

Some considerations on the principles of the Cognitive Theory of Multimedia

Learning for instructional video design for the elderly

Algumas considerações sobre os princípios da Teoria Cognitiva da Aprendizagem Multimídia para o design de vídeo instrucional para idosos

Algunas consideraciones sobre los principios de la Teoría Cognitiva del Aprendizaje Multimedia para el diseño de videos instructivos para personas ancianas

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Abstract

The COVID-19 pandemic exposed that the field of education has been using indiscriminately instructional videos. The starting point is evident, a lack of careful design, and in that scenario, the Cognitive Theory of Multimedia Learning may play a significant role. The rationale of this study is that the elderly, as the targeted audience, might have cognitive decay, hearing loss, or eyesight decline, which might impact the principles of the Cognitive Theory of Multimedia Learning. This work is an analysis of the evidence that supports or not these cognitive processing principles based on previous literature, with an additional investigation of the literature for the Brazilian scientific journals market. Then, some processing principles of this theory are evaluated for instructional video design for the elderly. The main results summarize that only instructional material directly related to the key learning goal should be included, that important information should be highlighted to learners, that longer videos should be broken into meaningful parts, and that redundancy in instructional videos for the elderly should be investigated considering their specificities.

Keywords: Instructional video; Video design; Elderly; Cognitive theory of multimedia learning.

Resumo

A pandemia do COVID-19 expôs que o campo da educação vem utilizando indiscriminadamente vídeos instrucionais. O ponto de partida é evidente, a falta de um projeto cuidadoso, e nesse cenário, a Teoria Cognitiva da Aprendizagem Multimídia pode desempenhar um papel significativo. A justificativa deste estudo é que os idosos, como público-alvo, podem apresentar declínio cognitivo, perda auditiva ou diminuição da visão, o que pode impactar os princípios da Teoria Cognitiva da Aprendizagem Multimídia. Este trabalho é uma análise das evidências que suportam ou não esses princípios de processamento cognitivo com base na literatura anterior, com uma investigação adicional da literatura para o mercado de periódicos científicos brasileiros. Em seguida, alguns princípios de processamento desta teoria são avaliados para o design de vídeos instrucionais para idosos. Os principais resultados resumem que apenas o material instrucional diretamente relacionado ao objetivo principal de aprendizagem deve ser incluído, que informações importantes devem ser destacadas para os alunos, que vídeos mais longos devem ser divididos em partes significativas e que a redundância em vídeos instrucionais para idosos deve ser investigada considerando suas especificidades.

Palavras-chave: Vídeo instrucional; Design de vídeo; Idoso; Teoria cognitiva da aprendizagem multimídia.

Resumen

La pandemia de COVID-19 expuso que el campo de la educación ha estado utilizando videos instructivos indiscriminadamente. El punto de partida es evidente, la falta de un diseño cuidadoso, y en ese escenario, la Teoría Cognitiva del Aprendizaje Multimedia puede jugar un papel significativo. El fundamento de este estudio es que las personas mayores, como público objetivo, pueden tener deterioro cognitivo, pérdida auditiva o disminución de la vista, lo que podría afectar los principios de la Teoría Cognitiva del Aprendizaje Multimedia. Este trabajo es un análisis de la evidencia que apoya o no estos principios de procesamiento cognitivo basados en literatura previa, con una investigación adicional de la literatura para el mercado de revistas científicas brasileñas. Luego, se evalúan algunos principios de procesamiento de esta teoría para el diseño de videos instructivos para adultos mayores. Los

resultados principales resumen que solo se debe incluir material didáctico directamente relacionado con el objetivo de aprendizaje clave, que se debe resaltar la información importante para los alumnos, que los videos más largos se deben dividir en partes significativas y que se debe investigar la redundancia en los videos instructivos para personas mayores. teniendo en cuenta sus especificidades.

Palabras clave: Video instructivo; Diseño de video; Anciano; Teoría cognitiva del aprendizaje multimedia.

1. Introduction

The COVID-19 pandemic exposed a grim reality, that mostly the field of education has been using indiscriminately instructional videos. The most popular or successful instructional videos hide the alarming fact that a massive quantity of ineffective videos has played a central role in education during the pandemic. The diagnosis is evident, a lack of careful design. Hence, the importance of design for developing instructional videos has increased in today's scenario.

The Cognitive Theory of Multimedia Learning (CTML) is significant for designing and evaluating instructional videos (Mayer & Moreno, 2003). Its principles have been developed not exclusively for videos, and recently, a systematic review performed the identification of these principles that are empirically supported for instructional videos in the scientific literature (Fyfield et al., 2022).

The work of Fyfield et al. (2022) was an analysis of 113 papers presenting 28 principles grouped into the three processing principles: extraneous, essential, and generative. The first group (extraneous) are the principles that reduce the distracting information, the second (essential) are related to improving the delivery of the essence of the learning objectives, and the third (generative) are those principles that approach students' engagement. In their systematic review, they have found strong evidence that coherence, segmenting and learner control, support the improvement of learning from instructional videos, while redundancy and modality are not supported. Their findings may be seen as design guides for instructional video development.

Unfortunately, aging brings some challenges. In the biological process of aging of human beings, it is often verifiable depression and cognitive decline in elderly adults (Paixão et al., 2019). Certainly, these challenges that are frequent in the age group elderly affect their ability of learning. Consequently, for instance, their needs might be different from the needs of young adults, and that might directly impact the principles of the Cognitive Theory of Multimedia Learning in the design of instructional videos. Hence, the rationale of this work is that it is reasonable to assume that, for video design purposes, the elderly, who is the target of the video, might have a cognitive decay, hearing loss, or eyesight decline. In the sense of the Cognitive Theory of Multimedia Learning, it means that the intended audience of the instructional video has intrinsic cognitive overload.

Additionally, Fyfield et al. (2022) identified some challenges in the literature, which derived from the myriad of media, methodologies, subject matters, definitions of terms, and learner ages, without considering the significant number of papers that described the video or the procedure used in the study inadequately. They realized that the diversity of studies limited their comparability. They observed a need for replication from experimental to naturalistic settings, that is, the experimental conditions were commonly unrealistic learning conditions. The measures among studies were inconsistent. A frail description of media suggests a need for standardization. They remark that despite these difficulties, it is not reasonable to expect researchers to report every detail of the design and development of their videos. However, to mitigate the problem, they advocate that research reporting on videos should wherever possible allow readers to view the video itself, via a link to an online version (Fyfield et al., 2022).

