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Soft Skills for Learning Biology in a Foreign Language in Digital Environments

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ABSTRACT

In a technological society, the adaptability of students and the need for interaction demand collaborative work, self-esteem, time management, and problem-solving skills. Considering the above, the inclusion of digital skills is essential because students often face difficulties in virtual modalities and sometimes fail to reach the expected conceptual-linguistic performance. This study aims to identify the impact of soft skills on learning biology in a foreign language in virtual environments. For this, a quantitative, correlational, and cross-sectional approach was followed, obtaining the following results: the management of emotions, interpersonal communication, critical thinking, autonomy and knowledge of the use of technology are elements that positively affect the conceptual learning of biology in English as a foreign language (EFL) since they allowed to analyze, evaluate and synthesize the information in virtual classrooms thanks to the emotional competence. Indeed, it reduces stress, avoids anxiety or frustration, and develops interpersonal communication skills for empathic, responsible, self-regulated, and autonomous interactions. All these elements contributed to the adaptation of such environments with motivational dyes based on collaborative work. The correlation between soft skills and learning biology in EFL was positive and strong. It helps to corroborate the hypothesis, pointing out that the more students apply soft skills in their learning process, the better their academic performance will be. In conclusion, socio-affective skills are a fundamental complement to cognitive skills. Above all, the contribution focuses on the functionality and influence of soft skills in online learning processes to foster high-quality praxis and their inclusion in educational programs.

Keywords: Soft Skills; Learning; Biology; Virtual Environment; Foreign Language

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ARTICLE INFO

Received: 1 August 2025 | Revised: 19 August 2025 | Accepted: 8 September 2025 | Published Online: 10 November 2025
DOI: https://doi.org/10.30564/fls.v7i12.11431

CITATION

Flores-González, E., 2025. Soft Skills for Learning Biology in a Foreign Language in Digital Environments. Forum for Linguistic Studies. 7(12): 666–680. DOI: https://doi.org/10.30564/fls.v7i12.11431

1. Introduction

Soft skills are considered a capacity that enables emotional management, adaptation to learning environments, assertive social interaction, and the negotiation of ideas, all of which are necessary for everyday life [1–4]. In the educational field, these skills have been the focus of analysis in various studies, demonstrating their usefulness for students' comprehensive development [5–9]. In this order of ideas, within foreign languages, linguistic and formative skills in the language require other skills that contribute to the improvement of communicative competence [10–12] since soft skills provide the opportunity to enrich this holistic training. At the same time, language learning for specific purposes is mediated by the trends and uses of technology (applications, websites, platforms, social networks), which produces in students the need to adapt and adjust the way they learn [13–16]. However, studies have shown that students in virtual environments experience difficulties developing communication and linguistic skills, impacting their academic performance because soft skills limit student learning [17].

This has led to interest in determining the impact of soft skills in digital environments on learning, in this case, biology. To this end, this study is conducted in three phases. First, the theoretical framework that supports the conceptual framework is presented. Second, an instrument is applied to obtain precise data based on students' perceptions of soft skills in learning biology in virtual environments. Finally, the results are examined to determine the correlation between soft skills and academic performance in learning biology in a foreign language.

2. Theoretical Framework

2.1. Learning in Virtual Spaces

The process of learning biology in a foreign language can be understood as the set of strategies and actions for acquiring knowledge and skills in a new linguistic system. It is a metacognitive process in which the student seeks to develop communicative competence to interact appropriately in real-life communication situations [18]. In this regard, technology has a leading role as a mediator between learning content and the student in virtual spaces. Thanks to its inclusion, the implementation of planned learning processes for communicative competences is facilitated through websites, applications, platforms, and software, generating self-management skills, autonomy, discipline, and organization [19]. In this way, there are essential aspects for learning in virtual spaces, including: the approach or methodology, the use of linguistic components, and learning strategies.

In the communicative approach, the meaningful and functional use of the foreign language is fundamental for the development of communicative competencies, which are learned and practiced through reception, production, and mediation activities [20]. In this sense, methodological approaches present a comprehensive range of teaching strategies and resources designed for both classroom and extracurricular settings. These methods aim to cultivate meaningful and experiential learning by engaging students with the linguistic and cultural dimensions of the foreign language. This is achieved through communicative tasks and activities, project development, and collaborative work [21,22]. Moreover, a task-based learning dynamic emphasizes meaningful interactions that align with specific communication goals, considering verbal needs and the negotiation of meanings. It also involves planning of content and simulating real-life communication situations [23]. This approach assesses a user's language proficiency across three levels: linguistic, pragmatic, and cultural.

