

WHAT HELPS YOU TO LEARN? INSIGHTS FROM UNIVERSITY STUDENTS AND FEEDBACK FROM NEUROSCIENCE

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Abstract

Declarative or explicit learning depends on several components that can be modified to achieve better learning habits and outcomes. The aim of this work was to analyze the learning strategies of Health Sciences university students and give them neuroscience-based feedback about their possibilities of improvement. Participants were students from four classes (Medicine, and Nutrition and Dietetics, years 2023-24 and 2024-25) who were following the subject “Nervous system physiology”. First, the students were invited to reflect on their learning strategies with the question “What helps you to learn or to study?”, through the interactive tool Wooclap. Their contributions were displayed as a dynamic word cloud in class. Next, the teacher provided scientific feedback, explaining briefly the neurophysiological mechanisms underlying their answers, and included further relevant items if they had not been mentioned. In the second phase, outside of class, the students’ answers were distributed in six pre-determined categories and analyzed. 163 answers were obtained, which corresponded to 27 items distributed in 4 categories: student involvement, organization and study tools, deep learning and teacher work. Two further categories (concept association and students’ health) were scarcely mentioned. Differences between classes were detected. For example, Nutrition and Dietetics students provided more answers in the category “student involvement” than medical students, while medical students reported a higher use of technology tools devoted to time management, artificial intelligence and flashcard preparation. This work could help to improve the students’ learning process, to adapt feedback to the characteristics of each class, to help determine the teacher’s pedagogical methodology and to introduce active learning methodologies.

Keywords: *Learning, university, neuroscience, Wooclap.*

1. Introduction

Declarative or explicit learning is the acquisition of knowledge or skills through conscious, intentional and strategy-driven processing, such as that which university students apply when they study, versus non-declarative or implicit learning, which is unconscious learning developed in motor and emotional activities. Learning is based on experience-driven flexible remodeling of different neural connections (synaptic plasticity) (Freedberg, Toader, Wassermann, & Voss, 2020). In the context of university education, multiple factors should be considered in order to improve students’ study habits and outcomes.

Student involvement is the cornerstone of the learning process. This is related to several factors, such as attention, which allows vast amounts of information to be filtered and prioritizes that which is the most relevant (Knudsen, 2018). A second important factor related to student involvement is motivation. It is crucial to make the effort to study in order to obtain future benefits. Motivation depends on the mesolimbic reward system, which is activated by achievable challenges (Pierce & Kumarasan, 2006; Hamid et al., 2016). It is especially relevant during adolescence since the reward system predominates over the prefrontal cortex until approximately the age of 25 (Casey, Jones & Hare, 2008).

Another fundamental feature of successful learning refers to task organization and planning, which align with the functioning of the prefrontal cortex. In addition, in order to consolidate learning it is essential to work on deep learning, or critical thinking, and concept association, which are related to explicit memory encoding by the hippocampus and its consolidation and recovery, in which the prefrontal cortex is also involved (Eichembaum, 2018; Choucry, Nomoto & Inokuchi, 2024).

In addition, students’ health must be considered, as it affects the learning capacity. Several health-related issues have an impact on brain health and therefore learning. Diet affects the brain directly or through the microbiota-gut-brain axis (Silva, Bernardi & Frozza, 2020). Physical activity improves brain

health, and specifically hippocampus function (Cotman, Berchtold & Christie, 2007). Sleep is fundamental for memory consolidation and for keeping the brain healthy (Choucry, Nomoto & Inokuchi, 2024). Meanwhile, chronic stress negatively affects the brain, altering for example the functioning of the reward system responsible for motivation (Hollon, Burgeno & Phillips, 2015) and the hippocampus involved in explicit learning and memory (McEwen, Nasca & Gray, 2016).

2. Objective

The aim of this work was to analyze the learning strategies of Health Sciences university students and provide them feedback based on neuroscience oriented to improving their learning habits.

3. Methodology

This study was carried out with 152 undergraduate students from Medicine (91 students) and Nutrition and Dietetics (61 students), who were following the subject “Nervous system physiology”. Four classes were involved as the experience was developed over two consecutive years (2023-24 and 2024-25). The work was divided in two phases. The first phase took place in the classroom and the second one was devoted to the in-depth analysis of the results obtained and the extraction of conclusions.

In the classroom, as part of the subject presentation during the first session, the interactive tool Wooclap (wooclap.com) was used to invite the students to reflect upon their learning strategies. For that purpose, the question “What helps you to learn or to study?” was asked. Students’ answers were anonymously recorded and shown in real-time on a screen as a dynamic word cloud. The teacher performed a preliminary analysis in class and provided scientific feedback, briefly introducing students to the neurophysiological mechanisms underlying their answers. When relevant items were absent from the students’ answers, the teacher commented on them and the mechanisms involved.