An example of research that makes available to readers the link to their material, and especially videos, is the work of Adam et al. (2019), which proposes a Human-Centered Design of Video-Based Health Education. Their links are available in the paper, for instance, as "Multimedia Appendix 1 - Basic digestion: sample physiology teaching video created in 2013",

within the journal website. Hence, this problem could be addressed by making the videos available on platforms such as YouTube (<https://www.youtube.com/>) or Rumble (<https://rumble.com/>) as requirements by journals prior to publication.

A brief examination of a sample of peer-reviewed papers, published from 2019 to 2022, corroborates that this is also the case in Brazil. This demonstrates the opportunity that the findings of Fyfield et al. (2022) represent in promoting the increase in the quality of papers related to video and education by requiring their availability within the author guidelines.

Azeredo et al. (2019) objective were to construct and validate an educational video on the subject of Congenital Syphilis. They described their study's methodology as a "research of the type development". They used the Delphi technique (Castro & Rezende, 2009; Scarparo et al., 2012) for analysis and validation of the content with the participation of 10 specialists in 2 cycles, and the script items presented Content Validity Index greater than or equal to 0.78 (Polit & Beck, 2006). After validation, they reported that the video was produced with the support of 2 "journalism professionals". They claimed that after the production of the educational material (video), it will be made available online so that it can be used by health professionals, academics and users interested in the subject (Azeredo et al., 2019). Though they claim the video is available online, they did not provide a link, a website, or any reference to it.

Vega et al. (2019) described their experience of making a video targeted on teachers, which theme was interdisciplinarity. Their focus was to present the theme with an emphasis on the characteristics of the phenomenon in its historical and epistemological aspects... to stimulate the teacher to adhere to interdisciplinary practices in the daily classroom (Vega et al., 2019). They only provide a PrintScreen of the video.

Lima et al. (2020) propose a script validation for the development of an educational video about the technique for performing urinary catheterization. They validate their video lesson script for theoretical learning with 11 expert Judges. They describe their methodology as a descriptive study based on the "Freirian" theory of education. The instrument for validation was a questionnaire with 4 multiple choices for each query (content, relevance, environment, language, and need for topic inclusion). They had not developed the video prior to the submission of their paper.

Sá et al. (2020) produced an educational video for elderly individuals about fall risks, that they validated with 22 judges, and assessed with 22 elderly individuals. They selected the content from the Fall Prevention Model (WHO, 2008), and the items from the Falls Risk Awareness Questionnaire (Lopes & Trelha, 2013), which were verified through the Content Validation Index and binomial test. They informed that the storyboard was built by a communications company, that after that content validation was obtained with nurse judges, then the video production began, which consisted of animation images and audio narration, and that the video covered the 12 principles of CTML. They only provide a sequence of scenes of the content, that is, they did not provide a link, a website, or any reference to the video.

Silva, E. de S. M. et al. (2020), they report their experience in the theme of advance organizers. They used "19 video classes dealing with mental health issues in general and 16 video classes with clinical cases". They restricted their videos to a maximum duration of 2 minutes. They claimed they had used YouTube, and they provided a PrintScreen without the link address or channel identification claiming that the image was recovered from the personal files of the authors.

Silva, C. R. D. T. et al. (2020) objective was to construct and validate an educational video about the frailty of elderly people. They developed their study in 3 stages: the construction of the educational video, validation by 22 expert judges, and validation by 22 elderly people. They used the Educational Content Validation Instrument (Polit & Beck, 2006; Yusoff, 2019) from the SuitabilityAssessment of Materials questionnaire (Sousa et al., 2015), and they considered for validation purpose agreement greater than 80%, which was verified using the Content Validation Index and the binomial test. They reported that the video duration is of less than 12 minutes, and they only provide a sequence of scenes of the content, that is, they did not provide a link, a website, or any reference to the video.

Siqueira et al. (2020) aimed in their study to evaluate the influence of a didactic video on the teaching-learning

process in a laboratory practice of science teaching given to an engineering class. They refer to the methodology they had used as descriptive exploratory. They presented a questionnaire to the students with 5 multiple choices ranging from “bad” to “excellent” about: (a) comprehension of the importance of the subject for the professional activity (motivation); (b) association between theoretical content learned in the classroom and practice; (c) understanding of objectives, experimental procedures, and laboratory equipment functioning; (d) comprehension of results, graphics and tables; and (e) recommendation of the didactic videos for future classes in the course. They provided the YouTube link of the video class, and they reported that the video production obeyed a minimum set of requirements, such as maximum duration of 4 minutes, information should contain an introduction, objectives of the practice, illustrations, and explanatory text.

Gomes et al. (2021) reported a process of constructing an educational video about the female and male long-term vesical bladder. They declare that it is a descriptive study. They divided the process into 3 stages: pre-production, which involved the search of the contents, the script, and management; the production, which means building the set, choosing the characters, and recording it; and the post-production, in which the images were edited and titles and images included. They provided some PrintScreen of the production and video, and they claim that they provided the links to the 2 videos, but they did not provide them, not even the name of their channel on YouTube.

Lengruher et al. (2021) described the production of a health educational video about health education on gastronomy. They evaluated 6 platforms: Moravi, Promo-Brazil, Animoto.com, Sparkol, Doodly.com and VideoScrib. They declare that their study is in nature qualitative, and of the development type of educational technology, divided into 3 stages: pre-production, production, and post-production. The validation stage was obtained with the Delphi technique (Massaroli, 2017) and the Content Validity Index (Alexandre, 2011). They did not provide a link to the video, a website, or any reference to it.

Oliveira et al. (2021) reported their experience in creating an educational video to teach the correct ways to dispose of and process domestic oil. They declare that their study is a descriptive experience report. They presented the script for 2 scenes. They provided the link for their video, which last less than 10 minutes.

