ABSTRACT

Critical thinking (CT) is an important issue in the development of professional competencies, but it is still poorly systematised in medical curriculum. The aim of this study was to observe the performance of unimodal and multimodal triggers in eliciting CT among 3rd-year medical students. Methodology: the study carried out a quantitative method study using twenty-eight students’ data related to two groups with different educational instruments: Euthanasia written vignette (EWV) + Anti-vaccine multimodal video (AMV) and Anti-vaccine written vignette (AWV) + Euthanasia multimodal video (EMV). Results: Multimodal triggers performance was superior in compared to written vignette (p=0.004) regarding the greater power of mobilizing
knowledge to respond appropriately to the items and enhance critical thinking. Conclusion: Multimodal triggers show promising results in enhancing critical thinking.

**Keywords:** curriculum, critical thinking, higher education, medical education, professional training, semiotic.

**RESUMO**

O pensamento crítico (TC) é uma questão importante no desenvolvimento de competências profissionais, mas ainda é pouco sistematizado no currículo médico. O objetivo deste estudo foi observar o desempenho de gatilhos unimodais e multimodais na indução do TC entre estudantes de medicina do terceiro ano. Metodologia: o estudo foi realizado com base em um método quantitativo, usando dados de vinte e oito alunos relacionados a dois grupos com diferentes instrumentos educacionais: vinheta escrita sobre eutanásia (EWV) + vídeo multimodal antivacina (AMV) e vinheta escrita sobre antivacina (AWV) + vídeo multimodal sobre eutanásia (EMV). Resultados: O desempenho dos gatilhos multimodais foi superior em comparação com a vinheta escrita ($p=0,004$) em relação ao maior poder de mobilização do conhecimento para responder adequadamente aos itens e aprimorar o pensamento crítico. Conclusão: Os gatilhos multimodais mostram resultados promissores no aprimoramento do pensamento crítico.

**Palavras-chave:** currículo, pensamento crítico, ensino superior, educação médica, treinamento profissional, semiótica.

**1 INTRODUCTION**

This research aims to verify the behaviour and effectiveness of unimodal (written) textual triggers and multimodal (audio-visual) videos in the Critical Thinking development of third-year medical students in Brazil.

Historically, the National Curriculum Guidelines of Brazilian medical courses have assimilated paradigm shifts in public health that originated throughout the 1960s and 1970s (BRASIL, 2014). Part of this includes introducing students into internship roles in the Brazilian Unified Health System, which has created fertile ground for a new culture of caring to be incorporated into trainees’ professional development. Further to this, as part of their professional development, medical students are expected to keep up to date with innovative knowledge, learn to manage uncertainty, develop reflective skills and consider "out of the box" forms of biomedical knowledge. In short, understanding health as a social product and critically evaluating the immediate and long-term consequences of their professional acts has become a core competency for trainees.
Thus, the development of a critical medical professional endowed with a systemic and humanistic vision is a responsibility for medical education providers as well as an ethical and social responsibility in a populous and heterogeneous country such as Brazil. To achieve this, the political-pedagogical project, curricular integration and the de facto performance of teachers, facilitators and preceptors requires continuous dialogical and reflective approaches. In addition to consistent investments in continuing education and teacher innovation, to culminate in an authentic and desirable cultural change at the heart of medical training. However, recent Brazilian studies demonstrate that medical students’ critical thinking is suboptimal and that educational strategies have been shown to be inefficient (ALMEIDA & PORTELLA, 2021).

1.1 THEORY AND PRACTICE OF CRITICAL THINKING

In this context, we were moved to study critical thinking (CT) to understand how medical students think and their dispositions for styles of thought, which in turn are inherited from a philosophical and scientific tradition, such as those imbued with ethical and humanitarian values and focused on social progress and citizenship. The term critical thinking was coined in the 1930s by John Dewey (1953) and conceptualised and operationalised by different authors and fields of knowledge (DIAS et al., 2011). It has only more recently been brought into health education research (in the 21st century), probably motivated by ongoing social transformations. Some authors understand clinical reasoning (CR) as a direct correspondent of CT (AMORIM, 2013; CERULLO & CRUZ, 2010), while others argue that the cognitive processes involved in CT go beyond a simple response model of logical thinking or clinical or heuristic reasoning (BENNER; HUGHES; SUTPHEN, 2008; ENNIS, 1993).

