

## Article

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# Visulgraph to Support the Teaching and Learning of Line Graph Description

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## ABSTRACT

Visual learning has received significant research attention in teaching and learning. However, there has been a lack of research conducted to explore its use in the teaching of graphs and charts. In fact, limited innovative tools have been designed for the specific purposes of teaching graphs and charts. Hence, this paper attempts to address this gap by exploring the use of *Visulgraph* to scaffold ESL learners in this context. *Visulgraph* was developed to assist students in describing the trends, movements and distribution patterns in a line graph, with a particular focus on preparing them using appropriate vocabulary in their spoken presentation. This study employed a one group pre-test and post-test experimental design and serves as a pilot study for the said innovation. Participants were forty-two (42) ESL learners from one of the polytechnics in Malaysia who attended a communicative English course. Data were collected via pre-and post-tests to measure vocabulary knowledge, a survey form and focus group interviews. The findings revealed that the majority of the participants (83.3%) have improved their vocabulary for graph description with the use of *Visulgraph*. The thematic analysis discovered five themes, namely, facilitating explanation of trends in graphs, facilitating reading and understanding of trends in graphs, enriching vocabulary for graph description, facilitating sentence construction and enhancing lesson clarity/ student learning. The findings offer insights into how students can be scaffolded in the teaching and learning of graphs and charts with visual support.

**KEYWORDS: Visual Learning, Vocabulary, Graphs and Charts, ESL Learners**

## INTRODUCTION

Vocabulary learning problems faced by non-native English speakers have been reported by many. A study conducted among university students revealed problems such as difficulties in pronouncing new words, spelling new words, using new words correctly, identifying the grammatical structure of words and guessing the meanings from context (Afzal, 2019). Salam

and Nurnisa (2021) also highlighted vocabulary learning difficulties such as pronouncing unique English sounds, spelling, memorizing long syllable words, and understanding the meaning of unfamiliar words. Susanto's (2021) findings confirmed that students have difficulties in pronouncing words, writing and spelling, inflexions and idiomatic words/expressions, choosing the appropriate meaning of the words and using words based on the context.

Despite having so many learning difficulties, issues regarding ineffective teaching and learning difficulties have also been discussed by many researchers (Mutalib et al., 2014; Saad et al., 2017). For instance, Mutalib et al. (2014) highlighted that rote-memorizing techniques, and doing and memorizing vocabulary exercises were some ineffective strategies highlighted by the students from a tertiary institution about their vocabulary problems. Critical issues such as limited range of teaching methods, the use of de-contextual methods and other inappropriate vocabulary teaching strategies were also highlighted by Saad et al. (2017).

When describing data in graphs and charts, there potentially exists some language barriers due to a lack of linguistic knowledge and vocabulary in the target language. Limited vocabulary knowledge was highlighted as one of the main difficulties faced by ESL learners (Mohamad Nor et al., 2015). There is thus a need for educators to activate students' deep semantic processing so that the new vocabulary can be stored in long-term memory (Hsiao & Oxford, 2002). Without sufficient vocabulary, ESL learners might face problems in communicating effectively. Besides, vocabulary knowledge can also help one to produce well-structured written texts (Viera, 2017). Owing to the fact that describing data in graphs and charts can be somewhat overwhelming for most ESL learners, particularly polytechnic students who have just gained exposure to research conduits, finding the most effective approach that allows this particular group of students to achieve the best possible outcome in graphs and charts lessons is a task of utmost importance.

While Mohamad Nor et al. (2015) highlighted the need for extra attention given to help Malaysian ESL learners with limited vocabulary of the English language, numerous prior studies (Alwadei & Mohsen, 2023; Jazuli et al., 2019; Saad et al., 2017; Tahir et al., 2023; Vedyanto, 2016) have suggested that visual teaching approach can work effectively for vocabulary teaching and learning. Visual learning should be extended to language learning and should not be overlooked by language teachers particularly those who focused merely on the verbal nature in a language classroom (Dolati & Richards, 2011).

The main purpose of the present study was thus to investigate the effectiveness of using a visual learning approach in teaching vocabulary of graphs and charts so as to prepare them for the oral presentation assessment. One of the major challenges of teaching the topic on graphs and charts is to keep students engaged and motivated in vocabulary learning. With this in mind, *Visulgraph*, a teaching and learning aid developed based on a visual learning strategy was proposed as one example of an attempt to overcome this challenge. Furthermore, integrating visual teaching is not always without challenges. Many educators struggle to create engaging and educational materials in a visual format to support student learning. This study thus adds to the limited research on the innovative tools to teach vocabulary for graph description and can thus serve as a good reference for ESL practitioners who wish to contemplate using this approach.

## LITERATURE REVIEW

### Visual Teaching Approach

Visuals, particularly images and pictures can facilitate student learning. An increasing number of scholars (Dalali & Mwila, 2022; Gan, 2010; Philominraj et al., 2017; Raiyn, 2016; Rossetto & Chiera-Macchia, 2010; Shabiralyani et al., 2015; Toister, 2020; Yunus et al., 2014) have indicated the benefits of using visuals for teaching and learning. For instance, in exploring the views of secondary school students and teachers on the effects of using visual aids in teaching and learning, Dalali and Mwila (2022) found that it can lead to active participation of students in the teaching and learning and can help simplify the concepts taught, leading to effective teaching and learning process.