The importance of the learners' cognitive and socioemotional aspects is highlighted due to the social nature of their learning, pointing out three major components. The first is linguistic, which refers to linguistic and lexical skills. The second is pragmatic, which addresses discursive and strategic skills; and the third is sociolinguistic, which refers to sociocultural and intercultural skills. All of these together enable the development of expression, understanding, and interpretation of the sociocultural meanings present in an interaction [24].

To develop the mentioned components, students can rely on the use of learning strategies, which can be classified as: a) cognitive strategies used for the comprehension and retention of linguistic knowledge; b) metacognitive strategies that allow students to understand their learning process; c) mnemonics used to memorize linguistic components; d) compensatory strategies as mechanisms for adapting cognitive and behavioral resources to complete a communicative task or activity; e) affective strategies associated with the

student's motivation and perception of language learning; and f) social strategies used in interaction activities to develop intercultural competencies [25].

2.2. Soft Skills in Learning Biology

Soft skills, considered as personal attributes that enable effective interaction and collaboration, first gained recognition in a military setting in 1972. The necessity for soldiers to develop skills related to social, communicative, and emotional aspects underscored the importance of these competencies in high-stakes environments. Since then, the relevance of soft skills has expanded significantly, particularly within educational frameworks. These skills are related to personality aspects oriented toward academic and professional success, as well as the completion of projects and assignments [26].

However, the suitable application of soft skills to educational processes has not yet been established. Various authors [27–29] identify essential soft skills that should be developed in both instructional and professional settings, including self-esteem, empathy, conflict resolution, collaborative work, creativity, communication skills, leadership, motivation, adaptability, time management, job competitiveness, responsibility, and ethics. These allow us to establish what is most relevant in training processes to achieve integrated learning from cognitive, metacognitive, and emotional perspectives [30]. In foreign language learning, the use of specific skills is seen as crucial, particularly when technology is involved. Thus, skills such as adaptability, assertive communication, and collaborative work enable interaction and collaboration among participants in a language class, and this engagement contributes to a productive learning experience [31,32].

Besides, communicative competence is considered a soft skill since its characteristics include the development of effective communication skills and social interaction, considering socio-emotional and behavioral aspects [33]. Among the soft skills that permeate learning are the following:

Emotional skills. These skills are responsible for promoting students' comprehensive cognitive and emotional development through emotional regulation [34].

Interpersonal communication skills. They are associated with social interaction activities and serve to establish effective and understandable communication through active listening and the expressive capacity to provide assertive and empathetic responses. They also regulate the adaptability of linguistic codes and verbal and nonverbal elements according to the communication channel [35].

Critical thinking. They are used to analyze and validate linguistic information, cultural aspects, and the effective use of resources. They allow for awareness in communicative activities and lead to critical reflection on the use of linguistic resources to ensure understanding of the messages in a conversation. It also develops the ability to resolve communication difficulties or problems with users from different cultures [36].

Motivation. It triggers in the student the desire or inspiration to learn a language through continuous practice of the structural elements of the target language and participation in conversations with native speakers. It develops an interest in managing the activities and resources, both physical and digital, used in the teaching process. In virtual classes, it is the key point for regulating the use and appropriate application of digital materials, as well as the dynamic implementation of planned activities to activate interactions among all course participants [37].

Adaptability to the use of technology. It allows for the management of activities, content, and resources within a virtual learning environment, utilizing techno-pedagogical mediation, metacognitive strategies, interaction management in virtual communities, and the use of technology as a learning tool, fostering the development of autonomy, socialization, and gamification [38,39].

Autonomy. It fosters responsibility and decision-making regarding students' performance and learning, considering their abilities and interests. It also generates positive attitudes that encourage self-assessment through critical reflection on strengths and limitations in learning, leading students to plan new strategies and actions for improvement [40].

Collaborative work. It enriches knowledge and improves students' skills and attitudes through group activities that share a common goal and experiences and knowledge. In foreign languages, it provides the opportunity to practice and reinforce linguistic and pragmatic knowledge, as well as the development of cultural understanding and mediation [41].