Common cases that correspond to patterns of low complexity or that configure emergency-medical situations are solved by good clinical reasoning, engrained in professional conduct. In these situations, rapid responses and training are indispensable for patient safety. However, these situations do not necessarily require CT skills to be elaborated in the therapeutic plan. That is, it is possible to state that although clinical reasoning and CT, are understood as synonyms (CERULO; CRUZ, 2010), in practice, they may refer to different perspectives and degrees of deepening; and have different applicability depending on the clinical situation or health needs. Although we use CT to a greater or lesser extent in everyday life, some people may have difficulty applying it in more abstract activities or academic life. The lack of familiarity...
with the underlying strategies of CT ends up hindering their generalisation and mental incorporation. Attention and focus on details, recognition of patterns, similarities and differences, formation of categories and prediction of possible outcomes, as well as openness to the understanding of new phenomena, parsimony and flexibility in drawing conclusions, are very desirable CT tools for any high-quality professional practice.

The pedagogue Donald Schön focused on the uncertainty in the day-to-day work of professional activity. He used the metaphor of a swamp to describe the ambivalent and changeable character of the vast majority of situations in any workplace, notably in education and health. According to Schön, in the topography of professional practice there is a high and hard terrain overlooking a swamp. In the high ground, manageable problems lend themselves to solutions through the application of research-based theory and technique. In the "swampy plain", ambiguous and confusing problems challenge the technical solution (SCHON, 1983). Consequently, there are technically brilliant professionals who are unable to deal with progressively complex scenarios, which would distinguish experts from the less proficient.

One of the greatest contributions of Donald Schön's work is his criticism of an "excessive attachment" to technical rationality. Fundamental to developing a broader conception of knowledge and professional performance. This involves recognising the limits and dangers of dichotomous reasoning and accepting complexity and "non-knowledge". Faced with situations of uncertainty, singularity and conflicts, the quotidian experience of healthcare staff could use artistic, creative and intuitive elements in decision-making.

Despite the indisputable relevance of this critical thinking tradition, the literature offers little evidence that teachers are succeeding in the implementation of CT in educational activities and that students are developing related skills (RIVAS; SAIZ; ALMEIDA, 2020). The relative ignorance of the general principles and applicability of CT, both by students and by medical educators, restricts its deployment as an educational objective. International experiences point to strategies in which the CT sometimes configures a discipline (or course) complementary to the curriculum and others in which the CT contributes to structuring the educational objectives of curricular activities as a whole (AMORIM, 2013).

We contest those theoretical approaches such as semiotics, a science that studies languages by which human beings communicate and transmit information and meanings, can contribute to teachers approaching this thoughtful point of view, focused on the "communication
power" of educational materials. Here the fundamental unit of communication is signs not the psyche, as all mentalistic schema can be reduced to sign relations. Further to this, semiotics was fundamental in the development of the concept of multimodality by Gunther Kress and so lends itself well to this paper’s objective of evaluating unimodal and multimodal triggers. From this perspective, learning involves acquiring or modifying sign relations, manifesting in behaviour change (CAMPBELL et al., 2019, STABLES, 2005, 2006). As such, semiotics in the tradition of Tzvetan Todorov has lots to offer as a theory of knowledge. Communication then, for medical students is not only relevant clinical information and data but also the representation of interactions and social relations, the emotions present, as well as the "text" most suitable for conveying it.

According to Charles Sanders Peirce’s concept of supersubjectivity, a sign cannot be understood as strictly objective or subjective and manifests itself in a relational form with other signs (objects of meaning), including transcending concepts of time. In this sense, semiotics can offer a paradigm shift in relation to the mind/body or subjective/objective dichotomies, which may contribute to the polarities experienced in medical education (TREDNNICK-ROWE, 2018). Hence, semiotics offers theoretical superstructures that can be used in the design of CT activities while trying to embed them in curricula capable of representing complex, dynamic concepts like euthanasia that are not easily parsed in reductionist mind-body terms.

The dominant format of educational materials used in general medical and healthcare education is the written vignette. For example, in the form of clinical cases or common ethical dilemmas to be solved. In contrast to this, the audio-visual mode, through videos, aggregating data, information, stimuli and various meanings, can elicit emotional responses that contribute significantly to learning (PEKRUN, 2005). The design of audio-visual material should employ techniques that enhance the emotional impact (RUSHBY, 1987).

