The Effectiveness of the Content and Language Integration Learning (CLIL) in Developing Scientific Communication in Chemistry among Secondary School Students

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Abstract

The current research aims to develop scientific communication in chemistry among secondary school students using the content and language integration approach (CLIL). The research sample consisted of (60) male and female students from the second secondary grade at Ali Abdel Shakoor Official Language School - East Kafr El-Sheikh Education Administration - Kafr El-Sheikh Governorate. They were divided into two groups: the first experimental group with (30) male and female students and the other control group with (30) male and female students. The research used the experimental method with a quasi-experimental design based on the pre- and post-administration of the scientific communication scale on students in the two groups (experimental and control). The research results showed a statistically significant difference at a significance level of (0.01) between the mean scores of students in the two groups in the scientific communication scale for each dimension separately in favor of the experimental group. There was also a statistically significant difference at a significance level of (0.01) between the mean scores of students in the two groups in the scientific communication scale as a whole in favor of the experimental group. The research recommended the necessity of training chemistry teachers in language schools on how to plan, implement and evaluate lessons according to the content and language integration learning (CLIL).

Keywords: Content and Language Integration Learning (CLIL) – Scientific Communication – Secondary School Students.

فاعلية مدخل التكامل بين المحتوي واللغة (CLIL) في تنمية التواصل العلمي في الكيمياء لدي طلاب المرحلة الثانوية

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الملخص

هدف البحث الحالي إلي تنمية التواصل العلمي في الكيمياء لدى طلاب المرحلة الثانوية باستخدام مدخل التكامل بين المحتوي واللغة (CLIL)، وتكونت عينة البحث من (٦٠) طالب وطالبة من طلاب الصف الثاني الثانوي بمدرسة علي عبدالشكور الرسمية للغات –إدارة شرق كفرالشيخ التعليمية– محافظة كفرالشيخ، تم تقسيمهم إلي مجموعتين الأولي تجريبية بواقع (٣٠) طالب وطالبة والأخرى ضابطة بواقع بواقع (٣٠) طالب وطالبة، واستخدم البحث المنهج التجريبي ذو التصميم شبه التجريبي القائم على القياسين القبلي والبعدي لمقياس التواصل العلمي علي طلاب المجموعتين(التجريبية والضابطة)، وأسفرت نتائج البحث عن وجود فرق ذو دلالة إحصائية عند مستوي دلالة (٠.٠١) بين متوسطي درجات طلاب المجموعتين في مقياس التواصل العلمي لكل بعد علي حدة لصالح المجموعة التجريبية، كذلك وجود فرق ذو دلالة إحصائية عند مستوي دلالة (٠.٠١) بين متوسطي درجات طلاب المجموعتين في مقياس التواصل العلمي ككل لصالح المجموعة التجريبية، وأوصي البحث بضرورة تدريب معلمي الكيمياء بمدارس اللغات علي كيفية تخطيط وتنفيذ وتقويم الدروس وفق مدخل التكامل بين المحتوي واللغة (CLIL).

الكلمات المفتاحية: مدخل التكامل بين المحتوي واللغة CLIL – التواصل العلمي– المرحلة الثانوية.

Introduction:

The world today is witnessing a great cognitive acceleration in all aspects of life, and development in all fields, and education cannot remain isolated from this development. The state has sought to develop education within the sustainable development plan and Egypt's Vision 2030, and education was one of its axes, and its goals are represented in empowering students with science, mathematics, and information technology skills. Given that education is the tool that prepares today's generations for the world of the future, teaching science requires aware, skilled learners who are aware of the learning process, in addition to possessing skills that qualify them for the world of tomorrow. It must also aim to provide learners with social and mental skills that enable them to interact with the surrounding world, transfer their experiences, and acquire twenty-first century skills.

