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MOTIVATION OF HIGH SCHOOL AND UNIVERSITY STUDENTS IN LEARNING BIOLOGY

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Abstract. *Motivation and learning strategies are central factors influencing academic performance, especially in complex subjects such as biology. Students' capacity to regulate their own learning, manage study strategies and maintain motivation can significantly affect their understanding and retention of scientific concepts. Exploring these factors in both high school and university students provides insight into developmental and contextual differences in learning approaches. A quantitative, cross-sectional, descriptive-correlational study was conducted with a convenience sample of 128 participants, including 65 high school students and 63 university students. Data were collected online using the DSML questionnaire, which evaluates motivational components: Test Anxiety, Self-Efficacy, and Course Utility; and strategic components: Source Diversity, Study Skills, and Self-Regulation on a 7-point Likert scale. This framework allows for the identification of distinct profiles and the analysis of relationships between motivation and learning strategies. The results revealed that each group exhibited unique motivational and strategic patterns, with statistically significant positive correlations between motivational factors and learning strategies. These findings suggest that higher levels of self-efficacy and perceived course utility are associated with more diverse and effective study strategies, while increased test anxiety may negatively impact self-regulation. Understanding these interdependencies can inform targeted interventions to enhance learning outcomes and support the development of self-regulated learners in both secondary and higher education contexts.*

Keywords*: Diversity of Strategies for Motivation in Learning (DSML), academic performance, motivational components, self-regulated learning, strategic patterns*

INTRODUCTION

In an educational context undergoing continuous transformation, understanding the mechanisms that support effective learning has become a priority for psycho-pedagogical research (CREDÉ & PHILLIPS, 2011; PANADERO, 2017). Motivation and learning strategies are recognized as two of the most important variables influencing academic success, contributing significantly to the engagement, persistence, and performance of pupils and students (ZUSHO ET AL., 2003; CHEN & ZHANG, 2021). These concepts are particularly relevant in the study of biology, which is a complex discipline that requires the development of critical thinking, analytical skills and the application of knowledge in various situations (SHUMOW ET AL., 2013; OSBORNE, 2019).

By its nature, biology involves both theoretical and practical dimensions. It is often taught in laboratory settings, where the learning experience can significantly influence students' motivation and cognitive engagement (SHUMOW ET AL., 2013; HOFSTEIN & MAMLOK-NAAMAN, 2021). Although laboratory activities can stimulate interest and enjoyment

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in learning, studies indicate that they are not always perceived as cognitively relevant (SHUMOW ET AL., 2013). This discrepancy raises a key question: how can biology learning environments be designed to enhance both affective interest and cognitive engagement? (FREEMAN ET AL., 2014).

Furthermore, numerous individual and contextual factors such as age, level of education, or previous educational experiences can shape these processes (DAI ET AL., 2025; AYDIN, 2016; GONZÁLEZ-CUTRE ET AL., 2020). The transition from high school to university is a critical stage in academic development, requiring adjustments in students' motivational and strategic profiles (SCHNITZLER ET AL., 2020). Despite the considerable amount of research on motivation and self-regulation of learning, comparative studies between high school and university students, particularly in the field of biology, are relatively limited (DAI ET AL., 2025; SCHUNK & DIBENEDETTO, 2020). Such an analysis is essential to understand how these concepts evolve throughout the educational pathway and to develop effective pedagogical interventions tailored to each level of education.

The relevance of this issue goes beyond the academic sphere, with important implications for the development of scientific and civic skills in future citizens. As a highly interdisciplinary subject, biology contributes to the understanding of fundamental phenomena of life, from health and biotechnology to ecology and climate change (NATIONAL RESEARCH COUNCIL, 2012; UNESCO, 2021). Strong motivation and effective learning strategies in this field are essential for developing a well-trained workforce in STEM fields, which are indispensable for technological and social progress (RIEGLE-CRUMB & KING, 2010; WANG, 2016; NATIONAL ACADEMIES OF SCIENCES, ENGINEERING, AND MEDICINE, 2017). Furthermore, studies such as those by Tai et al. (2006) and Dohn (2020) show that early motivation for science has a decisive contribution to career orientation and perseverance in scientific fields.