In this perspective, the student needs to be sensitised, curious, activated and motivated by the educational strategy. In other words, the effective trigger plays a crucial role in learning processes: generating enough engagement for given educational intentionality. Otherwise, activities will be limited or impaired. Medical educators need to be sensitised to the communication and language aspects, which transcend beyond the objective information and data, including interactions, relationships, emotional aspects and the most appropriate textual way for educational intentions to be achieved.
As a result of this context, medical education has been incorporating innovations in strategies, such as problem-based learning (PBL), team-based learning (TBL) and the use of high-fidelity simulation. These techniques aim to stimulate the autonomy, the search for knowledge and the intellectual maturity of the student, besides having the intention of better empowering him/her in the perception of the context and determinants of the health-disease process. Nevertheless, the resulting effect has been limited, requiring further investigation. Studies show that video clips with various emotional purposes sensitise students and that this induction of feelings impacts on the resolution of tasks after exposure to the material (VERLEUR et al., 2007). Videos can explore clinical encounters, social situations or any relevant content or topics according to the proposed activity.

The familiarity and abundance of technology, social platforms and streaming show immense potential for using these triggers in education. This modality (video) becomes comfortable for students who value interactivity and exposure to multiple stimuli. For learning to occur, the total burden of an educational activity (or any learning) cannot exceed the limit of cognitive resources of the individual (KIRSCHNER; KIRSCHNER, 2012). As such, using modalities, they are comfortable with will aid the CT process.

Of relevance also to the implementation design of CT activities are the theory of dual information processing, which considers two cognitive systems: the controlled one, related to new learning and the automatic, triggered during the execution of more straightforward tasks or tasks previously internalised by the individual, determining a reduced use of cognitive resources and less mental effort (ALVES et al., 2017). We also considered in our design the Theory of Cognitive Load as it relates to the mental effort employed in performing tasks or learning new topics. This is determined by the interaction between the limited capacity of retention and processing of visual, auditory and spatial information of working memory and the unlimited long-term memory capacity (KIRSCHNER; KIRSCHNER, 2012). The process depends on the nature of the task (simple or complex), the environment where learning takes place, and the subject's characteristics (motivation, resources, previous knowledge, cognitive style).

The educational psychologist John Sweller (2011), the principal author of the theory, states that the limitation of working memory and the unlimitedness of long-term memory requires the individual to allot resources for using knowledge. For this, it is necessary to create cognitive
strategies that allow for the automation of learning, no longer requiring the mental effort of the controlled system to be accessed (GERJETS; SCHEITER; CIERNIAK, 2009).

This mental load determines if adequate learning is possible, affecting memory, concentration and perception, and may contribute to cognitive errors and inadequate understanding that can persist negatively in professional life. The dynamics of health services, demand pressure, gaps in training, fatigue and emotional stress naturally favour automatic (or heuristic) and impulsive processes in decision-making rather than a more parsimonious and careful mental processing related to critical-reflexive thinking. In the area of health or other sectors, such as public safety, these errors can be seriously harmful to individuals and society (MA et al., 2013).

From this perspective, educational triggers that use more than one sensory modality (multimodal) would have a favourable potential for allowing the inclusion of more significant amounts of information, in addition to relevant stimuli within a syllabus, i.e., emotional motivation, support of attention, recovery of prior knowledge and facilitation of cognitive processing and CT. Thus, this research aims to verify the behaviour and effectiveness of unimodal (written) textual triggers and multimodal (audio-visual) videos in the critical thinking sensitisation of third-year medical students.

2 METHODODOLOGY

2.1 SAMPLE AND TYPE OF STUDY

We used the quantitative cross-sectional design with a sample of twenty-eight third-year students from a medical course in São Paulo. The course started in 2019, with a curriculum proposal based on active teaching-learning methodologies, following the national curriculum guidelines (Diretrizes Curriculares Nacionais (DCN)) for medical courses.

2.2 DESCRIPTION AND PROCEDURES OF THE SURVEY INSTRUMENTS

The survey instruments contained sixteen questions and evaluated two types of triggers: unimodal (written) and multimodal (audio-visual). The instrument was adapted from the CT model present in the RED Model's Critical Thinking Skills Framework, developed by Pearson Talentlens (2017), which in turn was based on the premises of Watson and Glaser (1964), in which three dimensions are considered using the acronym RED. This includes the skills aimed
2.3 COLLECTION DESIGN

The survey instruments were hosted on a Google server and administered to students during regular class hours, in addition to distribution by email. The research participants answered both the unimodal and multimodal instruments and had a singular opportunity to answer the survey. However, for each item, it was possible to adjust the responses before sending.