Souza Filho et al. (2021) objective was to evaluate student practice before and after using an educational video about the physical therapy physical examination of a critical patient at the bedside. They characterized their study as a Single-arm clinical trial study with 25 undergraduate students of Physiotherapy. Their protocol consisted of the inclusion of an educational video in the students' routine and their evaluative complement through the Miniex instrument (Megale et al., 2009). They evaluated the impact of the video by measuring the time of physical examination before (9.2 minutes on average) and after (13.4 minutes on average) watching the video. They provided the link for their video, which last less than 4 minutes.

Meneses et al. (2022) research was a study that aimed to develop and validate an educational video on podiatric care for the prevention of diabetic foot in the elderly. They started with an integrative review with the following research question: What podiatric care has been performed in elderly people with diabetes to prevent ulcers? For the construction of the video, they followed the 3 phases: pre-production (synopsis, script, and storyboard), production, and post-production. They used the Content Validity Index to evaluate their video by specialists in the field of stomatherapy, diabetes nursing care, and experience in health technology development for three criteria: objectives, structure and presentation, and relevance. They provided a table of the script with 3 columns (scene, image and text, and audio), a figure with the storyboard, and tables with the descriptive statistics of their study, but they did not provide a link to the video, a website, or any reference to it.

Sá et al. (2022) developed an educational video to assess the effectiveness of using an educational video in comparison with verbal nursing guidelines in increasing older adults' perception of falling risks, and as they described it was a randomized clinical trial in a cluster, with 138 community older adults, randomized into an intervention group, which watched an educational video, and a control group, which received verbal instructions. They assessed the perception of falling risk by FRAQ-Brazil (Lopes & Trelha, 2013) in the pre-test and after a 30-day follow-up. They reported that they used their video

presented in a previous paper (Sá et al., 2020).

2. Methodology

This study is the consideration of the rationale presented in the introduction, that is, the assumption that the elderly, as the targeted audience, might have cognitive decay, hearing loss, or eyesight decline, with regards to some of the principles of the Cognitive Theory of Multimedia Learning for instructional video design. It is the analytical reasoning applied to the limitations of the target audience, with the consequent analysis of some of the CTML principles, which represent cognitive overload in the its terminology.

The starting point of this study is the Fyfield et al. (2022) systematic review, an attempt of improving instructional video design. At first, an additional literature review might seem unnecessary, but it is worth evaluating a local scenario to verify if it corroborates their findings, and the local meaning of a country's scenario, which in this case is Brazil.

This probing into a local reality must include publications in local journals and especially in the native language, in this case, Portuguese. However, it is not necessarily a complete review of this local literature, a representative sample must suffice. In this study case, the search was conducted with Google Scholar (<https://scholar.google.com/>), and the time frame was from 2019 to 2022, because of COVID-19, which was an event that impacted the field of instructional videos. The selection criteria included that the papers must be published in local journals, must-have title and abstract in English and Portuguese, that is, the papers must be findable by the international research community. Hence, verification of titles and abstracts was conducted in a non-exhaustive way by a scan reading, in other words, a scoping review. This non-exhaustive literature review is presented as the second part of the Introduction of this paper, in a self-evident manner, it is a sample of 13 papers, which represents 11.5% of the 113 papers included in the final analysis of their systematic review (Fyfield, Henderson, & Phillips, 2022). Consequently, before proceeding to the main analysis of this work, in the section results, the papers reviewed in this study's Introduction are evaluated by their inclusion and exclusion criteria, which are presented in Table 1.

Table 1 – Inclusion and exclusion criteria in the systematic review of Fyfield, Henderson, & Phillips (2022).

<i>Inclusion criteria</i>	<i>Exclusion criteria</i>
Instructional videos.	VR videos, static media only, video conferencing.
Peer-reviewed empirical research written in English.	Early learning, EFL or language learning, or special education contexts.
Paper focused on learning from videos.	Meta-analyses and reviews.
Reported empirical results comparing video designs.	----

Source: Fyfield, Henderson, & Phillips (2022).

They excluded meta-analyses and reviews, but they presented in their paper a subsection named Systematic reviews into learning from instructional videos. Additionally, the elderly may be considered in a “special education context”, but it is not clear if they have done that.

The theoretical foundation of the analysis presented by Fyfield et al. (2022) is the Cognitive Theory of Multimedia Learning (CTML). It is composed of principles grouped into 3 types: extraneous, essential, and generative. Originally, Mayer and Moreno (2003) proposed 15 principles, and Fyfield et al. (2022) identified for instructional videos purposes additional 16, which totals 31, but 3 were not found in the selected pool of scientific studies, that is, the systematic review identified 28

principles for instructional videos. The results of this identification are presented in Table 2, the column “total” reports the total number of papers that discuss the given principle, “replicate” means the successful replication, while “fail” means a failure to replicate, and “modify” stands for modification of the principle, which includes boundary conditions or proposed changes to a principle’s definition (Fyfield et al., 2022).

The evidence reported by Fyfield et al. (2022) does not support all principles, as mentioned in the Introduction. Hence, in this study, a criterium is adopted to select the principles to be examined in light of the proposed rationale. The criterium is to select those principles that count for more than the average number of citations principles, that is, the total of the column “total” (166) divided by the number of principles in considerations (28), which is 5.929 (<6), presented in the section Results, Table 3, which partakes the structure of Table 2.

Table 2 - Description of design principles and count of papers coded to each.

Processing principle	Extraneous	Description of design technique	Total	Replicate	Fail	Modify
1	Coherence	Only instructional material directly related to the key learning goal should be included	10	8	2	2
2	Signalling	Important information should be highlighted to learners.	13	10	6	5
3	Redundancy	Written text should not be added when narration is present.	13	5	8	6
4	Spatial contiguity	Related elements should be presented in close physical proximity on the screen (also called split attention).	3	3	-	-
5	Temporal contiguity	Related elements (e.g., narration and visuals) should be presented at the same time.	-	-	-	-
6	Segmenting	Longer videos should be broken into meaningful chunks.	13	10	3	2
7	Background music	Avoid including distracting background music.	3	2	2	2
8	Audio quality	Audio should be clear, with no distracting hissing or interference	2	2	1	-
9	Video length reduction	Shorter videos are more effective than long ones	10	10	1	-
10	Perspective (1st superior)	Videos shot from the learner’s perspective are more effective than third-person perspective.	1	1	-	-
11	Presenter’s face	Avoid including the presenter’s face when alternative visuals are displayed.	7	1	2	5
12	Sound effects	Avoid including sound effects.	1	1	1	-

