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Information Visualization on the Reading Comprehension for Elementary School Students in Malaysia

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ABSTRACT

Visualization strategies are strategies that utilize images to help strengthen the students' understanding of reading comprehension. Through this strategy, students will describe the meaning obtained from the text in the form of rough sketches. The use of these images allows the students to be more focused on the continuation of reading because they understand the meaning more clearly. This study aims to investigate the impact of information visualization techniques on reading comprehension performance among elementary school students in Malaysia. The study adapted quantitative study through a quasi-experimental design and survey questionnaire. 300 students from Standard 4 to Standard 6 (10 to 12 years old) were chosen as the participants of the study. They were divided into Experimental Group (n=150) and the control Group (n=150). The experiment has been done in 2 classes per week, in a total of 6 weeks. The participants in the Experimental Group were taught reading comprehension using visualization technique, while the students in the Control Group were taught using conventional method. The reading comprehension score for all the students were recorded both in pre-test and post-test. After the experiment, the students in Experimental Group were asked to answer a set of questionnaires. The finding shows that the student in the Experimental Group has higher increment in terms of their reading comprehension score compared to the students in the Control Group after the experiment. Statistical analysis of Pearson correlation found a very weak significant positive correlation between visualization technique and reading comprehension score ($r=0.188$, $p<0.005$). The analysis of Multiple Linear regression also shows that visualization technique has a small effect only on the reading comprehension score ($R2=.275$, $R2Adj=.233$, $p<0.001$). It was also found that there is a significant difference on the information visualization technique on the reading comprehension score based on gender. The study concludes that there are other factors that affect the students' level of reading comprehension such as the students' cognitive ability, and the environment of study, in which visualization technique is only a fraction in improving the reading comprehension.

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1. Introduction

There are four basic skills of learning language namely listening, speaking, reading and writing. Reading is one of the sources of knowledge and the basis of self-formation towards acquiring knowledge [17]. Farrell mentioned that reading requires the readers to have active interaction with the text [1]. The purpose of reading is to understand the text being read and the content of the text gives meaning to the readers. When reading a text, the readers are expected to understand the materials that they have read [18]. In addition to that, reading can be defined as the meaningful interpretation of written or printed verbal symbols, and hence the goal of reading is comprehension [11].

The ability to read is a very valuable skill and is a dynamic process, which requires active and meaningful communication between the reader and the writer [12]. Reading is also said to be a person's ability to recognize visual forms and connect between forms and sounds and through experience as well as being able to interpret their meaning [9]. Reading comprehension depends on a combination in terms of language knowledge, cognitive style, and reading experience [1]. Reading comprehension is considered as one of the language skills. It is important and essential for the students to master reading comprehension [10]. According to Rogde, Hagen, Melby-Lervag, and Lervag, reading comprehension is composed by many other abilities and skills that are interdependent and interrelated [2]. Students need the skills to master comprehension so that they can fully understand the reading material [13].

Based on the General Handbook of Malaysia Integrated Primary School Curriculum each student is different from other in terms of experience, behaviour, practice, talents, and abilities. Hence, there are students who experiences difficulties to master the reading comprehension. Having difficulties with reading comprehension may become obstacles for the students to advance in their study and bring greater impact on their life [3]. Ngui and Nurfaradila Mohamad Nasri mentioned there are many students who faces difficulties in reading comprehension in Malaysia [4]. Reading is an essential thing for students, since they need to study and read books or material that are related to their lessons [14]. In fact, reading can be considered as the most important skills to acquire more than the other three skills which are listening, speaking, and writing [15].

Another study explored the visualization skills among elementary school students by Özkan *et al.,* argued that information visualization is among the most effective method that helps students to internalize concepts and to establish an association between them [5]. The study further outlined that visualization is very important, particularly in teaching mathematics, which is perceived as the combination of abstract concepts [20]. Despite the effectiveness and the significance of the information visualization in teaching elementary students, the current study established that most students experience various problems in using visual models and thus consider using calculation methods. As such, to assess the effects of information visualization on the learning outcomes of elementary students, the current study aimed to assess the effects of information visualization on understanding level of elementary students as well as evaluating the significant difference in learning outcomes of the student between those who used the methods and those who did not.

