Journal of
Literary Education

Assessing children's critical thinking through the "Critical Thinking Skills Evaluation Tool" (C.T.S.E.T.)

Evaluar el pensamiento crítico de los niños a través de la "Herramienta de Evaluación de Habilidades de Pensamiento Critico" (H.E.H.P.C)

Avaluació del pensament crític dels nens mitjançant "I'eina d'Avaluació de les Habilitats de Pensament Critic" (E.A.H.P.C)

Panagiota Mike. University of Thessaly, Greece. mikepanagiota@gmail.com.
https://orcid.org/0000-0001-7195-1741

Abstract

The present research study was carried out in a doctoral dissertation context aiming to explore how the wordless book's images promote critical thinking skills such as interpretation, analysis, explanation, inference and evaluation. The study sample was consisted of 120 First Grade students, who go to 4 state schools in Larissa (Greece). The *Critical Thinking Skills Evaluation Tool* (*C.T.S.E.T)* was designed. The research process was based on a quasi-experimental design in order to evaluate the comparison groups' critical thinking skills (experimental and control). Experimental group children's higher achievements make *C.T.S.E.T* an effective tool for assessing children's critical thinking skills in the process of interpreting the book's story only through images and lead to the conclusion that children's critical thinking is improved through the application of educational programs and practices for approaching the wordless books in school learning environments (Housen, 2002; Pantaleo, 2017; Yenawine, 2013).

Keywords: Critical Thinking, Wordless Book, Quasi-experimental design

Resumen

El presente estudio de investigación se llevó a cabo en un contexto de tesis doctoral sobre como las imágenes del libro sin palabras promueven habilidades de pensamiento crítico como interpretación, análisis, explicación, inferencia y evaluación. La muestra del estudio estuvo compuesta por 120 estudiantes de primer grado, que asisten a 4 escuelas públicas en Larissa (Grecia). Se diseñó la *Herramienta de Evaluación de Habilidades de Pensamiento Critico (H.E.H.P.C).* El proceso de investigación se basó en un diseño cuasi-experimental con el fin de evaluar las habilidades de pensamiento crítico de los grupos comparados (experimental y control). Los mayores logros de los niños en el grupo experimental hacen de *H.E.H.P.C* una herramienta eficaz para evaluar las

DOI: 10.7203/JLE.7.25440
Received: 17 /10/2022 Accepted: 07/03/2023 Published: 30/12/2023

habilidades de pensamiento crítico de los niños en el proceso de interpretación de la historia del libro solo a través de imágenes y llevan a la conclusión de que el pensamiento crítico de los niños se mejora mediante la aplicación de programas educativos y prácticas para el abordaje de los libros sin palabras en ambientes escolares de aprendizaje (Housen, 2002; Pantaleo, 2017; Yenawine, 2013).

Palabras clave: Pensamiento crítico, Libro sin palabras, Diseño cuasi-experimental

Resum

El present estudi de recent estudi de recerca es va dur a terme en un context de tesi doctoral i va abordar com les imatges del llibre sense paraules promouen les habilitats de pensament crític com ara la interpretació, l' anàlisi, l'explicació, la inferència i l'avaluació. La mostra d'estudi estava formada per 120 alumnes de primer grau, que van a 4 escoles públiques de Larissa (Grècia). Es va dissenyar l'eina *Eina d'Avaluació d'Habilitats de Pensament Crític (E.A.H.P.C.).* El procés de recerca es va basar en un disseny quasi experimental per tal d'avaluar les habilitats de pensament crític dels grups de comparació (experimental i control). Els èxits més elevats dels nens del grup experimental fan que el *M.A.H.P.C.* siga una eina eficaç per avaluar les labilitats de pensament crític dels nens en el procés d'interpretació de la història del llibre només a través d'imatges i porten a la conclusió que el pensament crític dels nens es millora mitjançant l'aplicació de programes educatius. i pràctiques per apropar-se als llibres sense paraules en entorns d'aprenentatge escolar (Housen, 2002; Pantaleo, 2017; Yenawine, 2013).

Paraules clau: Pensament crític, Llibre sense paraules, Disseny quasi experimental

1. Introduction

Wordless books are considered an ideal tool for developing oral and written skills (Smith, 2004). Besides, they promote the cultivation of visual literacy (Arizpe & Styles, 2003). Visual literacy skills provide children an important communication tool. The greatest benefit this tool offer children is being able to develop critical thinking skills through processing visual stimuli in school or out-of-school learning environments (Rowsell, McLean & Hamilton, 2012).