Problem-solving is especially effective in the field of foreign languages, as it encourages participation in dialogues on social issues by forcing students to use the language in

authentic communicative contexts. It is also used as an academic support resource for students who face greater challenges in language use for specific purposes through tutoring or advising, thus helping to strengthen their linguistic comprehension [42] in other subjects.

2.3. The Influence of Soft Skills on Learning in Virtual Environments

Virtual environments are characterized as practical spaces where different teaching modalities can be implemented for their proper functioning. Therefore, it has been decided to work through learning communities, which seek to facilitate and improve the teaching process through both academic and affective or recreational activities. This entails managing not only techno-pedagogical, but also socio-affective skills to counteract the artificial or unnatural aspects of human actions and the management of emotional behavior generated within digital interactions [43].

It triggers new methodological approaches for using technology in education. The first is the Learning and Knowledge Technologies (LKT), which focuses on the regulation of Information and Communication Technologies (ICTs) and their application in educational activities. The second is Empowerment and Participation Technologies (EPT), which aim to enhance students' ability to adapt to learning environments mediated by digital tools [44,45].

These new technological orientations demanded a competency framework that governs the responsible and effective usage of digital resources. A review of various digital competency frameworks for teachers highlights four key domains of knowledge that align with any other competency type: knowing, knowing how to do, knowing how to coexist, and knowing how to be. In the latter two, soft skills are fundamental to giving users of digital technologies a sense of empowerment and participation in virtual settings [46].

In these virtual settings, a greater emphasis is on developing hard and technical skills because students need to know how to utilize all the resources available on the web through tutorials, fact sheets, or induction courses on using educational platforms or applications, while relegating the emotional aspect.

On this point, one of the challenges teachers face in virtual environments is soft skills for a successful training process [47]. Communication can be hindered by attitudes such as apathy, frustration and conflicts [48]. Therefore, integration of soft skills like emotion management and interpersonal relationships, assertive communication, self-awareness, and collaborative work becomes essential to address these negative attitudes.

3. Methodology

The research design is quantitative, correlational, and cross-sectional to analyze the relationships between variables at a single point in time (at the end of the 2024–2025 school year). The following hypotheses are proposed, considering that the objective is to determine how soft skills influence biology learning in an EFL of a virtual educational environment:

H1 Soft skills impact learning biology in English in a virtual context.

H2 Soft skills do not impact learning biology in English in a virtual context.

The study sample is composed of 50 students from the sixth semester of Enrique Cabrera Barroso High School. This population was intentionally selected, as students at this level of training have sufficient experience to provide relevant data on the impact of soft skills on learning biology since they are in the last semester of the program. The sample included 24 men and 26 women who had participated in virtual courses, providing an appropriate context for studying the relationship between the variables of interest. Moreover, participants were informed about the study's objectives, procedures, and potential benefits prior to data collection. They understood that their participation was voluntary. After agreeing to take part, each participant read and signed an informed consent form. This process guaranteed their understanding of the study's terms, upholding ethical principles.

The instrument used for data collection was a questionnaire designed to measure various soft skills in students with a reliability of 0.95. The questionnaire included questions addressing the following dimensions: critical thinking and problem-solving, emotional competence, interpersonal communication skills, autonomy, adaptability to technology, motivation in the virtual learning, and collaborative work (see following tables for questionnaire items). Each dimension contains a series of statements with which students had to agree or disagree, using a Likert-type scale, to collect

quantitative data on students' perceptions.

Data analysis was conducted at the end of the semester, using statistical models suitable for correlational analysis. Analysis of variance (ANOVA) and Pearson correlation coefficients examine the relationships between soft skills and students' performance. The results were analyzed using **Table 1**, which presents the statistical values for each soft skill measured, as well as their relationship to the dependent variable (learning biology in English).

Table 1. Analysis model.

