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ORIGINAL

Self-Regulation and Communication Skills in Biology Enthusiast Students: A Gender Study

Autorregulación y Habilidades de Comunicación en Estudiantes Entusiastas de Biología: Un Estudio de Género

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ABSTRACT

Introduction: this research investigated the influence of gender on self-regulation and communication skills in 11th-grade Biology students. Effective self-regulation and communication are crucial for academic success and personal development, making this investigation vital for informing targeted educational strategies.
Method: a concurrent embedded mixed methods approach was utilized in this study. Data were collected from 104 11th-grade Biology students at SMAN 3 Singaraja and three Biology teachers. Quantitative data on self-regulation and communication skills were gathered via a Google Form questionnaire and analyzed using descriptive and inferential statistics (Mann-Whitney U test). Qualitative data, comprising teachers' perspectives, were analyzed using qualitative descriptive analysis.
Results: analysis revealed: (1) No significant gender difference in overall self-regulation, except for self-observation and self-reaction; and (2) Significant gender differences in communication skills, excluding assertive communication.
Conclusions: these findings highlight the nuanced relationship between gender and these skills. While overall self-regulation showed no significant gender disparity, specific indicators and communication skills exhibited gender-based differences. Future research should focus on developing gender-sensitive learning models to enhance self-regulation and communication skills in Biology students.

Keywords: Self-Regulation; Communication Skills; Gender; Biology Enthusiasts Students.

RESUMEN

Introducción: esta investigación investigó la influencia del género en la autorregulación y las habilidades de comunicación en estudiantes de Biología de 11° grado. La autorregulación y la comunicación efectivas son cruciales para el éxito académico y el desarrollo personal, lo que hace que esta investigación sea vital para informar estrategias educativas específicas.
Método: se empleó un diseño de métodos mixtos concurrente y embebido. Se recopilaron datos de 104 estudiantes de Biología de 11° grado en SMAN 3 Singaraja y tres profesores de Biología. Los datos cuantitativos sobre autorregulación y habilidades de comunicación se recopilaron a través de un cuestionario de Google Form y se analizaron utilizando estadísticas descriptivas e inferenciales (prueba U de Mann-Whitney). Los datos cualitativos, que comprenden las perspectivas de los profesores, se analizaron mediante un análisis descriptivo cualitativo.
Resultados: el análisis reveló: (1) No hay diferencias significativas de género en la autorregulación general, excepto en la autoobservación y la autorreacción; y (2) Diferencias significativas de género en las habilidades

de comunicación, excluyendo la comunicación asertiva.
Conclusiones: estos hallazgos destacan la relación matizada entre el género y estas habilidades. Si bien la autorregulación general no mostró disparidades significativas de género, indicadores específicos y habilidades de comunicación exhibieron diferencias basadas en el género. La investigación futura debería centrarse en desarrollar modelos de aprendizaje sensibles al género para mejorar la autorregulación y las habilidades de comunicación en estudiantes de Biología.

Palabras clave: Autorregulación; Habilidades de Comunicación; Género; Estudiantes Entusiastas de Biología.

INTRODUCTION

Education plays a crucial role in transforming students' 21st-century skills to align with the advancements in time and technology. Two essential skills students should possess are self-regulation and communication skills.[1,2] Communication skills fall under the cluster of interpersonal skills, while self-regulation falls under the cluster of intrapersonal skills.[1] Interpersonal skills pertain to an individual's capacity to engage and communicate proficiently with others within social environments. Conversely, intrapersonal skills relate to an individual's ability to comprehend their own identity and regulate their emotions, thoughts, and actions.[1]

Self-regulation in the context of learning refers to the process whereby students organize their tasks, assess their performance, and subsequently reflect on the results.[3] It embodies the capacity to plan, guide, and manage one's emotions, thoughts, and behaviors throughout the learning experience. Key attributes of self-regulation include executive functions, self-monitoring, persistence, self-discipline or self-control, and self-reinforcement. Additionally, self-regulation encompasses self-evaluation, which reflects self-efficacy, emotional stability, and an individual's locus of control.[4]