Philominraj et al. (2017) reported that visual learning is an essential part of the language learning experience, which constitutes both input and interaction for getting students involved in the whole learning process. In their study, flashcards and ICT smartboards were two of the most preferred visual learning practices of 504 students of higher secondary schools in English language lessons.

Perhaps, one might wonder whether an analogue or digital way of memorizing vocabulary items is more effective. According to Chen and Chan (2019), there was no significant difference in the effectiveness of using both methods: the AR and traditional flashcard methods in vocabulary learning. As Hashemi and Pourgharib (2013) summarized, using visual materials such as pictures and flashcards can promote retention of information, allow students to effectively apply the learned vocabulary and motivate student learning as well as overcome translation issues. This is also supported by Donasari and Rofiah (2023) in which affordances of using flashcards and visual worksheets, such as actively engaging students' sense of sight and providing a fun learning environment in the classroom were also highlighted. On the other hand, within a digital learning environment, Rahimi et al. (2021) also reported that using animated video can also enhance students' knowledge and understanding of Arabic vocabulary. In fact, visual learning is intrinsically related to multimodalities in education. Representing one key modality (visual), it can always be combined with other modalities, such as narration (auditory) or relevant interactive elements (kinesthetic) which can be incorporated when using visual tools, such as flashcards or images to create a richer learning experience.

As highlighted by Philominraj et al. (2017), visuals facilitate student learning by capturing their attention and sustaining their interest in learning. The same was noticed in post-secondary education when Gan (2010) reported that using visuals could arouse polytechnic students' interest in ESL learning. In this study, visuals were used to elicit student talk. Activities such as transforming text into visuals and transforming video clips into PowerPoint projects were conducted to create meaning-making learning experiences. It was also found that the use of visuals can play a significant role in promoting workplace literacy, particularly in enhancing the use of new vocabulary in the students' future workplace. As reported by one of the participants in Gan's (2010) study, using both visuals and text can promote better understanding and interpretation.

Visual learning manifested in reading context, such as Shabiralyani, et al. (2015) also demonstrated that it can help enrich student vocabulary (68%). Apart from that, the majority of the teachers and students had positive perceptions of using visual aids, such as in giving motivation to the students (70%), clarification of content (75%) and avoiding dullness (71%).

Some other benefits of using visual representation for reading are helping students to make sense of and process information (Yunus et al., 2014). Better student engagement with literary texts was also noted with the use of visual aids (Yunus et al., 2014).

In the writing context, by exploring the use of visual learning in facilitating students' guided writing, it was found that visual modalities can be used as an important tool to help ESL learners make meaning (Rossetto & Chiera-Macchia, 2010). Using storyboarding techniques, Toister (2020) concluded that visual learning can help increase student motivation to participate and overall written output quality. As they shared ideas and negotiated meaning through illustrations and storyline sequencing, they were better prepared for the writing process.

Not only that, in a problem-based learning visual environment, visual learning tools were found to increase the students' higher-order thinking skills. Better results were demonstrated by students via visual learning than traditional learning systems (Raiyn, 2016). These studies have thus demonstrated that a visual teaching approach can be used effectively to scaffold students in the teaching and learning process. More studies should be conducted to explore its use in other teaching contexts, such as for teaching graphs and charts in the present study.

### Visuals for Vocabulary Learning

A review of vocabulary literature conducted in the past decades has found a multitude of studies that demonstrated the effective use of visual support. Visuals, particularly infographics (Alwadei & Mohsen, 2023), vocabulary cards (Sheridan & Markslag, 2017) visual aids and pictures (Jazuli et al., 2019; Sadeghi & Farzizadeh, 2013) can facilitate students' vocabulary acquisition. These studies (Alwadei & Mohsen, 2023; Jazuli et al., 2019; Saad et al., 2017; Tahir et al., 2023; Vedyanto, 2016) have highlighted a multitude of benefits of using visuals in vocabulary lessons. However, these studies have predominantly concentrated on secondary education (Saad et al., 2017; Tahir et al., 2023; Vedyanto, 2016), leaving a gap in our understanding of the use of visual learning tools at the tertiary level.

Alwadei and Mohsen (2023) explored the effects of using infographics among EFL learners. It was found that the experimental group students outperformed the control group and that using infographics has improved the college students' vocabulary learning. Positive perceptions towards the use of infographics in developing vocabulary learning were related to its affordance in enhancing student understanding, keeping participants engaged and motivated during lectures, helping them to acquire new words, discover the meaning of unfamiliar words, and recognize the rules of word formation as well as to recognize how to use words appropriately while speaking and writing and recall the vocabulary they learned.

In another study, a positive and strong correlation ( $r=.84$ ) between the use of pictures in tests and the vocabulary achievement of the students was found (Vedyanto, 2016). Students were found to demonstrate positive attitudes such as concentration, confidence and enjoyment when visuals were used. This is because students struggled to think abstractly without visual support. "Slow, anxious and perplexed" were used to describe students who were in non-visual condition. As explained, perhaps visuals can potentially create a pleasant learning environment for the students.

