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The use of YouTube as a pedagogical tool in the teaching of embryology: an analysis of an active methodology in a medical course.

Use of YouTube as a pedagogical tool in embryology teaching: analysis of an active learning methodology in a medical course

Use of YouTube as a pedagogical tool in embryology teaching: analysis of an active methodology in the medical course

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SUMMARY:

Embryology is recognized as a discipline of high cognitive complexity due to its abstract, dynamic, and three-dimensional nature, which hinders the teaching-learning process in health science courses. In this context, the use of Information and Communication Technologies (ICTs), associated with active methodologies, can favor a greater understanding of embryological phenomena. This study aimed to evaluate the applicability of the flipped classroom, associated with the use of YouTube as a pedagogical tool, in the teaching of embryology. This is a longitudinal and quantitative educational intervention study, carried out with approximately 60 first-year medical students from a higher education institution in Juiz de Fora, Minas Gerais. Two pedagogical moments were compared: the traditional class and the flipped classroom.

The active methodology was based on the critical analysis of pre-selected YouTube videos, followed by group presentations. Student performance was assessed using pre- and post-intervention questionnaires containing five low-taxonomy questions. Statistical analysis was performed using the Mann-Whitney test. There was no significant difference in performance before and after the traditional lesson ($p = 0.1434$). In the active methodology, a significant difference was observed between the pre- and post-tests ($p < 0.0001$), however, with lower performance after the intervention.

Despite this, the comparison between the post-tests indicated superior performance in the active methodology ($p < 0.0001$). It is concluded that the intentional use of YouTube, associated with teacher mediation and active learning, has potential for application in the teaching of embryology.
Keywords: Embryology, Active Methodologies, Medical Education, YouTube, Educational Technologies.

ABSTRACT:

Embryology is recognized as a discipline of high cognitive complexity due to its abstract, dynamic, and three-dimensional nature, which makes the teaching-learning process challenging in health-related courses. In this context, the use of Information and Communication Technologies (ICTs) associated with active learning methodologies may promote a better understanding of embryological phenomena. This study aimed to evaluate the applicability of the flipped classroom model, using YouTube as a pedagogical tool, in Embryology teaching. This was a longitudinal quantitative educational intervention study conducted with approximately 60 first-semester medical students from a higher education institution in Juiz de Fora, Minas Gerais, Brazil. Two pedagogical approaches were compared: traditional lecture-based teaching and an active methodology that involved the critical analysis of selected YouTube videos, followed by group presentations. Student performance was assessed using pre- and post-intervention questionnaires containing five low-level taxonomy

questions. Statistical analysis was performed using the Mann-Whitney test. No significant difference was observed between performance before and after the traditional lecture ($p = 0.1434$). In the active methodology, a statistically significant difference was found between the pre- and post-test results (p

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< 0.0001), although performance was lower after the intervention. However, comparison between the post-tests demonstrated superior performance in the active methodology context (p < 0.0001). It is concluded that the intentional use of YouTube, associated with teacher mediation and active learning, presents potential applicability in Embryology teaching.
Keywords: Embryology, Active Methodologies, Medical Education, YouTube, Educational Technologies.

1. INTRODUCTION

Truly effective teaching is not based solely on the quantity of content.
whether it's taught or the complexity of the methods employed, but above all, it's in the way the student...
understands, assimilates, and incorporates knowledge into their cognitive repertoire (Freire, 1996). In
In 2020, the COVID-19 pandemic forced the suspension of in-person activities in institutions of
teaching at all levels, requiring rapid adaptation to remote learning as a strategy to ensure
academic continuity (Hodges, 2020). This modality has proven advantageous in several
contexts, by providing greater autonomy and control over the pace of study, in addition to promoting
self-regulation, motivation, and the active pursuit of knowledge beyond the formal learning environment.
(Murad, 2010; Wilkes, 2026).

In this scenario, when faced with the challenge of reorganizing their pedagogical practices, the institutions
Higher education institutions have begun to incorporate Information Technologies in a more structured way.
and Communication Technologies (ICTs) in the teaching-learning process (Hodges, 2020; Means, 2014). With the
With expanded internet access, students now have access to a large volume of information.
although not all of them present scientific reliability, which makes the development of
Critical thinking is essential for the selection, analysis, and validation of consulted sources (Wineburg, 2019).
In this way, the student assumes a more active role in constructing their own learning, strengthening
their autonomy, protagonism and engagement in active learning strategies (Murad, 2010;
Taylor, 2023).