Self-regulation skills are crucial for students to optimize their learning,[5,6] leading to educational success.[7] Students with self-regulation skills can discover effective learning strategies, forming an efficient learning system.[8] However, several research findings indicate that students' self-regulation in learning is still low.[9]

Research results from high school students in several cities in Indonesia indicate low self-regulation skills, particularly in several indicators such as independent learning skills, self-confidence, unawareness of learning goals' importance, and inability to manage emotions.[10,11] Various studies conducted in different countries around the world reveal low levels of self-regulation among high school students, as seen from low scores in indicators like self-control, self-efficacy,[12] self-evaluation, and self-motivation.[12]

Low self-regulation will have an impact on suboptimal learning processes, resulting in poor learning outcomes. In addition to self-regulation, another important skill that students need is communication skills as part of interpersonal skills.[1] Communication skills as interpersonal skills encompass not only the ability to express ideas, questions, arguments, and statements verbally and nonverbally but also the ability to listen attentively and consider the feelings of the interlocutor.[1] Self-regulation and communication skills are fundamental to enhancing students' capacities for lifelong learning.[13]

The components of communication skills encompass the following: (1) Active Listening, which involves attentively focusing on the speaker, seeking clarification of their meanings, and requesting the repetition of ambiguous ideas or statements; (2) Oral Communication, which pertains to the effective and constructive delivery of verbal messages; (3) Written Communication, characterized by the ability to write with clarity and precision; (4) Assertive Communication, which entails the direct expression of one's feelings, preferences, needs, and opinions in a manner that is neither threatening nor punitive; and (5) Nonverbal Communication, which serves to reinforce or replace verbal communication through the use of body language, gestures, vocal tone, or other physical cues.[1]

Communication skills among students in developing countries, particularly in Indonesia, are still low.[14] Communication skills are crucial in this modern era, but the current education system only emphasizes basic reading, speaking, and writing skills, which students have not mastered.[15]

Previous research has shown that self-regulation abilities and communication skills are associated with academic achievement,[16] and future career prospects.[17,18] One consideration to be noted in the development of self-regulation and communication skills is gender.[19,20] The gender-dichotomous approach in neuroscience is considered adequate to conclude how fundamental brain organization characteristics differ between most males and females.[21] Furthermore, various brain functions are associated with self-regulation and communication skills.[21,22]

Several studies have shown that gender influences self-regulation,[19,23] and communication skills.[24,25]

However, these studies have not yet addressed the aspects of self-regulation and communication skills that were analyzed. The objective of this study is to provide an in-depth examination of the indicators associated with self-regulation and communication skills.

METHOD

The research utilized a concurrent embedded mixed methods design,[26] wherein the quantitative approach served as the primary methodology, while the qualitative approach functioned as the secondary methodology. The quantitative method was employed to assess the differences in self-regulation between female and male students through the application of statistical tests. Meanwhile, the qualitative method was employed to gain an understanding of teachers' perceptions regarding the differences in self-regulation and communication skills of male and female students through a descriptive qualitative analysis based on interview results. The research steps are summarized in figure 1.