Not only that, visuals were reported to be able to help imagination and assist students in learning new vocabulary items (Saad et al., 2017). It was noteworthy that one of the participants in the study revealed allocating 80% of his/ her attention to the picture, with only 20% dedicated to the sentence.

Also, using both visual and written explanations, Tahir et al. (2023) have demonstrated that visual vocabulary can help increase the success rate of vocabulary learning among ESL learners. It is a more effective approach compared to the implicit approach. The visual vocabulary worksheets which come with annotation and explanations of the target words have helped learners to remember and better comprehend the target words. Another study (Jazuli et al., 2019) found that students had a higher motivation to learn and apply new words when learning them visually.

Sadeghi and Farzizadeh (2013) also discovered that students who learnt vocabulary with pictures outperformed the control group with the use of definitions only, owing to the significance of providing context to assist students on how to interpret the meanings of the word. Similarly, Sheridan and Markslag (2017) have discussed and highlighted the effective use of vocabulary cards for teaching vocabulary. The student-made vocabulary cards contain a lot of key elements about the target word, such as part of speech, meaning, illustration, phonetic symbols, L1 translation and sample sentences.

#### *Visual Learning theory and the underlying theories for creating effective visuals*

Visual learning was associated with the assimilation of information from visual formats (Raiyn, 2016). Learners tend to understand information better in the classroom when they see it. A review of the related theories might help to explain this. With his Cognitive Theory of Multimedia Learning, Mayer (2001) proposed that learning is best scaffolded through both words and pictures due to the availability of both visual and auditory/ verbal information-processing channels. Dual-coding theory also suggests that different types of information are processed by the brain using separate memory systems, such as verbal and image memory (Pavio, 1990). So, verbal associations and imagery can be used to expand on learned material. When visual information is presented to learners, the information will move from sensory memory to visual processors. Next time when the targeted words are shown, the image processor will be triggered, and the learners can associate the targeted words with the visuals. This will enable the information to be retrieved successfully. If learners use more pathways, for instance, both verbal and image to remember information, the information can be retrieved more easily at a later stage.

Raiyn (2016) also explained that the representation of the stored information in the hippocampus (the collection of information in the human brain) will trigger the creation of various cognitive maps in the brain. These maps will then help learners to find the shortest path between the source and the target destination.

Three theories, namely, the figure/ground principle, the hierarchy principle and the gestalt principle, as identified by Lohr (2003) can be used to facilitate our understanding of the effective use of visuals in learning (Chen, 2004). According to the figure/ground principle, there is a need to make the most important information stand out and to reduce the amount of information which requires the memory to process. Some strategies which can be used to direct attention are the use of big fonts and contrasting colours and shapes. The hierarchy principle suggests that there is a need to manipulate the hierarchy of visual perception to provide a clear direction or some structures for learners to navigate from one unit of information to the others. The five laws of gestalt, as suggested by Lohr (2003), namely, the law of closure, the law of contiguity, the law of similarity, the law of proximity and the law of previous experience can be used to enhance the concept of the 'whole' to help learners to see the big picture and reduce their cognitive load. Some of the strategies are directing learners to follow the expected sequence, grouping information with the use of the same colours, placing similar items closer to each other and presenting a familiar symbol to help learners link new information to previous

experience (Chen, 2004). With reference to these theories, *Visulgraph* was designed and prepared for the teaching and learning of line graph description in the present study. In particular, this study seeks to explore the effectiveness of using *Visulgraph* in instruction and learners' perceptions of how *Visulgraph* can facilitate the learning process.

## METHODOLOGY

*Visulgraph* is a teaching and learning toolkit developed especially to assist students in describing the trends, movements and distribution patterns in a line graph, with a particular focus on preparing them using appropriate vocabulary in their spoken presentation as required for their upcoming oral assessment. It is an overlay transparency printed with illustrations of the trend and movement of a line graph, featuring a total of sixty (60) lexical items related to the graph description. As shown in *Figure 1*, students placed the *Visulgraph* directly over their line graphs during graph analysis and chose the best vocabulary to describe the trends in their line graphs. They then labelled the trends of the line graphs with markers.