According to the literature review there are a lot of studies investigating responses when children read picture books (Giannikopoulou, 2008; Misiou, 2020). However, there is limited data from studies that focus on the development of children's critical thinking skills through "reading" wordless books (Pantaleo, 2017). This gap is attempted to be covered by the present thesis that adds a piece of original research to the international literature.

2. Theoretical framework

The theoretical framework of this work was: a) the ideas of the *American Philosophical Association*, known as the "consensus statement" (A.P.A., 1990; Facione, 1990a) regarding a commonly accepted definition of critical thinking and b) the *California Critical Thinking Skills Test (C.C.T.S.T.)* recommended by the American Philosophical Association (A.P.A., 1990). According to Facione (1990a) *C.C.T.S.T.* is the most appropriate tool for investigating critical thinking skills of individuals (Facione, 1990a).

Among the six (6) critical thinking skill evaluation indicators that proposed by the *American Philosophical Association* (A.P.A., 1990) (interpretation, analysis, explanation, inference, evaluation and self-control) for the construction of the present research tool were used only the five (5) first indicators (I). The last skill named *self-control* that related to the individual's motivation (self-regulated learning) (Facione, 1990a) was excluded as it was considered a challenging skill for First Grade students (Matta, 2017).

In order to adapt the *California Critical Thinking Skills Test (C.C.T.S.T.)* to the needs of the present research, *Bloom's Classification of Thinking Levels* (Bloom & Krathwohl, 1956) was used in combination with *Visual Thinking Strategies Curriculum (V.T.S.)* (Housen, 2001). In this way the present research tool included in the literature and in the context of an educational intervention that could be applied in school learning environments.

Bloom's Taxonomy is one of the most well-known tools for assessing critical thinking skills. It hierarchically describes the six levels of thinking: 1) knowledge 2) understanding 3) implementation 4) analysis 5) synthesis and 6) evaluation. The first three levels are lower level thinking skills and involve recall, understanding and implementation. The last three levels are higher level thinking skills and involve analysis, evaluation and creation (Bloom & Krathwohl, 1956).

V.T.S. (Visual Thinking Strategies) is a group-cooperative teaching method that originated in 1991 at the Museum of Modern Art in New York. The intent of Visual Thinking Strategies curriculum is "to build visual literacy" skills (Yenawine, 2013, p. viii). It exploits the images and develops the viewer's critical thinking skills. Particularly, the classroom teacher can apply this process when interacting orally with students during discussions in order to facilitate a student-centered discovery process that involves student discussing, discovering and reasoning about images. The VTS process consists of three (3) questions: a) What's going on in this image? b) What makes you say that? and c) What else can we find? (Housen, 1999, 2001; Pantaleo, 2017; Yenawine, 1999).

Based on the assumption that images are not just signs but meaningful open texts subject to the personal interpretation (Moriatry, 1996), they are part of a sign system that secretly speaks to us (Uspenskij et al., 2003 [1973]). Peirce's semiotics (1981; [1955]) formed the theoretical framework of this paper to document bibliographically why wordless books have been used as a tool in order to explore and promote the development of First Grade students' critical thinking skills. Based on Peircean semiotics during the meaning-making process of the wordless book, children focus not only on the "virtual symbols" but mainly on the "virtual signs" because they are more "open" to interpretation. The "virtual symbols are more "closed" interpretive conventions. Besides "virtual signs" are not based on arbitrarily defined relations of concepts but on personal experience (Peirce, 1991, p. 239).

3. Purpose - research questions

This paper contributes to the existing literature and provides data regarding the role of the wordless book in the development of First Grade students' critical thinking skills. Specifically, this study aims at investigating: a) the role of the wordless books in the development of students' critical thinking skills and b) the effect of specific approaches that based on the images of wordless books in order to develop First Grade students' critical thinking skills.

This study aims at investigating: a) the role of the wordless books in the development of students' critical thinking skills and b) the effect of specific approaches that based on the images of wordless books in order to develop First Grade students' critical thinking skills.

The following research questions were formulated to investigate the above objectives:

a) Is it possible to develop First Grade students' critical thinking skills through specific strategies for using wordless books?

b) Are there any differences between the type and number of First Grade students' critical thinking skills?