The 28 students included were divided into two groups depending on the critical thinking topic: Zeta - (Problem Situation) written about euthanasia (n=21) with one scenario involving an anti-vaccine video (n=21.) And Epsilon (Problem Situation) with one anti-vaccine writing scenario (n=7) and a video about euthanasia (n=7), generating 336 and 112 responses, respectively. For this study, it was convinced that the responses of the dimension "Recognise" referred to the previous knowledge and the responses of the dimensions "Evaluate" and "Delineate" to the CT itself.

2.4 THE TRIGGERS

The euthanasia and anti-vaccine themes were chosen because they were complex and allowed the development of conclusions from different perspectives and fields of knowledge. This permits students to develop the CT based on their personal values, previous knowledge and perception of impacts and stakeholders. Below we give examples of the written text for unimodal triggers and the sources of the multimodal triggers in each group.

2.5 ZETA GROUP

Euthanasia - Unimodal written (Problem Situation). "Patient Vitória, 27 years old, rides a motocross, with a history of spinal cord trauma during competition, occupying a hospital bed, quadriplegic, tracheostomised, with continuous ventilatory support for total paralysis of thoracic muscles, conscious, oriented in time and space, discusses with her coach about the possibility of immediate euthanasia, since it is a medical condition with no prospect of cure and reserved prognosis. She is single; she has not talked to her family about it. She keeps memories of her
achievements in her memory and is afraid of losing them. After the end of the dialogue with her coach, she engages in deep questions about this whole scenario and decides to meet his request.

2.6 ANTI-VACCINE - AUDIO-VISUAL MULTIMODAL


Source: https://www.youtube.com/watch?v=npYocgDntyY

2.7 EPSILON GROUP

Anti-vaccine - Unimodal written – (Problem Situation)

"Juliana, 32, is a mother of three children: Marcus, 3; Fillipo, 1.5 years old and Melinda, six months old. She attends a childcare consultation with Dr Cosme at the Vista Alegre Basic Health Unit and the dialogue is as follows: - Dr Cosme: "We need to talk again about vaccines Juliana [...] I see here that you haven't vaccinated any of your children. Why haven't they been vaccinated yet? - Juliana: "Because there are several studies linking vaccination with autism, and I never wanted to take this risk. Besides, I as a mother have the right to be free to choose whether to vaccinate my children. Vaccines can give you adverse reactions, don't you think, Doctor?" - DrnCosimo: "Yes! But the risk is very low and, in general, the events are light." - Juliana: "The government insists on meddling in our lives! What about our freedom? Where is it?" - Dr Cosme: "But Juliana [...] You see. [...] think about it [...] think about the social impact of your choices!"

The consultation ends, Juliana says goodbye and leaves. Dr Cosme's next consultation is childcare for the boy Mateus, 4, who developed deafness after contracting measles at the age of two."

2.8 EUTHANASIA - MULTIMODAL AUDIO-VISUAL

2.9 DATA ANALYSIS

The analytical technique we employed for the data involved using descriptive statistics (percentage and absolute values) and, after to verify the sample normality, comparative statistics (Anova and effect size by Cohen's). These approaches were applied to verify possible differences between the two models of triggers (uni and multimodal). Previously, both instruments were verified regarding robustness and validity (Cronbach’s alpha) and quality of items (difficulty index and discrimination index). Results were processed using SPSS 20.0. statistical package.