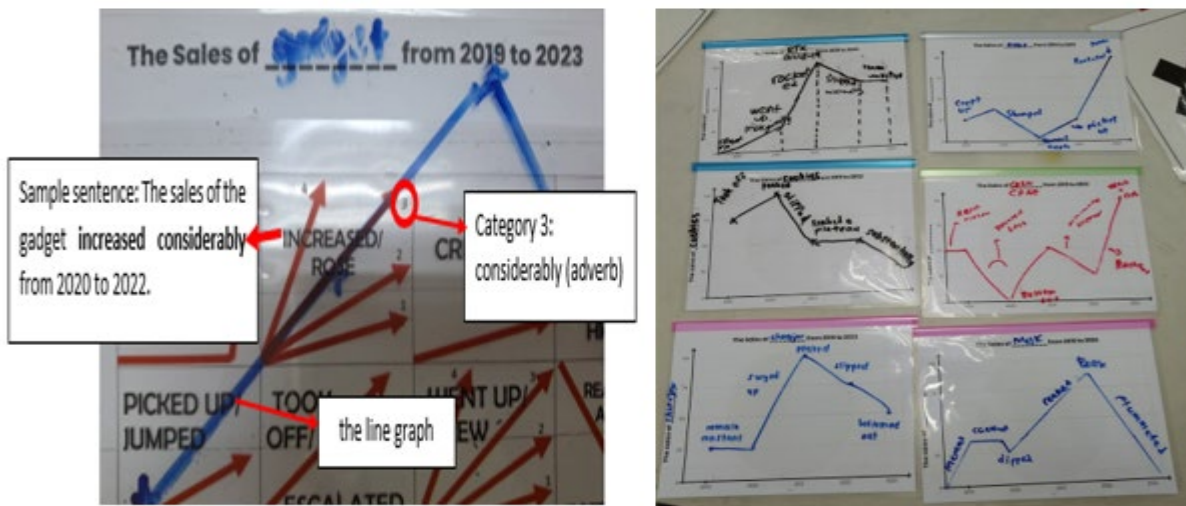


Figure 1. Graph Analysis with the Help of Visulgraph

Students practised constructing simple sentences using basic structures introduced by the instructor and used *Visulgraph* in small groups to explain the labelled trends to their peers and in front of the class, as shown in *Figure 2*.



Figure 2: Describing Trends in Line Graphs with the Help of Visulgraph

Data for this study were obtained from 42 students, who completed both pre- and post-tests which were conducted before and after the introduction of *Visulgraph*. Each test consists of ten fill-in-the-blank questions prompting students to choose the most appropriate lexical items from a set of ten options to describe the depicted movements of a line graph. While both tests were similar in the nature of the questions asked, the sequence and topic in the pre-test differed from those in the post-test to mitigate potential biases resulting from students relying solely on memorization.

Participants were Semester 4/5 Diploma students taking a communicative English course at one of the polytechnics in Malaysia. Male participants comprised 90.5% of the sample. As shown in *Table 1*, exactly two-thirds of the participants (66.7%) scored a grade below B, i.e., with average and below average results in their *Sijil Pelajaran Malaysia* (SPM), which is the Malaysian equivalent of the General Certificate of Education for secondary level students, while nearly a third of them (33.3%) had at least a B grade, i.e with good and excellent results in their SPM English paper.

Table 1. Participants' Language Proficiency

SPM English Result	Frequency	Percentage
A+, A, A- (Excellent)	4	9.5
B+, B (Good)	10	23.8
C+, C (Average)	17	40.5
D, E, F (Below average)	11	26.2
Total	42	100

As shown in *Figure 3*, apart from the data gathered from pre- and post-tests, participants' feedback on the use of *Visulgraph* in their learning was also obtained through an online survey and focus group interviews which were conducted after the use of *Visulgraph*. Before data collection, a

preliminary study was carried out with another group of students who had a similar background and experience. The questions in pre-and post-tests, an online survey and questions in the focus group interviews were piloted and feedback was taken into consideration to revise and prepare the final online survey and interview questions. Confusing language items and redundancy were adjusted before the actual data collection. Focus group interviews were conducted to solicit themes regarding the affordances offered by *Visulgraph* to cross-check with the findings from an online survey. The interview sessions were audio-taped and transcribed. The focus group interviews lasted for 20-25 minutes, and all the transcribed text was analyzed for emergent themes. Braun and Clarke’s (2006) six-phase thematic analysis framework was drawn upon to analyze both the responses from open-ended questions in the online survey and focus group interviews. After a rigorous and thorough ‘verbatim’ transcription, the thematic analysis began with repeated reading and active reading of the data set to search for meanings and patterns. Then, initial codes were created in *ATLAS.ti* version 8. Potential themes were coded by tagging and naming the selections of text within each data item. This was followed by themes reviewing which involved clustering of similar codes, relocating extracts which do not fit in an already-existing theme and discarding some others. After defining and naming the themes, a list of final themes and sub-themes was generated. In the last phase, examples for each theme were extracted from transcripts for the reports.

