The Effectiveness of a Visual Thinking Networks Training Program on improving Visual Thinking Skills and Science Achievement among Hard of Hearing Students with Visual Perception Disability

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Abstract
This study investigated the effect of using Visual thinking networking on improving visual thinking , visual perception and science achievement among hard of hearing students with visual perception disability. Eight students identified as having hard of hearing and deafness participated. The sample was divided into two groups; experimental (n= 4)and control (n= 4). Re-post and follow up tests were employed for data analysis. Findings from this study indicated the effectiveness of Visual thinking networking on improving visual thinking, visual perception and science achievement in the target students. On the basis of the findings, the study advocated for the effectiveness of Visual thinking networking on visual thinking, visual perception and science achievement among hard of hearing students with visual perception disability.

Keywords :*Visual thinking networking, visual thinking, visual perception, science achievement, hard of hearing students with visual perception disability*.

Introduction

Visual thinking networking represents the most recent metacognitive and knowledge representation strategy (KRS) used to enhance student learning (Fisher, Wandersee & Moody, 2000; Longo 2001a, 2001b, 2002). As a new theory driven strategy VTN encourages the learner to integrate multiple ways of thinking that inform concept formation. VTN was being developed at the time Anderson (1991, 1992, 1997) began paving a crucial path in science education, linking the empirical and theoretical findings from neurobiology and neurocognitive science to a constructivist view of learning.(Longo, 2001a).

Students use VTNs for organizing their science knowledge by constructing black and white or color network diagrams on paper using semantic and pictorial elements to represent knowledge relationships. It is important to note that although Cliburn (1990) used color coding in concept mapping, no study had been previously conducted to test the effectiveness of adding this attribute with respect to student learning and achievement. As a metacognitive learning strategy, VTN "empowers the learner to take care of her/his own learning in a highly meaningful fashion" (Novak, 1998a, p.1). The term "visual thinking" is derived from the work of Rudolf Arnheim (1969). For Arnheim "the perception of shape marks the beginning of concept formation" (p. 27).

Bloom’s contextual mapping (1995) represented a critical shift towards enhancing learning away from students constructing meaning solely derived from propositional (semantic) relationship to a strategy that encourages the “emotion-values-aesthetics, interpretive frameworks, personal experiences, and metaphors” (p. 169). Visual thinking networking extends the notion of Bloom's "contexts of meaning" by offering a place for learners to incorporate her/his visual metaphors as referents for non-concrete experiences. These metaphors specify meaning and aesthetic quality with the use of color and symbolic visualizations, in addition to incorporating knowledge derived from propositional relationships. VTN, then, is a tool for the learner to represent, organize, and revise her/his meaning-making of science knowledge by chunking and linking conceptual labels with symbolic visualizations of scientific concepts, processes, and experiences into a coherent whole.

The planning, organizing, the making of the chunks and the connections are undirected by the teacher and become an aspect that is most crucially idiosyncratic and imaginative.(Longo, 2001a).

Visual thinking networking among the deaf and hard of hearing students

The importance of visual thinking networking highlights as it helps to focus learner attention easily on ideas and make it easy to focus, freedom of thought and exploration, provide feedback to the ideas and complex meanings, allow changing and developing ideas easily and to express it in understanding way and characterized by diversity to meet all learners needs (Saleh & Mohamed, 2014)

Many deaf and hard of hearing students are passive learners; many of them process text by focusing on understanding word meanings first before analyzing the whole text (Long & Aldersley, 1984). visual thinking networking can be a tool for visual thinking ; those students become active learners through the use of visual thinking networking . Visual thinking networking is a way to help students visually decipher the meanings of learning materials. To learn meaningfully, individuals must choose to relate to new knowledge to relevant concepts and propositions they already know. This can be accomplished through visual thinking networking. Visual thinking networking "represent meaningful relationships between concepts in the form of propositions" (Novak & Gowin, 1985) (p. 15).

