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MEDICINE STUDENTS' PERCEPTION IN ACTIVE METHODOLOGY ABOUT EMBRYOLOGY TEACHING-LEARNING TOOLS

A PERCEPÇÃO DOS ESTUDANTES DE MEDICINA EM METODOLOGIA ATIVA SOBRE FERRAMENTAS DE ENSINO E APRENDIZAGEM DE EMBRIOLOGIA

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ABSTRACT

Introduction: Human embryology is admittedly difficult to understand, especially for students who are starting a course in the health area and mainly in medicine. Thus, teachers admit the constant need to innovate methods and use different tools that facilitate the teaching-learning process.

Objective: To evaluate the effectiveness of four basic embryology teaching-learning tools for medical students.

Methods: Descriptive, quantitative, and transversal study conducted in the laboratories of the Faculty Ceres-FACERES, among students in the first stage of the medical course. The following tools were used: modeling masses; movies and videos; elaborate schemes with structures to be named and colored; and three-dimensional plaster models, all aimed at demonstrating the main events of the first to eighth week of development. It was selected 60 students over 18 years of age who answered the evaluation questionnaire through Google Forms (Google LLC, California, United States of America), which contained thirteen questions to quantify the degree of satisfaction with each teaching-learning tool.

Results: Among the four tools evaluated, “Gypsum Models” proved to be the best tool evaluated by the study participants, followed by “Modelling Masses”, “Designed Schemes” and finally “Films/Videos”. It was identified that the differences occur when comparing the group's films/videos and plaster modeling ($p<0.001$) and when comparing elaborate schemes and plaster modeling ($p<0.001$).

Conclusion: The tool, plaster models, was the one that contributed the most to the understanding of embryology, reinforcing the importance of three-dimensionality for the understanding of this content.

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Keywords: Medical education. Teaching-learning tools. Embryology. Teaching.

RESUMO

Introdução: *A embriologia humana é reconhecidamente de difícil compreensão, principalmente para estudantes que estão iniciando um curso na área da saúde e principalmente na medicina. Assim, os professores admitem a necessidade constante de inovar métodos e utilizar diferentes ferramentas que facilitem o processo de ensino-aprendizagem.*

Objetivo*: Avaliar a eficácia de quatro ferramentas básicas de ensino-aprendizagem de embriologia para estudantes de medicina.*

Métodos: *Estudo descritivo, quantitativo e transversal realizado nos laboratórios da Faculdade Ceres-FACERES, entre alunos da primeira etapa do curso de medicina. Foram utilizadas as seguintes ferramentas: modelagem de massas; filmes e vídeos; esquemas elaborados com estruturas a serem nomeadas e coloridas; e modelos tridimensionais de gesso, todos com o objetivo de demonstrar os principais eventos da primeira à oitava semana de desenvolvimento. Foram selecionados 60 alunos maiores de 18 anos que responderam ao questionário de avaliação por meio do Google Forms (Google LLC, Califórnia, Estados Unidos da América), que continha treze questões para quantificar o grau de satisfação com cada ferramenta de ensino-aprendizagem.*

Resultados: *Dentre as quatro ferramentas avaliadas, "Modelos de Gesso" mostrou-se a melhor ferramenta avaliada pelos participantes do estudo, seguida de "Massas de modelagem", "Esquemas projetados" e por fim "Filmes/Vídeos". Identificou-se que as diferenças ocorrem na comparação dos filmes/vídeos do grupo e modelagem em gesso ($p<0,001$) e na comparação de esquemas elaborados e modelagem em gesso ($p<0,001$).*

Conclusão: *A ferramenta, modelos de gesso, foi a que mais contribuiu para o entendimento da embriologia, reforçando a importância da tridimensionalidade para a compreensão deste conteúdo.*

Palavras-chave: *Educação médica; Ferramentas de ensino-aprendizagem; Embriologia; Ensino.*

1 INTRODUCTION

Human embryology is the study of human development, from gametogenesis, fertilization, and embryonic development to organogenesis. Understanding this content

does not consist only in learning the definition of embryological terms, but in understanding what primitive structures will originate in the adult individual, considering their anatomical and functional aspects. However, embryology is considered even more comprehensive, as it admits that molecular events and prenatal development must be included, that is, the study of this content must happen from genes to birth [1,2].

All this knowledge makes it possible to correlate embryological events with the anatomical and physiological understanding and the emergence of congenital malformations, being these themes fundamental for the formation of the physician.3 Although all this knowledge is fundamental for clinical practice, the study of embryology is considered many sometimes uninteresting and not at all effective for many students [3,4].