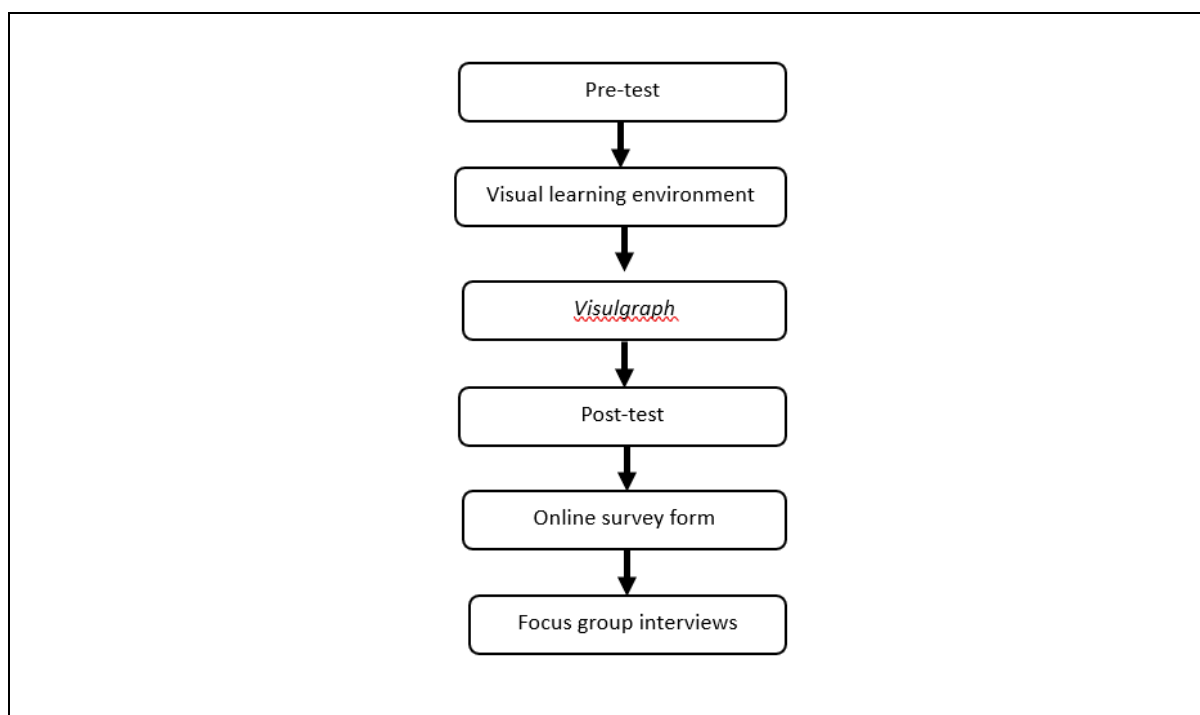


Figure 3. Data collection Procedure



## FINDINGS

As shown in *Figure 4*, the majority of participants (83.3%) showed improvement in their post-test. The pre-test shows that the majority of participants (61.9%) obtained a score of 1-3. Meanwhile, for the post-test, the majority of them (78.6%) obtained a score in the range of 5-8. On average, a score of 3.0 was recorded for the pre-test. Meanwhile, with the use of *Visulgraph*, an average score of 6.0 was obtained in the post-test. Slightly more than a quarter of the participants (26.1%) have shown a sizable increase of at least 50% in their post-test. Two of them achieved an improvement of 70% in their post-test.

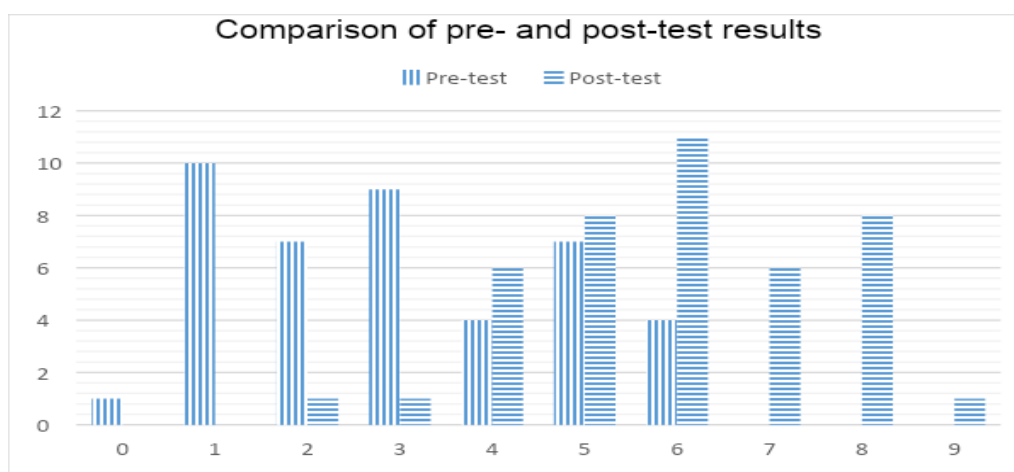


Figure 4. The pre-and post-test results

*Table 2* demonstrates the results of the paired sample statistics for the Pre and Post-tests of the group. The results of the test are presented as follows:

Table 2. Descriptive Statistics for pre and post-tests

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTest	3.000	4	1.73908	.26835
	PostTest	5.952	4	1.59194	.24564
	t		4		

Based on the statistical results of the paired sample t-test as shown in *Table 3*, there is a significant difference ( $t=-9.237$ ,  $df=41$ ,  $p<.05$ ) in the scores obtained by the participants. The effect size, calculated using Cohen’s  $d$  was 1.43, indicating a large effect.