From a theoretical perspective, this paper is anchored in the social-cognitive paradigm of learning (BANDURA, 1986; HADWIN & WEBSTER, 2019), which emphasizes the interaction between personal, behavioural, and environmental factors in the process of self-regulation of learning. In this framework, intrinsic motivation, self-efficacy, and the perception of course utility are considered determinants of academic persistence and performance (RYAN & DECI, 2000; SCHUNK & DIBENEDETTO, 2020). At the same time, learning strategies, such as diversifying information sources, study planning or self-regulation, mediate the effectiveness of the knowledge acquisition process (FLAVELL, 1979; HANDS & LIMNIOU, 2023).

The Diversity of Strategies for Motivation in Learning (DSML) tool (HANDS & LIMNIOU, 2023) provides a modern framework for assessing these dimensions, combining motivational and strategic perspectives into a unified model. Its subscales allow for a comprehensive analysis of the factors that influence performance and engagement in learning. The reciprocal relationships between these components, demonstrated in the literature (PINTRICH & ZUSHO, 2007; CHEN & ZHANG, 2021), show that high motivation supports the use of effective strategies, and their consistent application reinforces confidence and intrinsic motivation.

The aim of this paper was to investigate the relationships between motivation and learning strategies among high school and university students, in the field of biology, using the DSML questionnaire (HANDS & LIMNIOU, 2023). The objectives of the research are, on one hand, to identify differences in motivational and strategic profiles between the two groups and, on the other hand, to examine the relationships between motivational dimensions (self-efficacy, perceived usefulness of the course, test anxiety) and strategic dimensions (self-regulation,

study skills, diversity of sources). Thus, the study contributes to a deeper understanding of how psychological and behavioural factors interact to support academic success in biology, while also providing practical guidelines for optimizing the teaching process and the transition between educational stages.

MATERIALS AND METHODS

This study adopted a quantitative, cross-sectional research design, which involved collecting data at a single point in time, from a representative sample of the target population. The design was predominantly descriptive-correlational and aimed to describe the motivational and strategic profiles of the participants and examine the relationships between the variables investigated, without the intention of establishing causal relationships.

The variables included in the research were derived from the subscales of the DSML questionnaire, an instrument that integrates motivational and strategic dimensions of the learning process. The instrument used for data collection was the DSML questionnaire, developed by HANDS AND LIMNIOU (2023). The questionnaire contains 24 items distributed across six distinct subscales: Test Anxiety, Self-Efficacy, Course Usefulness, Self-Regulation, Study Skills, and Diversity of Sources. The scores for each subscale were calculated as the arithmetic mean of the corresponding items, after reversing the negatively worded items, where applicable.

From a motivational perspective, the study focused on three main dimensions: self-efficacy, perceived usefulness of the course, and test anxiety. The first refers to participants' perception of their own ability to learn and perform in biology. The second captures the extent to which they consider the subject content to be relevant and valuable for personal and professional development. The third reflects the level of tension and concern associated with assessment situations.

In addition, the learning strategies dimension is represented by self-regulation of the learning process, study skills, and the diversity of information sources used. These variables provide a broad picture of how pupils and students structure and manage their cognitive effort in the context of learning biology.

The target population of the study included high school and university students in Romania studying biology or related subjects. The final sample consisted of 128 participants, including 65 high school students and 63 university students. The high school students were recruited from various high schools across the country participating in the BIOS National Biology Competition. The university students were recruited from among those enrolled in bachelor's degree programs in biology and biochemistry at the Faculty of Chemistry, Biology, Geography in Timișoara, Romania.

Recruitment was carried out using an online non-probabilistic sampling method: the questionnaire was sent to students via institutional email addresses, and they were invited to respond voluntarily. In the case of high school students, the questionnaire was sent at the time of their presentation at the "BIOS" competition, maintaining the digital format of the questions.