Variable	Dimensions
Soft skills	Critical Thinking and Problem-Solving Emotional Competence Interpersonal Communication Skills Autonomy Adaptability to the use of technology Motivation Collaborative work

4. Results

In **Table 2**, the correlation coefficient of 0.95 represents a perfect positive relationship between the ability to understand, evaluate, and synthesize information from digital sources and the learning of biology in English. This finding indicates that students who demonstrate a high level of competence in the critical processing of digital information tend to perform better in this subject. From a scientific perspective, this relationship can be explained by the fact that the majority of the academic content in biology is available in English and in digital formats (educational platforms, databases, multimedia resources, or scientific articles). Therefore, students who can assess the quality of information, integrate diverse perspectives, and construct knowledge from digital data have an advantage in understanding complex concepts, carrying out experimental procedures, and applying their knowledge in different contexts.

Table 2. Critical Thinking and Problem-Solving dimension.

Attributes	Correlation (r)	*p*-Value
Analysis, evaluation, and synthesis of information from digital sources	0.95	0.000
Resolving linguistic and communicative problems in learning	0.68	0.002
Adaptation of learning strategies to address obstacles	0.85	0.000

Moreover, this skill reflects a high level of higher-order thinking, as defined by Bloom's Taxonomy, which aligns with the cognitive demands of learning science in a foreign language. The *p*-value of 0.000 further reinforces the statistical significance of this correlation, remarking the possibility of a random finding.

This evidence strongly supports the premise that soft skills associated with critical thinking directly influence the effectiveness of learning scientific content in English, particularly in settings where access to and use of digital information is crucial to knowledge construction.

Table 3 presents positive and negative correlations. As seen, emotional competence is an important aspect of soft skills that involves the ability to recognize, understand, and regulate one's own emotions and those of others. In educational settings, particularly in foreign language learning contexts such as studying biology in English, emotional competence plays a crucial role in how students tackle cognitive and linguistic challenges.

Table 3. Emotional Competence dimension.

Attributes	Correlation (r)	*p*-Value
Emotional management during learning biology	−0.65	$p < 0.01$
Resilience	0.82	$p < 0.01$

This research indicates a moderately strong negative correlation ($r = -0.65$) between emotional management during biology learning and performance in this subject when taught in English. This means that as difficulties in managing emotions increase, students' performance in both biology and English tends to decline. This data is statistically significant ($p < 0.01$) at a 99% confidence level, leading the rejection of the null hypothesis and the strong affirmation that there

is a meaningful association between emotional management and academic performance.

Thus, ineffective emotional management can lead to feelings of anxiety, frustration, or cognitive blockage, especially when students are confronted with complex subject matter (like biology) along with language barriers (such as English). This aligns with principles of neuroeducation, which imply that emotional stress can impede working memory and information processing, ultimately hindering learning.

Moreover, resilience serves as a protective factor since it is the ability to adapt positively in the face of challenges. Therefore, it enables students to manage the cognitive and linguistic demands of learning scientific content in a second language. This linked resilience to academic persistence, effective coping mechanisms for frustration, and a sense of self-efficacy.

Additionally, a strong positive correlation (r = 0.82) has been identified between resilience and learning biology in English. This means that students who demonstrate higher levels of resilience are likely to achieve better academic performance in this particular learning environment. This relationship is also statistically significant at a 99% confidence level, reinforcing the evidence of a strong positive connection.

Table 4 introduces two attributes: the ability to interact with others in digital environments through forums, chats, and video calls and the empathy and adaptability in virtual interactions.

Table 4. Interpersonal Communication Skill dimension.

Attributes	**Correlation(r)**	***p*-Value**
Interact with others in digital environments	0.88	0.0001
Empathy and adaptability in virtual interactions	0.65	0.002

The r value of 0.88 for the first criterion indicates a strong positive correlation, representing a solid connection between interaction and biology learning in English. From a functional perspective, the results confirm that students with a greater ability to interact successfully in digital environments tend to perform better in subjects taught in L2.

This phenomenon can be explained by social learning theory and socio-constructivist approaches, which recognize the value of interaction as a vehicle for knowledge construction. Furthermore, in virtual environments, interaction recovers its essence as it is the primary channel of academic exchange. The *p*-value of 0.0001 is significantly lower than the threshold of 0.05, indicating that the observed relationship has a confidence level greater than 99.99%.

Regarding the second dimension, the moderate to high positive correlation (r = 0.65) confirms a significant association, although of lower intensity than the previous one. It is important to remember that this skill involves not only affective components (empathy) but also cognitive ones (flexibility, self-regulation), all of which are essential in virtual environments where contextual cues are minimal. However, digital empathy allows for the creation of positive classroom climates, facilitating cooperative learning in L2, especially in science, where technical vocabulary can create additional barriers. Regarding the *p*-value = 0.002, it supports the statistical significance and reliability of the finding.