4. Research process

4.1. Research tool

Aiming to investigate the role of wordless books in the development of First Grade students' critical thinking skills the *Critical Thinking Skills Evaluation Tool (C.T.S.E.T.)* was designed. The *C.T.S.E.T.* was used for comparisons between the groups of First grade students who were the sample of the main research. Children's critical thinking skills were measured on the following

scales/ indicators: 1) *interpretation;* 2) *analysis;* 3) *explanation;* 4) *inference* and 5) *evaluation* (Facione, 1990a).

According to the design of *C.T.S.E.T.,* modern teaching practices during an educational intervention were applied. Besides cognitive activities were planned in order to develop First Grade students' critical thinking skills. The planning of the activities was done according to the material proposed by the Teacher Training Organization (T.T.O) which is applied in primary education (Koulaidis, 2007).

4.2. Study sample

The study sample was consisted of 120 First Grade students who go to four (4) state elementary schools in Larissa, the largest city of Thessaly region of Greece. Based on the research design, half of these students were allocated to the control group and the rest of them to the experimental group using the randomization method. Among the 120 students who finally participated in the survey, 118 were Greek students and 2 were Albanian. All participants came from all socio-economic strata.

4.3. Selection and presentation of research material

Journey (2018), Quest (2019), Return (2019) were the wordless books which have chosen after a thorough bibliographic review of studies that focus on wordless books. The intent of the review was to provide an adequate framework for the development of students' critical thinking skills (Arizpe & Styles, 2003; Housen, 2002; Yenawine, 2013). The wordless books were selected according to certain criteria such as the age of children/research participants, the authenticity and persuasiveness of the story as well as the function of images (Giannikopoulou, 2008). It was also necessary stipulation that children should not know the wordless books, which have been published recently and have been distinguished by winning an international literature or best illustration award.

5. Methodology

5.1. Preparation, conduct of research

During the prosecution of the research, face-to-face and remote meetings were held with the principals, teachers and parents of the children who would participate in the research. Aiming to weighting the *C.T.S.E.T*. tool, identifying ambiguities and avoiding errors in the design of the main research (Barribeau, et al., 2012) a pilot study was carried out with students from another public primary school in Larissa, which did not participate in the main study.

The main research was completed in three phases: the pre-test, the educational invasion and the post-test (Cohen & Manion, 1997; Creswell, 2011). During the conduct in the main research children were divided into two groups (control and experimental), equally distributed, by the method of randomization without having been equalized in terms of their qualitative characteristics (Cohen & Manion, 1997; Creswell, 2011).

During the pre-test, children were asked to "read" the wordless book entitled *Journey* (Becker, 2018). Then they were asked to answer to five (5) comprehension questions of the book's content. The educational invasion followed. Children who participated in the experimental group were introduced to the basic elements of the Visual Arts, specifically the point, the line, the shape, the form, and the color. Besides they "read" the other two wordless books of Becker's trilogy (*Quest* and *Return*) and they implemented creative reading activities in a playful form. Especially, the three (3) teaching hours of the Flexible Zone course were allocated every week in order to develop students' critical thinking skills. The students of the experimental group and the class teacher implement twenty-five (25) activities. These activities were designed by the researcher and given to the class teacher as an educational material.

The main research was completed in three phases: the pre-test, the educational invasion and the post-test (Cohen & Manion, 1997; Creswell, 2011). During the conduct in the main research children were divided into two groups (control and experimental).

The post-test was conducted in the same way as the pre-test. In all phases of the research the interviews of the children/participants were recorded. The transcribed interviews -before and after- in response to the researcher's prompting questions composed the research material. In order to evaluate the performance of the groups in the main and the pilot research, it was applied the method of Content Analysis (Kyriazi, 1998; Lincoln & Cuba, 1985; Weber, 1990).

6. Results

6.1. Survey statistical analysis

The student performance of the two groups (control and experimental) was evaluated through statistical analysis. All analyzes were performed with the SPSS Statistics 26 statistical package and the level of significance was set at $p < .05$. First, a normal distribution test was applied using the Kolmogorov-Smirnov test (K-S test) (Chakravarti, Laha & Roy, 1967) and a descriptive analysis of the data (means and standard deviations) was performed (Howitt & Cramer, 2011). The Means, the Standard Deviations, the Control of Normal Distribution through the Kolmogorov-Smirnov test and the positive or negative differences (Most extreme differences)

between the initial (Pre) and the final measurement (Post) of the examined variables are presented in Table 1.

Table 1. Means, standard deviations, normal distribution test between the initial (pre) and the final measurement (post) in the examined variables.