Among the 21st century skills known as the 4Cs (Creativity, Cooperation, Critical Thinking, and Communication), scientific communication is an important element in the teaching process, as communication takes place between the teacher and the learner through the teaching process. To achieve communication, language plays a vital role as a medium for thinking and for its use in transforming observations into ideas. Developing communication among the learner helps in expressing his ideas and opinions as well as formulating those opinions in a

way that helps him in conveying those ideas to others. Therefore, scientific communication must be developed among students for the learning process to be successful (Ezz El-Din, 2018, 203).

Scientific communication is concerned with stimulating the meaning in the minds of others, through verbal and non-verbal messages; which makes the process of examining the knowledge to be conveyed to students a very necessary matter, so that students receive knowledge and information in a clear image. The focus on scientific communication skills during the teaching of chemistry indicates that the learning process is an exchange process between the teacher and the students and that students and teachers learn from each other (Hoster et al., 2018, 45).

Scientific communication skills are among the most important scientific skills capable of facing future challenges in general. This comes from the fact that scientific communication benefits learners in several ways, including enriching their thinking to confront life problems, understanding the nature of science and its processes, and also shaping their beliefs, opinions, and scientific trends. Chung (2016, 23) indicates that scientific communication can be classified into verbal and non-verbal communication, while Muhammad (2023, 415) and Siraj (2019, 579) agreed that scientific communication skills are represented in listening, speaking, acting, reading, and writing. This research included seven dimensions of scientific

communication represented in: scientific reading, scientific writing, verbal skills, active listening, persuasion, non-verbal skills, and the use of electronic communication tools.

In light of the above, modern teaching strategies and approaches must be used to encourage students to develop scientific communication. Among the approaches that have received great attention over the past two decades, especially in Europe, is the CLIL approach, which has been praised by the European Commission and the Council of Europe as a distinctive methodology that combines learning academic content with learning and using an additional language in the European context.

The CLIL approach is a dual-focus approach in which a foreign language (a language other than the mother tongue) is used when teaching the content of a specific subject, focusing on awareness of the content of the subject in addition to enhancing learners' foreign language skills and employing them in learning this content (Garzon, 2021, 242).

Psychologists believe that the CLIL approach is an approach to cognitive stimulation, as it enhances learners' motivation and confidence, and develops their higher and lower levels of thinking (Montalto, 2016, 32). The CLIL approach is based on the four basic principles known as the following (4Cs): (Gerham, et al., 2020, 163 -189) content (subject matter), communication (language learning and use), cognition (learning and thinking), and culture (cultural

understanding and global citizenship) (Coyle & Meyer, 2022, 18).

Specialists recommended using different types of scaffolding with the CLIL approach in science, including multimedia scaffolding in which language is involved with visual resources, as well as tools to support second language learning in content classes: Model Sentence, Flow Chart, and Congress of experts (Fernandez-Fentecha et al., 2021, 10).

In light of the above, the research attempted to employ the approach of integrating content and language in teaching chemistry to secondary school students with the aim of developing their scientific communication.

Problem of the Study:

- The results of some previous research and studies that showed that there is a decline in scientific communication among learners, which recommended the necessity of developing it among learners at all educational levels, such as the study of Abu Al-Wafa (2023), the study of Farag (2020), and the study of Ezz El-Din (2018).
- Previous studies have recommended the necessity of employing the CLIL approach to develop different learning outcomes for learners, such as the study of Ezz El-Din (2022), the study of Abdel Aal (2021), the study of Trummer (2021), the study

of (Nurdillayeva et al. (2020), and the study of Tsang (2020).

- The researcher also conducted an exploratory study on a group of second-year secondary school students in the second semester of 2023/2024, numbering (30) male and female students at Ali Abdel-Shakoor Official Language School affiliated with the East Kafr El-Sheikh Education Administration - Kafr El-Sheikh Governorate, in order to identify the extent of second-year secondary school students' knowledge of scientific communication skills in the second semester; The researcher applied the scientific communication scale, which consisted of (25) statements, and the maximum score of the scale reached (75) degrees, and the average score of the sample reached (27) degrees at a percentage of (36%), which indicates weak scientific communication skills They have.