The construction of a visual thinking network can be viewed as a problem space to solve with a goal of building a meaningful structural knowledge base that shows relationships between concepts, principles, and theories. Overtime the novice learner should then have the capacity to transfer this problem solving skill to new situations. According to Novak (1998), since "metacognitive strategies are strategies that empower the learner to take charge of her/his own learning in a highly meaningful fashion… the learner who has knowledge organized into large, integrated conceptual frameworks can assimilate more related knowledge in less time and with greater potential for transfer and application" (p. 1).

Visual thinking networking represent mental map followed by it the learner during practicing education process and thinking as it sets a starting point and finishing with putting technique to develop learners learning and monitor performance, to identify strengths points to be strengthened and weaknesses to be improved in order to achieve the desired goals of the education process, as it provides organized knowledge which is working to find a relations and interdependence between them and the abstract concepts which are involved, and practicing different science processes among students(Saleh& Mohamed, 2014). According to Mourad Ali (2012) , it is effective across subject areas because they provide visual cues designed to assist students in their understanding of information by organizing information.

Visual thinking and science teaching

Visual thinking presents information structurally and serially. Visual thinking helps to understand the centre, lines and lets mentally move to the other place. It fixes partial figures and that is why it is needed for orientation in the maps in geography. Gazit E. (2005) proves the importance of visual thinking in astronomy. Visual thinking can help to understand the movement of stars and the laws of the solar system in this range. Visual thinking is important for spatial processes in science education (Bilbokaitė,2008) and etc. Spatial thinking is a kind of visual thinking or, it could be said, the part of visual thinking because it contains all operations suited with the location in space and perception of its variations. Since spatial thinking has very clear functions it is analyzed as an independent kind of thinking in scientific literature.

The importance of visual thinking in natural science disciplines is growing because of spatial abilities. These abilities are frequently needed for perception, comprehension and realization of the concepts. Visual thinking is given a sense because of visual representations. The last mentioned objects are the mostly recommended communication mode. The visual presentations show the full-scale perspective view of functions and connections (Bilbokaitė, 2008).

Visual thinking networking strategies encourages learners to choose meaningful color and symbolic visualizations to the scientific concepts, processes, and experiences into a coherent whole. In doing so, we encourage a broadened epistemological view of color as knowledge. This view supports Eisner's arguments for "a transformation of the ways in which we teach, the curriculum resources we employ, and the forms we allow students to use in order to represent what they have come to know" .(Longo, 2001a).

Further research is necessary to build on the vast amount of research into visual thinking networking with the deaf and hard of hearing students. This will allow researchers to determine how visual thinking networking can be best used as an intervention with the deaf and hard of hearing students as there is a dearth of research with this population.

Method

Participants

Eight hard of hearing with visual perception disability middle first grade students from Abi Muhjin Althagafi school in Taif participated in the present study.They were divided evenly into two groups;one experimental and the other was control group. Their age ranged from (12 to 13.6 years, M=13.1, SD 0.32) and their IQ ranged from 100-105, M=103,5 , SD= 1.92) .

The two groups were matched on age, IQ, visual thinking, science achievement, and visual perception (pre-test).

Table 1. *Mann-Whitney, Z Value, and significance level for experimental and control groups on age IQ, visual thinking, science achievement, and visual perception (pre-test).*

Variable	**Ex Group N=4**		**Con. Group N=4**		**Mann-Whitney**	**Z Value**	**Sig**
	Mean Ranks	Sum Ranks	Mean Ranks	Sum Ranks			
Age	4	16	5	20	6	0.584	-
IQ	4	16	5	20	6	0.584	-
Visual Thinking	3.38	13.50	5.63	22.50	3.5	1.340	-
Science Achievement	4.75	19	4.25	17	7	0.316	-
Visual Perception	3.75	15	5.25	21	5	0,949	-

Table 1 shows that all Z values did not reach significance level. This indicated that the two groups did not differ in age, IQ, visual thinking, science achievement, and visual perception (pre-test).