	Mean[a]	Std Deviation[a]	Absolute [b]	Positive [b]	Negative [b]	Kolm Smirnov	Asymp.Sig (2-tailed)	N
I1_interpretation Pre	1,53	,879	,458	,458	-,275	5,019*	,000	120
I1_interpretation Post	1,79	,961	,378	,378	-,271	4,145*	,000	120
I2_analysis Pre	1,44	,786	,454	,454	-,287	4,979*	,000	120
I2_analysis Post	1,62	,881	,408	,408	-,242	4,470*	,000	120
I3_explanation Pre	1,50	,810	,432	,432	-,268	4,728*	,000	120
I3_explanation Post	1,72	,918	,382	,382	-,236	4,189*	,000	120
I4_inference Pre	2,08	,927	,307	,268	-,307	3,368*	,000	120
I4_inference Post	2,38	,918	,432	,251	-,432	4,736*	,000	120
I5_evaluation Pre	2,31	,933	,404	,245	-,404	4,427*	,000	120
I5_evaluation Post	2,53	,850	,470	,288	-,470	5,151*	,000	120

I. Indicator; a. Normal parameters: Test distribution is Normal/ Calculated from data; b. Most Extreme Differences * p < ,001

Because the data resulting from the normal distribution test through the Kolmogorov-Smirnov test (K-S test) did not follow the normal distribution (p< .05) a non-parametric test of two dependent samples (Wilcoxon test) (Howitt & Cramer, 2011) was applied separately for each intervention group (control and experimental) to investigate whether there were statistically significant differences between the initial (pre) and the final measurement (post) in terms of interpretation, analysis, explanation, implication and evaluation.

Especially, regarding the control group, the results of the Wilcoxon test showed that there were not statistically significant differences between the initial (pre) and the final measurement (post) in terms of the interpretation (Z = -,856, p = ,392), the analysis (Z = -,841, p = ,401), the explanation (Z = -,368, p = ,713), the inference (Z = -,434, p = ,664) and the evaluation (Z = -,428, p = ,669) (Table 2).

Table 2. Means, standard deviations, normal distribution test of the examined variables in the control group

	Mean[a]	Std Deviation[a]	Minimum	Maximum	Statistic z	Asymp.Sig (2-tailed)	N
I1_interpretation	1,52	,873	1	3	-,856[a]	,392	60
I2_analysis	1,48	,792	1	3	-,841[b]	,401	60
I3_explanation	1,45	,769	1	3	-,368[b]	,713	60
I4_inference	2,03	,991	1	3	-,434[b]	,664	60
I5_evaluation	2,20	,988	1	3	-,428 [a]	,669	60

I. indicator; a. Based on negative ranks; b. Based on positive ranks; c. Wilcoxon Signed Ranks Test

On the contrary, regarding the experimental group, the results of the Wilcoxon test showed that there were statistically significant differences between the initial (pre) and the final measurement (post) in terms of interpretation (Z = -2.056, p < .05), analysis (Z = -2.663, p < .05), explanation (Z = -2.549, p < .05), inference (Z = -3.974, p < .001) and evaluation (Z = - 2.489, p < .05). In all the above analyses, the experimental group had a higher score in the final measurement (post), after the implementation of the intervention program in comparison to the initial measurement (pre) (Table 3).

Table 3. Means, standard deviations, control of normal distribution of the examined variables in the experimental group

	Mean[a]	Std Deviation[a]	Minimum	Maximum	Statistic z	Asymp.Sig (2-tailed)	N
I1_interpretation	1,70	,926	1	3	-2,056[a]	,040	60
I2_analysis	1,37	,712	1	3	-2,663[a]	,008	60
I3_explanation	1,42	,720	1	3	-2,549[a]	,011	60
I4_inference	1,95	,999	1	3	-3,974[a]	,000	60
I5_evaluation	2,25	,968	1	3	-2,489[a]	,013	60

I. indicator; a. Based on negative ranks; b. Wilcoxon Signed Ranks Test

In order to investigate whether there were statistically significant differences between the experimental group and the control group in interpreting, analyzing, explaining, inferring and evaluating separately for each measure (pre, post), a non-parametric two-independent sample test was used. Specifically, the Mann-Whitney U test was used to investigate whether there were statistically significant differences between the two independent sample variables.

More specifically, regarding the initial measurement (pre), the results from the Mann-Whitney U test showed that there were no statistically significant differences in the interpretation (U = 1792.00, p = .956), the analysis (U = 1677.50, p = .401), the explanation (U = 1716.00, p = .584) the inference (U = 1729.00, p = .684) and the evaluation (U = 1620.00, p = .263) between the experimental group and the control group (Table 4).