The use of ICTs presents itself as a viable strategy to assist in the process of
assimilation of content, especially in disciplines with high conceptual abstraction, such as
Embryology. This discipline is dedicated to the study of the formation and development of the individual.
contemplating its morphological and functional transformations from fertilization to birth.
(Moore, 2020; Sadler, 2021). However, the changes that occur in the intrauterine environment are
fast, dynamic and often simultaneous, requiring the student to have the ability to
understanding processes from a three-dimensional and temporal perspective can make it difficult to...
learning and causing demotivation (Abdel, 2022; Carlson, 2019).

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2. THEORETICAL FRAMEWORK

In the post-pandemic period, various pedagogical tools and protocols began to be used.
ICTs in a more strategic way, with the aim of increasing retention and understanding of
content considered complex (Means, 2014; Taylor, 2023). Among these initiatives, the following stand out.
the protocol proposed by Netto et al. (2025), which incorporates YouTube as a pedagogical tool
in health science courses, with an emphasis on the subject of embryology.

The aforementioned protocol is based on the wide availability of audiovisual materials in
The YouTube platform and its frequent use by students, exploring its potential as
a supplementary resource in the teaching of embryology and, possibly, in other disciplines in the field of
health (Mathew, 2024; Pradhan, 2024). By integrating previously selected videos into a
Using a structured active methodology, the proposal seeks to promote the visualization of processes.
embryological, to broaden student interaction and strengthen the consolidation of knowledge (Mathew,
2024; Netto, 2025). Despite its innovative and promising nature, this strategy has not yet been implemented.
subjected to formal scientific validation, which highlights the need for systematic investigation of
its effectiveness.

In this context, the purpose of this study is to evaluate whether the implementation of a
Active methodology, based on the flipped classroom and associated with the use of YouTube as a tool.
From a pedagogical standpoint, it is capable of improving the teaching-learning process in embryology. To achieve this,
The aim is to analyze student performance before and after its application, as well as to investigate its...
impact on content retention and comprehension.

3. MATERIALS AND METHODS

This is an educational intervention study, of a quasi-experimental nature and
longitudinal, with a quantitative approach, whose objective was to evaluate the effectiveness of a methodology.
Active learning applied to the teaching of embryology.

The sample consisted of approximately 60 students regularly enrolled in
first semester of the Medicine course and in the subject of Embryology, at an educational institution.
higher education institution located in Juiz de Fora, Minas Gerais, Brazil. Students from other institutions were excluded.
periods or courses, as well as those who did not agree to participate in the research. The study was approved by the
Research Ethics Committee (CEP), under CAAE 84632324.5.0000.5103, according to
Resolution No. 466/12 of the National Health Council (Brazil, 2013), and was made available to
Participants must sign the Free and Informed Consent Form (TCLE).

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The experimental design comprised two comparative stages. Initially, it was
A pre-intervention questionnaire related to Theme A was applied, containing five low-level questions.
taxonomy, with the aim of assessing the students' prior knowledge. Then, it was
A lecture was given following the traditional teaching model, and subsequently...
A post-intervention questionnaire was administered on the same topic, also with five questions.
Low taxonomy, to measure the effectiveness of the traditional methodology.

In the next stage, the proposed active methodology, related to Theme B, was evaluated.
Initially, a pre-intervention questionnaire was administered, followed by dividing the class into ten groups.
Groups, with approximately six students each, conducted critical analyses of videos.
previously selected by the teacher on the YouTube platform and, after a week, presented
The topics discussed were covered in class. At the end of the activity, a post-activity questionnaire was administered.
This intervention allowed for a comparison of the results with those obtained using the traditional methodology.

Data collection was carried out using questionnaire templates, and the results were...
organized in a Microsoft Excel spreadsheet. The statistical analysis compared the performances before
and post-intervention, regardless of the methodology, as well as the results between the
Traditional and active methodologies were used to verify the existence of statistically significant differences.
significant.
Since the instruments were analyzed in a non-paired manner, the Mann-Whitney test was used.
to compare performance distributions, although it is recognized that paired analyses
They would offer greater inferential accuracy.

4. RESULTS AND DISCUSSION

The study included students regularly enrolled in the first semester of the course.
In Medicine, with variations in the number of respondents between different evaluation periods, the
which is expected in educational studies conducted in real classroom settings. In the pre-test
In Group A, 53 students participated; in post-test A, 57; in pre-test B, 49; and in post-test B, 35.

Overall, the descriptive results indicated distinct performance patterns among the
traditional and active methodologies. In Theme A, corresponding to the traditional approach, it was observed...
Predominance of low scores in both the pre-test and post-test, with concentration of students
in the lower accuracy ranges. This pattern suggests maintaining similar performance both before
how long after the lecture.