Instruments

Nonverbal Intelligence Test (Saleh, 1978). Originally, depends on perceptions of the relationship between a range of shapes and the selection of the different one between the Group's units. It contains 60 questions, each question has five shapes, from which one is different. The respondent should recognize this different shape. The test lasts for 10 minutes. The test has good reliability and validity.

Visual Thinking Test .It consists of five sub skills; namely recognizing the visual shape skill, Analyzing the visual shape skill , relating relations in visual shape skill,

interpretation of ambiguity in the visual shape skill, and extracting meaning from visual shape skill. It is a multiple choice test. The test lasts for 40 minutes. The test has good reliability and validity.

Visual Perception Test. It contains 8 questions. The first question has some geometric shapes . The respondent chooses the shapes that is typical to the one on the right of the box . In the second question, there are five pictures for a person , two of which are the same . The respondent says which are the same. In the third question , there are 3 series of pictures for which the respondent tells which picture is different . In the fourth questions, there are some scattered words.

The respondent finds the word above the web. In the fifth question, respondents complete the incomplete parts of the words. In the sixth question, there is a maze. The respondents help the rabbit to go to the end. In the seventh question, the respondents math the letter with the right word. In the eighth question, the respondents help the bear get to the snake . when the student scores 17 , this means that he has not visual perception disability. The test lasts for 55 minutes. The test has good reliability and validity.

Science Achievement Test. It assesses hard of hearing student's acquisition of facts , concepts and principles included in the " Nature of matter" Unit. The test has good reliability and validity.

Procedure

Pre-intervention testing: All the eight tudents completed the Nonverbal Intelligence Test , Visual Thinking Test, Visual Perception Test and Science Achievement Test.

General Instructional Procedures: Instruction was delivered to the students in Abi Muhjin Althagafi school in Taif. Permissions were obtained from students' fathers, and the school principal. Students received 3 training sessions a week, lasting for 45 minutes. The training program itself lasted for 21 sessions.

Design and Analysis

The effects of implementing visual thinking networking intervention on visual thinking skills and science achievement among hard of hearing students with visual perception disability were assessed using pre- post- and follow-up testing.

Results

The first objective of the study was to determine if use of visual thinking networking intervention would be more effective for the treatment group compared to the control group. For this purpose, the post intervention scores of both treatment and control groups were analyzed. Table 2 shows Z Value results for the differences in post- test mean rank scores between experimental and control groups in Visual Thinking Test . The table shows that (Z) value was (2.323). This value is significant at the level (0.01) in the favour of experimental group.

Table 2. *Z Values results for the differences in post- test mean rank scores between experimental and control groups in Visual Thinking Test*

Variables	**Groups**	**N**	**Mean Ranks**	**Sum Ranks**	**Mann-Whitney**	**Z Value**	**Sig.**
Visual Thinking	Ex	4	2.5	10	Zero	2.323	0.01
	Cont.	4	6.5	26			

The second objective of the study was to determine if use of visual thinking networking intervention would be more effective for the treatment group compared to the control group .For this purpose, the post intervention scores of both treatment and control groups were analyzed. Table 3. shows Z Value results for the differences in post- test mean rank scores between experimental and control groups in Visual Perception Test . The table shows that (Z) value was (2.337). This value is significant at the level (0.01) in the favour of experimental group.

Table 3. *Z Values results for the differences in post- test mean rank scores between experimental and control groups in Visual Thinking Test*

Variables	Groups	N	Mean Ranks	Sum Ranks	Mann-Whitney	Z Value	Sig.
Visual	Ex	4	2.5	10	Zero	2.337	0.01
Perception	Cont.	4	6.5	26			

The third objective of the study was to determine if use of visual thinking networking intervention would be more effective for the treatment group compared to the control group .For this purpose, the post intervention scores of both treatment and control groups were analyzed. Table 4 shows Z Value results for the differences in post- test mean rank scores between experimental and control groups in Science Achievement Test. The table shows that (Z) value was (2.337). This value is significant at the level (0.01) in favour of experimental group.