Table 4. Differences between the performance of the control group and the experimental group in the initial measurement

	Mean[a]	Std Deviation[a]	Min	Max	Whitney U test[a]	Asymp.Sig (2-tailed)	N
I1_interpretation	1,52	,873	1	3			
control group_ pre					1792,00	,956	60
I1_interpretation_	1,53	,892*	1	3			
experimental group_ pre							60
I2_analysis_	1,48	,792	1	3			
control group_ pre					1677,500	,401	60
I2_analysis_	1,40	,785*	1	3			
experimental group_ pre							60
I3_explanation	1,45	,769	1	3			
control group_ pre					1716,000	,584	60
I3_explanation_	1,55	,852*	1	3			
experimental group_ pre							60
I4_inference_	2,03	,991	1	3			
control group_ pre					1729,000	,684	60
I4_inference_	2,12	,865***	1	3			
experimental group_ pre							60
I5_evaluation_	2,20	,988	1	3			
control group_ pre					1620,000	,263	60
I5_evaluation_	2,42	,869***	1	3			
experimental group_ pre							60

I. indicator; a. Grouping Variable: group* $p < ,05$ *** $p < ,001$

Regarding the final measurement (post), the results from the Mann-Whitney U test showed that there were statistically significant differences in the analysis (U = 1324.00 p < .01), the explanation (U = 1249.00 p < .01), the inference (U = 1007.00 p < .001) and the evaluation (U = 1293.00 p < .001) between the experimental group and the control group. Specifically, in the final measurement (post) the experimental group had a higher score in those indicators than the control group. Finally, there were no statistically significant differences in the interpretation (U = 1637.50 p = .324) between the experimental group and the control group (Table 5).

Table 5. Differences between the performance of the control group and the experimental group at the final measurement

	Mean[a]	Std Deviation[a]	Min	Max	Whitney U test[a]	Asymp.Sig (2-tailed)	N
I1_interpretation	1,70	,926	1	3			
control group_ pre					1637,500	,324	60
I1_interpretation_	1,88	,993*	1	3			
experimental group_ pre							60
I2_analysis_	1,37	,712	1	3			
control group_ pre					1324,000	,003	60
I2_analysis_	1,87	,965*	1	3			
experimental group_ pre							60
I3_explanation	1,42	,720	1	3			
control group_ pre					1249,000	,001	60
I3_explanation_	2,02	,1000*	1	3			
experimental group_ pre							60
I4_inference_	1,95	,999	1	3			
control group_ pre					1007,000	,000	60
I4_inference_	2,82	,567***	1	3			
experimental group_ pre							60
I5_evaluation_	2,25	,968	1	3			
control group_ pre					1293,000	,000	60
I5_evaluation_	2,80	,605***	1	3			
experimental group_ pre							60

I. indicator; a. Grouping Variable: group* $p < ,05$ *** $p < ,001$

7. Conclusions

Evaluating the dialogues of First grade students it was found that the students of the experimental group compared to children in the control group scored better on the five (5) critical thinking assessment indicators (interpretation, analysis, explanation, inference, evaluation) (Housen, 2002; Pantaleo, 2017; Yenawine 2013).

Particularly, in accordance with the *C.T.S.E.T.* tool it was found that the performance of children in both the control and experimental groups did not show statistically significant differences on the five investigated critical thinking indicators before the implementation of the educational invasion (pre-test). On the contrary, obvious statistical differences were found in the performance of the children of the experimental group during the post-test. Final data of the survey proved the positive effect of the educational invasion that implements wordless books.

The comparative analysis of the two groups' performance showed that the children in the experimental group developed higher order critical thinking skills through providing teacher's

guidance and explicit instructions (Halpern, 2014; Law, 2012). In particular, it was found that the children met the requirements of the *C.T.S.E.T*. objectives. They were able to identify the key information of the image and predict the development of the book's story. Finally, they managed to identify the figurative elements in order to fully substantiate a point, conclusion or argument.

The survey results confirm the positive effect of the *C.T.S.E.T.* as a research tool in the development of children's critical thinking skills. The results demonstrate that the implementation of wordless books provides a strong motivation to integrate this kind of picture book into the educational process in order to develop children's critical thinking skills.

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How to cite this paper:

Mike. P. (2023). Assessing children's critical thinking through the "Critical Thinking Skills Evaluation Tool" (C.T.S.E.T.). *Journal of Literary Education*, (7), 47-58. https://doi.org/10.7203/JLE.7.25440