

# A Framework for the Visualization and Assessment of Critical Thinking in Educational Media

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*This research addresses the role of cognitive processes and learning transfer in critical thinking and describes different approaches to its instruction and visualization. It also reviews widely known and novel methods for assessing critical thinking in school education settings. Based on this theoretical background, it proposes a framework to describe how critical thinking is visualized in educational media, focusing on how information is arranged through the main text types, namely, description, exposition, argumentation, narration and dialogue. The framework defines four main approaches to visualizing critical thinking: individual thinking skills, storytelling, dialectical argumentation and rhetorical argumentation. These approaches are applied to the analysis and classification of multiple educational media. Finally, the possible role of the framework in the design of educational media and the assessment of critical thinking is discussed.*

*Keywords: Critical thinking, visualization, text types, assessment, educational media*

## Introduction

Critical thinking can be approached through different disciplinary perspectives and instruction methods (Zechmeister & Johnson, 1992). However, regardless of the approach, the instruction of critical thinking in school settings will necessarily imply the visualization of specific knowledge, skills, and attitudes. Likewise, any method for critical thinking assessment will focus on the particular information being visualized in the instruction process.

Regardless of the formal characteristics of the learning contents and educational media supporting the visualization and assessment of critical thinking, the information is conveyed and comprehended through the use multiple text types. The text types are recurrent structures for organizing information (Adam, 1992), which include storytelling, description, argumentation, explanation and dialogue. As they are deeply ingrained in both verbal and visual expression patterns, text types can be widely recognized across linguistic, cultural and geographical boundaries.

Several frameworks, in competence-based for international, and national curricula include critical thinking. Research on the instruction of critical thinking offers insights on the role and possibilities of specific text types in the visualization and assessment of critical thinking skills. Furthermore, frameworks focused on the classification of educational media describe how multiple text types converge in the critical thinking process (Mena, 2020).

However, there are no frameworks for the unified analysis of the visualization and assessment of critical thinking in educational media through the use of text types. This article aims at providing such a framework, based on the role played by different text types in the organization and presentation of verbal and non-verbal information in educational media.

## Research Design & Methods

This article analyses literature and educational media related to the instruction, visualization and assessment of critical thinking, published in English, Spanish and Japanese. The research was organized in three main phases. In the first one, recurrent patterns in the visualization and assessment of critical thinking were identified while focusing on the expression and interactions of different text types. The second phase involved the definition of framework for the visualization and assessment of critical thinking in educational media, based on the trends and correlations identified on the previous phase. In the third phase, in order to verify the framework's reach and applicability, it was applied to the analysis and classification of specific educational media developed in different regions.

## Results

The visualization of critical thinking entails making visible, in explicit or implicit ways, the ideas of the individuals involved in the learning process. Although ideas are psychological constructs created and organized in the individuals'

minds, individuals can convey the content of their ideas through their actions and their spoken and written speech. During the instruction of critical thinking, it is expected for students and teachers to participate in learning activities in which they make their ideas visible not only to others but also to themselves. These activities usually require the use of a variety of educational media. For example, students may write essays or participate in debates, expressing their own arguments to their teachers and peers while using data sharing applications and digital devices. They can also use educational software to externalize and arrange their ideas, and by doing so, they can effectively make their own thinking process visible to others. In this way, the visualization of critical thinking involves both dialectic interactions and metacognition.

Regardless of the specific characteristics of the methods and educational media involved in the learning and assessment activities, it is possible to identify four main approaches to the visualization of critical thinking: individual thinking skills, narrative, dialectical argumentation, and rhetorical argumentation. These approaches can be used as a framework to categorize specific learning experiences and educational media.

**Visualization through individual thinking skills**

The individual thinking skills include multiple cognitive processes that can be expressed separately or simultaneously during a task. They are hierarchically organized according to their complexity. Lower complexity skills include ordering, comparing, multilateral viewing, and branching out; higher complexity skills include predicting, making abstractions, structuring, analyzing, and evaluating (Kurokami, 2017).