Processing principle	Essential	Description of design technique	Total	Replicate	Fail	Modify
13	Pre-training	Learners should be introduced to key names and characteristics before the lesson	2	2	-	-
14	Modality	Use spoken narration rather than written text.	13	6	9	2
15	Multimedia	Use words and pictures rather than words alone	2	2	-	-
16	Speech rate (fast)	Speech rate should be faster than conversational speaking.	2	2	1	1
17	Transience	Video loses advantages over static media when too much information is presented too quickly	6	4	3	-
18	Worked example	Include completed guidance or examples when solving problems or learning skills.	3	2	1	-

19	Learner control	Students should be given control over playback.	18	13	4	5
20	Reviews	Videos should end with a summary of the content.	3	3	-	-
Processing principle	Generative	Description of design technique	Total	Replicate	Fail	Modify
21	Personalisation	Narrations should use first/second person conversational speech.	6	4	3	2
22	Voice principle	Narrations should be recorded in a human voice rather than synthesised, machine voice	-	-	-	-
23	Embodiment principle	Videos should include human movement or gestures, such as showing hands when assembling.	11	8	4	4
24	Guided discovery	Interface should provide hints and feedback as learner solves problems.	1	0	1	-
25	Self-explanation	Videos should prompt students to explain the learning goal to themselves.	4	2	2	-
26	Drawing	Leaners should be encouraged to draw the learning goals.	-	-	-	-
27	Dialogue	Videos that show dialogue between an instructor and learner outperform straight declarative videos	2	2	-	-
28	Emotional design	Warm, high-saturation colours and anthropomorphisms should be used in videos	4	3	3	3
29	Misconceptions	Videos should dispel common misconceptions at the start.	2	2	-	-
30	Integrated learning activities	Integrate practice activities, either during pauses in the presentation or following the video	7	7	-	3
31	Interactivity	Videos that include learner controllable content outperform standard playable video	4	3	1	1

Source: Fyfield, Henderson, & Phillips (2022).

The basic three types of demands in CTML. Essential Processing is directed to understanding the presented material, such as, selecting, organizing, and integrating words or images. Incidental Processing, which treats the aspects of nonessential material. Representational Holding, is aimed at holding verbal or visual representations in working memory.

These are the three types of cognitive-processing demands in CTML, and the total Intended Processing is the summation of them. When the total Intended Processing exceeds the learner's cognitive capacity it is called Cognitive Overload. Therefore, lessening Cognitive Overload may require the redistribution of Essential Processing, minimizing Incidental Processing, or cutting Representational Holding (Mayer & Moreno, 2003).

Mayer & Moreno (2003) describe five scenarios with Cognitive Overload in multimedia learning, and they propose 9 suggestions to deal with them. The effectiveness of the suggestions were extracted from the experience on a 12-year program of research carried out at the University of California, Santa Barbara (UCSB). Their work is summarized in Table 3. Afterward, analytical reasoning based on the proposed rationale is applied to the principles in Table 2, to reexamine the findings of Fyfield, Henderson, & Phillips (2022) for the elderly, which may provide design guides for instructional video development for that age group.

Table 3 - Load-Reduction Methods for Five Overload Scenarios in Multimedia Instruction.

<i>Type of Overload Scenario</i>	<i>Load-Reducing Method</i>	<i>Description of Research Effect</i>
<i>Type 1: Essential processing in visual channel > cognitive capacity of visual channel</i>		
Visual channel is overloaded by essential processing demands.	Off-loading: Move some essential processing from visual channel to auditory channel	Modality effect: Better transfer when words are presented as narration rather than as on-screen text.
<i>Type 2: Essential processing (in both channels) > cognitive capacity</i>		
Both channels are overloaded by essential processing demands.	Segmenting: Allow time between successive bite-size segments.	Segmentation effect: Better transfer when lesson is presented in learner-controlled segments rather than as continuous unit.
	Pretraining: Provide pretraining in names and characteristics of components	Pretraining effect: Better transfer when students know names and behaviors of system components.
<i>Type 3: Essential processing + incidental processing (caused by extraneous material) > cognitive capacity</i>		
One or both channels overloaded by essential and incidental processing (attributable to extraneous material).	Weeding: Eliminate interesting but extraneous material to reduce processing of extraneous material.	Coherence effect: Better transfer when extraneous material is excluded.
	Signaling: Provide cues for how to process the material to reduce processing of extraneous material.	Coherence effect: Better transfer when extraneous material is excluded.
<i>Type 4: Essential processing + incidental processing (caused by confusing presentation) > cognitive capacity</i>		
One or both channels overloaded by essential and incidental processing (attributable to confusing presentation of essential material)	Aligning: Place printed words near corresponding parts of graphics to reduce need for visual scanning.	Spatial contiguity effect: Better transfer when printed words are placed near corresponding parts of graphics.
	Eliminating redundancy: Avoid presenting identical streams of printed and spoken words.	Redundancy effect: Better transfer when words are presented as narration rather than narration and on-screen text.
<i>Type 5: Essential processing + representational holding > cognitive capacity</i>		
One or both channels overloaded by essential processing and representational holding.	Synchronizing: Present narration and corresponding animation simultaneously to minimize need to hold representations in memory.	Temporal contiguity effect: Better transfer when corresponding animation and narration are presented simultaneously rather than successively.
	Individualizing: Make sure learners possess skill at holding mental representations.	Spatial ability effect: High spatial learners benefit more from well-designed instruction than do low spatial

Source: Fyfield, Henderson, & Phillips (2022).

3. Discussion

This section is composed of two parts. First, it is presented an evaluation of a sample of the scientific literature of Brazil to verify if it confirms the results of the systematic review of Fyfield et al. (2022), with regards to their inclusion and exclusion criteria. This local literature sample is a non-exhaustive literature review composed of a sample of 13 papers, representing 11.5% of the 113 papers included in their systematic review. The second part is the analytical reasoning applied to the rationale of this study, *i.e.*, it is to consider the assumption that the elderly might have cognitive decay, hearing loss, or eyesight decline, which may be considered a Cognitive Overload (CTML) for instructional video design.