Statement of the Research:

The research problem was represented in the weakness of scientific communication among second-year secondary school students in language schools; which requires addressing this problem by using the integration approach between content and language, in light of what previous studies recommended regarding the necessity of paying attention to using modern approaches and teaching strategies in teaching and

learning chemistry to develop the ability to communicate scientifically, and therefore the following main question was formulated:

How can the integration approach between content and language (CLIL) be employed to develop scientific communication among secondary school students?

The following questions branched out from it:

1. What is the effectiveness of the integration approach between content and language (CLIL) in developing the dimensions of scientific communication (scientific reading, scientific writing, verbal skills, active listening, persuasion, non-verbal skills, use of electronic communication tools) for each dimension separately among second-year secondary school students in language schools?
2. What is the effectiveness of the integration approach between content and language (CLIL) in developing the dimensions of scientific communication for the dimensions as a whole among second-year secondary school students in language schools?

Aims of the Research:

The current research aims to experiment and study the effectiveness of the CLIL approach in developing

scientific communication among second-year secondary school students in language schools.

Research Importance:

The research importance is represented in:

- **Theoretical importance**: Providing a theoretical background on the content-language integration approach and how to use it in teaching.
- **Applied importance**: The current research can benefit teachers and supervisors from an applied perspective in:
  - Increasing chemistry teachers' awareness of the dimensions of scientific communication and how to develop them among students through the content-language integration approach.
  - Preparing a checklist of some dimensions of scientific communication that need to be developed among second-year secondary school students in language schools that can be used by designers and developers of chemistry curricula in secondary schools.
  - Preparing a scientific communication scale that can be used by teachers and developers of chemistry in secondary schools.

Delimitations of the study:

The research was delimited to the following:

- **Human boundaries**: A group of students enrolled in the second year of secondary school languages - East Kafr El-Sheikh Education Administration - Kafr El-Sheikh Governorate.
- **Objective boundaries**: The scientific content of the unit (Bonds and Forms of Molecules) was taught in the chemistry subject in the second semester of the second year of secondary school languages using the CLIL approach.
- **Spatial boundaries**: The educational treatment was carried out and the research instruments were applied to the second year secondary school students at Ali Abdel-Shakoor Official Language School - East Kafr El-Sheikh Education Administration - Kafr El-Sheikh Governorate.
- **Temporal boundaries**: The educational treatment and the research instruments were applied in the second semester of the academic year 2024-2025 AD.

Theoretical Background and previous studies:

The First Dimension: Content and Language Integration Learning

The Concept of Content and Language Integration Learning (CLIL):

The CLIL approach is defined a dual-focused educational approach that aims to develop both awareness of scientific content as well as English language skills (reading, writing, speaking, and listening) and employ this in non-linguistic content (Garzón- Díaz, 2021,242).

The researcher defines it procedurally as: an approach that focuses on both learning the content of the chemistry subject and employing English language skills in a systematic manner without delving into specialized linguistic details to develop scientific communication, by following teaching procedures represented in: Context Creation Stage, Exploring and Generating Ideas, Interpretation and Development of Ideas, Scaffolding and Support, Self-Perspective and Application of Ideas, Reflection and Decision-Making, Evaluation to teach the content of the unit (Bonds and forms of molecules) prescribed for second-year secondary school students in language schools in the second semester.

Principles and Theories Underlying the CLIL Approach:

Wolf (2020, 105) pointed out that the CLIL approach is based on theories of cognitive psychology and social constructivism, which emphasize that language learning occurs when learners engage in content, which is

primarily based on a set of scientific concepts formulated in precise scientific language.

Psychologists believe that the CLIL approach is an approach to cognitive stimulation, as it enhances motivation and confidence in learners, and develops higher and lower levels of thinking (Montalto, 2016, 17). The CLIL approach is based on the following four basic principles known as the 4Cs (March, 2002, 170), (Coyel et al., 2010, 50), (Gerham, et al., 2020, 163 -189):

- **Content**: Content includes not only the acquisition of knowledge and skills associated with a non-linguistic curriculum, but also the learning method, where learners build their knowledge, understanding, and develop their skills.
- **Cognition**: Learning content is linked to thinking, and to enable learners to build their interpretation of the content, they practice higher thinking processes such as synthesis, analysis, problem solving, and evaluation, and language is used functionally during these processes.
- **Communication**: Learning takes place through interaction and not just speaking, so using the English language during learning is essential; therefore, this language must be clear.
- **Culture (sometimes the 4th C is referred to as Community or Citizenship**: Language is an element of culture; therefore, it is necessary to be

aware of how to use a foreign language in the context of the cultures that use this language.