The main objective of this study is to investigate the impact of information visualization on the achievement of learning outcomes for elementary school students in the context of reading comprehension. There are three majors research objectives derived from the main objects, such as to examine the effect of information visualization on reading comprehension level of elementary students., to determine the significant differences on the effects of visualization technique on reading comprehension level based on gender and to assess whether there are significant differences in students' outcomes between those that use information visualization and those who do not.

The conceptual framework for this study is according to the Cognitive Theory and Visual, Auditory and Kinaesthetic (VAK) model. According to Cognitive theory, students learn better through visual learning. The process of visual learning includes visual cognition process which is the main focus of the study. Visualization techniques mostly used pictures, diagrams, charts, and many other visual stimuli to help the students understanding, remembering, as well as forming and editing visual information, and hence achieve certain level of reading comprehension. In addition, the Visual, Auditory, and Kinaesthetic (VAK) Model of learning also has been adapted to this study. As there are three aspects in the model namely visual, auditory, as well as kinaesthetic, the study will mainly focus on the visual learning style. According to this learning style, the students learn better by looking at visual of text and any other form of visualization to help them remember and understand the text.

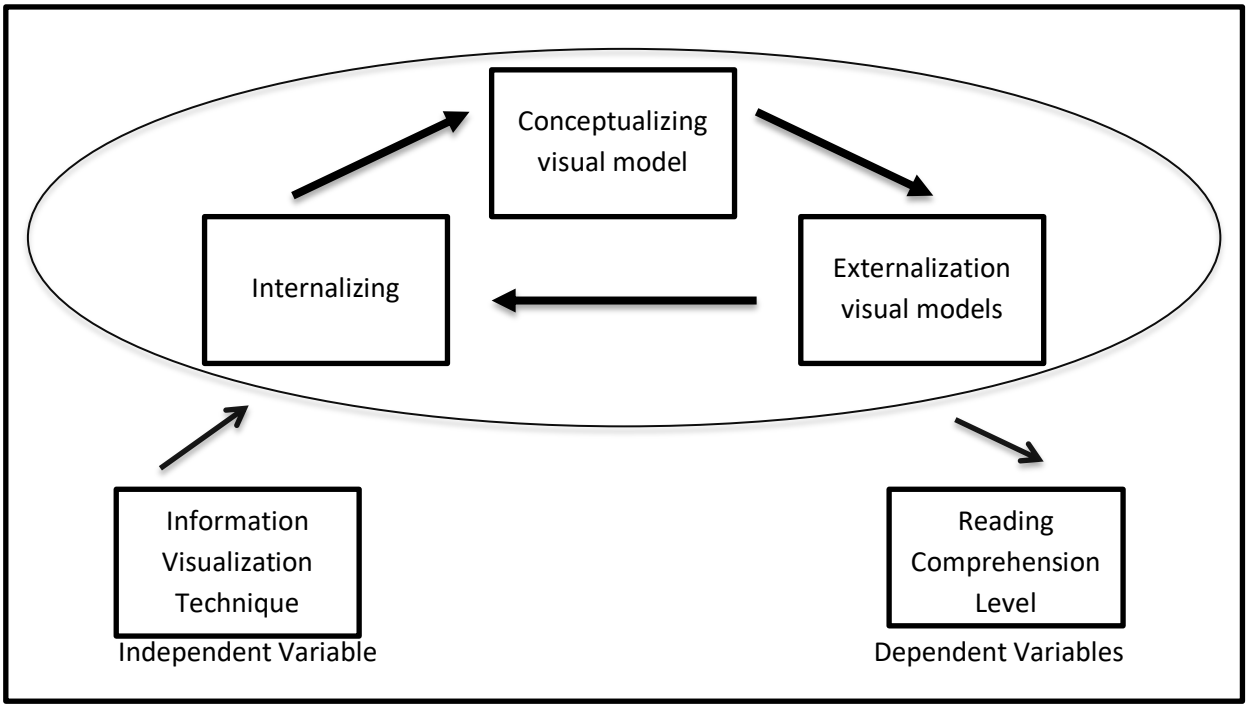

Fig. 1. Theoretical Framework

Three research hypotheses had been derived from the research objectives for this study. The first hypotheses indicate there is a significant effect of information visualization on the reading comprehension level of elementary students. The second research hypotheses stated there is a significant difference of the effect of information visualization on the reading comprehension based on gender. The last research hypotheses for this study indicate there is a significant difference of the reading comprehension score between student who are taught using information visualization strategy and those who were not.