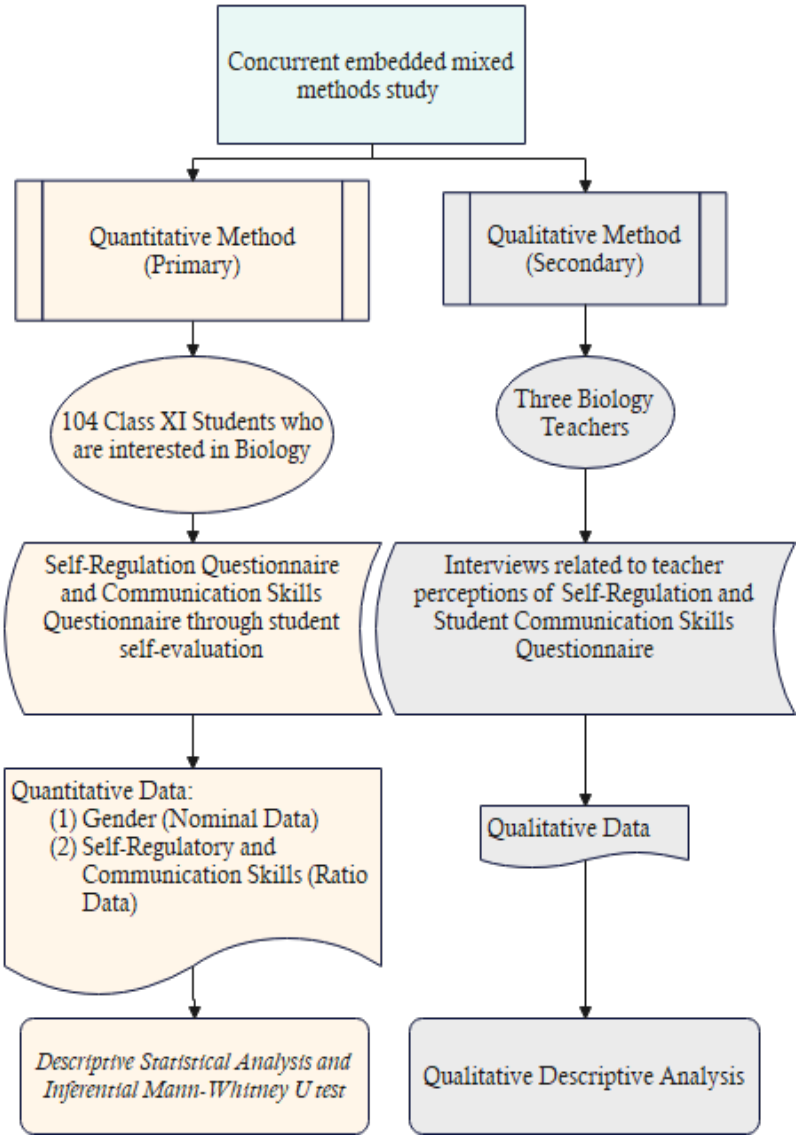


Figure 1. Research Process

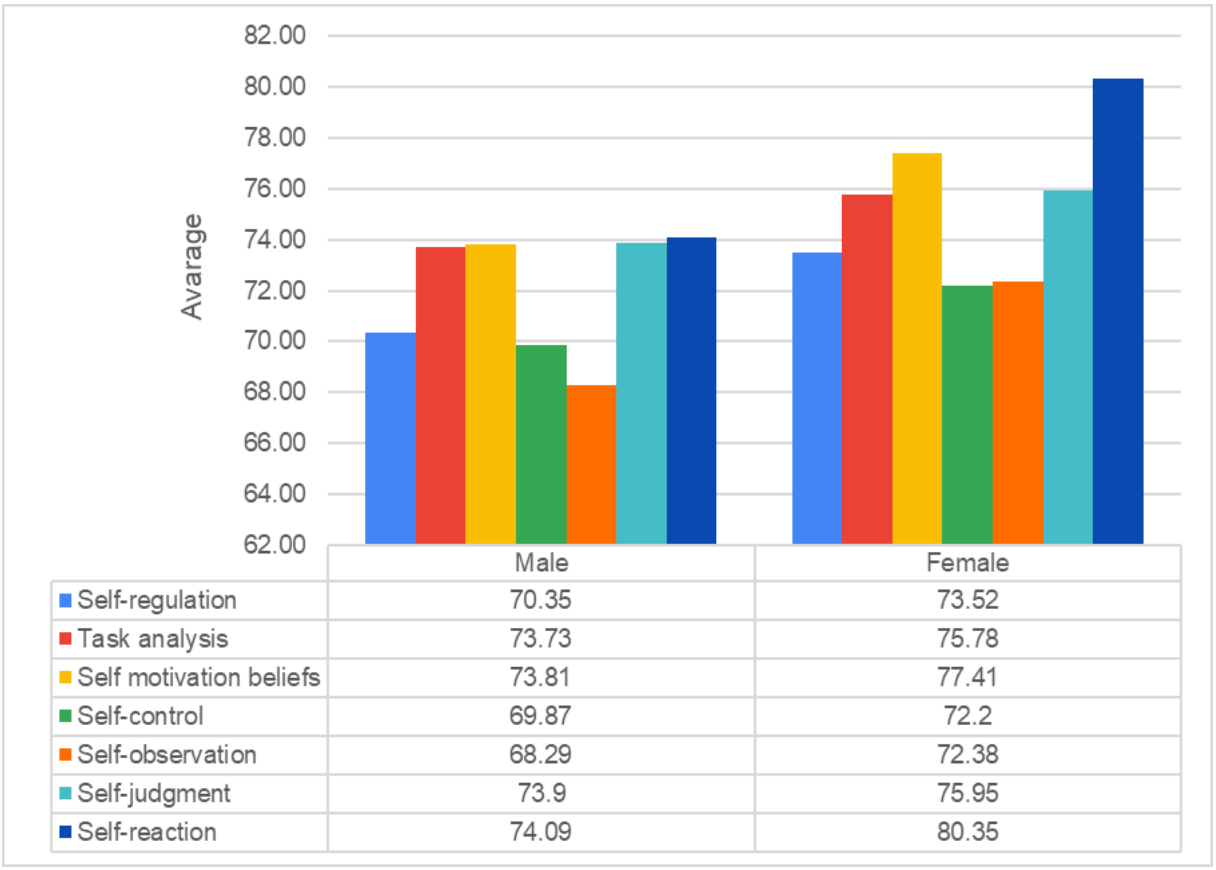
The number of participants in this study was 104 Class XI students interested in biology at SMAN 3 Singaraja and three biology teachers. The self-regulation instrument uses a questionnaire with a Likert scale of 1-5, totaling 60 statements. Interpersonal communication instruments used questionnaires with a Likert scale of 1-5, totaling 71 items. The instrument has been revised from the results of expert validation tests. The results of self-regulation validation tests using *Corrected Item-Total Correlation* values -0,346-0,625 and reliability values with *Cronbach's Alpha* 0,898 are categorized as very reliable. There are 49 valid self-regulation instruments, and 11 failed. Corrected *Item-Total Correlation* values of -0,563-0,676 and reliability values with *Cronbach's Alpha* of 0,931 are categorized as very reliable. The number of valid interpersonal communication instruments

is 65, and 6 failed. Quantitative data of nominal scale type for gender and ratios for self-regulation scores and communication skills were taken through *Google form questionnaires*. Quantitative data were examined utilizing both descriptive and inferential statistics, specifically employing the Mann-Whitney U test, which was calculated using SPSS software. In contrast, qualitative data obtained through interviews were analyzed through qualitative descriptive methods.

The principal aim of data integration is to leverage qualitative insights derived from interviews to elucidate the quantitative results obtained from surveys. By amalgamating both data types, a more comprehensive understanding of the impact of gender on self-regulation and communication skills is achieved. Following the analysis of the data, significant thematic areas within both quantitative and qualitative data types are identified to ascertain how these qualitative insights contribute to the interpretation of the quantitative findings related to the research variables.[27]

RESULTS AND DISCUSSION

The average value of self-regulation ability and its indicators based on gender differences between male and female is shown in figure 2.