Supporting frameworks for learning using the CLIL approach:

CLIL can be supported by scaffolding. Students may not know the specific vocabulary and expressions used, so it is essential to provide appropriate support for language use, which can be verbal (such as writing prompts, definitions, or metalinguistic clues), procedural (such as instructional frameworks, mutual dictation, or dictogloss), or learning tools (such as graphic organizers, visuals, or multimedia) (Clotild & Andrea, 2016,8). Specialists have recommended using different types of scaffolding with CLIL in science, including multimedia scaffolding, in which language is engaged with visual resources (Fernandez-Fontecha et al., 2021, 10).

Importance and Advantages of Using the CLIL Approach in Teaching Chemistry:

Marsh (2002, 170) pointed out that using the CLIL approach in teaching non-linguistic subjects (such as: chemistry, physics, biology, mathematics, etc.) has many advantages, including:

- Students benefit from higher quality teaching and from input that is meaningful and understandable.

- CLIL strengthen students' ability to process input, which prepares them for higher-level thinking skills, and enhances cognitive development.
- In CLIL, literacy development takes place in the first language, which is cognitively beneficial for the child. Later, literacy skills will transfer to the additional languages.
- In CLIL the students' affective filter may be lower than in other situations, for students takes place in a relatively anxiety-free environment.
- Students' motivation to learn content through the foreign language may foster and sustain motivation towards learning the foreign language itself.

The Second Dimension: Scientific communication

The Concept of Scientific Communication:

Kusuma & Fariyani (2021, 8) see scientific communication as the ability to read a graph, table or diagram of the results of an experiment, explain the results, change the way the data is presented and interpreted, and report systematically.

The researcher defines it procedurally as: the student's ability to use vocabulary, symbols, and scientific evidence to express scientific ideas and phenomena and exchange ideas with others through several levels, which are: reading, writing, persuasion, verbal and non-verbal communication, active listening,

and the use of electronic communication tools. It is measured by the score obtained by the second-year secondary school student in language schools on the scale prepared for that purpose.

Types of Communication:

It is based on the channels used for communicating, the process of communication can be broadly classified as verbal communication and non-verbal communication. Verbal communication includes written and oral communication whereas the non-verbal communication includes body language, facial expressions and visuals diagrams or pictures used for communication (Chung, 2016, 23).

Dimensions of Scientific Communication:

The studies of Muhammad (2023), Zaki (2019), Siraj (2019), Hamad (2017), and Rizk (2014) agreed that the basic skills of scientific communication are (listening, speaking, acting, reading, writing), and employing these skills requires many activities by the teacher to develop them, as these skills develop the individual's ability to use scientific vocabulary and symbols to express and understand ideas and relationships, which can be detailed as follows:

- **Speaking Skill:**

Speaking skill is not limited to oral discussion only, but it must include describing shapes, graphic

representation, explaining concepts and symbols, as well as explaining relationships, justifying answers, giving examples of a concept, and expressing a problem in the student's language.

- **Representation Skill:**

Representation means re-evaluating ideas or problems in a different or new form; it helps to understand the idea. Representation skill includes several skills such as translating a picture or illustration into scientific or mathematical symbols and words, or translating a scientific or mathematical problem or scientific idea into a different form that is simpler in formulation or easier to understand.

- **Writing Skill:**

Writing is of great importance in expressing ideas, concepts, and relationships and communicating them to others (teachers, students, etc.), which contributes to the development of scientific communication, as students rediscover knowledge, understand it, and clarify it by writing about it to others. Writing helps discover and correct misunderstandings among students, as well as strengthening communication channels between the teacher and his students, increasing students' efficiency, and providing evidence of students' ability to achieve scientific achievement.