Casas and Azevedo (2011) [5] attribute a large number of technical terms as one of the factors that make it difficult to understand embryology. Thus, for the teaching-learning process to occur satisfactorily, it is of paramount importance that there are necessary supports for the teacher and the student, such as practical teaching materials, for the best use of the classes. Oliveira et al. (2012) [4]

admit that one of the limitations of the study of human embryology is the difficulty, on the part of academics, to spatially visualize the embryonic structures and dynamic processes that occur throughout development. Thus, the teaching of embryology focused only on theoretical, expository, and teacher-centered classes make it difficult to implement concepts that are difficult to assimilate [3,6,7].

In the same sense, the teaching of medicine is traditionally organized in theoretical and practical classes, supported by books and study guides; however, for the new active teaching-learning methodologies, these resources alone are not enough. Therefore, the search for new methods is constant to increase student satisfaction and provide effective learning an example would be the strategies that favor the teaching and learning of embryology.8 Even in active methodologies, such as Learning Based on Problems (LBP), there is a great difficulty in understanding this content by students that is, the teaching-learning process of human embryology becomes less abstract and more effective [4,8].

The resources used by professors and students are, until then, activities in styrofoam, modeling clay, plaster, biscuit, with recyclable materials, models, videos, virtual atlases, and discussion of articles; in addition to more traditional resources such as microscope slides and textbooks and atlases [9-11].

It becomes clear that an important factor in learning is the teaching strategy employed, which must be quite diversified, especially in terms of embryology content. Based on the considerations presented, Mello et al. (2010) [9] stated that the teacher should always use alternative methods that help in the teaching-learning process; this will make students more motivated and facilitate the acquisition of more abstract concepts.

The use of innovative technologies applied to the development of student perceptions is of great importance for learning, making some more complex subjects, such as embryology, easy to understand. Within this scenario, the use of different teaching resources in the classroom can be powerful means to promote more effective learning.

Given the above, this study aimed to evaluate the perception of medical students in active methodology on teaching-learning tools in embryology (Model masses, films/videos, elaborate schemes, and plaster models).

2 METHODS

STUDY DESIGN

A descriptive and cross-sectional study was conducted in the laboratories of FACERES school of medicine, in May 2018, among students in the first stage of the course.

STUDY POPULATION AND SAMPLE SIZE

Undergraduate students enrolled in the first semester of the Medicine course at the teaching institution Faculdade Ceres-Faceres, over 18 years old, of both sexes and who consented to participate in the study and who had the content of embryology

in the course load were included in the study. Students from other states that have embryology as pragmatic content were excluded.

The sample size was calculated considering the proportion that maximizes the required sample size through a larger variance [variance of p = p(1-p)] and proportion of p=0.50. Expected frequency = 50%, acceptable margin of error = 5% and 95% confidence interval. Therefore, the study population consisted of a total of 60 medical students from the institution.

DATA COLLECT

Initially, the teaching-learning tools modeling masses, films/videos, elaborate schemes, and plaster models were used in a four-week scheme, once a week, in groups of 5 or 6 students during the embryology module, the first stage in the morphofunctional laboratories (**Table 1**).

Table 1. Tools and development of activities.

TOOLS	*DEVELOPMENT OF ACTIVITIES*
1. Modeling putties	Assembling sequential events such as gastrulation and neurulation and presenting them. They used the malleability of the mass to demonstrate some processes that are difficult to understand, bidirectionally, in books.
2. Movies/videos	They selected films/videos and discussed the content among colleagues. They punctuated the main events and exposed them to the teacher. They used films/videos to follow, mainly, the most dynamic and complex processes.
3. Elaborated schemes	They named the pointed structures and processes and colored the leaflets and their derivatives. They used the boards with sequential schemes to understand the order of events and fix them.
4. Plaster models	They identified the observed structures, attributed functions to them, and established the order of the models based on the events to present them. They used the models to review the sequence of events and the names of important structures.

After the use of each tool and the collection of consents via the Free and Informed Consent Form (ICF), the students individually answered the evaluation questionnaire through Google Forms (Google LLC, California, United States of America), which contained thirteen questions to quantify the degree of satisfaction with each teaching-learning tool, in addition to the possibility of inserting suggestions (the only field available for writing). To answer the questionnaire, the Likert scale was used (from 1 to 5), in which each number means the student's degree of veracity towards

the tool (Table 2).

To quantify the students' evaluation, thirteen questions were applied to each tool, in addition to the possibility for the student to make suggestions (this is the only field, where the academic has the freedom to write), (supplementary material).

Table 2. Questionnaire used for data collection with responses categorized according to a Likert scale (from 1 to 5).