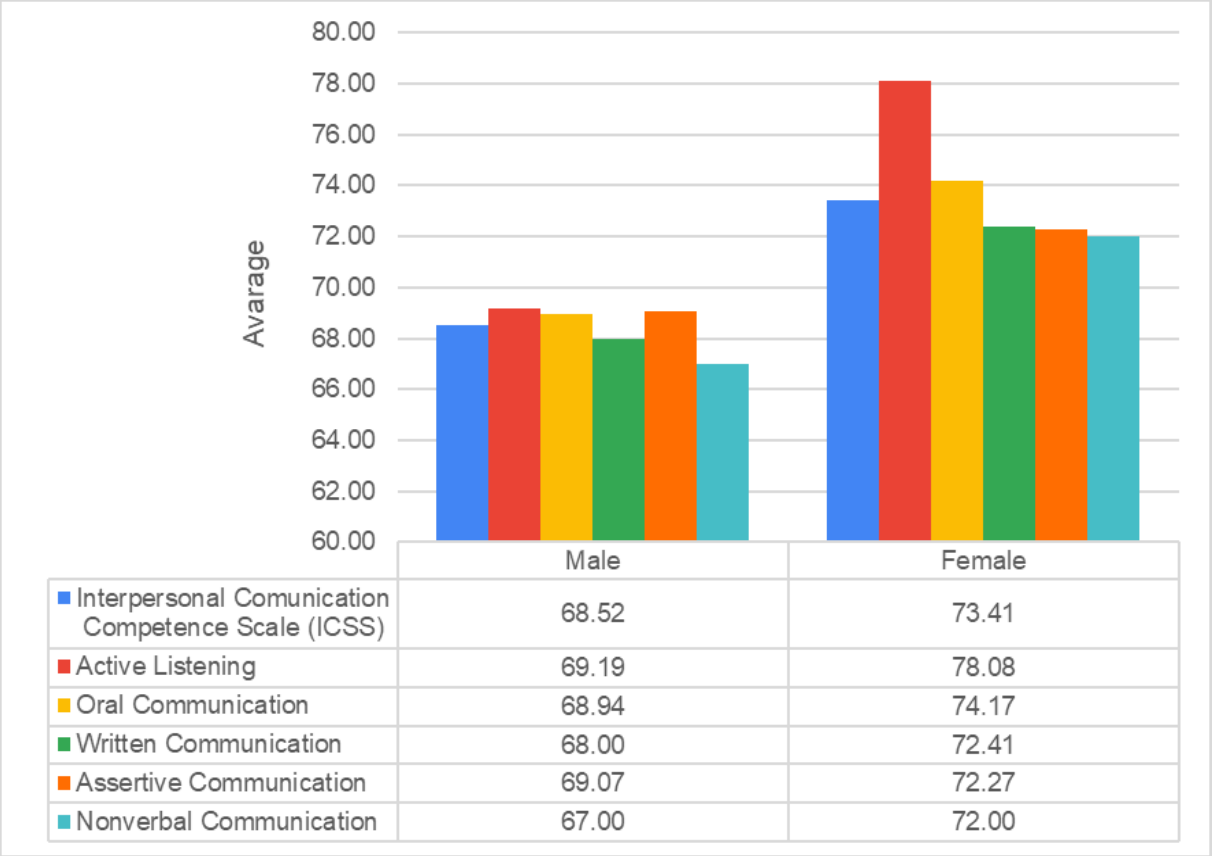
	Male	Female
Self-regulation	70.35	73.52
Task analysis	73.73	75.78
Self motivation beliefs	73.81	77.41
Self-control	69.87	72.2
Self-observation	68.29	72.38
Self-judgment	73.9	75.95
Self-reaction	74.09	80.35

Figure 2. Average Self-Regulation Ability Scores and Indicators Based on Gender

Figure 2 shows that the average self-regulation and indicators are generally lower in males than in females. Other research shows females have better *self-regulation* and grades in some subjects.[28] Females have a higher *value of self-regulation* than male[29].

