International Education and Culture Studies
ISSN 2766-6778
Vol. 4, No. 1, 2024
Published by STSL Press

Original Paper

Need Analysis: Level of Visualization Skill in Technical Communication Graphics Subject in Secondary School

Harith Azidin Kamarudin[1], Zaliza Hanapi, Ridzwan Che Rus & Tee Tze Kiong[2]

[1] Faculty of Technical and Vocational, Sultan Idris Education University, Tanjung Malim, Malaysia

[2] Faculty of Technical and Vocational Education, Universiti Tun Hussein Onn, Batu Pahat, Malaysia

Correspondence author: Zaliza Hanapi, Faculty of Technical and Vocational, Sultan Idris Education University, Tanjung Malim. E-mail address: zaliza.hanapi@ftv.upsi.edu.my

Abstract

Visualization skills are important for students studying technical communication graphics, engineering drawing and computer-aided design and multimedia. Nevertheless, the level of visualization skills in the subject of Technical Communication Graphics is still at a moderate level. This study aims to see the level of visualization skills in technical communication graphics subjects at the secondary school level in Malaysia. This study also explores the topic of visualization skills that are difficult to master and looks at the importance of visualization skills to master the topic. The methodology of this study uses a quantitative and survey-based approach. The instrument used is a set of questionnaires. The data collected from the form questionnaire was analyzed using SPSS 27.0 software and the results were described using descriptive statistical methods. Cronbach's Alpha reliability value for the entire questionnaire item is 0.795. Based on the analysis of survey data among 107 respondents, it was found that the average value of the mastery of visualization skills for TCG subjects was at a moderate level (M = 3.32, SD = 0.65), showing that there is still a lot of room for improvement in this aspect. A low level of agreement was found in the descriptive examination of the teacher's perception of the level of producing auxiliary view blocks (M = 2.50, SD = 0.71) and producing development drawings (M = 2.56, SD = 0.74). A high level of agreement was found in the descriptive examination of the perception teachers about the importance of visualization skills to master the topics of auxiliary view and development drawing (M = 4.51, SD = 0.56). Overall, the findings show that the topic of auxiliary views and development drawings is a difficult topic to master. Therefore, visualization skills are very important to master topics that are difficult to master in TCG subjects.

Keywords: visualization skills, technical communication graphics, secondary school, quantitative analysis

1. Introduction

Technical Communication Graphics (TCG) is one of the specialized elective subjects (MPEI) which was formerly known as Engineering Drawing in the KBSM system with the aim of producing students who are knowledgeable, skilled and practice values in TCG to develop imaginative, creative, innovative and inventive abilities. According to the Malaysian Ministry of Education (2017), Technical Communication Graphics (TCG) is a subject that aims to produce students who are able to communicate graphically and effectively with confidence, in addition to fostering their interest in various fields of technology. Through this subject, students can develop their imaginative, creative, innovative and inventive abilities.

In the field of technical and vocational education, especially in the subjects of Engineering Drawing or Technical Communication Graphics, students' visualization skills are very important. Students need this skill to interpret an object visually and shadow before translating it in verbal or graphic form. Therefore, visualization in the field of drawing production becomes an interesting phenomenon to be debated. Improving visualization skills in engineering education is important for engineers to create and

interpret technical drawings, which are important in thinking, modeling and problem solving processes. A study by Tumkor and deVries (2015) found that strong spatial visualization skills are associated with success in engineering and that some students with poor spatial ability have problems understanding the basic concepts of engineering drawings.

However, the level of visualization skills among TCG students in Malaysia has not reached a high level. Previous studies have reported that Malaysian students have a medium or low level of visualization skills, and they face difficulties in mastering some TCG topics such as oblique drawing and isometric drawing that require visualization skills, ie students have difficulty imagining a graphic representation of a 2D to 3D object or vice versa. This is supported by Sawant et al. (2023) poor visualization skills usually occur in first-year engineering students who have no basic knowledge of engineering drawings. In addition, the findings obtained by Farzeeha (2017) revealed that engineering students in Malaysia have a moderately high level of visual ability.