Table 3. Paired sample t-test for the pre and post-tests of the group

		Paired Differences					
Pair	PreTest - PostTest	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
1		-2.95238	2.07132	.31961	-9.237	41	.000

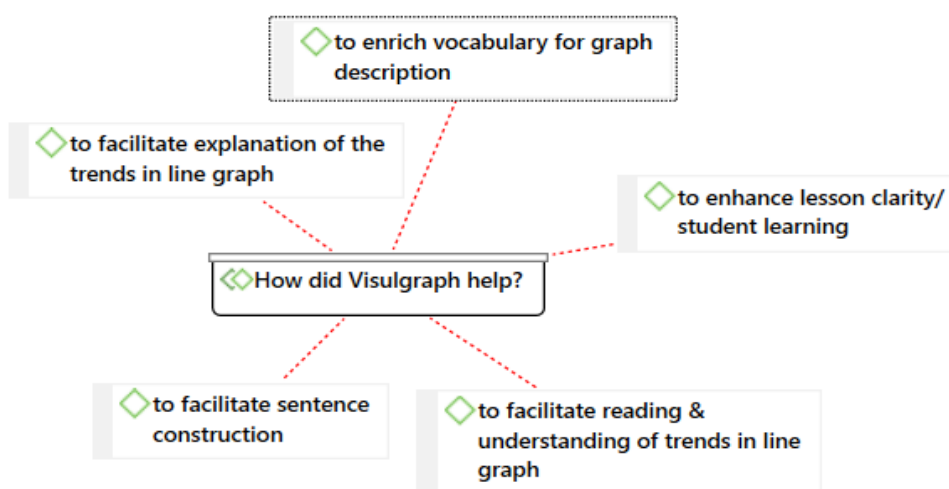


Figure 5. A Summary of Emergent Themes Identified

Qualitative data were analyzed using *Atlast.ti version 8.0* and the results are presented as follows. *Figure 5* shows an overview of the emergent themes identified. Almost all of the participants (92.9%, n= 39) responded that *Visulgraph* helped them in their learning. Five themes, namely, facilitating explanation of trends in line graphs, facilitating reading and understanding of trends in line graphs, enriching vocabulary for graph description, facilitating sentence construction and enhancing lesson clarity/ student learning emerged from the data.

Affordance 1 Facilitating the explanation of trends in line graphs

It is greatly acknowledged by the participants that *Visulgraph* can be used to facilitate the explanation of trends in line graphs. As demonstrated in the following excerpts, words such as ‘know how to explain’ (S22), ‘menerangkan dengan betul/ to explain correctly’ (S6), ‘easy to explain’ (S25), ‘explain ... very well’ (S41) were used by participants.

“Yes, because i know how to explain about the line graph” (S22)

“Boleh menerangkan line graph dengan betul” (S6) Translation: “Can explain the line graph correctly.”

*“easy to explain the graph” (S25)*

*“Its help me to understand how to explain the line graph very well” (S41)*

Besides, as highlighted by S37, *Visulgraph* helped them to explain trends in line graphs with the appropriate vocabulary.

*“It has helped me to differentiate the line graph with correct vocabulary whenever I need to explain it” (S37)*

Besides, both S5 and S16 also highlighted that *Visulgraph* can help them to produce more detailed description of data in line graphs.

*“useful as a guide for telling the detail and condition of the line graph” (S5)*

*“it helps me to tell more details about the bar graph” (S16)*

The explanation of trends in line graphs could also be due to the effective comparison of different trends in graphs with the use of *Visulgraph*. For instance, as stated by S18, *“we can easily compare the line graph by using the word given” (S18)* Another participant said: *“Easy to compare (different trends) in graph” (S36)*

Some lexical items/ structures taught via the use of *Visulgraph* were: The sales reached a high of/ peaked at, The sales plummeted from A to B in 2023, The sales increased considerably from A to B in 2023, There was a considerable increase in the sales of ... from A to B, The sales fluctuated dramatically from A to B in 2023, There was a dramatic fluctuation in the sales of ... from A to B in 2023, The sales of ... dropped significantly from A to B in 2023.

### *Affordance 2 Facilitating reading and understanding of trends in line graph*

Many participants highlighted another affordance offered by *Visulgraph*, i.e to help them in reading and understanding the trends in line graphs. Positive words, such as “membantu... mudah memahami” / helped ... understanding easily” (S8), ‘very easy to understand’ (S35), ‘easier to understand’ (S34), ‘more understanding’ (S15) were used by the participants, as shown in the following excerpts:

*“ianya membantu saya untuk mudah memahami apabila mendapat graf lukisan” (S8)*  
*Translation: It helped me to understand easily when I have a plotted graph later on.”*

*“Very easy to understand the Line Graph” (S35)*

*“it can be more easier to undestand” (S34)*

*“it help me because the transparent film of line graph helped you to more understanding about movement of graph” (S15)*

More detailed explanation was given by S39 and S23 as they highlighted that *Visulgraph* can help them to understand the changes or movements in line graphs.

*“This helps learners understand how data changes over a period and how it can be represented visually through a line graph” (S39)*

*“we can know for every change that occurs on the line graph” (S23)*

With regard to that, some students also highlighted that *Visulgraph* helped them in analyzing the trends in line graphs easily. As S9 stated, it can help them to determine whether an ascending or a descending trend is shown in a line graph. *“If is because can help me to determine whether the graph is ascending or descending in more detail” (S9)* Similar point was highlighted by S14, S20 and S33. As revealed:

*“can help me to identify what is happening in the graph and tell about the progress of each available information” (S14)*

*“Get to know how to look at line graph” (S20)*

*“It helps me to ... and analysis the line graph” (S33)*

### Affordance 3 Enriching vocabulary for graph description

Participants reported that *Visulgraph* is useful for vocabulary building. As stated by S30, *“Because i can learn more vocabulary with this transparent film”*. Similarly, another student, S28 echoed that: *“I can learn more vocabulary”* As S12 added, with *Visulgraph*, he/she can use more interesting vocabulary when describing trends in line graphs. *“saya dapat menggunakan perkataan yang lebih menarik” (S12)*

Some participants have even highlighted that *Visulgraph* can help with their vocabulary retention. As stated by S31, *“The film really helped and to memorize” (S31)*. Similarly, S21 mentioned that *Visulgraph* helped them to get the meaning of the different vocabulary into his/her memory As stated, *“Able to memorize the meaning of lines in line graphs” (S21)* Perhaps, word-picture associations could really help develop and strengthen the students' vocabulary.