3 RESULTS

The participants in the sample had an average age of 30.6 years, with a predominance of males (53.6%), and the majority from the State of São Paulo, Brazil (60.7%). The statistical analysis is summed in Table 1 concerning each mode and trigger model. It is possible to observe the robustness of the instruments for both the unimodal trigger and from the multimodal. All items presented acceptable or satisfactory classification regarding the discrimination index. The instruments as a whole showed high Cronbach’s alpha scores, indicating that it is a good instrument for reproducibility and reliability.

| Table 1: Analysis of evaluation instruments in different models of triggers. |
|------------------|------------------|------------------|------------------|------------------|------------------|
|                  | Chonbach’s Alpha | Item Discrimination Index | Classification | Answers to the item |                  |
|                  |                  |                          |                | Did not meet intentionality (%) | Meet intentionality (%) |
| Instruments with a unimodal triggers | 0.835 |                        |                |                        |                  |
| 1a                | 0.341            | Acceptable              |                | 17.6                  | 82.4             |
| 1b                | 0.390            | Acceptable              |                | 94.1                  | 5.9              |
| 1c                | 0.600            | Satisfactory            |                | 82.4                  | 17.6             |
| 2a                | 0.760            | Satisfactory            |                | 70.6                  | 29.4             |
| 2b                | 0.643            | Satisfactory            |                | 76.5                  | 23.5             |
| 3a                | 0.627            | Satisfactory            |                | 64.7                  | 35.3             |
| 3b                | 0.652            | Satisfactory            |                | 82.4                  | 17.6             |
| 3c                | 0.663            | Satisfactory            |                | 70.6                  | 29.4             |

Instruments with a multimodal triggers 0.818

|                  |                  |                          |                |                        |                  |
| 1a                | 0.367            | Acceptable              |                | 23.5                  | 76.5             |
| 1b                | 0.340            | Acceptable              |                | 64.7                  | 35.3             |
| 1c                | 0.638            | Satisfactory            |                | 41.2                  | 58.8             |
| 2a                | 0.372            | Acceptable              |                | 52.9                  | 47.1             |
| 2b                | 0.500            | Satisfactory            |                | 70.6                  | 29.4             |
| 3a                | 0.902            | Satisfactory            |                | 47.1                  | 52.9             |
| 3b                | 0.672            | Satisfactory            |                | 64.7                  | 35.3             |
| 3c                | 0.991            | Satisfactory            |                | 58.8                  | 41.2             |

Source: Authors
In Table 2, the comparison between the instruments and paired items also demonstrates the performance of the triggers. The multimodal triggers showed superior performance in relation to CT than unimodal (written) both in the parametric (p=0.004) and non-parametric (0.002) tests, with a moderate effect size in both comparisons. This result is in concordance with the literature. It is reasonable to assume that adequate multimodal material brings more opportunities to generate more attractive and dynamic communication and, in this way, more critical thinking elicitation.

<table>
<thead>
<tr>
<th>Parametric comparison of the instruments with normal distribution</th>
<th>f</th>
<th>p</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1a</td>
<td>0.689</td>
<td>0.040</td>
<td></td>
</tr>
<tr>
<td>Item 1b</td>
<td>30.476</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Item 1c</td>
<td>8.784</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>Item 2a</td>
<td>3.060</td>
<td>0.090</td>
<td></td>
</tr>
<tr>
<td>Item 2b</td>
<td>0.573</td>
<td>0.455</td>
<td>0.59 (effect size moderate)</td>
</tr>
<tr>
<td>Item 3a</td>
<td>1.338</td>
<td>0.256</td>
<td></td>
</tr>
<tr>
<td>Item 3b</td>
<td>5.476</td>
<td>0.026</td>
<td></td>
</tr>
<tr>
<td>Item 3c</td>
<td>1.793</td>
<td>0.190</td>
<td></td>
</tr>
<tr>
<td>Total of the two instruments</td>
<td>29.210</td>
<td>0.004</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Parametric comparison of the instruments with non-normal distribution</th>
<th>f</th>
<th>p</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1a</td>
<td>0.789</td>
<td>0.039</td>
<td></td>
</tr>
<tr>
<td>Item 1b</td>
<td>29.254</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Item 1c</td>
<td>7.584</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Item 2a</td>
<td>2.980</td>
<td>0.005</td>
<td></td>
</tr>
<tr>
<td>Item 2b</td>
<td>0.658</td>
<td>0.061</td>
<td>0.50 (effect size moderate)</td>
</tr>
<tr>
<td>Item 3a</td>
<td>1.564</td>
<td>0.284</td>
<td></td>
</tr>
<tr>
<td>Item 3b</td>
<td>6.001</td>
<td>0.020</td>
<td></td>
</tr>
<tr>
<td>Item 3c</td>
<td>1.598</td>
<td>0.099</td>
<td></td>
</tr>
<tr>
<td>Total of the two instruments</td>
<td>30.245</td>
<td>0.002</td>
<td></td>
</tr>
</tbody>
</table>