The visualization of critical thinking through individual skills is widely used in Japan, and usually involves the use of thinking tools. Thinking tools are graphic organizers used to support the learning of general thinking abilities (usually referred to in Japanese as *shikouryoku*) through the activation of individual thinking skills (usually referred to in Japanese as *shikou skiru*). The acquisition of such general thinking abilities involves fully comprehending the concept and mechanisms of each individual thinking skill and solving problems by appropriately applying these skills to different situations (Taizan, 2019). Each thinking tool is used to address one or more individual skills. For example, Venn diagrams are used to make comparisons, PMI charts are introduced in multilateral viewing exercises, and plot diagrams are employed to make abstractions.

In recent years, the systematic utilization of multiple thinking tools has been incorporated into the curricula of elementary and secondary schools in Japan. These curricula approach general thinking skills as the process of acquisition and activation of individual thinking skills as forms of procedural knowledge (Taizan, Kojima & Kurokami, 2012). It should be noted that, the structured and compartmentalized nature of the information conveyed while dealing with individual thinking skills usually requires the use of description and explanation. Accordingly, School television programs, such as NHK's *Oops! Let's upgrade our information skills* (NHK, 2016), and online mind map editing tools such as *MindMeister* (MeisterLabs, 2007) support the visualization and development of individual thinking skills using mainly descriptive and explanatory forms of expression.

**Figure 1**

Oops! Let's upgrade our information skills.



**Visualization through storytelling**

Storytelling encompasses all forms of narrative expression. Stories can support the instruction of critical thinking by depicting problems and presenting arguments. Depending on the characteristics of the stories and the learning activities included in the teaching process, learners may be given the opportunity of making their ideas visible in different ways. In some cases, the instructor provides a story as a learning aid, and learners are requested to comment on its content or complete it with new elements. In other instances, learners create entirely new stories, based on subject-matter content or their own personal experiences.

Written stories infusing critical thinking components also allow instructors to guide interactions in which learners can externalize the results of their thinking process. Short tales may depict everyday situations in which critical thinking skills are required (Sannomiya, 2002). Novel-like stories can describe how children actively participate in debates at

school and express their own opinions (Lipman, 1998). Written stories allow learners to engage in role-playing by enacting their events and dialogues and having Socratic discussions on the presented issues and arguments. These interactions support the creation of communities of inquiry, in which learners collectively pose questions and find their own answers. As manifestations of shared cognition, communities of inquiry provide valuable insights into the social and inter-individual mechanisms of critical thinking.

Various media are effectively used to visualize critical thinking through narrative. Learners can grasp critical thinking principles and procedures by analyzing four-panel comics (Michita, 1999). They can also improve their rhetorical and argumentative abilities by designing and creating their own comics (Kang, 2017) or create internet *memes*, probably the most minimalistic form of storytelling, as tools for media analysis and argumentation (Wells, 2018). Likewise, television programs may depict stories where children and teenagers apply their thinking skills. For instance, in *Neuro what* (Pakapaka, 2016) a little girl explores the world with his uncle, using scientific thinking to learn about neuroscience. In *The power of logic* (NHK, 2020), a group of high school students and their teacher deal with everyday life situations while applying concepts and methods related to formal and informal logic, such as syllogisms, logical fallacies, analogies and correlations.

**Figure 2**

Neuro What.



### Visualization through dialectical argumentation

Depending on their construction process and presentation, arguments can be classified as dialectical or rhetorical (Blair, 2012). Dialectical arguments are shaped by conversation, and thus, are the result of interactions between two or more learners. On the other hand, the expressions of individual deliberation, aimed to persuade broad audiences, can be considered as rhetorical arguments.