According to Ali et al. (2022), students face difficulties with visualization skills when learning engineering drawings, which causes a lack of understanding of the teaching content and makes it difficult for them to learn in this situation. In addition, Marji et al. (2019) found that the visualization ability of TCG students is very weak and suggested the integration of traditional teaching methods with computer-aided methods and the production of visualization-related modules to increase the level of visualization ability of TCG students. One effective method is through the use of technology. For example, mobile augmented reality (MAR) has been shown to have a positive effect on students' visualization skills in learning orthographic projection Omar et al. (2019). Likewise, 3D simulation technology has been found to be an efficient teaching tool to improve spatial visualization skills in clothing design (Ramlie et al., 2018). These technological tools provide an interactive and immersive experience that can help in enhancing visualization abilities. This is supported by Abdul Khader and Brahadeeswaran (2018), student visualization will be easy and comprehensive by seeing objects in 3D form virtually through animation and computer graphics. Directly, increasing the level of students' visualization abilities will certainly have an impact on students' motivation in learning TCG.

The importance of visualization skills in Technical and Vocational Education and Training (TVET) is indeed important especially at the secondary level. However, there is no direct study specifically focusing on visualization skills in TVET in 2023. The most relevant information comes from a study by Mariano & Tantoco (2023) which assessed the employability skills of TVET graduates. This study emphasizes the importance of various skills including communication, interpersonal skills, teamwork, problem solving, and critical thinking for TVET graduates. Visualization skills, although not explicitly mentioned in this particular study, can be considered part of this broader skill set, especially in areas such as problem solving and communication.

Based on relevant references, there is increasing interest in assessment and improvement of visualization skills in Malaysia. A study conducted on the use of 3D hologram pyramids found that it had a positive effect on students' visualization skills (Khoo et al., 2023). Furthermore, there is a need to develop appropriate instruments to assess visual literacy skills in mathematics, especially among pre-university students in Malaysia (Lailatul Zuraida et al., 2021). These studies show recognition of the importance of visual literacy skills in the context of education in Malaysia. This study focuses on assessing and improving visualization skills among students in Malaysia and the recognition of the importance of visualization skills in the context of education in Malaysia.

In addition, there is a lack of research on the importance of visualization skills in TCG subjects and has not been fully done after being introduced for 6 years in the KSSM system. Therefore, this study aims to examine the level of visualization skills in TCG subjects at the secondary school level in Malaysia. This study also explores the topic of visualization skills that are difficult to master and looks at the importance of visualization skills to master the topic. The findings of this study can have implications for curriculum design, teaching and learning strategies, and assessment methods for GKT subjects.

2. Method

2.1 Research Design

This study uses the Design and Development Research (DDR) approach, founded by Richey and Klein

(2014), to design and develop visualization model in TCG subject. The DDR approach originally consisted of four phases: Requirements Analysis Phase I, Design Phase II, Implementation Phase III and Evaluation Phase IV. Nevertheless, Saedah et al. (2020) modified the DDR approach to adapt it to various fields of research and not only focused on the field of teaching. This modified DDR approach has only three phases. Figure 1 illustrates the phases included in the modified Design Research and Development (DDR) approach.

Figure 1. Phases in a modified design and development research (DDR) approach

2.2 Respondents of the Study

In this study, a simple random sampling method will be used. Random sampling is easy to use because the selected sample can be generalized to the study population (Creswell,2014). The selection of this method is due to the suitability and ease of obtaining feedback and views from the study respondents, namely 107 teachers from 32 schools who teach TCG subjects to obtain their responses to answer the questionnaire.

2.3 Research instrument

The study collected data using a questionnaire instrument consisting of two parts as shown in Table 1

Table 1. Questionnaire's section

Section	Construct
A	Respondent demographic information
B	Determine the level of visualization skill in the subject TCG

A five-point Likert scale was used to create questionnaire items to collect responses using the questionnaire. A five-point Likert scale was used in the research questionnaire, namely Strongly Agree (5), Agree (4), Disagree (3), Disagree (2), and Strongly Disagree (1).