- **Listening Skill:**

Speaking skill is an important skill for effective scientific communication. Through it, the individual can successfully achieve the communication process. However, for this to happen, listening skill must be available, which provides the feedback that the sender relies on to ensure that the communication process is taking place effectively. He continues the sending process or changes the way the message is presented or modifies its contents to achieve the desired goal of the communication process.

The Importance of Scientific Communication:

Ezzeldin's study (2018, 185) indicated that scientific communication is a fundamental pillar in learning science, as through it the student can have the ability to use scientific language to express what he has learned of concepts, rules and theories, and that scientific communication skills focus mainly on two aspects, which are oral communication and written communication.

Zaki's study (2019, 890) also showed that scientific communication helps students understand the nature of science and its processes, form their beliefs, opinions and scientific trends, and motivate them to self-learn, share ideas with others and coexist with scientific and technological changes.

In science learning, students must master the skills in communicating science because, by having good science communication skills, one can express ideas, opinions, and information obtained through scientific activities both orally and in writing correctly, and information can be well received by listeners (Sari, 2020, 183).

Levels of Scientific Communication:

Muhammad (2023, 17) and Muslim (2011, 584) identified the levels of scientific communication in six basic levels, which are:

- **Scientific vocabulary level:** (which consists of letters of the alphabet and indicates the intended meaning).
- **Scientific sentence level:** (which consists of two or more words and has a useful meaning).
- **Phrase level (scientific paragraph):** (which consists of two sentences or a group of scientific sentences indicating a complex meaning or partial meanings).
- **Article level:** (which consists of two or more paragraphs and covers a scientific topic, a practical phenomenon, or addresses a scientific idea with criticism or analysis).
- **Expression level:** Expression means written writing in a correct and precise scientific language,

provided that the ideas are well-organized scientifically.

Elements of Scientific Communication Process:

Farag (2020), Hamad (2017) agreed that there are four basic elements of scientific communication that are interconnected and complementary to each other, they are as follows. Sender, Message, Communication Channel, Receiver.

Research procedures:

To answer the research questions and test the validity of its hypotheses, the research procedures were represented in the following stages:

1. **Reviewing the educational research literature related to the research topic and benefiting from it.**
2. **Analyzing the content of the unit (Bonds and Forms of Molecules).**
3. **Preparing a checklist of scientific communication dimensions.**
4. **Preparing research instruments represented in the scientific communication scale in chemistry**.

A. **Determining the objective of the scale:** Measuring the extent to which second-year secondary school students possess the dimensions of scientific communication represented in: scientific reading, scientific writing, verbal skills,

active listening, persuasion skills, non-verbal communication, and the use of electronic communication tools.

B. Formulating the scale phrases:

The scientific communication scale consisted of (52) statements, including (35) positive statements and (17) negative statements, which were specified to measure the dimensions of scientific communication, as the scale booklet consisted of the cover page with the name of the scale, then the instructions page for how to respond to the scale statements, followed by several pages that included the scale statements.

A. Formulating the scale instructions:

The scale instructions aimed to give the student a brief overview of the scale's purpose, subject, and how to respond to the scale's statements.

B. The Apparent validity (judges' validity): The scale was presented in its initial form to a group of judges.

C. Internal consistency validity:

Pearson's correlation coefficient was calculated between the score of each dimension and the total score of the scientific communication scale, which is a statistically significant correlation at a significance level of (0.01), indicating that the scale's internal consistency has been achieved.

D. Calculating the scale's stability:

Cronbach's alpha coefficient was used, and statistical processing showed that the scale's stability coefficient is (0.88), which indicates that the scale has an acceptable degree of stability.

E. Estimating the scores of the scientific communication scale:

The maximum (total) score of the scale was (156) degrees, and the minimum score of the scale was (52) degrees.