Overall, the results show that interpersonal communication skills in digital environments are strongly associated with learning scientific content in a foreign language. The extremely high correlation value for the attribute of digital interaction indicates that mastery of online communication tools and strategies is a key factor in understanding and applying biology knowledge in English. At the same time, empathy and adaptability are also fundamental, especially in fostering productive collaborative contexts. Taken together, these findings strengthen the argument that soft skills not only complement but also enhance disciplinary learning in digital and bilingual environments.

In **Table 5**, the dimension of autonomy as a soft skill shows significant associations with biology learning in English, according to the results of a Pearson correlation analysis. These findings empirically support the hypothesis that greater student autonomy is linked to improved performance in bilingual disciplinary contexts.

Table 5. Autonomy dimension.

Attributes	Correlation(r)	*p*-Value
Manage one's own learning without constant supervision	0.85	0.001
Time management to complete learning tasks and activities	0.65	0.012
Decision-making about online learning resources	0.80	0.005

Specifically, the ability to manage one's own learning without constant supervision demonstrated a very high positive correlation (r = 0.85) with biology learning in English, with a robust level of significance (p = 0.001). This indicates that students with higher levels of self-regulation tend to perform better in learning scientific content in a foreign language. As such, cognitive autonomy facilitates better adaptation to the learning environment, aiding the assimilation of biological terminology, concepts, and processes presented in English.

Additionally, effective time management for completing academic tasks and activities was positively related to the overall performance (r = 0.65; p = 0.012). Although this correlation is slightly lower than the previous one, it remains statistically significant and high. This finding reinforces the importance of planning and time management in autonomous and bilingual learning settings. It also supports the hypothesis (H1) by highlighting that students who structure their study time efficiently face fewer barriers when engaging with content in English, which directly impacts their academic performance.

Lastly, the ability to make informed decisions about online learning resources showed a very high and significant correlation (r = 0.80; p = 0.005). This emphasizes the importance of critical digital literacy as a facet of autonomy in an educational environment where many scientific materials are available in English and in digital format. Such skills enable students to appropriately select, evaluate, and utilize these resources. Together, these three aspects of autonomy represent key competencies for success in language-mediated educational contexts.

In **Table 6**, the data indicate positive correlations among the three assessed attributes. First, a strong and significant correlation was found between familiarity with digital learning tools and learning biology in English (r = 0.75, p = 0.02). This means a consistent relationship between these two factors.

Table 6. Adaptability to technology.

Attributes	Correlation (r)	*p*-Value
Familiarity with digital learning tools	0.75	0.02
Adaptation to new technological environments	0.62	0.05
Appropriate use and consumption of technologies	0.80	0.01

Similarly, the attribute adaptation to new technological environments showed a moderate correlation (r = 0.62) that is borderline statistically significant (p = 0.05). This implies that a greater ability to adapt to new technological contexts may be associated with better performance in learning scientific content in English.

The strongest correlation was identified in the attribute appropriate use and consumption of technologies, with a correlation coefficient of r = 0.80 and a p-value of 0.01. This result indicates a very strong and highly significant positive relationship between the responsible and strategic use of technologies and disciplinary learning in a foreign language.

In summary, various aspects of technology adaptability are significant, particularly when considering appropriate and learning-oriented technological practices.

In **Table 7**, the three attributes of the motivational dimension show positive and statistically significant correlations with learning biology in English. This means that motivation, in its various forms (internal, attitudinal, and evaluative) directly and strongly influences academic performance in digital and bilingual contexts. Among these attributes, intrinsic motivation has the strongest association (r = 0.82), followed by a positive attitude towards digital challenges (r = 0.68) and the perception of relevance (r = 0.60). These findings highlight the need to develop pedagogical strategies that foster intrinsic motivation, enhance

a positive attitude toward digital environments, and clearly communicate the importance of learning in bilingual contexts. By doing so, the learning of disciplinary content such as biology can be improved.

Table 7. Motivation.