The findings are substantiated by neuroscientific evidence that is believed to be associated with self-regulation capabilities. Specifically, cortical maturation, as assessed through measurements of cortical thickness, occurs at a slower rate in males than in females, particularly within frontal regions such as the anterior cingulate cortex, prefrontal cortex, and orbitofrontal cortex.[21,22] The anterior cingulate is part of the limbic system, and it plays a role in regulating emotions, motivation, and pain perception.[30] The anterior cingulate is also involved in memory and learning.[31] The prefrontal cortex comprises multiple subregions and is integral to various executive functions, including planning, decision-making, self-control, and problem-solving.[31,32] Additionally, it is linked to the processing of social and emotional information.[33] Conversely, the orbitofrontal cortex, situated at the anterior and inferior aspects of the prefrontal cortex, is pivotal in decision-making processes that involve value assessment and satisfaction, as well as in the processing of

emotional and social information.[34]



	Male	Female
Interpersonal Comunication Competence Scale (ICSS)	68.52	73.41
Active Listening	69.19	78.08
Oral Communication	68.94	74.17
Written Communication	68.00	72.41
Assertive Communication	69.07	72.27
Nonverbal Communication	67.00	72.00

Figure 3. Average Interpersonal Communication Skill and Indicators Based on Gender

Figure 2 shows that the average score of interpersonal communication skills and indicators is higher in females than in males. The male group all averaged indicators of interpersonal communication skills with ICCS in the intermediate *category*. Meanwhile, in the female group, almost all average indicators of interpersonal communication skills with ICCS also fall into the intermediate category (intermediate*), except for the indicator of* active listening (active listening*) in the category of proficient (*proficient*)*.

Based on neuroscientific research, several findings suggest females have better interpersonal communication skills than males. Firstly, females have a higher volume of gray matter (GM) in the cerebral cortex than males,[22] which functions in information processing. Secondly, the frontal region in females matures at a faster rate than in males,[22] which governs various functions such as language, motor skills, memory, personality, and other cognitive processes. Thirdly, females exhibit higher fractional anisotropy (FA) in the posterior corpus callosum compared to their male counterparts,[22] which enhances the transfer of information between the left and right hemispheres of the brain, thereby promoting more effective coordination and integration of cognitive functions.

Additionally, females generally perform better in verbal abilities, such as fluent speaking or word recall, than males.[22,35] These factors contribute to females' superior interpersonal communication skills compared to males.

The Differences in Self-Regulation Abilities Examined by Students' Gender

Table 1 presents the outcomes of the Mann-Whitney U test concerning students' self-regulation in relation to gender. The results of the Mann-Whitney U test reveal that there is no statistically significant difference in self-regulation abilities between the groups of male and female students. However, when examined by each indicator, there are significant differences in the self-control and self-reaction indicators, where females exhibit better self-control and self-reaction than males. The difference analysis presented in table 1, utilizing the Mann-Whitney U test, indicates that there is no statistically significant difference in self-regulation abilities between male and female student groups. Nevertheless, an examination of the means reveals that females exhibit higher self-regulation abilities, with a mean score of 73,52. These findings imply that, while there is no significant overall difference in self-regulation abilities between female and male students, notable differences may exist in specific indicators of self-regulation.

Table 1. Mann-Whitney U Test Results

Variables/Indicators	Average ± SD		Mann-Whitney U	Asymptotic Sig.
	Male	Female		
Self-Regulation	70,35 ± 8,65	73,52 ± 8,56	1369,00	0,063
- Task analysis	73,73 ±13,84	75,78 ± 12,72	1315,00	0,139
- Self-motivation beliefs	73,81 ± 9,55	77,41 ± 9,64	1382,50	0,050
- Self-control	69,87 ± 9,64	72,20 ± 9,20	1304,50	0,162
- Self-observation	68,29 ± 11,34	72,38 ± 9,73	1405,50	0,033
- Self-judgment	73,90 ±10,65	75,95 ± 10,69	1253,50	0,302
- Self-reaction	74,09 ±12,14	80,35 ± 11,75	1451,00	0,014