2. Methodology

A research strategy can be defined as a technique as well as the process of gathering and analysing the collected data to make conclusive statements about the proposed research questions [6]. This study will employ a quantitative research strategy through experimental research method. Nardi *et al.,* outline that a quantitative strategy involves the collection of numerical data and generalizing on a particular study [6]. This approach was chosen because it enhances knowledge development using observable variables. The approach was also employed as it enables the

researcher to assess various variables to predict, explain, and monitor the overall nature of the research questions [20].

A quasi-experimental design will be used as the research instrument in this study [16]. The students are divided into 2 groups, namely experimental group, and control group. Each group contains 150 students. Probability and non-probability sampling techniques had been adapted for this study. Through probability sampling technique, every member in a population has the same opportunities to get chosen as sample. On the other hand, researcher is allowed to focus on small sample when utilizing non-probability sampling. Both sampling techniques can be used when conducting quantitative and qualitative study. The current study will also employ a simple random sampling technique during data collection. This approach was chosen because it ensures that all the members of the target population have an equal chance of being included in the sample. The experimental group of students will be taught reading comprehension using information visualization techniques, while the students in control group will be taught in conventional method for reading comprehension. There will be 3 lessons of reading comprehension per week, and the study is conducted in a total of 6 weeks. After the experiment, the level of reading comprehension skills among students in both experimental group and control group will be assessed using the standard assessment. Besides that, the current study will utilize structured questionnaires as data collection tools. The questionnaires will be structured to include only close-ended questions to enhance the collection of numerical data suitable for quantitative research studies. The purpose of the questionnaire is to assess the student's reading comprehension after learning through information visualization techniques through their own viewpoint.

Table 1
Quasi-Experimental Design

Control Group – Conventional Method of Teaching and learning	Experimental Group – Information Visualization Technique Experimental Design
1. First, the teacher is required to write the topic in text form on the board and asked the students whether they knew what it meant or not, if not the text would be explained. 2. Next, the teacher read the text and asked the students to listen and pay attention closely to the pronunciation of each word. This process will be continued until the student able to read the text accordingly.	**1. Teacher Models** a) The teacher demonstrates (model) the strategy by using a reading title and first paragraph to the students. b) Then, the teacher sketches what she sees in her mind and labels the pictures. Teacher also shows the simple sketch to the student as well. c) The teacher continues reading more paragraphs and again sketches what is visualized and labels it. **2. Guided Practice** a) It begins with the teacher reading the remaining pages, and stop at multiple points of interest from the reading material (if necessary). b) The teacher asks the students to visualize and creates sketch in their mind according to the point of interest. c) The teacher encourages students to share and discuss their visualization among peer and sketch their visions on paper. d) Students share their sketches with their peer and the teacher responsible to points out individual differences from the student sketches.

3. Then, teacher continues reading the text again and gave some definitions or synonyms for the new words when it was needed. Finally, the students were asked to paraphrase the reading part for the next session.	**3. Independent Practice** a) This level starts with the teacher continue reading the text while the students are drawing and labelling with their own visualization. b) When complete, the students share and discuss the final drawing or labelling among the peer. c) The students are encouraged to reflect their drawing for improving their understanding about the reading topic.

There are a total of 13 questions in the questionnaire. The questionnaire is divided into 2 sections namely Section A (Demographic Profile) and Section B (Impact of Visualization Technique). The measurement items in Section B are designed with Likert-scale type ranges from point 1 (strongly disagree), to point 3 (partially agree), and point 5 (strongly agree). Table 2 shows the breakdown of the Likert-style scale used in the questionnaire.