Attributes	Correlación (r)	*p*-Value
Intrinsic motivation to learn biology	0.82	0.003
Positive attitude toward challenges in digital learning	0.68	0.005
Perceived relevance and usefulness of learning biology in a digital environment	0.60	0.010

In **Table 8**, the results indicate a strong and significant relationship between the two aspects of collaborative work and Biology learning in English. First, the attribute (working on group projects on virtual platforms) demonstrated a correlation coefficient of r = 0.95 with a *p*-value of 0.001. This indicates a very strong and statistically significant positive relationship ($p < 0.01$). This increased participation in collaborative activities conducted through digital platforms is closely associated with higher academic performance in Biology when taught in English.

Furthermore, the attribute sharing resources and knowledge with other students showed a correlation coefficient of r = 0.82, with a *p*-value of 0.002. This also represents a strong and significant positive correlation ($p < 0.01$), implying that actively sharing information among peers is consistently linked to improved learning outcomes in the subject.

Overall, these results support the hypothesis that collaborative work, viewed as a soft skill, positively and significantly influences the learning of scientific content in English. The high magnitude of the observed correlations means that these collaborative practices may play a mediating or enhancing role in learning within bilingual contexts or in the teaching of science in foreign languages.

Table 8. Collaborative work dimension.

Attributes	Correlation (r)	*p*-Value
Work on group projects on virtual platforms	0.95	0.001
Share resources and knowledge with other students	0.82	0.002

The results reveal a high correlation between the dependent and independent variables, which may be because the sample comprises students from a single institution, limiting the generalizability of these findings to other populations. Therefore, homogeneity could have impacted the strength of the observed relationship, as the participants share common contextual and sociodemographic characteristics. Consequently, to improve the validity and applicability of this empirical approach, future studies should replicate this analysis with more diverse samples. It will provide a deeper understanding of the consistency of the patterns found across different groups, institutions, and educational levels.

5. Discussion

Based on the results obtained in this study, it is inferred that critical reasoning, problem-solving, resilience, interpersonal communication, autonomy, adaptability, motivation, and collaborative work skills favor learning biology in English from a cognitive to a socio-emotional perspective. However, the attributes that have the greatest impact are critical thinking, collaborative work, interpersonal communication, autonomy, and managing negative emotions. The last attribute should be regarded as a crucial factor in technological and educational interventions, as it can hinder learning.

Students perceive themselves as having critical and reflective thinking, so they have the ability to objectively select, evaluate, and use digital information, as well as compare positions and draw accurate conclusions [49]. This finding is consistent with previous research indicating that students with judicious mental processes, logical judgment, and analytical reasoning tend to focus their learning goals and determine the technological tools that best benefit them, allowing them

to even evaluate their progress [50]. However, some studies reveal that, due to free access to multiple online resources, students choose media and platforms based on their intuitive judgment, tendencies, and beliefs without prior analysis, which hinders and delays their linguistic improvement [51]. In summary, the attributes of the first dimension are crucial because analyzing digital information significantly enhances learning by fostering critical thinking skills. Additionally, solving linguistic problems helps improve comprehension of English content and the ability to adapt strategies, which are key skills for overcoming learning challenges.

Similarly, students who recognize they have skills for emotional management and control experience fewer feelings of anxiety, stress, or tension during their learning process. According to various authors, the regulation and management of emotions, feelings, and thoughts are essential for generating awareness, reducing impulsiveness, and operationalizing them efficiently, which leads to decision-making for resolving conflicts (technical, social, linguistic) present in multimedia environments [52–54]. Moreover, in the digital language for specific purposes such as biology, socio-affective regulation impacts the student's academic performance since it helps them to analytically specify the objectives of communicative learning, face linguistic difficulties (grammar, pronunciation, structure), and challenge modal tendencies [55,56]. It also fosters skills such as self-management, self-esteem, and adaptability to change learning strategies, explore applications, and practice the language, personalizing the acquisition process [57]. In this way, attributes of the second dimension offer valuable opportunities to enhance biology learning. By fostering perseverance in the face of challenges and managing negative emotions, these qualities could optimize student engagement and performance.