Note: Source of indicators **(5)**, SPSS analysis results

Table 1 shows significant self-regulation differences in self-observation and self-reaction indicators, where females had higher scores than males. Females excel in self-control, including self-recording and self-experimentation.[19] Females exhibit better self-observation by (1) tracking the strengths and weaknesses of their learning performance and the effects caused by them; (2) quickly realizing their shortcomings/errors and correcting them; (3) being mindful of the weaknesses and strengths in their learning processes; (4) understanding the factors that accelerate or hinder their learning performance and utilizing this understanding to enhance their learning effectiveness and efficiency; (5) being aware of the specific timing, location, style, or methods that are optimal for their learning; and (6) trying out new learning approaches for better outcomes.

These findings are corroborated by neuroscientific evidence indicating that cortical maturation, as assessed by cortical thickness, occurs at a faster rate in females than in males, particularly within the frontal regions, including the anterior cingulate cortex, prefrontal cortex, and orbitofrontal cortex.[21,22] The anterior cingulate cortex is also implicated in memory and learning,[31,32] which are closely associated with the capacity to monitor strengths and weaknesses in learning performance. The prefrontal cortex, comprising several subregions, plays a vital role in executive functions such as planning, decision-making, self-control, and problem-solving.[31,32] These functions are essential for fostering self-awareness and for making informed decisions regarding the most effective strategies during the self-observation process.

Self-reaction encompasses the ability in self-satisfaction/affect and adaptive-defensive tendencies **(3)**. Self-reaction, in detail, includes (1) satisfaction with performance outcomes or continued efforts to achieve better performance; (2) understanding the impact of performance on learning outcomes; (3) valuing effort while continuously improving the quality of future performance; (4) being willing to make changes in self-regulation patterns for better performance; (5) persistence and having various alternative strategies to enhance future learning performance. Self-reaction is the foundation for successful task completion and adaptive development across all stages of life.[36] Additionally, from a psychological perspective, male students tend to utilize direct action strategies and avoid unpleasant experiences, while female students are more inclined to engage in talking about issues and seek support from others.[37]

These tendencies are closely related to the prefrontal cortex and orbitofrontal cortex, which exhibit faster growth in females than males. The prefrontal cortex consists of several subregions and plays a role in executive functions, particularly decision-making and problem-solving.[31,32] The prefrontal cortex is also associated with social and emotional information processing,[33] crucial in interpreting performance outcomes. On the other hand, the orbitofrontal cortex is located in the front and bottom regions of the prefrontal cortex. The orbitofrontal cortex is involved in value-based decision-making and satisfaction processing, as well as the processing of emotional and social information.[34]

The Differences in Communication Skill Abilities Examined by Students' Gender

The results of the Mann-Whitney U Test presented in table 2 reveal a significant difference in communication skills based on gender, as measured by the ICCS. The female group exhibits superior communication skills, achieving a mean score of 73,41, whereas the male group attains a mean score of only 68,52.

The results of the Mann-Whitney U Test demonstrate significant differences between the male and female groups across nearly all indicators of the ICCS, with females consistently achieving higher mean scores in each respective indicator. Previous research also supports the finding that females have better communication skills than males.[38] Gender is considered an important factor related to students' communication skills. These findings align with prior research indicating that gender typically exerts an influence on communication skills.[38] Performance in communication skills is better for females compared to males in terms of empathy, structure, verbal and nonverbal aspects.[24]

Table 2. Mann-Whitney U Test Results

Variables/Indicators	Average ± SD		Mann-Whitney U	Asymptotic Sig.
	Male	Female		
Interpersonal Comunication Competence Scale (ICSS)	68,52±8,53	73,41±8,56	1500,50	0,005
- Active Listening	69,19±12,58	78,08±11,81	1560,00	0,001
- Oral Communication	68,94±9,26	74,167±9,55	1444,50	0,016
- Written Communication	68,00±10,61	72,41±10,19	1418,00	0,027
- Assertive Communication	69,07±9,46	72,27±9,03	1345,00	0,091
- Nonverbal Communication	67,00±8,89	72,00±9,66	1445,00	0,016