1	The embryology content covered is difficult to understand: • Totally disagree • I disagree • Neither agree nor disagree • I agree • I totally agree
2	The tool used motivated you to study Embryology: • Totally disagree • I disagree • Neither agree nor disagree • I agree • I totally agree
3	The tool is interesting: • Totally disagree • I disagree • Neither agree nor disagree • I agree • I totally agree
4	The tool was easy to use: • Totally disagree • I disagree • Neither agree nor disagree • I agree • I totally agree
5	Would you recommend this tool to a colleague: • Totally disagree • I disagree • Neither agree nor disagree • I agree • I totally agree
6	The tool made it easier for you to learn: • Totally disagree • I disagree • Neither agree nor disagree • I agree • I totally agree
7	It was pleasant: • Totally disagree • I disagree • Neither agree nor disagree: • I agree • I totally agree

8	It was dynamic: • Totally disagree • I disagree • Neither agree nor disagree • I agree • I totally agree
9	Allowed interaction between colleagues: • Totally disagree • I disagree • Neither agree nor disagree • I agree • I totally agree
10	It favored the fixation of the content: • Totally disagree • I disagree • Neither agree nor disagree • Totally agree
11	It favored the observation of the three-dimensionality of embryonic structures: • Totally disagree • I disagree • Neither agree nor disagree • I agree • I totally agree
12	It made possible the association with the theoretical content: • Totally disagree • I disagree • Neither agree nor disagree • I agree • I totally agree
13	It facilitated monitoring the sequence of embryological events: • Totally disagree • I disagree • Neither agree nor disagree • I agree • I totally agree

DATA ANALYSIS

The completed questionnaires were extracted from Google Forms™ and exported to Microsoft Excel 2016. Categorical data were presented as frequencies and percentages, with a definition of mean and standard deviation. The variable “Score” corresponds to the sum of the answers to the 13 questions described. Question 1 was defined on an inverse scale to the others, since, contrary to what happens with the other questions, higher answers indicate dissatisfaction with the tool. The inversion was performed using the formula Y = 6 – X, in which X indicates the value informed by the respondent and Y is the inverted value. Thus, the higher the score, the better the

evaluation of the teaching tool.

As the data were not normal (Shapiro-Wilk test, W = 0.93.73. p < 0.001), equality between the responses for the four tools was tested using the non-parametric Kruskal-Wallis test and p-value < 0.05 was considered statistically significant. Subsequently, the data were coded and exported to the Statistica Program version 7.0 for analysis.

ETHICAL APPROVAL

A study was carried out following the Brazilian National Health Council, Resolution nº 466/212, and approved by the Research Ethics Committee of FACERES school of medicine (nº 4.169.379). All participants who agreed to participate voluntarily provided their consent before participation.

3 RESULTS

A convenience sample of 60 medical students was invited to participate in the study and complete the study questionnaire. The number of participants was different for each type of tool, with 56 responses for modeling clay, and 43 responses for films/videos, followed by 57 and 55 responses for naming and coloring schemes and plaster models, respectively (**Table 3**).

Table 3. Results of the students' perception obtained from the application of the Modeling Putty tool, films/videos, naming and coloring schemes, and plaster models.

Variables	Totally Agree	Disagree	Neither agree nor disagree	Agree	Totally Agree
	n -%	n -%	n -%	n -%	n -%
Modeling Putties					
Modeling Putties	1-1.8%	5-8.9%	20-35.7%	21-37.5%	9-16.1%

The embryology content covered is difficult to understand	4-7.1%	4-7.1%	14-25%	13-23.2%	21-37%
The tool used motivated you to study in Embryology	5-8.9%	6-10.7%	11-19.6%	12-21.4%	22-39.3%
The tool is interesting	3-5.4%	3-5.4%	8-14.3%	17-30.45%	25-44.6%
The tool was easy to use	6-10.9%	7-12.7%	9-16.4%	12-21.85	21-38.2%
Would you recommend this tool to a colleague?	4-7.1%	3-5.4%	14-25%	14-25%	21-37.5%
The tool facilitated your learning	4-7.1%	3-5.4%	14-25%	14-25%	21-37.5%
It was pleasant	4-7.1%	3-5.4%	11-19.6%	20-35.7%	18-32.1%
It was dynamic	1-1.8%	2-3.6%	7-12.5%	15-26.8%	31-55.4%
Allowed interaction between colleagues	0-0%	2-3.6%	2-3.6%	17-30.4%	35-62.5%
It favored the fixation of the content	4-7.3%	5-9.1%	8-14.5%	18-32.7%	20-36.4%
It favored the observation of the three-dimensionality of embryonic structures	2-3.6%	4-7.1%	14-25%	16-28.6%	20-35.7%
It made possible the association with the theoretical content	4-7.1%	3-5.4%	9-16.1%	21-37.5%	19-33.9%
Facilitated monitoring of the sequence of embryological events	3-5.4%	4-7.1%	6-10.7%	17-30.4%	26-46.4%