F. Appropriate time to respond to the scale:

The appropriate time to respond to the scale items in its final form was calculated as (45) minutes

5. **Preparing the research materials, including: preparing the teacher's guide, and the student's activity booklet.**
6. **Presenting the research materials to a group of specialized arbitrators.**
7. **Selecting the research group from the second year secondary school students at Ali Abdel-Shakoor Official Language School in the East Kafr El-Sheikh Education Administration - Kafr El-Sheikh Governorate, and dividing it into two experimental groups and a control group.**
8. **Applying the research instrument pre-test on the two research groups.**

9. **Instructional treatment, where the unit (Bonds and Forms of Molecules) was taught using the integration approach between content and language to the students of the experimental group and the control group in the usual way.**
10. **Applying the research instrument post-test on the two research groups**.

Research results:

To answer the research questions, the following statistical hypotheses were formulated:

1. There is a statistically significant difference at a significance level of ($\alpha \leq 0.01$) between the mean scores of the students of the experimental group and the scores of the students of the control group in the post-administration of the scientific communication scale for each dimension separately in favor of the students of the experimental group.
2. There is a statistically significant difference at a significance level of ($\alpha \leq 0.01$) between the mean scores of the students of the experimental group and the scores of the students of the control group in the post- administration of the scientific communication scale as a whole in favor of the students of the experimental group.

To verify the validity of the hypotheses, the value of the "T-test" was calculated to indicate the difference between the mean scores of the experimental and control

groups in the post- administration of the scientific communication scale. The results of the treatment are summarized in the table1:

Table 1

The Arithmetic Mean, Standard Deviation, and (t) Values for the Differences between the Average Scores of the Students of the Control and Experimental Groups in the Post-Administration of the Scientific Communication Scale

Scientific Communication Skills	Number of Statements	Group	Number of Students	Arithmetic Mean	Standard Deviation	Degrees of Freedom	T-value	Statistical Significance
Scientific Reading	8	Experimental	30	21.4667	1.25212	58	24.666	.000*
		Control	30	10.7000	2.03673			
Scientific Writing	9	Experimental	30	23.6333	1.54213	58	28.681	.000*
		Control	30	11.8667	1.63440			
Verbal Skills	7	Experimental	30	18.7667	1.07265	58	19.963	.000*
		Control	30	10.0667	2.13240			
Active Listening	8	Experimental	30	21.2667	1.20153	58	32.435	.000*
		Control	30	10.0667	1.46059			
Persuasion Skills	7	Experimental	30	18.2667	1.22990	58	24.870	.000*
		Control	30	9.1333	1.59164			
Non-Verbal Communication	5	Experimental	30	13.4667	0.86037	58	25.720	.000*
		Control	30	7.0333	1.06620			
Using Electronic Communication Tools	8	Experimental	30	22.0333	1.48401	58	26.980	.000*
		Control	30	11.3667	1.58622			
Scientific communication as a whole	52	Experimental	30	138.8333	7.43678	58	28.146	.000*
		Control	30	70.2333	11.10975			

The values of (t) shown in Table1 indicate the presence of a statistically significant difference between the mean scores of the students of the control and experimental groups on the scientific communication

scale (scientific reading, scientific writing, verbal skills, active listening, persuasion, non-verbal skills, use of electronic communication tools) for each skill separately and the skills as a whole and in favor of the experimental group.

To determine the size of the effect and effectiveness of the independent variable, the value of each of (η^2, d) and the percentage of the adjusted gain of the Blake were calculated, and this can be explained from the table2:

Table 2

Values of (η^2) and (d) to Determine the Effect Size and Values of (MG_{Blake}) to Determine the Effectiveness of the CLIL Approach in Developing Scientific Communication.