Regarding interpersonal communication skills, students with this ability have better language performance, as skills such as active listening, focused attention, and concentration on the message allow for clear, contextualized, and fluid interaction. Similar research assures that empathy, respect, and openness foster open cultural and communicative exchanges, dynamic participation, and active interrelationships [58]. Thus, students with social skills take advantage of the diversity of interactions enabled by multimodal resources such as chat, videoconferencing, and digital platforms. Furthermore, the characteristics of virtual environments generate spontaneous and more realistic intercommunication, enhancing the acquisition of new sociolinguistic knowledge of language in biology [59]. As seen, incorporating these attributes into the educational process not only boosts the construction of scientific knowledge in a foreign language but also fosters stronger group cohesion and a deep commitment to learning, creating a more collaborative and engaging learning environment for everyone involved.

Likewise, learning autonomy is shown to be a beneficial skill for improving language performance in digital environments. In this context, self-management is a fundamental skill for students as it fosters responsibility and control over their own learning. It is important in bilingual environments where additional cognitive effort is required. Data derived from studies confirm that determination and responsibility, as part of autonomy, generate self-discipline, commitment, perseverance, and objectivity in achieving goals [60]. Furthermore, the virtual context allows multiple possibilities for students to personalize their learning. Indeed, it involves a process of reflection, analysis, and responsibility to establish the work pace, regulate time, and select digital media that suits their needs and learning styles. Besides, personalized or ubiquitous learning helps students better understand content, stimulate memory, and retain knowledge [61,62]. Similarly, effective time management contributes to suitable planning and timely completion of academic tasks, which enhances understanding of complex content and overall performance. Furthermore, making informed decisions about resources enables students to optimize the selection and use of digital materials, leading to more effective engagement with content presented in English. Collectively, these attributes underscore soft skills as strategic components in improving biology learning in bilingual contexts.

Moreover, the habit of using digital tools is presented as a key skill for students to adapt to technological trends. In other words, familiarity allows them to accept innovations, improve digital skills, and solve technical situations with enthusiasm and curiosity [63] as well as to reduce technological barriers, enabling students to function more fluently in virtual environments. In relation to the above, similar findings confirm the relationship between the improvement of receptive and productive language skills and the daily use of technology, developing digital competencies [64]. Additionally, the data obtained indicate that adaptation to emerging technology

generates updated learning, sparks creativity, and acquisition of innovative knowledge[65], promoting technological and versatile skills crucial for online language development in biology[66]. Then, the thoughtful integration of technology has the potential to enhance interaction with content and optimize the digital learning experience, fostering more dynamic and personalized strategies for diverse learners in a content and language integrated methodology.

It is also concluded that there is a significant association between students' motivation and their language proficiency and performance in biology. Recent research affirms that highly motivated students achieve better academic performance than those with low levels of interest[67]. In the field of language technology, intrinsic motivation is presented as a key factor in completing exercises, tasks, and activities, promoting participation, dedication, willingness, and a positive attitude[68]. In this instance, intrinsic motivation promoted autonomous and sustained learning, as it was linked to a personal interest in comprehending biological phenomena beyond the confines of academic demands. Moreover, a positive attitude toward the educational process facilitated cognitive and emotional receptiveness, which favors meaningful knowledge construction. Lastly, the recognition of the content's applicability was a catalyst for active student engagement, effectively linking theoretical concepts to real-world contexts and practical applications. In contrast, a lack of motivation causes students to experience apathy, discomfort, and frustration, producing tension and fear when facing learning challenges[69].

Finally, the ability to collaborate is an ideal skill for academic development in virtual environments. Indeed, virtual group work facilitates social learning processes by creating spaces for interaction that encourage discussion, analysis, and cooperative problem-solving, essential components for internalizing scientific concepts. In this context, previous studies show that collaboration on platforms is important because it fosters social skills, the exchange of ideas and experiences, and the construction of social, cultural, and pragmatic knowledge of the language[70,71]. This can impact productivity and satisfaction when collaborating and working together[72,73], because sharing resources among group members optimizes access to diverse materials and strengthens collaborative learning, which fosters the development of complementary knowledge and mutual support among participants. Consequently, these technology-mediated approaches demonstrate that soft skills are vital in enhancing group dynamics and impacting disciplinary learning in a foreign language.