Movies/Videos

The embryology content covered is difficult to understand	1-2.3%	3-7%	12-27.9%	15-34.9%	12-27.9%
The tool used motivated you to study in Embryology	6-14%	6-14%	12-27.9%	12-27.9%	7-16.3%
The tool is interesting	4-9.3%	8-18.6%	8-18.6%	16-37.2%	7-16.3%
The tool was easy to use	1-2.3%	1-2.3%	10-23.3%	15-34.9%	16-37.2%
Would you recommend this tool to a colleague?	4-9.3%	5-11.6%	11-25.6%	12-27.9%	11-25.6%
The tool facilitated your learning	4-9.3%	7-16.3%	10-23.3%	12-27.9%	10-23.3%
It was pleasant	7-16.3%	9-9.20%	9-20.9%	12-27.9%	6-14%
It was dynamic	5-11.6%	4-9.3%	11-25.6%	13-30.2%	10.23.3%
Allowed interaction between colleagues	9-20.9%	4-9.3%	11-25.6%	8-18.6%	11-25.6%
It favored the fixation of the content	3-7%	5-11.6%	13-30.2%	12-27.9%	10-23.3%
It favored the observation of the three-dimensionality of embryonic structures	0-0%	3-7%	12-27.9%	11-25.6%	17-39.5%
It made possible the association with the theoretical content	0-0%	7-16.3%	10-23.3%	12-27.9%	14-32.6%
Facilitated monitoring of the sequence of embryological events	0-0%	4-9.3%	10-23.3%	13-30.2%	16-37.2%

Elaborate Schemes

The embryology content covered is difficult to understand	3-5.3%	4-7%	13-22.8%	18-31.6%	20-35.1%
The tool used motivated you to study in Embryology	1-1.8%	3-5.3%	15-26.3%	19-33.3%	19-33.3%
The tool is interesting	1-1.8%	2-3.6%	9-16.1%	21-37.5%	23-41.1%
The tool was easy to use	5-8.8%	6-10.5%	15-26.3%	14-24.6%	17-29.8%
Would you recommend this tool to a colleague?	1-1.8%	5-8.8%	12-21.1%	20-35.1%	19-33.3%
The tool facilitated your learning	2-3.5%	3-5.3%	9-15.8%	22-38.6%	21-36.8%
It was pleasant	5-8.8%	3-5.3%	18-31.6%	24-42.1%	7-12.3%

It was dynamic	3-5.3%	2-3.5%	13-22.8%	25-43.9%	14-24.6%
Allowed interaction between colleagues	1-1.8%	1-1.8%	8-14%	26-45.6%	21-36.8%
It favored the fixation of the content	2-3.5%	3-5.3%	10-17.5%	24-42.1%	18-31.6%
It favored the observation of the three-dimensionality of embryonic structures	4-7%	9-15.8%	15-26.3%	21-36.8%	8-14%
It made possible the association with the theoretical content	1-1.8%	5-8.8%	9-15.8%	24-42.1%	18-31.6%
Facilitated monitoring of the sequence of embryological events	1-1.8%	4-7%	11-19.3%	27-47.4%	14-24.6%
Gypsum Models					
The embryology content covered is difficult to understand	1-2.3%	3-7%	12-27.9%	15-34.9%	12-27.9%
The tool used motivated you to study in Embryology	6-14%	6-14%	12-27.9%	12-27.9%	7-16.3%
The tool is interesting	4-9.3%	8-18.6%	8-18.6%	16-37.2%	7-16.3%
The tool was easy to use	1-2.3%	1-2.3%	10-23.3%	15-34.9%	16-37.2%
Would you recommend this tool to a colleague?	4-9.3%	5-11.6%	11-25.6%	12-27.9%	11-25.6%
The tool facilitated your learning	4-9.3%	7-16.3%	10-23.3%	12-27.9%	10-23.3%
It was pleasant	7-16.3%	9-9.20%	9-20.9%	12-27.9%	6-14%
It was dynamic	5-11.6%	4-9.3%	11-25.6%	13-30.2%	10.23.3%
Allowed interaction between colleagues	9-20.9%	4-9.3%	11-25.6%	8-18.6%	11-25.6%
It favored the fixation of the content	3-7%	5-11.6%	13-30.2%	12-27.9%	10-23.3%
It favored the observation of the three-dimensionality of embryonic structures	0-0%	3-7%	12-27.9%	11-25.6%	17-39.5%
It made possible the association with the theoretical content	0-0%	7-16.3%	10-23.3%	12-27.9%	14-32.6%
Facilitated monitoring of the sequence of embryological events	0-0%	4-9.3%	10-23.3%	13-30.2%	16-37.2%

Table 4 shows that the mean scores were higher and lower for plaster casts and films/videos respectively.