Table 4. *Z Values results for the differences in post-test mean rank scores between experimental and control groups in Visual Thinking Test*

Variables	Groups	N	Mean Ranks	Sum Ranks	Mann-Whitney	Z Value	Sig.
Science	Ex	4	2.5	10	Zero	2.337	0.01
Achievement	Cont.	4	6.5	26			

The fourth objective of the study was to determine the effect of visual thinking networking intervention on improving visual thinking. The children's performance on visual thinking was measured post and follow up intervention. Table 5 shows Z Value result for the differences in post and follow up test mean rank scores for the experimental group in visual thinking test. The table shows that (Z) value did not reach the significance level .This indicates that this are not differences in post and follow up test mean rank scores for the experimental group in visual thinking test .

Table 5. *Z Values results for the comparison of mean rank scores of experimental group at post and follow up intervention in visual thinking test*

Variable	Ranks	No.	Mean Ranks	Sum Ranks	Z Value	Sig.
Visual	Negative	2	2	2	0.577	Not
Thinking	Positive	2	4	2		
	Equal	0				
	Total	4				

The fifth objective of the study was to determine the effect of visual thinking networking intervention on improving visual perception. The children's performances on visual perception was measured post and follow up intervention. Table 6. shows Z Value result for the differences in post and follow up test mean rank scores for the experimental group in visual perception test. The table shows that (Z) value did not reach the significance

level .This indicates that this are not differences in post and follow up test mean rank scores for the experimental group in visual perception test .

Table 6. *Z Values results for the comparison of mean rank scores of experimental group at post and follow up intervention in visual perception test*

Variable	Ranks	No.	Mean Ranks	Sum Ranks	Z Value	Sig.
Visual Perception	Negative	1	2	2	0.577	Not
	Positive	2	2	4		
	Equal	1				
	Total	4				

The sixth objective of the study was to determine the effect of visual thinking networking intervention on improving science achievement. The children's performances on science achievement were measured post and follow up intervention. Table 7. shows Z Value result for the differences in post and follow up test mean rank scores for the experimental group in science achievement test. The table shows that (Z) value did not reach the significance level .This indicates that this are not differences in post and follow up test mean rank scores for the experimental group in science achievement test .

Table 7. *Z Values results for the comparison of mean rank scores of experimental group at post and follow up intervention in science achievement test*

Variable	Ranks	No.	Mean Ranks	Sum Ranks	Z Value	Sig.
Visual Perception	Negative	2	2	4	0.576	Not
	Positive	1	2	2		
	Equal	1				
	Total	4				

Discussion

The present study evaluated the effects of visual thinking networking intervention on improving visual thinking, visual perception and science achievement among hard of hearing students with visual perception disability. The study results showed that the visual thinking networking intervention was effective in improving visual thinking skills and science achievement of all children participated in this study.

Furthermore, the children in this study did not receive any type of reinforcement or behavior modification strategies while participating in the sessions. Removing strategies such as prompting techniques, token systems, and other reinforcement systems reduced the potential for confounds within the study. Therefore, one can conclude that the visual thinking networking intervention was primarily responsible for the change in the visual thinking, visual perception and science achievement of children participated in the study. This goes in line with the results of the many studies in this field (e.g, Ali, 2013; AbdulHamid, 2013; Abdo, 2012; AbdMola, 2010; AbdAlazeim, 2009)

In summary, visual thinking networking intervention effectively improved the visual thinking, visual perception and science achievement among hard of hearing students with visual perception disability who participated in this study. Overall, results from this study contribute to the visual thinking networking literature for improving the visual thinking, visual perception and science achievement among hard of hearing students with visual

perception disability. The present study lends empirical support to the notion that hard of hearing students with visual perception disability can be taught and can learn appropriately.

Implications

The results of this study have several important implications. This study adds to the literature on the effectiveness of visual thinking networking intervention among hard of hearing students with visual perception disability. Results appear to indicate that visual thinking networking intervention is an effective instructional strategy for improving visual thinking , visual perception and science achievement among hard of hearing students with visual perception disability. visual thinking networking intervention provides students with a visual representation of the content in a text and this may facilitate the learning of content knowledge.

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