Table 2
Breakdown of the Questionnaire

Section	No. of Items	Measurement Items
Section A – Demographic Profile	5	1. Gender 2. Age 3. Race 4. Group of Experiment 5. Reading Comprehension Score
Section B – Impact of Visualization Technique	8	1. Do you think information visualization has a beneficial effect on learning English? 2. Do you think learning through information visualization affect your reading comprehension? 3. I am interested in learning English if the teacher uses visual materials as teaching method. 4. It is easily understanding text when using visualization technique. 5. It is easily remembering the meaning of text when using visualization technique. 6. Do you think visual motivates you to learn English? 7. Do you agree information visualization able to improve reading comprehension skill? Do you agree you have learned English Vocabulary by looking at visual materials?

A manipulation check was used to validate for the validity and reliability of the quasi-experiment. For this research, the participants in the experimental group were explained on the learning of reading comprehension by using visualization technique. The teachers will explain on the information visualization technique, and the research objectives. Besides that, a basic teaching demonstration has been done to a total of 10 teachers to validate for the right teaching method of information visualization technique, and to standardize the technique used in the learning sessions.

A validity test helps in measuring how well a statistical test evaluates the assigned function without significant changes. All the respondents will need to go through face validity to make sure only elementary students from Standard 4 to Standard 6 in Sekolah Kebangsaan Sri Sendayan participated in the research. This process is required to make sure the questionnaire developed to

conduct the research is relevant, reasonable, unambiguous, as well as clear so that the data collected is valid for the research. On the other hand, reliability can be defined as a measure of how well the test score is. This consequently helps in determining the consistency and the stability of the statistical tests. In this research, the researcher evaluated the reliability of the research instruments using Cronbach's Alpha. According to the Hair *et al.,* a research instrument is considered reliable when each variable tested with Cronbach Alpha will get a minimum value of 0.7.

Table 3
Summary of Data Analysis

Objectives	Analysis
1. To examine the effect of information visualization on reading comprehension level of elementary students.	Pearson Correlation test and Multiple Linear Regression analysis.
2. To assess whether there are significant differences in students' outcomes between those that use information visualization and those who do not.	Teachers' assessment
3. To determine the significant differences on the effects of visualization technique on reading comprehension level based on gender.	T-test

3. Results

3.1 Reliability Analysis

The value of Cronbach's Alpha is used to define the reliability of the data. Table 4 shows the value of Cronbach's Alpha for the measurement items used in research instrument. According to the findings, the value of Cronbach's Alpha recorded for all the 8 items is 0.949. Hence, the measurement items used in the research instrument has a good reliability that according to the Cronbach's Alpha value description [8]. With the higher Cronbach's Alpha value indicated higher agreement between items. It showed response value for each participant across the questionnaire are consistent. The questionnaire used developed to conduct the research is relevant, reasonable, unambiguous, thus the data collected is valid for the research.

Table 4
Breakdown of the Questionnaire

Variable	No. of Items	Value of Cronbach's Alpha
Visualization Techniques	8	0.949

3.1.1 Analysis of respondents' demographic profile

There are a total of 300 participants participating in this research, in which each group (Experimental and Control) contains 150 participants. In this section, only the demographic data for participants in the experimental Group is presented. In the gender's category, female participants have higher participation compared to the male participants, in which there are 87 female participants (58.00%), and 13 male participants (42.00%).

In terms of age, only those from 10, 11, and 12 years old participated in the study, in which majority of the participants are 11 years old (64 students - 42.70%). Then, 46 (30.70%) participants of the study are 12 years old, and 40 (26.70%) of them are 10 years old. Majority of the participants are Malay, in which there are 114 (76.00%) Malay students participated in the study, followed by 22 (14.70%) Chinese students, and 11 (7.30%) Indian students. On the other hand, the least students who participated in the study in from another race which accounted by 3 (2.00%) of them. The students' reading comprehension score after participated in the quasi-experimental designed by the

researcher is recorded and categorized into grade. Majority of the students got A for the reading comprehension score, in which it is represented by 86 (57.30%) students. Then, there are 50 (33.30%) who got grade B, and 14 (9.30%) students got grade C.