Learning activities that introduce dialectical argumentation can support the establishment of communities of inquiry and visualize the learners' thinking process. Common examples include classroom debates in which special attention is paid to the adequate construction of arguments and the identification of personal biases and logical fallacies. Debates can also be carried out through computer-based systems, which may foster the learners' motivation while keeping a record of their interactions (Aoyagi *et al.*, 2010). Moreover, by introducing online debating tools, the communities of inquiry may include students from different cities and even different countries (Davis & Rouzie, 2002).

Dialectical argumentation can also play a central role in supporting teamwork. For example, by using the six thinking hats (De Bono, 1985), learners can engage in complex tasks while performing complementary functions related to information processing, intuition, judgment, optimism, creativity and thinking process management. This approach facilitates collaboration when searching for solutions to community issues, proposing new policies, and creating new products (Higuchi & Karaki, 2018).

**Figure 3**

World peace and other 4th grade achievements.



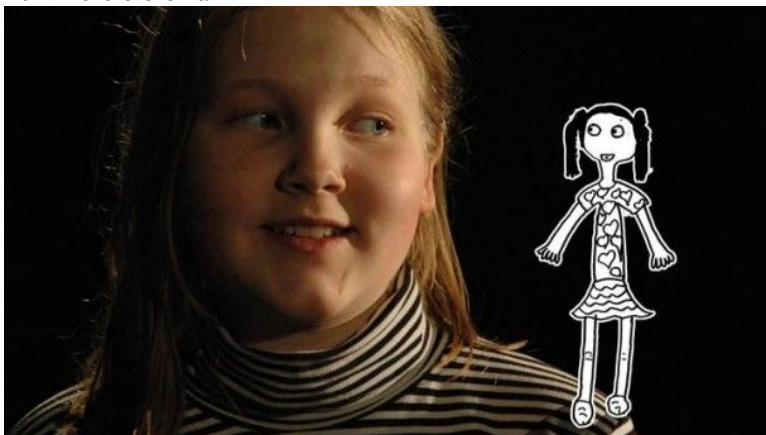
Regarding the expression of text types, dialectical argumentation will always integrate argumentative discourse and dialogue. The film *World peace and other 4th grade achievements* (Farina, 2010) is a clear example of educational media depicting dialectical argumentation. It is a documentary film describing an 8-week program where elementary school children participate in a global politics game. During this experience, the students engage in dialectical argumentation as they discuss and make decisions about armed conflicts, poverty and other issues.

**Visualization through rhetorical argumentation**

In rhetorical argumentation, learners are expected to express their own arguments in a structured and unilateral manner, while providing valid evidence. In school education, rhetorical argumentation can be expressed through both oral and written activities. While oral activities usually involve giving speeches to an audience, written activities typically consist of presenting essays to peers and instructors. In both cases, students express are expected to express their arguments in the form of monologues.

As they are static texts susceptible to review and analysis, it could be asserted that essays offer a better opportunity to visualize the learners’ thinking process. When promoting rhetoric argumentation through essay writing, instructors should encourage learners to create personal essays to explore their own writing style and freely convey their own ideas (Newkirk, 1989). Rhetoric writing exercises can be enhanced by combining them with dialectical argumentation activities. Learners can participate in reading clubs and writing book reports while collaborating in group journals (Yamamoto, 2011). They can also analyze the rhetoric structure of an essay, connect its contents to their previous knowledge and apply the obtained insights to write their own essays, while collaborating with their peers (Sawaguchi, 2013). The integration of rhetoric and dialectic argumentation allows learners to further benefit from the thinking visualization process, as they can improve their own essays or reports by incorporating new ideas presented during the collaborative interactions. Educational media can resort to rhetorical argumentation to convey information related to critical thinking, while simultaneously becoming into tools for supporting learning activities where students engage in rhetorical argumentation. *I think therefore I am* (Ylesradio, 2009) is a television program that integrates critical thinking visualization through rhetorical argumentation by allowing elementary school children to express their own ideas on philosophical questions. It aims at supporting the development of thinking and discussion skills, and offers a visual rendering of the children’s ideas by integrating animated elements.