3.1 Evaluation of the local literature review

The systematic review of Fyfield et al. (2022) for improving instructional video design presented four inclusion criteria (Table 1): (i) instructional videos; (ii) peer-reviewed empirical research written in English (all local papers were peer-reviewed, but some were published on Portuguese); (iii) paper focused on learning from videos; (iv) and reported empirical results comparing video designs. They presented three exclusion criteria (Table 1): (v) VR videos, static media only, video conferencing; (vi) early learning, EFL or language learning, or special education contexts; and (vii) Meta-analyses and reviews. It is presented in Table 4 the evaluation of the sample of papers published in Brazil regarding this work.

Table 4 – Local sample papers’ evaluation regarding the work of Fyfield, Henderson, & Phillips (2022).

<i>Paper</i>	<i>Comments</i>	<i>Inclusion Criteria</i>				<i>Exclusion Criteria</i>		
		(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
Azeredo <i>et al.</i> (2019)	Construction and validation of video.	Yes	No	No	No	No	No	No
Vega <i>et al.</i> (2019)	Construction of video.	Yes	No	No	No	No	No	No
Lima <i>et al.</i> (2020)	Script validation of video.	Yes	No	No	No	No	No	No
Sá <i>et al.</i> (2020)	Construction and validation of video based on CTML for the elderly.	Yes	Yes	No	No	No	No	No
Silva, E. <i>et al.</i> (2020)	Construction and use of videos.	Yes	No	No	No	No	No	No
Silva, C. R. D. T. <i>et al.</i> (2020)	Construction and validation of video for the elderly.	Yes	Yes	No	No	No	No	No
Siqueira <i>et al.</i> (2020)	Construction a video and its evaluation focused on learning	Yes	No	Yes	No	No	No	No
Gomes, Missio & Bergamaschi (2021)	Construction of video.	Yes	No	No	No	No	No	No
Lengruber <i>et al.</i> (2021)	Construction and validation of video.	Yes	No	No	No	No	No	No
Oliveira <i>et al.</i> (2021)	Construction of video.	Yes	No	No	No	No	No	No
Souza Filho <i>et al.</i> (2021)	Construction of video and evaluation of student’s practice before and after using it	Yes	No	Yes	No	No	No	No
Meneses <i>et al.</i> (2022)	Construction and validation of video for the elderly.	Yes	No	No	No	No	No	Yes
Sá <i>et al.</i> (2022)	Randomized clinical trial in a cluster to assess the use of an educational video in comparison with verbal guideline	Yes	Yes	Yes	No	No	No	No

Source: Authors.

All 13 papers are related to instructional video, that is, all of them satisfy criterium (i). Besides that, all 13 papers do not comply with the inclusion criterium (iv), and the exclusion criteria (v) and (vi). That being said, the papers by Sá et al. (2020), Silva, C. R. D. T. et al. (2020), and Sá et al. (2022) are written in English satisfying the inclusion criterium (ii), while all others are written in Portuguese. Only the papers of Siqueira et al. (2020), Souza Filho et al. (2021) and Sá et al. (2022).

3.2 Evaluation of the principles of the Cognitive Theory of Multimedia Learning for video design to the elderly

The theoretical foundation of the systematic review presented by Fyfield, Henderson, & Phillips (2022) is the Cognitive Theory of Multimedia Learning (CTML). They identified for instructional videos purposes additional 16, from the originally 15 principles proposed by Mayer & Moreno (2003), but 3 were not found in the selected pool of scientific studies

resulting in principles for instructional videos presented in Table 2.

Some of the evidence reported by Fyfield, Henderson, & Phillips (2022) was insufficient or ambiguous. Therefore, in this study, a criterium is adopted to select the principles to be examined in light of the proposed rationale aiming to have more representativeness and to avoid the condition of insufficiency or ambiguity. The criterium is to select those principles that count for more than the average number of citations principles, that is, the total of the column “total” (166) divided by the number of principles in considerations (28), which is 5.929 (<6), presented in the section Results, Table 5, the columns having the same meaning as in Table 2.

Table 5 - Description of design principles that count 6 or more papers coded to each.

Processing principle	Extraneous	Description of design technique	Total	Replicate	Fail	Modify
1	Coherence	Only instructional material directly related to the key learning goal should be included	10	8	2	2
2	Signalling	Important information should be highlighted to learners.	13	10	6	5
3	Redundancy	Written text should not be added when narration is present.	13	5	8	6
6	Segmenting	Longer videos should be broken into meaningful chunks.	13	10	3	2
9	Video length reduction	Shorter videos are more effective than long ones	10	10	1	-
11	Presenter’s face	Avoid including the presenter’s face when alternative visuals are displayed.	7	1	2	5
Processing principle	Essential	Description of design technique	Total	Replicate	Fail	Modify
14	Modality	Use spoken narration rather than written text.	13	6	9	2
17	Transience	Video loses advantages over static media when too much information is presented too quickly	6	4	3	-
19	Learner control	Students should be given control over playback.	18	13	4	5
Processing principle	Generative	Description of design technique	Total	Replicate	Fail	Modify
21	Personalisation	Narrations should use first/second person conversational speech.	6	4	3	2
23	Embodiment principle	Videos should include human movement or gestures, such as showing hands when assembling.	11	8	4	4
30	Integrated learning activities	Integrate practice activities, either during pauses in the presentation or following the video	7	7	-	3

Source: Fyfield, Henderson, & Phillips (2022).

The rationale of this study is to consider the assumption that the elderly might have cognitive decay, hearing loss, or eyesight decline, and to take into consideration this assumption as causing Cognitive Overload, in the case of instructional video design, which means that the Intended Processing exceeds the learner’s cognitive capacity. That is, at least one of the three types of demands in CTML (Essential Processing, Incidental Processing, or Representational Holding) is compromised. Mayer & Moreno (2003) presented five scenarios with Cognitive Overload in multimedia learning, and they proposed nine suggestions to deal with them.