Table 4. Descriptive statistics of the "Score" variable for each of the teaching-learning tools.

Tools	*Mean*	*Minimum*	*Maximum*	*Standard Deviation*
Modeling Putties	49.55357	17.00000	65.00000	11.47950
Movies/Videos	44.46512	19.00000	63.00000	10.80200
Elaborated Schemes	47.98246	13.00000	62.00000	9.601881
Gypsum Models	54.16071	24.00000	63.00000	9.773390

Table 5 presents the sum of the scores, the sample size for the four groups and the

test result (H = 26.25826; p < 0.001) indicates that there is a difference between the four groups representing the greatest satisfaction for the models tool in plaster.

Table 5. Sum of the study participants' satisfaction scores, the sample size for the four groups (p < 0.001).

Tools	*N*	*Sum of Scores*
Modeling Putties	56	6136.500
Movies/Videos	43	3342.500
Elaborated Schemes	57	5390.000
Gypsum Models	56	7709.000

Kruskal-Wallis ANOVA by Ranks; Escore (Spreadsheet1) Independent (grouping) variable: Ferramenta Kruskal-Wallis test: H (3, N= 212) =26.25827 p =.0000

The “Gypsum Models” was the tool that was best evaluated by the study participants, followed by “Modelling Masses”, “Elaborated Schemes”, and finally “Films/Videos”. This result can be represented by the table below (**Table 6**), which presents the multiple comparisons between the scores of the four groups, it was identified that the differences occur when we compare the film/video and plaster modeling groups (p<0.001) and when elaborated schemes and plaster modeling were compared (p<0.001), that is, the research participants point out that the “Gypsum Models” tool is significantly different from the “Films/Videos” and “Elaborated Schemes” tools.

Table 6. Comparison between p-values of scores and between teaching and learning tools.

Teaching-learning tools	*Modeling putties*	*Films/ Videos*	*Elaborated schemes*	*Gypsum Models*
Modeling Putties		0.062715	1.000000	0.092555
Movies/Videos	0.062715		1.000000	0.000009
Elaborated Schemes	1.000000	1.000000		0.001130
Gypsum Models	0.092555	0.000009	0.001130	

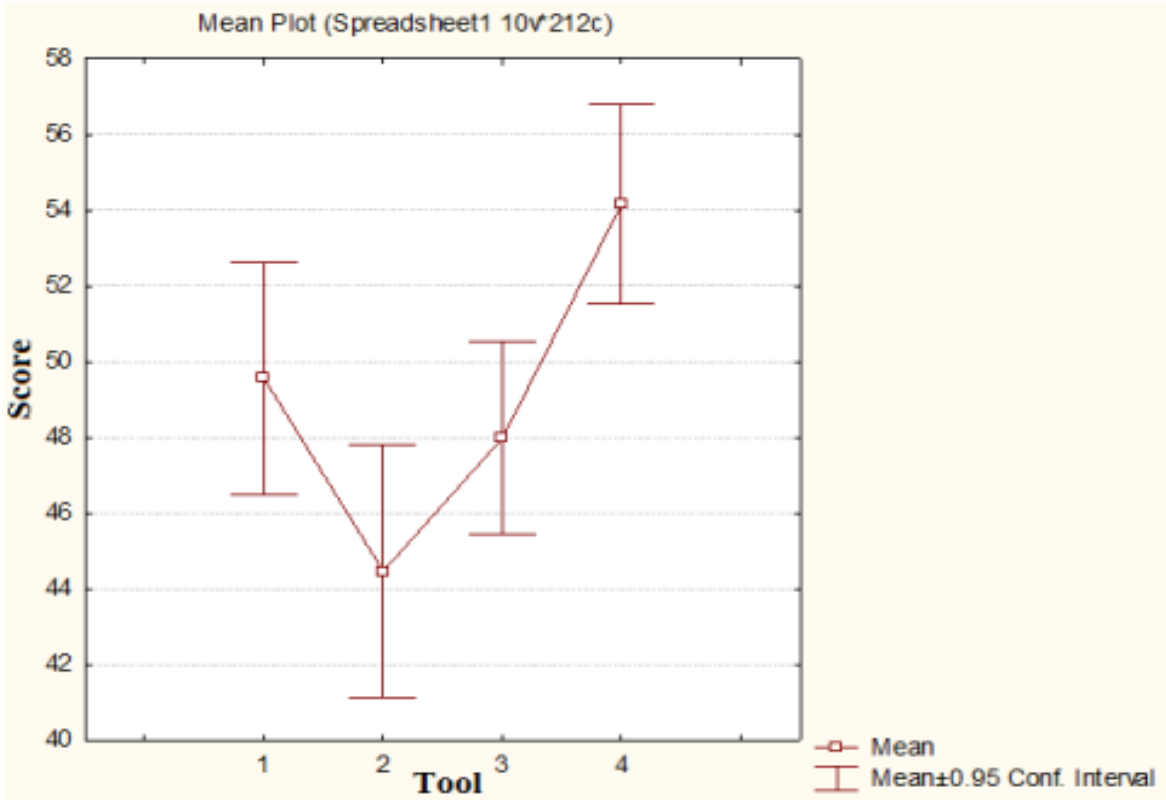
Multiple Comparisons p values (2-tailed); Escore (Spreadsheet1) Independent (grouping) variable: Ferramenta Kruskal-Wallis test: H (3, N= 212) =26.25827 p =.0000