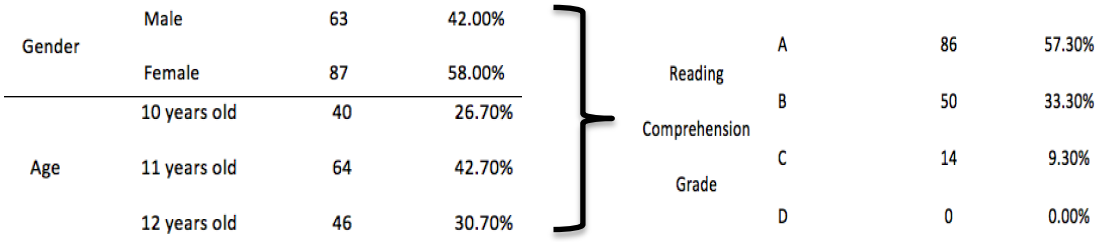

Fig. 2. Respondents' Demographic Profile versus Reading Comprehension

3.1.2 Analysis of reading comprehension level

This section presents the reading comprehension score analysis for the participants of the study. The reading comprehension score is calculated based on the standard assessment. Scores are given based on correct comprehension used by the students. The teacher will sum up all the scores at the end of the lessons. According to Table 5, the initial pre-test score of reading comprehension for the experimental group is 5880, and it has increase to a total of 7800 after 6 weeks of studying using visualization technique. Meanwhile, in the control group, the initial score is 5878, and has increase to 6450 after the 6 weeks of studying using conventional method. This research found that the students in experimental group has more than double increment compared to those in the control group regarding their reading comprehension score. However, the initial reading comprehension score for both groups are almost the same.

Table 5
Analysis of Reading Comprehension Level Based

Group	Number of Participants	Total Score		Increment
		Pre-Test	Post-Test	
Experimental Group	150	5880	7800	1920
Control Group	150	5878	6450	572

3.2 Inferential Analysis

This section presents the findings from inferential analysis of Pearson correlation and Multilinear regression, which mainly to analyse the correlation and influence of visualization technique on reading comprehension score. Independent t-test was also done to find the significant differences between the effects of information visualization technique on reading comprehension based on gender.

3.2.1 Pearson correlation analysis

Table 6 shows the Pearson correlation analysis between visualization technique and reading comprehension score. The grade of comprehension score for the students (A, B, C and D) is used in this analysis. According to the finding, it shows that the visualization technique has a positive very weak correlation with the reading comprehension grade ($r=0.188$, $p<0.005$).

Table 6
Pearson Correlation Analysis between Reading Comprehension Score and Impacts of Visualization Technique

		Reading Comprehension Score
Visualization Technique	Pearson Correlation	0.188**
	Sig. (2-tailed)	0.000
	N	150

3.2.2 Multiple linear regression analysis

Table 7 shows the analysis of Multiple Linear Regression between the visualization technique and reading comprehension score. Multiple Regression analysis was adapted to prove the significant correlation made in Pearson correlation analysis. Data were analysed using a Multiple Regression using the Enter Method. The regression equation between the visualization technique and reading comprehension score shows a small effect size (R^2=.275, R^2_{Adj}=.233) and was a significant $p < 0.001$. Hence, the overall regression model is accurate for the data.

According to Table 7, there was a significant positive relationship between visualization technique and reading comprehension score (β=.652, t=5.310, p<.005), with the model predicting that one-unit change in visualization technique would result in an additional 0.329 of reading comprehension score increment.

Table 7
Regression Coefficient between on the Impact of Visualization Techniques on Reading Comprehension Score

Variable	**B**	**β**	**T**	***P***	**R**	**R^2**	**R_{adj}**
(Constant)	4.144		22.289	0.000			
Visualization Technique	0.329	0.652	5.310	0.000	0.524	0.275	0.233

3.2.3 Independent T-test

This section presents the findings of an independent T-sample analysis for differences of the information visualization effect on the reading comprehension score between gender. In the SPSS application, group 1 and 2 were predetermined by male and female respectively. Based on Table 8, it can be seen that the value of sig. was 0.021, where it was less than 0.05 (p <0.05). Based on the statistical analysis of this Levene's test, the equal variances not assumed is necessary to use. The findings of the research prove that there is a difference between the information visualization effect on reading comprehension score based on gender.