### Affordance 4 Facilitating sentence construction

Some participants highlighted the essential role of *Visulgraph* in facilitating their sentence construction. As reported by S3, *“it help me to build the sentence to talk about the line graph” (S3)*. Besides, S7 added that *Visulgraph* helped them to come out with appropriate sentences. As stated, *“Yes because i can explain or present topic in the graph with the suitable sentences” (S7)*. Furthermore, S40 supported these statements by saying that *Visulgraph* helped by giving them the ideas to construct sentences when describing data in the line graphs. As reported, *“it gave me an idea to build sentences based on line graphs” (S40)*.

### Affordance 5 Enhancing lesson clarity/ student learning

*Visulgraph* can help deliver the lesson on graphs and charts well. Words such as ‘clear/ jelas’ and ‘easy to understand/ mudah untuk difahami’ were highlighted by S32, as in the following excerpt,

“Prmbelajaran (pembelajaran) lebih jelas dan mudah untuk difahami. Sangat membantu.” (S32) Interestingly, S27 described the whole learning experience as ‘novel’ and ‘unique’ due to its role in enhancing his/her learning process. “*Since I’ve spent much of my time as a student studying from books or papers, utilising the translucent film feels novel and unique to me, which enhances my learning process throughout the lesson.*” (S27)

### Issues

Three (n=3) participants, however, highlighted the issue of unclear instructions on how to use *Visulgraph* effectively. As highlighted by S17, “*Because the line graph for me I don’t know to place the appropriate arrow on the graph, so for this graph I don’t understand a little to read arrow*” Perhaps, clearer instructions on how to use *Visulgraph* can be prepared in a booklet so as to result in the desired outcomes in the future.

## **DISCUSSION**

The results that emerged from the data demonstrated that *Visulgraph* has many affordances for teaching and learning for the topic of graphs and charts. In particular, it is useful for facilitating student explanation of trends in line graphs, facilitating the reading and understanding of trends in line graphs, enriching vocabulary for graph description, facilitating sentence construction and enhancing lesson clarity/ student learning.

With sentence fluency issues abound, students may find it hard to make descriptions. However, *Visulgraph* was found to help students convey spoken messages. In this study, students were pushed to verbalize their ideas using the chosen vocabulary once they had identified the right vocabulary to use with *Visulgraph*. The findings demonstrate that it can facilitate students in the explanation of trends in line graphs, Pateşan et al. (2018) highlighted a good point in that visuals can help create connections between the mother tongue and English, thereby reducing the heavy reliance on direct translation. Also, when used effectively, visual aids can help students become interactive and more confident in talking in the ESL classroom (Halwani, 2017). As Halwani (2017) highlighted, one of the students mentioned that he/she was more aware of what to say when visual aids were used. The fear of making mistakes was also greatly reduced in the lessons with visual aids. This is also supported by findings in another study (Dalali & Mwila, 2022) which reported that visuals can help motivate students and increase their classroom participation. The need to go beyond the written words in teaching and learning is particularly relevant for the topic of graphs and charts as one needs to talk about the changes and movements they see in the graphs. Once students had gained confidence in talking about their graphs with *Visulgraph* in small groups, they were invited to the front of the class. Students showed their focus, confidence and enjoyment with the use of visuals (Vedyanto, 2016). Now, they would describe their graphs with *Visulgraph* to the whole class. This activity also serves to review the vocabulary and sentence structures of other students.

The finding that *Visulgraph* can facilitate sentence construction can be justified by the careful design of the activity. To make the learning meaningful, an entrance activity which requires

students to bring in their own data and draw their own graphs was first conducted. After which, students were introduced to *Visulgraph* in which they placed the transparent films on their graphs and tried to identify the appropriate vocabulary to describe the different trends/movements in their line graph. To help develop a solid foundation and understanding of how to construct simple sentences, some basic sentence structures were first introduced to students to complement examples and modelling. In small groups of 3-4, students then used the *Visulgraph* to practise the sentence structures learned in which they take turns explaining the trends in line graphs to their group members and the whole class.

As addressed by Shane et al. (2011), language elements can be represented by visual element cues to support language instruction. To enhance comprehension and production of novel utterances, such as in describing the trends in graphs and charts, efforts must be made to help learners first understand the symbolic meaning of the visual cues and the rules governing the syntactic configurations.