From Table 5, after selecting the more representative principles (12), it is elaborated Table 6, which presents the same information, but in percentage regarding the total of each principle. First, it is important to highlight that the percentage of “Replicate” added to the percentage of “Fail” does not necessarily sum up to 100%, nor summing “Replicate” to “Modify”. If it is considered that a percentage of 2/3 (66.7%) or more represents that the evidence supports the principle, then 9 principles

(1, 2, 6, 9, 17, 19, 21, 23, and 30) are supported, that is, 9 in 12 (75%) principles are supported. The Extraneous principles of Redundancy and Presenter’s face, and the Essential principle Modality are not supported (principles 3, 11, and 14).

Therefore, from Table 6, if it is considered that the elderly might have cognitive decay, hearing loss, or eyesight decline, it is clear that the Extraneous Principles of Coherence and Signalling are important, but Redundancy – written text should not be added when narration is present, seems backward, that is, when you one or more of the mentioned conditions redundancy helps the understanding of the message. For instance, those who have hearing impairment many times make use of lip reading for compensating for the hearing loss.

Table 6 - Description of design principles that count 6 or more, with replication and fail presented in percentage.

Processing principle	Extraneous	Description of design technique	Replicate %	Fail %	Modify %
1	Coherence	Only instructional material directly related to the key learning goal should be included	80.0	20.0	20.0
2	Signalling	Important information should be highlighted to learners.	76.9	46.2	38.5
3	Redundancy	Written text should not be added when narration is present.	38.5	61.5	46.2
6	Segmenting	Longer videos should be broken into meaningful chunks.	76.9	23.1	15.4
9	Video length reduction	Shorter videos are more effective than long ones	100.0	10.0	-
11	Presenter’s face	Avoid including the presenter’s face when alternative visuals are displayed.	14.3	28.6	71.4
Processing principle	Essential	Description of design technique	Replicate %	Fail %	Modify %
14	Modality	Use spoken narration rather than written text.	46.2	69.2	15.4
17	Transience	Video loses advantages over static media when too much information is presented too quickly	66.7	50.0	-
19	Learner control	Students should be given control over playback.	72.2	22.2	27.8
Processing principle	Generative	Description of design technique	Replicate %	Fail %	Modify %
21	Personalisation	Narrations should use first/second person conversational speech.	66.7	50.0	33.3
23	Embodiment principle	Videos should include human movement or gestures, such as showing hands when assembling.	72.7	36.4	36.4
30	Integrated learning activities	Integrate practice activities, either during pauses in the presentation or following the video	100	-	42.9

Source: Authors.

The Extraneous Principles of Segmenting is compatible with cognitive deficiency because in such cases, it occurs an attention deficit. After all, decreased processing speed (Brébion et al., 2020) impacts the reading ability, which could be trouble with reading fluency. Hearing loss may impact reading fluency, too. Then, eyesight decline may cause trouble with word reading accuracy. If trouble reading causes fatigue, then the Extraneous Principle of Video length reduction is desirable. The Extraneous Principles of Segmenting is not supported by evidence, but it is not clear if for the elderly it would be or not interesting to have an instructional video including the presenter’s face.

In regards to Essential Principles in Table 6, the Modality is not supported by evidence but is evident that within the realm of the presented rationale it is probable that having both communication channels (visual and auditive) operational at the same time (Redundancy) is desirable. The Transience and Learner control Principles are compatible with the rationale. The Generative Principles in Table 6 are compatible with the elderly group.

The evaluation of the supportiveness of the evidence from Table 6, for the five overload scenarios from Table 3, results in Table 7. Type 1 is not supported (Modality), and it was commented on in the previous paragraph. Type 2 is partially supported (Segmenting), and not representative (Pretraining), though it seems reasonable in the case of the elderly, which requires confirmation. It is worth noticing that Type 3 is completely supported by evidence, and validated in the case of the elderly group. Then type 4 is partially not representative, and partially not supported, but in the case of aligning, it is not clear its impact requires further investigation, and as commented before, due to the rationale, Redundancy might be desirable. Finally, type 5 is not representative, and both principles are not clear in their influence suggesting further investigation.

Table 7 – Evaluation of the supportiveness of the evidence for Five Overload Scenarios.

<i>Type of Overload Scenario</i>	<i>Load-Reducing Method</i>	<i>Supportiveness</i>
<i>Type 1: Essential processing in visual channel > cognitive capacity of visual channel</i>		
Visual channel is overloaded by essential processing demands.	Modality effect:	NOT SUPPORTED
<i>Type 2: Essential processing (in both channels) > cognitive capacity</i>		
Both channels are overloaded by essential processing demands.	Segmenting:	SUPPORTED
	Pretraining:	NOT REPRESENTATIVE
<i>Type 3: Essential processing + incidental processing (caused by extraneous material) > cognitive capacity</i>		
One or both channels overloaded by essential and incidental processing (attributable to extraneous material).	Weeding (Coherence):	SUPPORTED
	Signaling:	SUPPORTED
<i>Type 4: Essential processing + incidental processing (caused by confusing presentation) > cognitive capacity</i>		
One or both channels overloaded by essential and incidental processing (attributable to confusing presentation of essential material)	Aligning (Spatial contiguity):	NOT REPRESENTATIVE
	Eliminating redundancy (Redundancy):	NOT SUPPORTED
<i>Type 5: Essential processing + representational holding > cognitive capacity</i>		
One or both channels overloaded by essential processing and representational holding.	Synchronizing (Temporal contiguity):	NOT REPRESENTATIVE
	Individualizing (Special contiguity):	NOT REPRESENTATIVE

Source: Authors.

4. Discussion

The evaluation of the sample of local papers from Brazil represents a limitation of this work. Though it might be considered representative because of the time frame, published in the last four years, starting in the year previous to the beginning of the COVID-19 pandemic, and mostly, because of the quantity, which represents 11.5% of the total number of papers evaluate in the work of Fyfield, Henderson, & Phillips (2022).

In Table 4, the work of Sá et al. (2020), Silva, C. R. D. T. et al. (2020), and Meneses et al. (2022) are focused on the elderly, and the instructional video design could be considered a “special education context”, and then, they would comply with exclusion criterium (vi). This would be one more reason to exclude these studies from this systematic review.