Note: Source of indicators **(1)**, SPSS analysis results

Based on neuroscience research, several findings suggest potential reasons for females' superior communication abilities compared to males. Firstly, females have a higher volume of gray matter (GM) in the cerebral cortex compared to males, which is involved in information processing.[22] Secondly, the frontal regions in females mature at a faster rate than in males, which governs various functions including language, motor skills, memory, personality, and other cognitive processes.[22] Thirdly, females exhibit higher fractional anisotropy (FA) in the posterior section of the corpus callosum compared to their male counterparts, thereby enhancing the exchange of information between the left and right hemispheres of the brain, which facilitates more effective coordination and integration of cognitive functions.[22] Furthermore, females generally perform better in verbal abilities, such as fluent speaking or word recall, than males.[22,35] These factors contribute to females' better communication skills in active listening, oral/verbal, written, and nonverbal communication compared to males.

Teachers' Perceptions of Self-Regulation and Interpersonal Music Skills of Students

Based on the interview results, it was revealed that teachers do not fully understand student self-regulated learning. Furthermore, teachers have never designed a learning model to develop student self-regulation. They lack knowledge about student planning, learning strategies, and reflective learning processes. Teachers have not observed, paid attention to, or assessed students' self-regulation abilities. Therefore, it is crucial for teachers to understand and implement self-regulated learning in order to foster students' independence in the future. However, based on the teacher's observations, female students tend to be more disciplined in completing tasks and more organized in note-taking. This finding is consistent with research indicating that teachers' ability to analyze tasks and learning needs is still low.[39] The teacher's ability to select and implement learning strategies, monitor, organize, and control the learning process is insufficient.[39] Teachers are more focused on delivering instructional material and learning activities, paying less attention to students' self-management abilities in learning.[11] Self-regulated learning is essential for students' lifelong learning abilities.[11]

Based on the interview results, several differences in communication skills were found between female and male students. Female students generally tend to have better and neater handwriting than male students. Additionally, female students speak more and provide more descriptions than male students. Females generally exhibit better communication skills than males.[38] However, in discussions, students' abilities depend on their mastery of the discussed concepts, and politeness in communication varies based on individual personalities. Female students are usually more expressive in nonverbal communication, such as body language, but this also depends on individual students. In terms of listening and note-taking, female students tend to be more active than male students, some of whom tend to talk while the teacher explains. Therefore, teachers can develop students' communication skills through various activities such as presentations, discussions, summarizing, note-taking, essay writing, or creating presentation slides. Additionally, according to the teacher, female students have better empathy skills in communication. The ability of female empathy when communicating is better than males.[40]

Research Implications

Based on the results and discussion, several implications can be inferred. The analysis and discussion revealed notable differences in various indicators of self-regulation and communication skills among students interested in biology, differentiated by gender. Moving forward, it is essential to develop and implement tailored learning strategies aimed at enhancing self-regulation and communication skills for students of both genders. Treatment in learning has a more significant influence than gender.[25] Learning models can be used to improve self-regulation and communication skills.[11]

CONCLUSION

Based on the results and discussions, several conclusions can be drawn: (1) There is no significant relationship between gender and self-regulation, with the exception of the Self-reaction indicator; (2) No significant differences in self-regulation exist between gender groups, apart from the self-observation and Self-reaction indicators; (3) A significant relationship is observed between gender and communication skills, excluding the written communication and assertive communication indicators; (4) Significant differences in communication skills are evident based on gender groups, with the exception of the assertive communication indicator. These findings are noteworthy as they reveal varying analytical outcomes in both variable and indicator values, which can inform the development of self-regulation and communication skills among biology students, taking gender into account.

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CONFLICT OF INTEREST

The author declares that there are no conflicts of interest.

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