Referring to Table 8, a positive t value ($t_{147.428}$= 2.928, p <0.005) refers to the information visualization effect on reading comprehension score in the first group (males) was higher than the second group (females). A p value of less than 0.005 (p = 0.004) also indicates that this T-test analysis is significant. Overall, based on this independent sample T-test analysis, the study found that the information visualization effect on reading comprehension for male students was higher than female students. Thus, hypothesis 3 is accepted; where there are significant differences between information visualization effect on reading comprehension score based on gender.

Table 8
Independent T-test Analysis

		Levene's Test: Equality of Variances		T-test: Equality of Means		
Model		F	Sig.	t	Df	Sig. (2-tailed)
Information Visualization	Equal variances assumed	5.422	0.021	2.809	148	0.006
	Equal variances not assumed			2.928	147.428	0.004

** Note: When sig. value in Levene's test is <0.05, the values in equal variances not assumed will be used.*

As observed from Table 8, a comparative analysis on the efficiency of reading between information visualization approach and existing reading approach revealed great significance [F = 5.422, p <.05]. The evidence of this analysis shows that there would be great difference between student scores and the application of information visualization approach and existing approach. Through comparison, it shows that, the experimental group performance is better than control group toward mastering reading skill. This implied that mastering reading skill with information visualization approach was more effective in this case when compared to the existing approach.

After 6 weeks of experiment, it shows that the students in experimental group who learn reading comprehension through visualization technique has more total scores of reading comprehension compared to those in control group who learn through conventional method. However, it was found through Pearson correlation analysis that there is a very weak positive correlation between visualization technique and reading comprehension score. Multiple Linear regression analysis also shows that visualization technique only produces small effects on reading comprehension score. Nevertheless, it was found that there is a significant positive relationship between visualization technique and reading comprehension score. Besides that, it was also found that there is a significant difference of the information visualization effect on reading comprehension score based on gender. Hence, hypotheses of the study are accepted.

4. Conclusions

Elementary school students are still lacking in terms of English language comprehension because they still beginners in speaking English as the second language. However, reading comprehension required that linguistic knowledge to understand the contents of the text. To be able to improve English reading comprehension, the students need a strategy. The visualization strategy is a strategy among many other strategies that can help students to improve the English language comprehension. This strategy is suitable for the elementary school students because they use their creativity in reading. They do not only depend on reading activities, but also creatively sketching and labelling making it easier for them to understand certain text.

In the future, any researcher who wishes to further the research on related topic may fill in the study gap left by this study. A broader view on the impact of information visualization on the reading comprehension of students can be perceived through a mixed method approach. The mixed method in a study is related to the methodological approach used to conduct research that includes collecting, analysing, and mixing quantitative studies such as surveys and qualitative studies such as interviews. This approach is used to provide a better knowledge of the issues studied in research. Researchers can collect extensive data when integrating both research approaches. It also helps eliminate weaknesses that exist because of using a single research approach (Schoonenboom and Johnson). The major advantage of the mixed method is the triangulation probability. Triangulation involves the use of different approaches to investigate the same concept. Triangulation provides

space to identify different conceptual areas more accurately by looking at them from other dimensions with several methods and techniques. To use triangulation successfully and effectively, researchers need to analyse the diverse forms of information provided by both methods. The mixed method is also used when there is a need to construct a theory about a particular idea or concept that is the focus. Qualitative approaches were found to be more suitable for developing theories, while quantitative provided a better way to test theories. Second, the study can be developed more by make use of the demographic profile collected. For example, the researcher may analyse the impact on information visualization technique based on reading comprehension score and make comparison according to gender, or socioeconomic status, and many more. Other analysis can be done too, such as comparing the best strategies of information visualization such as charts, diagrams, or images to improve reading comprehension level.

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