In Theme B, corresponding to the proposed active methodology, the performance observed in the pre-
The test showed a higher distribution of correct answers compared to the other test times.

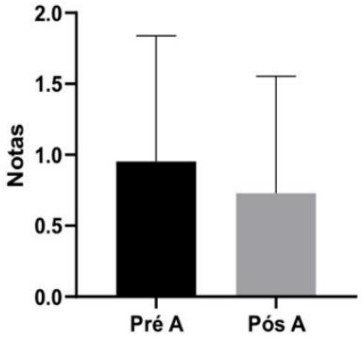
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evaluative. However, in post-test B, a redistribution of scores to ranges was observed.
Intermediate and lower performance levels, with a reduction in the frequency of higher results.

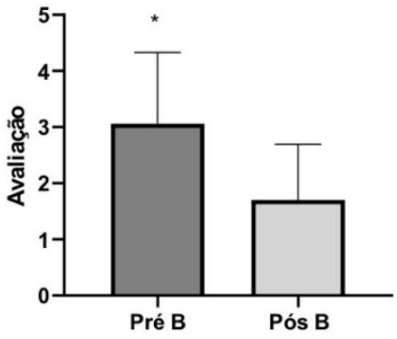
Statistical analysis showed that there was no significant difference between the scores of
students who took pre-test A and post-test A. In other words, when comparing the
Regarding student performance before and after the traditional lesson, behavior was observed.
statistically similar in both evaluation moments (Graph 1).



Mann Whitney test
P value 0,1434

Graph 1: Comparison of the scores of students who took pre-test A (prior test).
to the classroom) and to post-test A (test after the traditional classroom). Statistical test applied: Mann-Whitney.
p-value = 0.1434.

Conversely, when comparing the students' performance on pre-test B and post-test B,
A statistically significant difference was found between the two time points (Graph 2). However,
This difference occurred in the opposite direction to what was expected, since the performance observed in the post-
The test result was lower than that recorded in the pre-test.



Mann Whitney test
P value <0,0001

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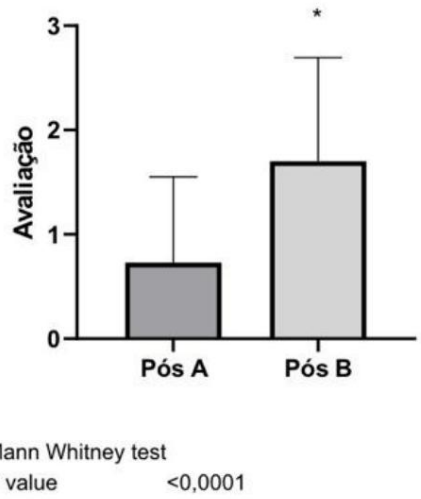
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Graph 2: Comparison of the scores of students who took pre-test B (prior test).
to the proposed methodology) and to post-test B (test after applying the proposed methodology). Test
Applied statistical test: Mann-Whitney. p-value < 0.0001.

Despite this finding, the comparison between the performances obtained in post-tests A and B
showed a statistically significant difference, indicating superior student performance.
Students who were subjected to the active methodology compared to those evaluated after the traditional lesson (Graph 3).

Figure 3: Comparison between post-test A and post-test B. Statistical test applied: Mann-



Whitney. p-value < 0.0001.

Taken together, the results suggest that, although the active methodology did not produce
There was an improvement in immediate performance when comparing the pre-test and post-test of Theme B.
The final performance observed after its application was superior to that obtained with the traditional approach.

These findings should be interpreted in light of the conditions under which the instruments were applied and
the characteristics of the study design, and discussed in greater depth in the following section.

The results of this study allow for relevant reflection on the use of methodologies.
active ingredients associated with Information and Communication Technologies (ICTs) in the teaching of Embryology,
a discipline traditionally recognized for its high degree of abstraction, temporal dynamism and
The need for three-dimensional spatial reasoning. These characteristics make learning
embryological studies are particularly challenging for students entering health-related courses.
especially in the early stages of medical training, when they are still in the process of
Adaptation to the cognitive demands of higher education in health. Recent studies indicate that...
Embryology remains one of the basic curricular components with the highest demand for
Visualization strategies, clinical integration, and active pedagogical mediation, especially in curricula.
contemporary approaches based on competencies and meaningful learning (Abdel, 2022; Mathew,

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2024).

In the present study, the traditional teaching methodology, represented by a lecture-based class, followed by post-intervention assessment, no statistically significant difference was found in Student performance before and after the activity. This finding suggests that, under the conditions in which Although the intervention was applied, oral exposure alone may not have been sufficient to promote gain. measurable immediate learning. This result aligns with the literature on health education. which indicates that models focused predominantly on content transmission tend to to have less impact when compared to approaches that require active participation from student, information retrieval, group discussion and shared construction of meaning (Heck, 2023; Bingen, 2023).