In the second phase, outside of class, the students’ answers were thoroughly analyzed. Five learning categories were defined a priori according to the neuroscience mechanisms involved in explicit learning: 1) student involvement, 2) organization and study tools, 3) deep learning or critical thinking, 4) concept association and 5) student health. An additional sixth category (teacher work) was included to cover teaching tools that students might consider helpful for their learning. Students’ answers constituted items that were placed in one of these categories. These items may have been mentioned by several students. For every class, the percentage of answers in each category was calculated with respect to the total number of answers. Comparisons between the four classes were carried out by analyzing the items included and the percentual distribution of categories.

4. Results and discussion

4.1. Phase 1: In-classroom experience

When the question “What helps you to learn or study?” was displayed in the classroom, students’ answers were shown as a real-time word cloud. Then, preliminary approaches detected contributions mainly related to four out of the six pre-defined categories, while no items were mentioned which were strongly linked to the categories “concept association” and “student health”.

In-classroom experience was completed with feedback from the field of neuroscience that was aimed at introducing students to the mechanisms involved in items they had mentioned, and including relevant items that were absent in their contributions. As this was the first session of the subject, feedback was brief, simple, based on examples, accessible to beginners’ level and linked to future topics of the subject. In the category “student involvement”, the mechanism of attention was related to the functioning of the corticothalamic circuit (Knudsen, 2018) and motivation to the corticostriatal circuit and the mesolimbic reward system (Hamid et al., 2016). The category “organization and study tools” was related to functions of the prefrontal cortex. The absent category “concept association” was considered essential for learning. Therefore, it was introduced and linked to the category “deep learning” to be explained in relation to the engrams association in the hippocampus (Choucry, Nomoto & Inokuchi, 2024).

4.2. Phase 2: Data analysis

A relevant percentage of the students that were present during this experience (103 out of 152, 67.76%) participated actively providing a total of 163 answers to the question “What helps you to learn or study?”. These answers corresponded to 27 items (Table 1), which were distributed in four of the established categories: 1) student involvement (4 items, 11.66% of the answers), 2) organization and study tools (16 items, 62.58 %), 3) deep learning (2 items, 10.43 %). and 4) teacher work (5 items, 14.72%).

These items were mentioned from 1 to 34 times. The most valued items were: “schema” (34 mentions, 20.86 % of the answers), “videos” (13 mentions, 7.97%) and “understanding” (11 mentions, 6.75%).

Categories were not rigid, but some items in the “organization and study tools” category could be related also to other categories. For example, “repeating / reviewing / explaining it to someone” could also be assigned to “deep learning”. Besides, items like “schematic diagrams / conceptual maps / comparative tables” although they deal with “concept association”, weren’t placed in that category, as the sense of high-level associations was not perceived in students’ answers, since they did not reflect a relationship between different teaching units or with everyday situations.

Table 1. Contributions to the question “What helps you to learn or to study?” in four classes (Medicine 2023-24 and 2024-25 and Nutrition and Dietetics (N&D) 2023-24 and 2024-25). The number of mentions that every item received is shown.