The inclusion criteria were active study of biology as a compulsory or optional subject and informed consent to participate. Demographic informations, such as gender, age, and educational level, were also collected to characterize the sample. Before completing the questionnaire, participants were informed about the purpose of the research, the duration of completion, the anonymity of responses and the right to withdraw from the study at any time without consequences. Informed consent was obtained electronically, and all responses were treated confidentially, exclusively for research purposes.

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RESULTS AND DISCUSSIONS

The analysis of the collected data aimed to investigate the motivational and strategic profiles of the participants using the DSML questionnaire. The sample consisted of 128 participants, divided into two distinct groups: 65 high school students and 63 university students.

The student group included 40 girls (61,5%), 24 boys (36,9%), and one participant who preferred not to disclose their gender, aged between 15 and 19, distributed relatively evenly across classes, with a predominance of natural sciences profiles (52,3%).

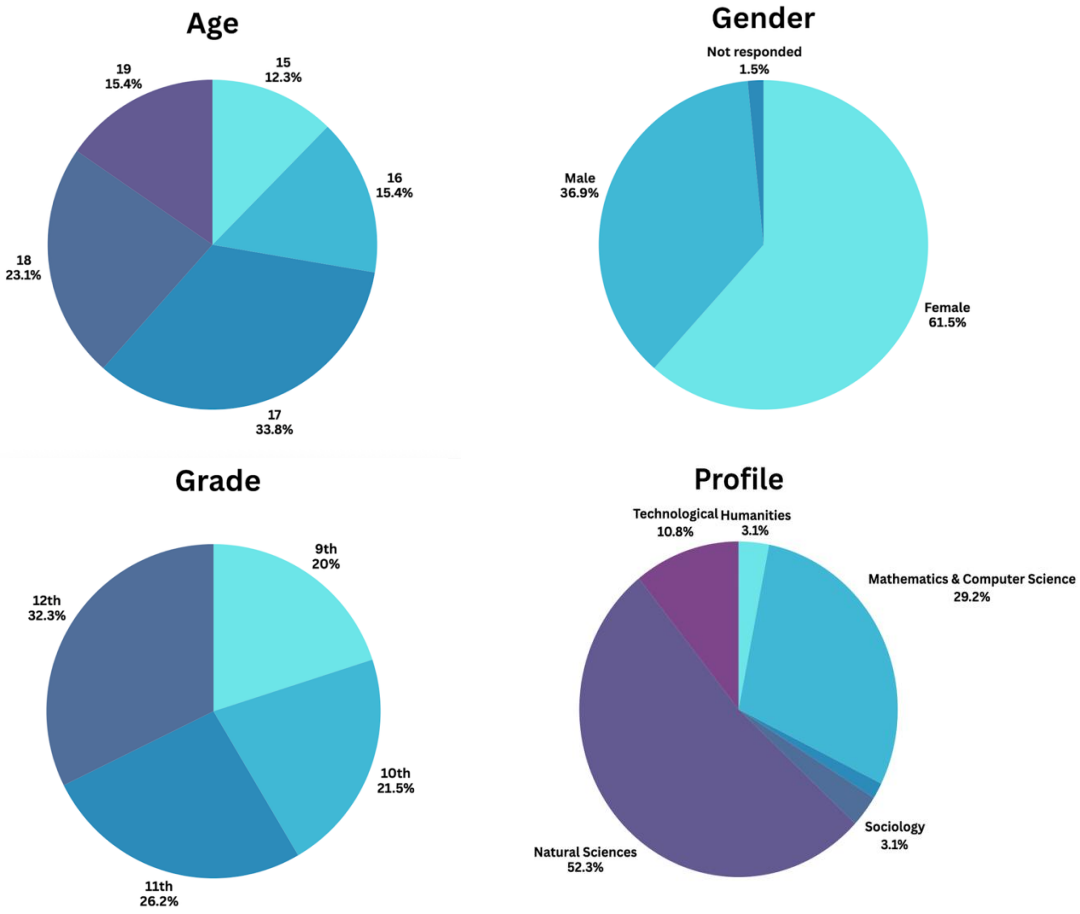

Figure 1. Demographic characteristics of the high school participants

The group of students had a higher average age, between 19 and 32 years old, with a majority of female students (83%), predominantly enrolled in Biology (67%), and the rest in Biochemistry (33%).