Source: Authors

4 DISCUSSION

Socio-semiotic theorists such as Michael Halliday (2003) affirm that language is not only a reflection of reality, but the agent of its construction and expansion (HALLIDAY, 2003). Thus, one of the areas that are currently missing in CT research concerns the construction and evaluation of educational triggers by educators, not considering the modality but also the complex interaction with the theme and the present context. In other words, even if audio-visual materials are highlighted in the literature (and in the present study) as more effective and sensitising, the intrinsic mode does not guarantee that the intricate network of potential meanings
will be explored from the point of view of learning. Another methodological limitation in the
literature is to arbitrarily consider unimodal triggers as written text and multimodal triggers as
videos. From a semiotic point of view, the boundaries between modes are potentially more fluid
and interchangeable. E.g., a written text can be included within a video and vice versa. Therefore,
there is some merit in future research exploring more artistic manifestations of multimodal
discourse as educational triggers in terms of dialogue where more and varied possibilities of
communication and semiosis could be explored.

Thus, the theme (or field) and the tenor (interpersonal and social relationships) are
dimensions to be considered by teachers of educational materials that allow the students to
expand and optimise their intellectual exploitation.

The aspects raised by the triggers, from the perspective of CT in this study, approached
crucial topics such as the doctor-patient relationship and the dichotomy between individual and
collective rights. For example, one participant noted:

“The big question is about the state’s responsibility to support families with people with
special needs, under the condition of mandatory vaccination. Since vaccination is recommended
and not mandatory, if it becomes mandatory, the state should bear the responsibilities if
irreversible side effects associated with them occur. Just like the individual who decides not to
get vaccinated, he also owes satisfaction to society and the state. On the other hand, individual
freedoms must be respected and, therefore, I totally disagree with the obligation of vaccination.”

Possibly, medical courses have not prioritized the deepening of these discussions, because
they are often departmentalized in more “humanistic” areas such as bioethics, medical
psychology and mental health. We contend that issues such as: The ability of health professionals
to argue and negotiate in the face of divergent opinions, The impacts of health behaviors on
parties involved, Legal risks, Safety and health care, Clinical uncertainty, and patient autonomy.
Should be considered as part of the core medical curriculum; and not relegated to a specialist or
select units.

Medical semiotics can provide an integrative epistemological pathway that reduces
compartmentalisation trends between medical humanities and biomedicine and favours the
development and consolidation of CT as an introjected practice. In this context, medical practice
can be situated as a communicational field supporting the interaction of meanings between
biology, society, and culture. Understanding these different narratives would generate a significant qualitative increase in professional training (COBEY, 2009).

Thus, the phenomena of health – from biology, through the expression of medical complaints and symptoms by the patient to the political, cultural, and social repercussions of these, are semiotic in nature. This contribution to medical education would promote a change in basic assumptions, necessary both to meet the complexity of society's health needs and to situate the medical profession as an agent inducing citizenship and critical thinking within the challenging and multifaceted context of the 21st century.

The reality of Brazilian medical courses is that curricula tend to be standardised a priori. A periodic critical review process is crucial for educational innovations. Another point to consider is that there are some topics where redeeming CT for holistic education is more relevant than stimulating clinical reasoning and vice versa. The teacher and curriculum should define the focus. Regarding the vaccine issue, the student's previous knowledge is naturally more advanced given its biomedical connection – not necessarily superior or more critical – than in relation to euthanasia, for example. Understanding this, one can prioritise what is most important at each moment. Therefore, it is not a question of stimulating critical thinking indiscriminately.

There are standardised modules in any undergraduate degree in medicine, for example, physiology, pharmacology, anatomy, and biochemistry, in which the openness to a critical perspective is initially lower by the very nature of the concepts. Critical thinking becomes crucial as we acquire more content and cognitive repertoire. On the other hand, mapping students' values and preconceptions become more valuable when there is already direct contact with patients, their families, and a multidisciplinary team. The curriculum's concern should also be based on the bi-directional conversion between CR and CT and how educational materials – and practice scenarios – positively or negatively modulate this process.