In general, the students agreed that the subject is difficult to understand, but

the plaster model tool facilitated learning because it is easy to handle, dynamic and three-dimensional projection. And most disagree that it was not very useful in all criteria. While in the field of suggestions for the Films/v tool, the following was observed: “There is none”; “Theoretical class on this subject to improve students' understanding”; “That I could do at home."; “I preferred the dough”.

Also, the students agreed that the subject is difficult to understand and that this tool is useful, but it was not as effective for learning as the previous one, as it notoriously did not help much in fixing the content. In the naming and coloring schemes tool, it was mentioned that such a tool was useful for facilitating its learning, being mainly easy to use and interesting. The best qualitative assessment of the teaching tools was also represented by the plaster models that were received as adjectives: dynamic, interesting, facilitates the fixation of the content, and easy to handle. The graph below shows the mean and 95% confidence intervals for the four tools (**Figure 1**).

Figure 1. The plot chart shows the mean and the 95% confidence interval for the four tools.



Legends: 1: Modeling Putties; 2: Films/Videos; 3: Elaborated Schemes; 4: Gypsum Models.

4 DISCUSSION

This study identified the perception of college medical students who adopt the active methodology of teaching tools in the area of embryology. In the literature, most studies propose the use of tools that stimulate the visual as facilitators of the teaching-learning process. In the present study, the comparison between four different tools allowed us to identify plaster models as the ones preferred by medical students in their initial phase of graduation.

All the tools were considered by the students as interesting, pleasant, dynamic, and for socialization among colleagues, with the “Gypsum Molds” being the best evaluated, thus highlighting the importance of handling materials and three-dimensionality for understanding embryology. In addition, the importance of study groups (interaction between students) for the sharing of knowledge was remarkable, guaranteeing the greatest interest of students.

Besides, Freitas et al. (2008)[10] highlight the importance of three-dimensional models by stating that these models fill the space between theory and practice, allowing an inductive analytical relationship of reality. The use of biscuit to work with the complex and abstract contents of embryology allowed students to mold the structures and simulate the morphogenetic movements so expressive in development and, therefore, form mental images closer to the real dynamic structures that succeed in the embryological period, making learning more meaningful, in addition to developing skills such as cooperation and creativity [11,12].

Some authors advocate the need to combine text and image, in addition to other complementary tools [13]. However, illustrations are considered one of the most important tools to facilitate both the understanding of the topic and the fixation on the matter [3]. So, it is right to say that images always help in understanding texts. However, some care must be taken, as the presence of a large number of technical terms and images can be harmful if they contain unnecessary information for

understanding the topic, which can overload the student's cognitive system. On the other hand, terms and images, which help in understanding the conceptual aspects addressed, can contribute in an essential way to learning. Therefore, the analysis of image quality is essential to define its potential as a teaching tool [7,11].

In the present study, the complexity of the embryology content identified by the participants is related to the real increase in the difficulty of the content during the classes, thus, the use of tools that can facilitate the teaching-learning process is valued. Elias and Carneiro (2017) [14], in an interdisciplinary proposal, together with the students, built a giant carpet from diversified materials where the stages of embryonic development were portrayed. With this activity, students recognized the importance of dialogue between theory and practice in a creative proposal for the unification of art with the concepts of embryology. The present study did not bring information about the theory and also, unlike the literature, it analyzes the perception of students from a higher education institution that adopts the active methodology.