Data analysis was carried out using Statistical Packages for the Social Sciences (SPSS) software version 27.0. Data analysis is based on descriptive statistics that look at mean scores, standard deviations and percentages. Confirmation by Bougie and Sekaran (2019) explains that descriptive statistics can be used to explain a phenomenon that occurs. The respondent's level of agreement is taken into account in answering the questions of the needs analysis phase. Table 2 shows the interpretation of the mean agreement of the needs analysis used based on the study of Tschannen-Moran and Gareis (2004).

Table 2. Min value according to five Likert scale

Min Score	Interpretation
1.00 until 1.80	Very Low
1.81 until 2.60	Low
2.61 until 3.40	Moderate

4.21 until 5.00	High
3.41 until 4.20	High

2.4 Validity of Research Instruments

The research instrument was reviewed and validated by three experts to confirm the content and language of the questionnaire. The questionnaire was distributed to the study respondents online via google form after getting permission from the school administration.

2.5 Reliability of the Research Instrument

Cronbach's alpha is a statistical measure used to assess the internal consistency of research instruments, such as questionnaires or surveys. It is widely used in various fields, including science education, psychology, and medicine, to assess the reliability of research instruments (Taber, 2017). The argument stated by (Hair Jr et al., 2019), the interpretation of Cronbach's alpha value can be evaluated through the classification in Table 3. Reliability testing has also been done on the set of questionnaires before being distributed to real respondents.

Table 3. Interpretation of Cronbach's Alpha reliability coefficient

Cronbach's Alpha Value, α	Interpretation
> 0.90	Excellent
0.80 – 0.90	Very good
0.70 – 0.80	Good
0.60 – 0.70	Moderate
<0.60	Poor

Pre-testing the questionnaire and conducting a pilot study is important (Ali et al., 2018). For this pilot study, the researcher conducted a survey using questionnaire-based instrumentation (Johannis et al., 2020). The questionnaire was given to 30 respondents who were randomly selected from the population. Reliability based on Cronbach's Alpha value was investigated in this pilot study. In the context of this study, the value of Cronbach's alpha coefficient obtained is $\alpha = 0.795$. This is consistent with the view of Mehmood et al. (2020) found that Cronbach's alpha for all variables was greater than 0.7, indicating acceptable and considered reliability. Table 4 shows the coefficient of Cronbach's alpha value obtained:

Table 4. Cronbach's Alpha reliability coefficient for each construct

Section	Construct	Number of Item	Cronbach's Alpha
B	Determine the level of visualization skills in the subject TCG	18	0.795

To show the normality of the data distribution whether normal or not normal, normality tests using Skewness and Kurtosis are performed. Skewness values should be between -1 and +1, while Kurtosis values should be between -3 and +3. Table 5 shows the Skewness and Kurtosis values obtained, this shows that the data collected is in a normal state. This is in line with the range determined by Blanca et al. (2013) to show normality.

Table 5. Results of normality test using Skewness and Kurtosis

Section	Construct	Values of normality test	
		Skewness	Kurtosis
B	Determine the level of visualization skills in the subject TCG	-0.347	0.037

3. Result

3.1 Respondents' Demographic Profile

This section discusses the general profile of the respondents, including information on each respondent's gender, age, education level, and previous teaching experience in the fields of Engineering Drawing and Technical Communication Graphics. The results are displayed in Table 6 using frequency and percentage.

Based on Table 6, the majority of respondents are female which is 53.3% of the total number of respondents. The majority of respondents (47.7%) were between 40 and 49 years old. With 84.10%, the majority of respondents have at least a bachelor's degree in terms of their level of education. The majority of respondents, 31.80% have more than 16 years of experience teaching TCG subjects.

Table 6. Respondents' demographic information

Item	Category	Frequency	Percentage (%)
Gender	Male	50	46.7
	Female	57	53.3
	Total	107	100.0
Age	20-29	4	3.70
	30-39	29	27.10
	40-49	51	47.70
	>50	23	21.50
Education Level	Diploma	4	3.70
	Degree	90	84.10
	Master	13	12.10
Experience Teaching TCG	<5	10	9.30
	6 -10	13	12.10
	11-15	25	23.40
	16-20	34	31.80
	>26	8	7.50

3.2 Determine the level of visualization skills in the subject TCG

In the second part of the questionnaire, there are eighteen items constructed to determine the teacher's perception of Visualization Skills in TCG subjects. Table 8 displays the results of descriptive statistics of 107 teachers and their perceptions.