Independent variable	Dependent variable (Scientific communication skills)	(t) Value	(η^2)Value	(d) Value	MG_{Blake}
Content and Language Integration Approach CLIL	Scientific Reading	29.345	0.913	5.36*	1.309*
	Scientific Writing	25.518	0.934	4.66*	1.300*
	Verbal Skills	25.854	0.873	4.72*	1.325*
	Active Listening	37.036	0.948	6.76*	1.352*
	Persuasion Skills	24.127	0.914	4.40*	1.270*
	Non-Verbal Communication	22.412	0.919	4.09*	1.313*
	Using Electronic Communication Tools	25.322	0.926	4.62*	1.328*
	Scientific communication as a whole	28.546	0.932	5.21*	1.313*

Note (*) values are statistically significant when indicated at 0.01

From Table 2, it concluded that the values of (d) ranged between (4.09- 6.76), which are high values compared to the standard value (0.8), and the value of the adjusted gain ratio for Blake MG_{Blake} for the students of the experimental group ranged between (1.270-1.352), which is greater than the value (1.2) that Black determined to judge the effectiveness, and this in turn enhances the acceptance of the first directed hypothesis of the research, as it was confirmed that the use of the integration approach between content and language had a significant impact on the development of scientific communication (scientific reading, scientific writing, verbal skills, active listening, persuasion skills, non-verbal communication, use of electronic communication tools, skills as a whole), among the students of the experimental group.

Interpretation of the Results Related to the Development of the Dimensions of Scientific Communication:

The results of the scientific communication scale can be interpreted as follows:

- The stages and steps of teaching using the CLIL approach were based on a set of foundations and principles represented in (content, perception, communication, culture, citizenship) which the researcher took into account while teaching the prescribed content, which helped to develop scientific communication skills significantly.

- All stages of teaching using the CLIL approach contributed to the development of scientific communication skills, starting from the stage of creating the context, where students inferred the main idea of the lesson and presented it in reading and writing, which helped to develop their scientific reading and writing skills.
- The exploration and idea generation stage provided the opportunity for students to conduct activities with each other, which helped them use their hands and cooperate with their colleagues to reach conclusions and write a simple report on their observations and conclusions for the experiment, which led to the development of their non-verbal communication skills and scientific writing skills. Students within each group were also given the opportunity to discuss with each other and present their ideas to the rest of the groups, which helped develop their verbal and non-verbal communication skills, persuasion and active listening.
- In the interpretation and idea development stage, students answered questions and each student expressed the question in his own style and presented it to his colleagues, which helped develop his ability to persuade.
- In the scaffolding and reinforcement stage, the teacher provided many examples and brief

explanations in English using body language. He also encouraged students to ask questions and inquiries in English, which helped develop their reading, persuasion and active listening skills.

- As for the self-perspective and idea application stage, students were given the opportunity to express their opinions using English, which helped develop their verbal and non-verbal skills.
- In the reflection and decision-making stage, students were encouraged to ask questions orally related to the lesson topic and write reports in the student activity booklet, which helped develop scientific reading and writing skills and persuasion skills.
- In the evaluation stage, summaries and reports were prepared by the students. The teacher also asked students oral questions, which helped develop scientific writing skills and the use of electronic communication tools and active listening.
- The integration between the stages of the integration approach between the content and the teaching language used, which consisted of seven consistent stages, as well as the activities and activating the role of the laboratory in conducting experiments and using the teacher's guide and student activity booklet, helped develop students' scientific communication skills.

Research Recommendations:

1. Training chemistry teachers in language schools to teach using the integration approach between content and language, and how to plan lessons and implement them according to the teaching procedures based on this approach.
2. Guiding students to practice scientific communication skills during learning and in their general lives.
3. Holding training courses for chemistry teachers on how to prepare teacher guides that include activities and procedures that achieve teaching using the integrated approach between content and language.
4. Providing a stimulating, exciting and motirating classroom learning environment to encourage and motivate students to practice scientific communication.

Research Suggestions:

Based on the research results and the recommendations presented, it was suggested to conduct the following future research:

1. Conducting similar studies and research at other educational levels.
2. Preparing training programs for teachers on employing the integrated approach between content and language in teaching.

3. Studying the effectiveness of the integrated approach between content and language in developing the depth of chemical knowledge and creative self-efficacy of secondary school students.