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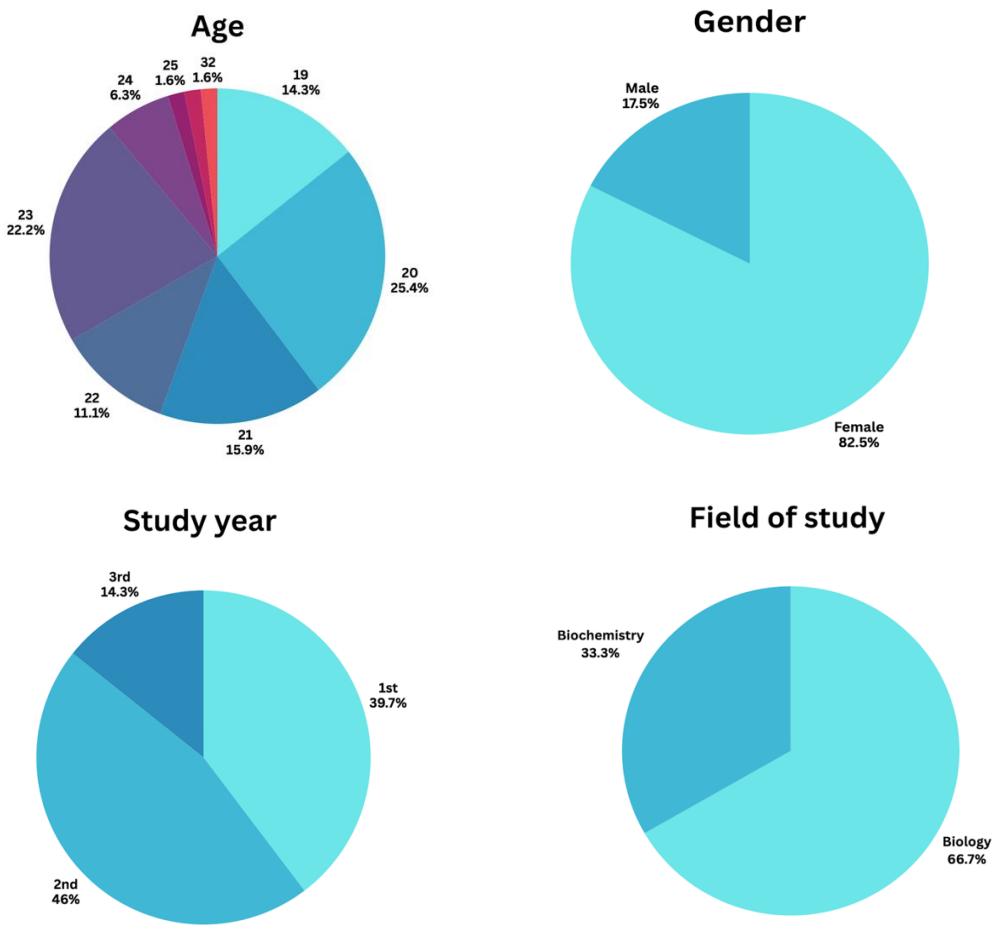

Figure 2. Demographic characteristics of the university participants

For high school students, the average scores on the DSML subscales revealed a complex motivational profile. The Self-Efficacy (M = 5.58), Diversity of Sources (M = 5.57), and Course Usefulness (M = 5.52) subscales recorded the highest values, indicating a positive perception of one's own competence, willingness to use various resources in learning, and appreciation of the relevance of the discipline. ANOVA analysis confirmed significant differences between the means of the subscales for the group of students, and the Welch test, applied due to the violation of the assumption of homogeneity of variances ($p = .001$), reconfirmed the statistical significance of these differences ($F = 42.46$, $df = 178.7$, $p < .001$).

In contrast, Self-regulation (M = 3.23) and Test Anxiety (M = 3.71) were significantly lower, highlighting difficulties in autonomous learning management and pronounced emotional vulnerability in the context of assessments.