In the field of suggestions that was opened to students in the questionnaire used, theoretical classes were requested, reinforcing the degree of difficulty they had in understanding the content from the videos. Thus, the tool was considered insufficient for beginner students who have difficulty understanding the subject. The “Films and videos” tool was the most criticized by the students, so it is suggested that the teacher selects films/videos, since the student’s difficulty in selecting these quality resources and with a viable duration in the course was noticed class period.

In the same sense, some authors report that the difficulty can be justified by abstract concepts to the high complexity of embryology, from the microscopic character of the structures to the absence of adequate teaching resources [8,15]. In these aspects, the “Films and Videos” tool also may have failed by not showing the details of the structures or presenting them in scenes that were too fast, making understanding unfeasible. Casas and Azevedo (2011) [5] created a playful material in the form of didactic games with low-cost and easily accessible materials that help the teacher in the teaching of human embryology, the tool “Schemas to name and color” also has creativity, practicality, and playfulness. However, the results of the present study value the authors' reporters who reported that the stages of human development,

even if described superficially, are complex and rich in details, and can be considered a factor of difficulty in the teaching-learning process of human embryology [5-7,9,13,16], therefore, the scheme for naming and coloring highlights the student's difficulties in presenting complex drawings with many structures.

For the best use of the tool “Schemas to name and color” it is suggested a readjustment considering the observations of the students in the classroom, to better present the sequence of embryological events. However, after remodeling, the tool should be tested again, since it is known that images play a central role in the conception of memory, which is a set of mental images of sensual impressions, but with a temporal component. Furthermore, the authors claim that images are more easily remembered than their corresponding verbal representations, which favors learning [17]. The tool “Gypsum models” was the one that most aroused the interest of the students and was the best evaluated by them. Elias and Carneiro (2017) [14] were successful in building a giant rug with their students, demonstrating the importance of the association between theory and practice in an artistic/manual activity; Likewise, using the “Gypsum Models” tool, students were able to associate their knowledge, interact with each other and show interest in play by asking to paint the models. However, the painting of plaster pieces by students is only possible in extracurricular activities, as it requires time and craft skills since these pieces are part of a permanent collection of the institution.

The “Gypsum Models” were considered easy to use and understand, favored by the beauty of the colored pieces and the richness of dimensions; students felt motivated to study embryology. The three-dimensionality of the pieces was the item that most favored this tool, a fact confirmed by several authors when they report that the use of three-dimensional didactic models, to assist in the teaching and learning process of embryology, brings students closer to the microscopic reality of the structures that many sometimes it seems abstract [3,7,10,11,18]. The plaster models make the student a better understanding of the events, precisely because they are manageable, facilitating the observation of structures and embryological events from all sides or angles; that is, observing the embryo from the dorsal and ventral views; or even cranial and caudal.

Freitas et al. (2008) [10] reported that 3D models are of real importance in learning in embryology, as they fill the gap between theory and practice, making the understanding of this subject easier as these models resemble the reality of embryological events. However, the originality and representativeness of the "Gypsum Models" make this tool considered by the students the best teaching-learning technique, precisely because it better evidence and guarantees the three dimensionality of embryological structures and events. Despite this, all teaching-learning tools were evaluated as being subject to indication and being able to be used for learning embryology in different

aspects. However, it is important to emphasize the individuality of each student, since each individual has their abilities and preferences, which makes it increasingly necessary to develop teaching tools and assessment instruments.

5 CONCLUSION

This study provided students with the analysis of different methods to achieve effective embryology learning. All tools were considered efficient and interesting by most students; however, the teaching-learning tool "Gypsum models" was considered the most effective, mainly due to the guarantee of the three-dimensionality of the structures. It also made it possible to verify the need for study tools with fewer technical terms, less complex images, and selection of information, respecting the need of the first-semester student.

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Not applicable.

ETHICS APPROVAL

A study was carried out following the Brazilian National Health Council,

Resolution nº 466/212, and approved by the Research Ethics Committee of FACERES school of medicine (nº 4.169.379).

INFORMED CONSENT

All participants who agreed to participate voluntarily provided their consent before participation.

DATA SHARING STATEMENT

No additional data are available.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

SIMILARITY CHECK

It was applied by Ithenticate@.

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REFERENCES

1. Moore KL, Persaud TVN, Torchia MG. Embriologia Clínica. 10aed. Rio de Janeiro: Elsevier; 2016.

2. Schoenwolf GC, Bleyl SB, Brauer PR, Francis-West PH. Larsen - Embriologia Humana. 5a ed. Rio de Janeiro: Elsevier; 2016.