References:

First: Arabic References:

Ezzeldin, Sahar Mohamed. (2018). Using Learning in Flipped Classes to Develop Scientific Communication and Retention of Learning Impact and Acceptance of Technology in Learning Science for Intermediate Stage Female Students in Saudi Arabia. *Journal of Educational Sciences*, 3(1), 183-237.

Farag, Fahmy Awad. (2020). A training program based on the STEM integrated approach to develop project-based teaching and scientific communication skills for pre-service chemistry teachers. Master's thesis, Faculty of Education, Kafrelsheikh University.

Hamad, Taghreed Rafeeq. (2017) The Effect of Using Task-Based Learning (TBL) Strategy in Developing Concepts and Scientific Communication skills among Female Ninth Graders. Unpublished master's thesis, Faculty of Education, Islamic University of Gaza.

Mohamed, Amany Abdel-Shakour. (2023). Using the Schwartz model in teaching biology to develop some scientific communication skills and the enjoyment of learning among high achieving secondary school students. *Egyptian Journal of Science Education*, 26(4), 377-413. Retrieved from http://search.mandumah.com/Record/1421486

Rizk, Fatima Mustafa. (2014). The Use Of Assessment For Learning Strategies In Improving Analytical Thinking And Scientific Communication In Science Among Six Grade Primary School Students. *Arab Studies in Education and Psychology*, 2(55), 141-192.

Siraj, Susan Hussein. (2019). Building an electronic sign language scientific dictionary for teaching science in the flipped classroom via smartphones to develop scientific communication skills and academic integration among hearing-impaired students in the preparatory stage. *Journal of the College of Education*, 34(4), 468-575 Retrieved from http://search.mandumah.com/Record/1035510

Zaki, Hanan Mustafa. (2019). A Suggested Program in the Bio and Nanotechnological culture based on the theory of cognitive flexibility and its effect in The development of scientific communication and future thinking skills and The awareness of the biological safety of students in the Faculty of Education. *Sohag Journal of Education*, (59), March, 883-985.

Second: Foreign References

Clotilde, B. M., & Andrea, C. (2016). (CLIL) & IBSE methodologies in a chemistry learning unit. *European Journal of Research and Reflection in Educational Sciences*, 4(8), 1-12

Coyle,D&Meyer,O.(2022). Beyond CLIL: Pluriliteracies Teacher Education for Deeper Learning.*Cambrridge University Press*

Fernández-Fontecha, A., O‟Halloran, K. L., Wignell, P. & Tan, S. (2021). Scaffolding CLIL in the science classroom via visual thinking: A systemic functional multimodal approach. *Linguistics and Education*, 55, 1-10.

Galán Rodríguez, N. M. (2018). Students and teacher's perceptionsand motivation in a Galician Plurilingual High School: a study in (CLIL) Physics and Chemistry. *[Published Doctoral thesis], Coruna university.*

Garzón-Díaz, E. (2021). From cultural awareness to scientific citizenship: implementing content and language integrated learning projects to connect environmental science and English in a state school in Colombia. *International Journal of Bilingual Education and Bilingualism*, 24(2), 242 - 259.

Graham, K. M., Mathews, S. D., & Eslami, Z. R. (2020). Using children‟s literature to teach the 4Cs of CLIL: A systematic review of EFL studies.*Latin American Journal of Content & Language Integrated Learning*, 13(2), 163–189

Hoster, L., Hosek, M., Richmond, P., McCroskey, C,. &Mottet,P. (2018). *Handbook of Instructional Communication (2nd.ed)*. Rutledge Taylor & Francis Group.

Kusuma, Q.& Fariyani, H.H.(2021): Fotiem test to analyze scientific communication skills in linear motion, *Journal of Physics: Conference Series* 1796 (2021), 1-11.

Marsh, D. (2002). CLIL/EMILE –The European Dimension: Actions, trends and foresight potential. Retrieved from Jyväskylä, Finland: https://jyx.jyu.fi/handle/123456789/47616.

Wolff,D.(2020).The European Framework for CLIL Teacher Education.Synergies Italie.16.105-116