The findings of the present study show various implications related to the presence of soft skills in digital environments for learning biology in English. First, currently, it is essential for students to develop and demonstrate interpersonal skills such as empathy, respect, interest, creativity, communication, time management, and conflict resolution, among others[74]. This impacts socio-affective management to adapt and confront the challenges and conflicts that arise in cyber environments. Secondly, the competencies of emotional intelligence, autonomy, and attentive and assertive listening facilitate both the acquisition of knowledge and collaborative relationships in new technological educational contexts, favoring social language learning about biology. Thirdly, the importance of motivation for decision-making is highlighted, as it allows students to set goals, direct their learning, and perform appropriately.

Based on the presented results, the research hypothesis is confirmed, which leads to the establishment that soft skills positively impact biology learning in English, which is reflected in students' academic performance in virtual spaces.

In terms of curriculum design implications, it is advisable to intentionally integrate soft skills such as effective communication, collaboration, self-regulation, and critical thinking as complementary learning objectives alongside disciplinary and linguistic content. This integration requires pedagogical activities to promote collaborative problem-solving, scientific debate, and self-reflection. Such practices lead to plan contextualized tasks that link biology teaching to real-life situations and social scenarios. Given that a foreign language can generate high levels of anxiety, teachers must foster a classroom environment where mistakes are part of the learning process. In line with this, it is necessary to provide teaching training in Content and Language Integrated Learning (CLIL), along with pedagogical strategies that strengthen socio-emotional skills. This training should be practical, contextualized, and applicable to the teaching of biology. Moreover, curriculum designers have to focus on promoting activities that encourage dialogue, scientific argumentation, team decision-making, and self-managed learning.

The findings of this research provide a valuable framework for reimaging teaching in other subjects such as technology, engineering, physics, mathematics, chemistry, and STEM areas integrated with languages. Indeed, adapting these strategies can foster more comprehensive, equitable, and competent education in the 21st century.

At this point, the study's contribution is identified as it explains how soft skills affect academic performance in teaching a subject for specific purposes in virtual environments. It is useful for designing educational programs that promote the development of these skills in students, thus improving their performance in learning biology in English and their adaptation to these environments.

Regarding limitations, other external factors that impact biology learning could be considered, such as socioeconomic status, limited access to technology, and the student's personal and family circumstances. Although these factors cannot be controlled in the study, they likely impact latent academic performance in emerging contexts. Furthermore, the study has a limited temporal scope, as soft skills are individual and variable in their development, making their consistency and evolution difficult to accurately and continuously determine. Another major limitation of the study is the small sample size (50 students). This number limits the representativeness of the results and restricts the possibility of generalizing the conclusions to a broader population. In addition, the research was conducted in a single high school. This narrow focus means that the results are heavily influenced by the unique characteristics of that particular context, including the students' socioeconomic background, teacher training and methodology, available resources, and institutional culture, among other factors.

Future research should focus on studies about the use of digital tools and platforms to promote interaction, communication, and contextualized biology learning, teacher training in virtual environments for motivational design, emotion management in biology classrooms, and the development of communication in digitalization based on resilience, among others.

6. Conclusions

The research demonstrates that both cognitive knowledge (knowledge of technological tools, technical knowledge, and critical-reflective thinking) and socioemotional factors (empathy, communication, motivation, adaptability, and collaboration) positively support biology learning in digital environments, confirming the relevance of the research hypothesis. Therefore, currently, for learning a subject in L2, emotional intelligence, social skills, and personal management must be included for the acquisition of knowledge and the development of transversal skills necessary for life. In this way, soft skills allow students to respond to the multicultural and social challenges inherent in a digital multilingual society. Consequently, it is crucial to implement specific teaching strategies to develop these skills. Nonetheless, the results of this study should be interpreted with caution due to the sample size of 50 students. While the findings provide fundamental insights into the trends and perceptions within the analyzed group, further research is necessary to expand the sample and consider a broader diversity of institutional contexts. It will improve the applicability of the findings.

Funding

This work received no external funding.

Institutional Review Board Statement

This study was conducted in strict adherence to ethical guidelines to ensure the protection and respect of all participants involved.

Informed Consent Statement

Informed consent was obtained from all participants involved in the study.

Data Availability Statement

The data supporting the findings of this study are available from the author upon request.

Acknowledgments

I sincerely thank the participants who voluntarily took part in this study. Their time, willingness, and invaluable collaboration were fundamental for this research.

Conflicts of Interest

The author declares no conflict of interest.

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