In spite of no paper in Table 4 satisfy inclusion criterium (iv) – empirical results comparing video designs, the studies from Sá et al. (2020) and Sá et al. (2022) are related, not only each paper has six authors, from which five authors are the same, the second paper is the continuation of the first, that is, it is based on the instructional video produced in the first. The combination of the two papers would be a study that satisfies inclusion criteria (i), (ii), and (iii) (except criteria iv), and it would not be included in any exclusion criteria. Nevertheless, the second paper is a randomized clinical trial in a cluster to assess the use of an educational video in comparison with verbal guidelines, it has a comparison of educational methods –

verbal versus instructional video. Hence, if a verbal guideline is considered the zero ground, or baseline, for the instructional video design, then this combination of papers could be included in the systematic review of Fyfield, Henderson, & Phillips (2022).

This local scenario from Brazil suggests that first most local publications regarding instructional videos are about constructing and validating videos. Almost all papers present the construction and validation of instructional video, except Sá et al. (2022), that is, 12 in 13. However, if the work of Sá et al. (2020) and Sá et al. (2022) is considered as one, as previously suggested, then, in fact, all papers would be related to constructing and validating educational videos (12 in 12). A possible reason for this situation is that the availability of educational videos in Portuguese may be still insufficient for conducting studies that compare instructional video design techniques. It is important to emphasize that all local papers were for use by native Portuguese speakers.

Additionally, this scenario might suggest that the pressure of publication may impose a restricted time frame, which induces a premature submission, or the submission of partial results, spoiling the submission of the final results of the work, and consequently, harming the quality of local publications. Or, maybe the complete results are not submitted to the local journals, which requires further investigation.

The rationale of this work, the assumption that the target audience, the elderly, might have Cognitive Overload caused by cognitive decay, hearing loss, or eyesight decline, may be considered as a “special educational context” for instructional video design, in terms with the systematic review of Fyfield, Henderson, & Phillips (2022). The Principles of the Cognitive Theory of Multimedia Learning, in this case, which are representative and supported are reduced in number, from 31 principles to 12 with a rate of 2/3 (Table 6), that is, 38.7%. If the five overload scenarios are considered, then from 9 suggestions, it remains only 3, a third, or from 31 down to 3 (9,7%).

5. Final Considerations

The scenario of papers published by Brazilian journals seems to be grooming from reporting educational video production to more advanced research, such as randomized controlled trials in a cluster. In particular, instructional videos for the elderly are incipient, the availability of educational videos in Portuguese that fulfill basic needs of quality may be still dim, and the pressure for publication may be inducing premature submission of partial results, in the field of instructional video.

The consideration of the rationale, the assumption that the elderly present a natural Cognitive Overload (CTML), caused by cognitive decay, hearing loss, or eyesight decline, restricts, even more, the results of Mayer & Moreno (2003) and Fyfield, Henderson, & Phillips (2022). The Extraneous Processing Principles of Coherence, Signalling, and Segmenting, stand out, that is, only instructional material directly related to the key learning goal should be included, important information should be highlighted to learners, and longer videos should be broken into meaningful bits. The Redundancy Principle is a puzzle that should be further investigated, because of the specificities of the older age group.

Therefore, for the Brazilian journals scenario, with regards to educational or instructional video design, it is interesting to have a baseline protocol as a recommendation for the acceptance of submitted papers, which itself could be further work. Additionally, further research should be performed to verify the Redundancy Principle for the design of instructional videos for the elderly.

References

Adam, M., McMahon, S. A., Prober, C., & Bärnighausen, T. (2019). Human-Centered Design of Video-Based Health Education: An Iterative, Collaborative, Community-Based Approach. *Journal of Medical Internet Research*, 21(1), e12128. <https://doi.org/10.2196/12128>

Alexandre, N. M. C., & Coluci, M. Z. O. (2011). Validade de conteúdo nos processos de construção e adaptação de instrumentos de medidas. *Ciência & Saúde Coletiva*, 16, 3061-3068. <https://doi.org/10.1590/S1413-81232011000800006>