3. Meira MS. O uso de modelos tridimensionais no ensino de embriologia humana: contribuição para uma aprendizagem significativa. (Dissertação de doutorado em Ciências: Química da Vida e Saúde). Universidade Federal de Santa Maria, Rio Grande do Sul; 2015.

4. Oliveira MS, Kerbauy MN, Ferreira CNM, Schiavão LJV, Andrade RFA, Spadella MA. Uso de material didático sobre embriologia do sistema nervoso:

Avaliação dos estudantes. Rev Br Ed Med, 2012; 36 (1), 83-92. doi: http://dx.doi.org/10.1590/S0100-55022012000100012

5. Casas LL, Azevedo ROM. Contribuições do jogo didático no ensino de embriologia. Rev. Areté/ Rev. Amazônica de Ensino de Ciências. 2011; 4(6), 80-91. Recuperado de http://periodicos.uea.edu.br/index.php/arete/article/view/17

6. Netto CG. E-book sobre embriologia humana tem casos clínicos. Jornal da Unicamp, 2014; 9(9). Recuperado em http://www.unicamp.br/unicamp/sites/default/files/jornal/paginas/ju_615_paginacor_09_we b.pdf

7. Palhano JS, Costa MDM. A construção de modelos didáticos com materiais diversificados para o estudo da embriologia. (Produção didático-pedagógica). Universidade Estadual de Ponta Grossa, Paraná; 2014

8. Allen M, Bourhis J, Burrell N, Mabry E. Comparing student satisfaction with distance education to traditional classrooms in higher education: a meta analysis. Am J Dist Educ. 2002;16(2):83-97.

9. Mello JM, Alves AMP, Bespalhok DN, Torrejais MM, Puerari IF. Sondagem das condições didático pedagógicas do ensino de embriologia humana no ensino fundamental e médio. Arq Mudi, 2010; 14(1/2/3), 1-10. doi: http://dx.doi.org/10.4025/arqmudi.v14i1/2/3

10. Freitas LAM, Barroso HFD, Rodrigues HG, Aversi-Ferreira TA. Construção de modelos embrionários com material reciclável para uso didático. Biosc J. 2008; 24(1), 91-97. Recuperado de http://www.seer.uful.br/index.php/biosciencejournal/article/download/6732/4443

11. Oliveira AA. Construção de modelos didáticos para o ensino do desenvolvimento embrionário humano. Arq MUDI, 2015; 19(1), 1-10. doi: http://dx.doi.org/10.4025/arqmudi.v19i1.28172 12. Paula L, Reis MM, Rodovalho ARS, Guimarães GS, Campos MR. Modelos em biscuit: uma ferramenta para o ensino de embriologia. (Artigo produzido para o Congresso Nacional de Ensino de Ciências e Formação de Professores - CECIFOP). Universidade Federal de Goiás, Regional de Catalão; 2017. http://cecifop.sistemasph.com.br/index.php/cecifop/CECIFOP2017/paper/download/149/27 3

12. Matos AM, Coutinho FA, Chaves ACL, Costa FJ,Amaral FC. Referenciais teórico metodológicos para a análise da relação texto-imagem do livro didático de biologia: Um estudo sobre o tema embriologia. RBECT. 2010; 3(1), 92-114. DOI: 10.3895/S1982- 873X2010000100006

13. Elias MA, Carneiro FT. Instalação artística como ferramenta interdisciplinar para o ensino de desenvolvimento embrionário. Arq MUDI, 2017; 21(1), p.14-18. http://periodicos.uem.br/ojs/index.php/ArqMudi/article/view/36917/pdf

14. Vlnieska V. Aplicando diferentes recursos didáticos: uma avaliação de aprendizagem em embriologia. (Trabalho de conclusão do curso de Ciências Biológicas). Universidade Federal do Paraná. Curitiba; 2013

15. Montanari T. Dispositivos móveis e modelagem no ensino de embriologia. Renote, 2017; 15(2). http://dx.doi.org/10.22456/1679-1916.79182

16. Cornelsen EL, Vieira EMA, Seligmann-Silva M. Imagem e memórias. Belo Horizonte: FALE/UFMG; 2012.

17. Aversi-Ferreira TA, Aversi-Ferreira RAGMF, Nascimento GNL, Nyamdavaa N, Araujo MF, Ribeiro PP et al. Teaching embryology using models construction in practical classes. Int J Morphol. 2012; 30(1), 188-195. doi: http://dx.doi.org/10.4067/S0717-95022012000100034