**Figure 4**  
I think therefore I am.



**Discussion**

As previously established, each visualization approach displays distinct features closely related to a limited number of text types. While the expression of individual thinking skills relies heavily on description and explanation, storytelling necessarily resorts to narrative and dialogue. Because of their nature, dialectical argumentation combines arguments with dialogical interactions, and rhetorical argumentation focuses on the unilateral expression of arguments. During specific learning activities involving the visualization of critical thinking, these correlations should become apparent not only in the structure and contents of educational aids, such as textbooks and worksheets, but also in the learners' thinking processes and results.

Furthermore, educational media should be expected to clearly exhibit the predominant text types of their main critical thinking visualization approach. However, educational media, such as television programs, films, computer-based learning systems, videogames and mobile applications are complex products, able to convey information in multiple ways. Thus, regardless of their main visualization approach, in most educational media it is possible to find expressions of additional text types (Table 1). In such cases, the text types closely related to the main visualization approach fulfill a key function in educational media, establishing recurrent stylistic and structural characteristics, and defining the concrete forms of critical thinking expression each specific medium seeks to nurture in learners.

Concurrently, additional moderately related text types can play supplementary roles. These roles include providing contextual information, improving comprehension by reorganizing complex ideas, and enhancing the learners' aesthetic experience. For example, although educational media approaching critical thinking through storytelling will certainly emphasize narrative and dialogue, they may also integrate elements of description, explanation or argumentation. This convergence of text types can be clearly observed in some of the aforementioned educational media. *The power of logic*, in a fundamental level, tells the story of the group of students and their teacher, but it also infuses explanatory elements by including in the story scenes where the teacher uses visual aids to break down difficult concepts to the students. *World peace and other 4th grade achievements* mainly depicts students interacting through dialectical argumentation, but it also includes interviews where individual students convey their feelings and opinions, allowing them to engage in rhetorical argumentation.

**Table 1**

*Recurrent interaction patterns between visualization approaches and text types in educational media*

	Individual thinking skills	Storytelling	Dialectical argumentation	Rhetorical argumentation
Description	○	□	□	□
Explanation	○	□	□	□
Narrative	□	○	□	□
Dialogue	□	○	○	×
Argumentation	□	□	○	○

Closely related: ○    Moderately related: □    Barely related: ×

It should be noted that the fundamental role of educational media is supporting learning in both formal and informal education settings. In school settings, learning results are expected to be assessed through the introduction of suitable tools. Each of the visualization approaches included in the framework calls for specific sets of assessment methods. For instance, the use of educational media involving the visualization of individual thinking skills should be followed by assessment activities focusing on metacognition. In the same way, story-based media may require assessment methods dealing with problem solving and decision making. Media featuring instances of dialectical or rhetorical argumentation may support assessment methods focusing on media literacy, collaboration and informal logic.

## Conclusion

This research proposes a set of four approaches as a framework for the visualization and assessment of critical thinking in educational media. Namely, by focusing on the role of text types, structures for organizing information that are ubiquitous in all media, this set of approaches offers an analysis and categorization tool that can be applied to all educational media dealing with the instruction of critical thinking, regardless of their specific learning objectives or formal characteristics. The results of this research suggest that the dynamic interactions between the different critical thinking visualization approaches become completely apparent only in specific educational media. However, as many of these interactions recurrently appear in educational media, they can also be taken into consideration when predicting

the potential and limitations of existing media. Furthermore, these interactions can offer valuable references when designing new media aimed at supporting the development of critical thinking skills.

Further research on the visualization and assessment of critical thinking should include the analysis of the correlation between school subjects and visualization approaches in educational media, the creation of new educational media purposely integrating multiple visualization approaches to provide effective learning environments, and the development of novel assessment methods based on each of the visualization approaches.

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