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The relationships between the DSML subscales in students revealed significant interdependencies. Self-regulation was negatively correlated with Test Anxiety (F = 2.117, p = .017), suggesting that increased anxiety affects self-regulation ability, while it was positively correlated with Learning Strategies (F = 2.007, p = .025) and with the perception of Course Usefulness (F = 1.872, p = .038), indicating that students who self-regulate better use learning strategies more effectively and recognize the relevance of the course more clearly. Self-efficacy was positively associated with Self-regulation (F = 3.514, p < .001) and Course Utility (F = 3.326, p = .001), emphasizing that confidence in one's own abilities stimulates control and organization of the learning process.

These results show that students exhibit a motivational profile in which perceived competence and resource appreciation are high, but self-regulation and anxiety management remain vulnerable. This finding is consistent with the literature, according to which adolescents feel the pressure of assessments more intensely and may have difficulties in self-regulating their learning (PUTWAIN, 2009; ZIMMERMAN & SCHUNK, 2011).

Table 1

ANOVA Results on Highschool Students' Motivational Profiles

Dependent variable	Independent variable	F	P (Sig.)
Self-regulation	Test anxiety	2.117	.017
	Self-efficacy	1.089	.398
	Diversity of resources	1.089	.398
	Course utility	1.872	.038
	Learning strategies	2.007	.025
Test anxiety	Self-regulation	2.310	.009
	Self-efficacy	.919	.576
	Diversity of resources	.645	.868
	Course utility	1.145	.344
	Learning strategies	1.076	.408
Self-efficacy	Self-regulation	3.514	.000
	Test anxiety	1.770	.068
	Diversity of resources	1.387	.191
	Course utility	3.326	.001
	Learning strategies	1.144	.346
Diversity of resources	Self-regulation	1.009	.492
	Test anxiety	1.413	.179
	Self-efficacy	2.516	.008
	Course utility	2.901	.003
	Learning strategies	1.577	.116
Course utility	Self-regulation	3.314	.001
	Test anxiety	3.422	.001
	Self-efficacy	3.552	.001
	Diversity of resources	2.378	.014
	Learning strategies	2.106	.030
Learning strategies	Self-regulation	1.723	.084
	Test anxiety	1.560	.129
	Self-efficacy	1.739	.081
	Diversity of resources	.979	.484
	Course utility	2.275	.019

Among university students, the average scores showed a slightly different profile. The subscales Diversity of Sources (M = 5.49), Course Usefulness (M = 5.43), and Self-Efficacy

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(M = 5.30) were the highest, indicating a strong appreciation for varied resources and a positive perception of academic relevance. In contrast, Self-regulation (M = 4.31) and Learning Strategies (M = 4.68) were lower, suggesting that although students express confidence in their skills and use diverse resources, autonomous management of learning and consistent application of strategies remain challenges.

ANOVA analysis confirmed significant differences between subscales, and Dunn's post hoc test identified homogeneous subsets, indicating the existence of some positively perceived dimensions and others that are more vulnerable. Significant relationships between subscales included correlations between Self-Regulation and Anxiety (F = 1.862, p = .042), between Self-regulation and Learning Strategies (F = 2.612, p = .004), between Self-efficacy and Diversity of Sources (F = 1.927, p = .044), and between Course Usefulness and Learning Strategies (F = 1.905, p = .038).

These correlations indicate the interdependence of motivation, perception of course relevance, and strategy application, confirming the theoretical models of self-regulated learning (BANDURA, 1997; PINTRICH & ZUSHO, 2007).