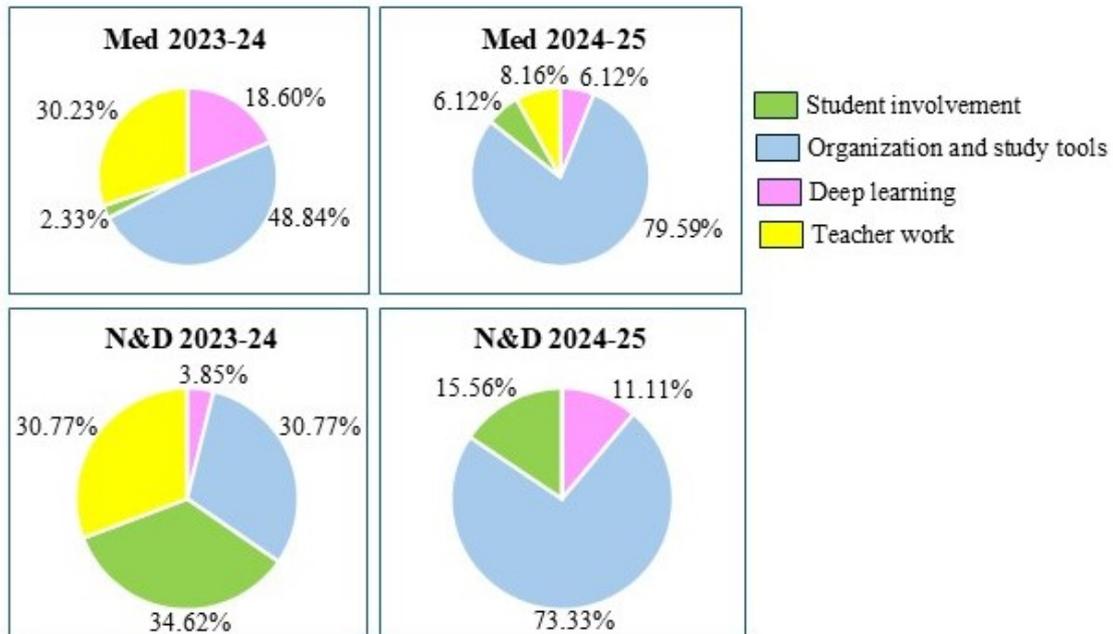
Category	Items provided by the students	Med 23-24	Med 24-25	N&D 23-24	N&D 24-25	TOTAL
Student involvement	Attending class and paying attention	1	1	4	2	8
	Taking notes		2	2	4	8
	Studying daily			3		3
	Feeling like studying (motivation)				1	
Organization and study tools	Schematic diagrams, conceptual maps, comparative tables, drawings	8	5	5	16	34
	Videos	2	6	3	2	13
	Images	1	3		5	9
	Repeating, reviewing	6			3	9
	Books		6			6
	Simple explanations, explaining it to someone, Feynman method, ELI12	1	4		1	6
	Highlighting, colors		1		4	5
	Friends	1	3			4
	Online notes		4			4
	ChatGPT		3			3
	Writing it		2			2
	Anki, Flashcards		1		1	2
	Music		1		1	2
	Pomodoro technique (time management)	1				1
Mnemonic techniques	1				1	
Deep learning	Understanding, being clear about the basic concepts	4	3		4	11
	Reasoning, explaining processes, logic among concepts	4		1	1	6
Teacher work	Summaries, a summary after a long explanation	4		3		7
	Clear and slow explanation in class	2	3	1		6
	Repeating, emphasizing important concepts in class	5				5
	Asking questions in class, review questions with solutions	2		3		5
	Examples			1		1
	Complete presentations		1			1
	TOTAL	43	49	26	45	163

Differences between classes were detected (Figure 1). In the category “student involvement” Nutrition and Dietetics students provided more contributions (34.62% of the total contributions in 2023-24 and 15.56% in 2024-25) than medical students (2.33% of the total contributions in 2023-24 and 6.12% in 2024-25). They were aware of and communicated the importance of paying attention in class, taking notes, studying daily and staying motivated.

The category “organization and study tools” had the highest total representation (61.96%) and ranged from 30.77 % of the total contributions in Nutrition and Dietetics 2023-24 to 79.59 % in Medicine 2024-25 (Figure 1). Only medical students reported the use of technology tools and their percentage of use respect to the total of tools was low (Table 1): 0.99% in 2023-24, which increased to 4.95% in 2024-25. These technology tools were devoted to time management, artificial intelligence or flashcard preparation.

The category “deep learning” was mentioned in the four classes (Figure 1) ranging from 3.85 % of the total contributions in Nutrition and Dietetics 2023-24 to 18.60 % in Medicine 2023-24. Meanwhile, the category “teacher work” had a higher representation in 2023-24 classes than in 2024-25 and was not mentioned by 2024-25 Nutrition and Dietetics students. Regarding teacher work, the most valued items were “summaries”, “clear and slow explanations in class”, “repeating and emphasizing important concepts in class” and “asking questions”.

Figure 1. Distribution of the contributions to the question “What helps you to learn or to study?” in different learning categories. Contributions were recorded in four classes (Medicine 2023-24 and 2024-25 and Nutrition and Dietetics (N&D) 2023-24 and 2024-25).



These results show that relevant information about student learning strategies can be extracted from the interactive and dynamic Wooclap cloud generated in response to the question “What helps you to learn or to study?”. This study has brought to light differences between classes. Therefore, it could help provide information about the specific learning characteristics of each particular group in the first introductory session, and to orient the teacher toward an appropriate pedagogical methodology. Also, this study may contribute to predicting the results from future word clouds.

Making students conscious of their learning process could improve their study habits, leading in the short-term to higher motivation in class and better grades and in the long-term to the acquisition of relevant tools for professional development. This experience could be transferred to different disciplines to promote student reflection and to provide them with tools to improve their study habits. It supports the use of active learning methodologies that have been demonstrated to improve learning outcomes in university students (Freeman et al., 2014). It could also be used to introduce active learning methodologies once students are aware of the importance of their involvement.

5. Conclusions

The question “What helps you to learn?” promoted student reflection about their study habits and made them aware of likely resources. The interactive tool Wooclap allowed for the management of large groups, helped to keep students engaged and promoted learning from peers. An explanation of the neural mechanisms involved in the learning process could help reinforce the benefits that students gained from reflecting on their approach to learning. Differences between classes provided valuable information about their specific peculiarities and motivations.

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