL are positive for learning, not only for Biology lessons but also for English skills.

Concerning language learning our research therefore, is in line with previous investigations, where the positive effect of CLIL approach has been observed as regards L2 communicative competence in general (Dallinger et al., 2016; Salamanca and Montoya, 2018; Nykiporets and Ibrahimova, 2021) and the different skills and linguistic aspects involved. In the case of reading, our results are in line with Chostelidou and Griva (2014), and Hamidavi et al. (2016). Both show that after several teaching sessions, there is a significant difference in the reading skills of CLIL students and those non-CLIL, where the former outperformed the latter not only in reading but also in subject content. As for vocabulary and grammar, our results echo studies such as, Moghadam and Fatemipour (2014), Pérez-Cañado and Basse (2015), and Castellano-Risco et al. (2020) evidence the positive development of these linguistic aspects under CLIL instruction. Castellano-Risco et al. (2020) affirmed that it is not the amount of vocabulary input but the educational context which has a significant effect in L2 vocabulary learning, reinforcing the idea of the CLIL approach over a tradition ELF context. Likewise, Moghadam and Fatemipour (2014) remarked the benefits of the CLIL approach. They found important vocabulary gains in Iranian participants studying Math within a CLIL context. In the case of grammar, Pérez-Cañado and Basse (2015) analyzed and compared the linguistic errors made by students under CLIL and non-CLIL instruction. They observed that the latter showed more serious errors than the former.

Within CLIL programs, the language has a triple role, that is, in addition to being the object of study, it is also the vehicle of communication and a cognitive trigger (Llinares et al., 2012). As Arnó-Macía and Mancho-Barés (2015) point out, the role of language learning in CLIL programs is a key factor for their success and for correct linguistic outcomes on the part of students and encourage collaboration between language teachers and content lecturers to achieve the expected L2 proficiency in undergraduates. Yet, the so-called team teaching in bilingual contexts has received less attention up to now. The role of team teaching is especially relevant in CLIL, given the dual nature of this approach, where language and content go hand in hand and are placed at the same level of importance. Studies such as Lasagabaster (2018), and Querol-Julián and Beltrán-Palanques (2021) show that not only does team teaching improve L2

communicative competence, but this improvement comprehends all its verbal and non-verbal components (Hashimi et al., 2021). These studies highlight the value of teacher collaboration from different disciplines and the importance of teacher training in this regard. In fact, studies such as Sandholtz (2000), Wadkins et al. (2004), and Ramírez-Casalvolone (2021), claim for teacher training in CLIL environments and the need for CLIL teachers to be instructed in specific teaching techniques to be applied in those learning environments.

CONCLUSION AND IMPLICATIONS

The reported findings highlight the critical value of CLIL for reform efforts aimed at increasing the quality of instruction in schools. The aim of this research was dual to enhance content and language learning in Biology through both CLIL and team teaching. For that purpose, it was designed an experiment with control and experimental groups taking part in a Biology course taught by CLIL in the university.

The results showed that in content knowledge students belonging to the experimental group do start from a higher level of knowledge than those in the control group (see **Table 2**). They also reach a higher level of knowledge in the content, Biology, than those in the control groups, which is reasonable because both groups are being taught the Biology topic. Nonetheless, with the statistical analysis performed and showed in **Table 4** we can state that the students in the experimental group experienced an improvement in a higher extent than the students in the control group.

The positive results in the students' achievement of both, Biology and English, serves to provide and reinforce the models proposed to future teachers, current university students, for the teaching of Biology in diverse contexts or with international students.

Nonetheless, this study has several limitations. On the one hand, the sample size provided that this study was conducted

with a relatively small sample. Actually, larger samples may yield more realistic results, so it can be considered as a pilot study to analyze whether it is worth the promotion of changes in the institution regarding the subject and language teaching. On the other hand, more research in this area is needed not only in Biology but also in other subjects, to face the challenge declared by Abzhanova (2020) of measuring content and language acquisition through CLIL approach. It is our hope that the present paper can offer teacher educators new insights and help illuminate ways of legitimizing CLIL in the curriculum as a critically important strategy worth implementing. We also suggest researchers/educators to focus on CLIL-T to increase the effectiveness of teaching science content and second language together.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Suleyman Demirel University Research Ethics Committee. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

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