In contrast, the strategy based on active methodology, associated with the use of YouTube. As a teaching resource, it showed superior performance compared to the post-test of the approach. traditional. This finding is relevant because it suggests that the combination of flipped classroom, analysis Critique of videos and presentations in small groups can foster more favorable pedagogical conditions. compatible with the cognitive complexity of embryology. The use of audiovisual resources tends to This will especially benefit content characterized by movement and morphological transformation. sequential and spatial representation needs, such as embryonic folding, neurulation, organogenesis and septations. Furthermore, the group format can enhance learning through through peer explanation, negotiation of meanings, and consolidation of knowledge of active verbalization (Mathew, 2024).

However, these results should be interpreted with caution. Although it has been A significant difference was observed between pre-test B and post-test B; this difference occurred in the direction... Contrary to expectations, with performance decreasing after the intervention. This finding, at first glance Paradoxically, this does not necessarily invalidate the pedagogical proposal, but it does indicate that the performance The immediate effects on students can be influenced by contextual variables that go beyond the direct effect. of the teaching strategy. A plausible hypothesis is the occurrence of cognitive fatigue, since the The post-test was administered after the classroom presentations, a time potentially associated with fatigue. to reduced sustained attention and decreased performance in rapid recall tasks. In scenarios In educational settings, especially in initial medical school classes, performance on short tests can be... sensitive to the timing of the application, the level of accumulated demands, and the student's attentional state. (Lindner, 2025).

Furthermore, it is important to consider that active methodologies do not always produce improvement. immediate in point-in-time assessments of low taxonomy, especially when the learning process It emphasizes understanding, integration, and critical elaboration. In many cases, the main gain...

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The pedagogical value of these approaches may lie less in immediate memorization and more in...
development of autonomy, self-regulation, qualified information seeking and retention of medium-level knowledge
deadline. The literature in health education has shown that student-centered strategies
They often deliver significant benefits in engagement, motivation, and learning.
self-regulated, although such gains are not always fully captured by short instruments,
immediate and predominantly cognitive of low complexity (Wilkes, 2026).

Another central aspect of this discussion concerns the use of YouTube as a tool.
The platform is widely used by students in the health field as an educational resource.
supplementary learning, especially in visual subjects such as Anatomy and
Embryology. Its accessibility, multimodal language, and potential for repetition favor review.
autonomous content and learning at an individual pace. However, literature also
This demonstrates that the quality of the available videos is heterogeneous, with variations in accuracy.
scientific rigor, reliability of sources, depth of content, and pedagogical suitability (Sivri,
2026). In this sense, the distinguishing feature of the methodology tested in this study does not seem to reside solely in
use of the platform itself, but above all, in the teacher's curation of videos, in the critical mediation of
content and the transformation of audiovisual resources into a structured learning activity.
active. This pedagogical mediation is essential for YouTube to cease being just a tool.
from passive consumption and become a formative device.

Therefore, although the results do not allow for a definitive validation of
The methodology, based on rigorous experimental tests, offers initial evidence supporting its
pedagogical applicability in the teaching of embryology. The data suggest that the strategy based on
The flipped classroom, with critical analysis of pre-selected videos, can represent a
a relevant teaching alternative, particularly for promoting greater student protagonism and interaction.
peer interaction and visual support for complex content.

However, the interpretation of these findings must take into account certain methodological limitations.
Among them, noteworthy examples include the unpaired analysis of instruments and the use of distinct themes in...
comparative methodologies, the variation in the number of participants between different time points.
evaluative methods and the use of questionnaires composed of only five questions with low taxonomy, which
This can limit the sensitivity to detect more complex learning gains. Thus, studies
Future studies should seek more robust methodological designs, with randomization or matching.
individual, application of the same theme in comparative methodologies, use of instruments
validated at different taxonomic levels and including medium- and long-term retention measures
deadline. It would also be advisable to incorporate a qualitative assessment of student perception, the
In order to understand not only performance, but also the impact of strategy on motivation,

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in cognitive safety and in the learning experience.

FINAL CONSIDERATIONS

This study suggests that the use of YouTube as a pedagogical tool, when
When combined with active learning methodologies and teacher-led guidance, it can make a significant contribution to...
teaching embryology. Although the results do not allow for a definitive validation of
Regarding the proposed strategy, the findings point to its potential pedagogical applicability, especially in supporting the understanding of complex and visually dynamic content. Future studies, with
More robust methodological designs are needed to further evaluate their
effectiveness.

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