- Azeredo, L. G., Diaz, C. M. G., Souza, M. H. T., de Costenaro, R. G. S., & Portela, J. D. L. (2019). Construction and validation of educational technology about Congenital Syphilis. *Research, Society and Development*, 8(12), e458121939. <https://doi.org/10.33448/rsd-v8i12.1939>
- Brébion, G., Stephan-Otto, C., Huerta-Ramos, E., Usall, J., Perez del Olmo, M., Contel, M., Haro, J. M., & Ochoa, S. (2014). Decreased processing speed might account for working memory span deficit in schizophrenia, and might mediate the associations between working memory span and clinical symptoms. *European Psychiatry*, 29(8), 473-478. <https://doi.org/10.1016/j.eurpsy.2014.02.009>
- Castro, A. V., & Rezende, M. A. (2009). A técnica Delphi e seu uso na pesquisa de enfermagem: revisão bibliográfica. *Revista Mineira de Enfermagem*, 13(3), 429-434. <https://repositorio.usp.br/bitstreams/9437750f-2dcc-405c-95f9-d8c663684e39>
- Fyfield, M., Henderson, M., & Phillips, M. (2022). Improving instructional video design: A systematic review. *Australasian Journal of Educational Technology*, 38(3), 150-178. <https://doi.org/10.14742/ajet.7296>
- Gomes, G. I., Missio, L., & Bergamaschi, F. P. R. (2021). Sondagem vesical de demora masculina e feminina: o processo de construção de um vídeo educativo. *Research, Society and Development*, 10(11), e192101119592-e192101119592. <https://doi.org/10.33448/rsd-v10i11.19592>
- Lengruber, M. R., Macedo, E. C., Paula, D. G. de, Brendim, M. P., Cunha, K. C., Mendes, L. E. B., Ramos, M. N. P., & Oliveira Junior, M. P. de. (2021). Elaboration and development of educational video in health “Knowing gastrostomy”. *Research, Society and Development*, 10(3), e23210313060. <https://doi.org/10.33448/rsd-v10i3.13060>
- Lima, M. V., Tavares, G. M. M., Zorzin, F. B., Farias, K. M., Pereira, R. F., Franco, B. H. S., & Montandon, D. S. (2020). Script validation for the development of an educational video: urinary catheterism, what now? *Brazilian Journal of Health Review*, 3(4), 9597-9607. <https://doi.org/10.34119/bjhrv3n4-195>
- Lopes, A. R., & Trelha, C. S. (2013). Translation, cultural adaptation and evaluation of the psychometric properties of the Falls Risk Awareness Questionnaire (FRAQ): FRAQ-Brazil. *Brazilian journal of physical therapy*, 17, 593-605. <https://doi.org/10.1590/S1413-35552012005000128>
- Massaroli, A., Martini, J. G., Lino, M. M., Spenassato, D., & Massaroli, R. (2017). Método DELPHI como referencial metodológico para a pesquisa em enfermagem. *Texto & Contexto-Enfermagem*, 26(4). <https://doi.org/10.1590/0104-07072017001110017>
- Mayer, R. E., & Moreno, R. (2003). Nine Ways to Reduce Cognitive Load in Multimedia Learning. *Educational Psychologist*, 38:1, 43-52, https://doi.org/10.1207/S15326985EP3801_6
- Megale, L., Gontijo, E. D., & Motta, J. A. C. (2009). Avaliação de competência clínica em estudantes de medicina pelo Miniexercício Clínico Avaliativo (Míniex). *Revista Brasileira de Educação Médica*, 33, 166-175. <https://doi.org/10.1590/S0100-55022009000200002>
- Meneses, J. C. B. C. de, Alves, D. de A., Alencar, A. M. P. G., Lisboa, K. W. de S. C., Oliveira, C. R. T. de, Sampaio, L. R. L., Abreu, R. N. D. C. de, Borges, J. W. P., Meneses, H. R. F. de, & Silva, F. M. (2022). Development and validation of an educational video on podiatric care for the prevention of ulcers in elderly people with diabetes. *Research, Society and Development*, 11(7), e59411729777. <https://doi.org/10.33448/rsd-v11i7.29777>
- Oliveira, A. V. de., Balbino, C. M., Rocha, G. de A., & Santana, P. P. C. (2021). “De Olho no Óleo”, educational video. *Innovation technology for teaching: experience report. Research, Society and Development*, 10(10), e253101018840. <https://doi.org/10.33448/rsd-v10i10.18840>
- Paixão, Y. A. de, Curado, P. F., Orlandi, A. A. d. S., Netto, L. S. S., Rezende, F. A. C., Osório, N. B., & Nunes, D. P. (2019). Declínio cognitivo e sintomas depressivos: Um estudo com idosos da universidade da maturidade (Cognitive decline and depressive symptoms: a study with the elderly of the university of maturity). *Humanidades & Inovação*, 6(11), 120-127. <https://revista.unitins.br/index.php/humanidadesinovacao/article/view/1578/1078>
- Polít, D. F., & Beck, C. T. (2006). The content validity index: are you sure you know what's being reported? Critique and recommendations. *Research in nursing & health*, 29(5), 489-497. <https://doi.org/10.1002/nur.20147>
- Sá, G. G. D. M., Santos, A. M. R. D., Galindo, N. M., Carvalho, K. M. D., Feitosa, C. D. A., & Mendes, P. N. (2020). Building and validating an educational video for elderly individuals about fall risks. *Revista Brasileira de Enfermagem*, 73(suppl 3), e20200010. <https://doi.org/10.1590/0034-7167-2020-0010>
- Sá, G. G. D. M., Santos, A. M. R. D., Carvalho, K. M. D., Galindo Neto, N. M., Gouveia, M. T. D. O., & Andrade, E. M. L. R. (2022). Effectiveness of an educational video in older adults' perception about falling risks: a randomized clinical trial. *Revista da Escola de Enfermagem da USP*, 56. <https://doi.org/10.1590/1980-220X-REEUSP-2021-0417>
- Scarpato, A. F., Laus, A. M., Azevedo, A. L. D. C. S., de Freitas, M. R. I., Gabriel, C. S., & Chaves, L. D. P. (2012). Reflexões sobre o uso da técnica Delphi em pesquisas na enfermagem. *Rev Rene*, 13(1), 242-251.
- Silva, E. de S. M. e, Monteiro, B. M. M., Ono, B. H. V. S., & Souza, J. C. (2020). Video classes as advance organizers in health education during the pandemic: experience report. *Research, Society and Development*, 9(10), e4049108839. <https://doi.org/10.33448/rsd-v9i10.8839> <https://doi.org/10.33448/rsd-v9i10.8839>
- Silva, C. R. D. T., Felipe, S. G. B., Carvalho, K. M. D., Gouveia, M. T. D. O., Silva Júnior, F. L., & Figueiredo, M. D. L. F. (2020). Construction and validation of an educational gerontechnology on frailty in elderly people. *Revista Brasileira de Enfermagem*, 73. <https://doi.org/10.1590/0034-7167-2020-0800>
- Siqueira, M. V. B. M., Borges, I., Faria, T. W. F., & Gonçalves, J. L. (2020). Evaluation of a didactic video in the teaching-learning process in Engineering and Physics laboratory practices. *Research, Society and Development*, 9(10), e3839108755-e3839108755. <https://doi.org/10.33448/rsd-v9i10.8755>
- Sousa, C. S., Turrini, R. N. T., & Poveda, V. B. (2015). Tradução e adaptação do instrumento “suitability assessment of materials”(SAM) para o português. *Revista de Enfermagem UFPE on line*, 9(5), 7854-7861. <https://doi.org/10.5205/1981-8963-v9i5a10534p7854-7861-2015>

Souza Filho, L. E. C. de ., Cunha, K. da C., Santos, M. C. de S., Falcão, L. F. M., & Normando, V. M. F. (2021). Impact of a systematic educational video for physical examination in the discent practice of physiotherapy in an Intensive Care Unit Research, Society and Development, 10(5), e26910514940. <https://doi.org/10.33448/rsd-v10i5.14940>

Vega, A. P. V., Ribeiro, B. C., Padova, L. C., & Ghisleni, T. S. (2020). Interdisciplinarity in production of educational content: the theory and practice relation. Research, Society and Development, 9(1), e128911791-e128911791. <https://doi.org/10.33448/rsd-v9i1.1791>

World Health Organization. (2008). WHO global report on falls prevention in older age. World Health Organization. <https://apps.who.int/iris/handle/10665/43811>

Yusoff, M. S. B. (2019). ABC of content validation and content validity index calculation. Resource, 11(2), 49-54. https://eduimed.usm.my/EIMJ20191102/EIMJ20191102_06.pdf