All in all, students were scaffolded through modelling, analyzing, discovering and applying the skills in describing trends and movements in line graphs. Analyzing the trends and locating the most appropriate vocabulary to use were the main concerns. Most of the students have discovered new vocabulary and can therefore add the new knowledge to their existing knowledge. Some of them might discover some misconceived vocabulary. This is consistent with findings in another study (Saad et al., 2017) which found that visuals play a role in assisting learners to learn new vocabulary items. The finding on enriching vocabulary is in parallel with findings from other studies that visuals can help students to increase their vocabulary (Shabiralyani, et al., 2015) and help them tremendously in understanding the meaning of a word (Saad et al., 2017). A similar finding was reported by Jazuli et al. (2019) when students were found to be able to understand and remember the new words better when learning with visual support.

Some students even responded that *Visulgraph* can help them to remember the vocabulary better. This is also supported by Vazquez and Chiang (2014) when it was highlighted that the effective use of visuals resulted in improved information retention and comprehension by enabling students to make visual connections between images and concepts. Halwani (2017) also highlighted that lessons illustrated with visual aids can promote enhanced concentration among learners. *Visulgraph* provides opportunities for students to acquire information visually and this motivating and meaningful approach to teaching and learning makes learning more concrete and interesting for the students and it also explains why it seems to encourage them to participate actively in the learning process. As they get interested and more involved in the learning activity, information retention can take place easily. As Pateşan et al. (2018) suggested, meaningful visuals play a significant role in supporting students in memorization of new vocabulary or structures. This is also supported by prior research (Arif & Hashim, 2009) which suggests that “pictures gained better attention than words”. “Metal scaffolds’ as described in another study (Carney & Levin, 2002) highlighted the crucial role of visuals in helping both teachers and students correlate and coordinate accurate concepts.

As for enhancing lesson clarity/ student learning, Pateşan et al. (2018) mentioned that visual cues are effective tools which can be used to display complex information effectively. This could be due to clarification of content as reported by the majority of the students and teachers in Shabiralyani, et al.’s (2015) study. The advantages of visuals claimed by Kang (2004) seem to support this finding particularly when it was highlighted that visuals can help learners develop a holistic understanding that the words alone cannot convey sufficiently. They can help

to clarify complex concepts and assist them in processing information and restructuring ideas as well as promoting learning retention through synthesis and analysis. This finding seems to support results from another study (Yunus et al., 2014) in that visual aids can help students to better understand abstract ideas.

Many participants highlighted that *Visulgraph* can facilitate the reading and understanding of trends in line graphs. The seven C principles, as proposed by Levin and Mayer (1993) can help to explain this. Pictures allow the text to be more compact/concise, concentrated, coherent, comprehensible, correspondent and codable. The conclusion that visual aids can help beginner ESL middle and high school students improve their English language acquisition in reading and writing (Halwani, 2017) has thus reaffirmed the positive effect of using visual aids in the lessons of graphs and charts in this study. This finding is in parallel with the results from Dalali and Mwila (2022) as it was found that the majority of the students responded that visual aids can help them understand the lessons easily, motivate them and enhance their classroom participation. Drawing upon the Cognitive Load Theory of Sweller (1994), the author explained that students' enhanced understanding of a particular subject is due to the active interaction which takes place between information structures and students' cognitive construction. When visual aids are used to elaborate difficult concepts, students will be able to remember the information learnt. Also, this is supported by Raiyn (2016) who found that visual learning can increase students' higher-order thinking skills such as selection, ordering, contrasting and evaluation. The fact that vocabulary knowledge was found to be a strong predictor for learners' reading comprehension seems to support the finding from this study that *Visulgraph* can help learners in reading and understanding trends in graphs.

## CONCLUSION

This paper introduces a new visual learning strategy in the teaching and learning of graphs and charts. The results of this study indicate the beneficial aspects of integrating visual learning through an innovative tool, *Visulgraph* to boost students' vocabulary learning. The significant margin improvement and students' positive feedback regarding the affordances of the visual learning strategy have further confirmed the pedagogical benefits of using visuals to support student learning. The visual representation of words in *Visulgraph* not only helped create meaningful vocabulary learning in context but also assisted students in constructing sentences for effective graph description, which is one of the important language skills for the particular learning topic. Overall, the implications can be very constructive for ESL practitioners, particularly in the context of Malaysian polytechnics in creating more effective and interactive lessons to engage students actively in learning and providing a better educational experience for classes on graphs and charts. However, as the study was only conducted with a small group of ESL learners in the Malaysian polytechnic context, the findings are not generalizable. Findings should be interpreted with caution and further exploration with more representative samples in other contexts is encouraged. Also, while this study provides valuable insights into the use of *Visulgraph*, it is important to acknowledge the limitations inherent in the one-group pre and post-test design. The absence of a control group makes it difficult to attribute the observed changes to the intervention, as some external factors could also influence the results. Therefore, future studies can be conducted with a two-group pre-post test design to effectively gauge the effectiveness of the intervention by making comparisons of the two groups over time.

Future studies might also explore the extent to which the innovative visual learning tool, *Visulgraph* might affect the students' overall speaking and writing performance on a larger scale and for a longer time frame. As highlighted by Dalila (2021), the provision of seminars and training to help teachers improvise, prepare and use visual aids to enhance the teaching and learning process is necessary. Therefore, in view of the affordances of using *Visulgraph*, more educators can be inspired to use similar innovative teaching aids created within the visual learning framework for more effective teaching and learning.

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