Due to the updating of the Flexnerian biomedical model, educational innovations in medical courses tend to fetishise expensive hardware that prepares students to adopt positions in the healthcare industrial complex, notably in the diagnostic, procedural and hospital medicine sectors. Thus, diagnostic reasoning and psychomotor dexterity are considered superior aspects of medical education, both by teachers and students, owing to the economic environment in which medicine functions. In this context, the assessment of learning aims for the development
of higher production performance per unit of time, dialoguing with goals and indicators of public and private services, oriented to generate scale.

However, the interference of cognitive biases, values, and styles of thought in medical conduct can negatively affect society. Movements such as anti-vaccine groups or advocating for the prescription of drugs without proven efficacy can find validation in medical professionals, for example.

In addition to their professional performance in a strict sense, the physician is called to express judgments and opinions, acting in the capacity of expert opinion-makers on specific topics or as social leaders. If the medical student does not have opportunities to mature critical reflections about himself and his professional role based on a cognitive-ethical system (which is translatable to a social context) it may be difficult to continue learning about these aspects in the much longer period of their professional life.

Depending on the effectiveness of the educational strategy, these competencies can be introjected with a lower cognitive load. Often, the introduction of the humanities in medical courses lacks innovations, being perceived as being only mildly stimulating in the students' view. Moreover, the ambience in the small groups can favour debate, detail, and parsimony - essential elements of critical thinking, to the extent that teachers have made technical and epistemological preparation for this, in addition to their qualified educational materials. Future studies in this area should identify strategies that facilitate generalisations of critical thinking, including more detailed mapping of students' exposure to the formal and hidden curricula. Graduation should be understood by teachers as a prime opportunity for openness and cognitive and emotional awareness. The cultivation of critical thinking can improve the quality of professionals who graduate from the courses and favour scientific development, the exercise of citizenship and the social responsibility of medicine in a more expanded sense.

5 LIMITATIONS AND STRENGTHS

About the limitations of this study, there is no definitive process to delimitate between clinical reasoning and critical thinking, as such determinations remain partly a result of the subjective opinion of the authors.

Because of the societal nature of the topics of euthanasia and vaccine movements, it was not possible to blind the participants. The students were exposed to the material and instrument
in an uncontrolled environment, with some variability in the way each student performed the task. While pragmatically, this unequal distribution of knowledge is likely to occur in the real-world, it can potentially bias the effect size.

Subsequent studies can improve methodological aspects in order to be able to individualise how theme, mode and emotional-relational aspects interact in the motivation and performance of students according to educational objectives.

In another way, this research showed some strength points. It allowed us to verify that unimodal and multimodal triggers can coexist in a complementary way within various curricular activities. It is possible that a written unimodal trigger may be less stimulating and sensitising than a multimodal trigger. In more unprecedented topics that require the development of ethical skills – such as euthanasia – the emotional component fulfils a relevant educational function. For this purpose, multimodal materials such as film fragments or even dramatic materials can be useful. If the goal is to develop more analytical and critical thinking in students, the materials should bring a higher density of elements, aspects, and social interactions, such as those present in the video about anti-vaccine movements. For this, it is plausible that the more mature the students are, the more effective our proposal will be when implemented.

Nevertheless, dexterity in written and spoken language, both for the exercise of critical thinking and professional training, should be developed in medical courses. Additionally, written texts should be produced in a commonplace and amicable tone, reinforcing the language already used in health education to promote reflexivity. Potentially, written unimodal triggers can be powerful activators of previous knowledge to the extent that the student recognises in the text situations or circumstances experienced at other moments of the curriculum, e.g., clinical cases. During our research, we also observed that regardless of the tool to be used, prior exploration of these materials by lecturers is fundamental to "calibrate" the degree of coverage desired by the educational activity in question.

6 CONCLUSION

Multimodal triggers can bring more sensory and cognitive opportunities to awaken engagement and activation of previous knowledge and new learning in medical students. The current generation is prone to sensory overload, catalysed by technology which influences how they learn and the cognitive load to which they are exposed.
Written texts also stimulate other abilities, such as imagination, concentration, and abstraction, equally relevant to educational formation. If these opportunities are taken advantage of strategically by teachers from the perspective of CT, the resulting development of educational objectives could be better. However, the same preoccupation with CT can be included in the design and use of unimodal triggers whose scope could be better exploited. Moreover, it is always important to point out that a comprehensive unimodal material, which allows educational exploration, will be of more utility than an audio-visual material chosen or produced without following an appropriate rationale.
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