Table 2

ANOVA Results on University Students' Motivational Profiles

Dependent variable	Independent variable	F	P (Sig.)
Self-regulation	Test anxiety	1.862	.042
	Self-efficacy	1.033	.460
	Diversity of resources	1.556	.109
	Course utility	1.133	.361
	Learning strategies	2.612	.004
Test anxiety	Self-regulation	2.852	.002
	Self-efficacy	.652	.853
	Diversity of resources	1.085	.399
	Course utility	1.225	.282
	Learning strategies	1.718	.068
Self-efficacy	Self-regulation	1.559	.123
	Test anxiety	1.325	.226
	Diversity of resources	1.927	.044
	Course utility	1.439	.169
	Learning strategies	.906	.563
Diversity of resources	Self-regulation	2.269	.020
	Test anxiety	.583	.856
	Self-efficacy	1.156	.339
	Course utility	.847	.611
	Learning strategies	1.047	.425
Course utility	Self-regulation	1.030	.439
	Test anxiety	1.486	.157
	Self-efficacy	1.445	.173
	Diversity of resources	.440	.946
	Learning strategies	.799	.658
Learning strategies	Self-regulation	2.065	.030
	Test anxiety	1.414	.180
	Self-efficacy	1.222	.290
	Diversity of resources	1.361	.206
	Course utility	2.017	.034

Comparatively, students show high scores in Self-efficacy, Diversity of sources, and Course usefulness, but lower scores in Self-regulation and significantly higher scores in

Anxiety, which indicates emotional difficulties in the learning process. University students show a more balanced and integrated profile, with high scores in Self-efficacy and Diversity of sources. Self-regulation does not reach maximum levels, signalling the need to continue developing autonomous learning management skills. These differences reflect the transition from a more directed educational context to a more autonomous one and suggest that the development of self-regulation skills does not occur automatically but may require deliberate interventions, even at the university level.

The results confirm the hypothesis that there are significant differences between the motivational and strategic profiles of pupils and students. The relationships identified between subscales, including positive correlations between Self-Efficacy and Self-Regulation and negative correlations between Anxiety and Self-Regulation, highlight the interdependence of motivation and learning strategies, as well as the significant influence of emotional factors on the effectiveness of the learning process. These findings are consistent with the literature and provide an applied perspective for the development of educational interventions aimed at reducing anxiety and improving self-regulation at both the high school and university levels (CASSADY & JOHNSON, 2002; PINTRICH, 2004).

In practical terms, the results suggest that teachers can adapt teaching strategies to support self-regulation and anxiety management by introducing metacognitive activities, guided study planning, and formative assessments. Furthermore, the relevance of the course, which was perceived as positive in both groups, can be leveraged through practical examples, interdisciplinary projects, or case studies, which could stimulate more effective use of learning strategies and strengthen motivation. For pupils and students, understanding their own motivational profile can serve as a guide for self-reflection, self-optimisation and the development of self-regulated learning strategies (NILSON, 2013).

The limitations of the study include its cross-sectional design, which does not allow for causal inferences, and the exclusive use of self-report questionnaires, which may generate biases. Future research could integrate mixed methods, longitudinal studies, and comparisons between different disciplines or educational contexts to deepen the understanding of motivational and strategic profiles and the factors that influence them.

CONCLUSIONS

The study highlighted the existence of distinct motivational and strategic profiles among both high school students and university students majoring in biology and biochemistry, confirming the hypothesis that these two categories differ significantly in how they perceive the learning process and the strategies they apply. Statistical analyses also showed significant relationships between certain components of motivation, such as self-efficacy, test anxiety, and perceived course usefulness and learning strategies, such as self-regulation and diversification of information sources. These findings underscore the fact that motivation and learning strategies do not function independently, but influence each other in complex ways, shaping the educational experience of pupils and students.

Integrating the results obtained in the context of the specialized literature contributes to a more nuanced understanding of how students learn biology, highlighting the differences that may arise between high school and university. In addition, these results emphasize the need to adapt teaching strategies to the cognitive and motivational development level of each group, in order to support both learning efficiency and the active involvement of participants.

In practical terms, the results suggest that teachers can support the learning process by reducing test anxiety, increasing the perceived usefulness of the course, and encouraging self-

regulation. Furthermore, findings such as the interdependence between motivation and strategies indicate the need for educational interventions that target both dimensions simultaneously.

The study also highlights the importance of continuing research in this area to explore these relationships in greater detail and test them in diverse educational contexts so that the conclusions can be generalized on a broader scale. Overall, the research makes a significant contribution to strengthening the understanding of the psychological factors involved in academic success in biology.

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