Table 7 displays the results of descriptive statistics of 107 teachers and their perceptions. The results of

the study show that the overall mean score value is 3.32, which is at a moderate level. Analysing each item, there are 2 items with a low mean score. The items are A5 (Mean = 2.50 & SD = 0.71) and A15 (Mean = 2.56 & SD = 0.74). Seven items are in the moderate mean, namely A4 (Mean = 2.93 & SD = 0.77), A6 (Mean = 3.36 & SD = 0.78), A7 (Mean = 3.20 & SD = 0.76), A8 (Mean = 3.39 & SD = 0.86) , A9 (Mean = 3.29 & SD = 0.78), A13 (Mean = 3.13 & SD = 0.73) and item A14 (Mean = 2.95 & SD = 0.77). There are 6 items that have a high mean value, namely item A1 (Mean = 3.63 & SD = 0.54), A2 (Mean = 3.53 & SD = 0.62), A3 (Mean = 3.39 & SD = 0.72), A10 (Mean = 3.75 & SD = 0.61), A11 (Mean = 3.68 & SD = 0.54) and item A12 (Mean = 3.67 & SD = 0.66). The findings for the second part of the questionnaire show that there are several aspects that provide important input in the process of improving the Visualization Skills of the Form 4 TCG subjects, especially the level of visualization for the low Auxiliary View topic. Visualization Skill Level for Isometric Drawing and Oblique Drawing is moderate. For Form 5, the level of mastery of visualization is low for the topic of development drawing and needs to be given attention from the aspect of Visualization Skills so that achievement in this topic can be increased. In addition, the analysis of item A16 (Mean = 4.22 & SD = 0.60), A17 (Mean = 4.25 & SD = 0.72) and item A18 (Mean = 4.51 & SD = 0.56) shows that the topic of Additional Views and Development Drawings is a difficult topic to master and perception teachers agree that Visualization Skills are very important to master those difficult topics in TCG Subjects.

Table 7. Level of visualization skills in the subject TCG

No.	Item	Mean	SD	Interpretation
A1	Accurately draw orthographic drawings of flat and inclined surface blocks	3.63	0.54	High
A2	Accurately draw orthographic drawings of flat, inclined and curved surface combination blocks.	3.53	0.56	High
A3	Produces dimensional orthographic drawings that have accurate surface combinations.	3.39	0.72	High
A4	Draw the Auxiliary View of the inclined surface of the block given two orthographic views correctly.	2.93	0.77	Moderate
A5	Produces Auxiliary Views for inclined and curved surface blocks that are accurately given two orthographic views	2.50	0.71	Low
A6	Draw Isometric Drawings of geometric blocks of flat, inclined and oblique surfaces accurately.	3.36	0.78	Moderate
A7	Draw Isometric Drawings of geometric blocks of flat, inclined, oblique, circular and curved surfaces accurately.	3.20	0.76	Moderate
A8	Accurately draw Oblique Drawings of flat, inclined and oblique surface blocks.	3.39	0.86	Moderate
A9	Draw Oblique Drawings of flat, inclined, oblique and curved surface blocks accurately.	3.29	0.78	Moderate
A10	Produce blocks through the application of Perspective Drawing elements in One Point and Two Point Perspective Drawing.	3.75	0.60	High
A11	Determining the accuracy of element positions and line types in the production of Perspective Drawings.	3.68	0.62	High
A12	Producing Perspective Drawings systematically, accurately and neatly as clear graphic communication.	3.67	0.65	High
A13	Analysing the best method for producing development	3.13	0.73	Moderate

	drawing based on blocks.			
A14	Determining the method to be used in producing development drawings based on the analysis that has been conducted.	2.95	0.77	Moderate
A15	Producing development drawings systematically, accurately, and creatively.	2.56	0.74	Low
A16	Auxiliary view topic is the most difficult topic in Form 4	4.22	0.60	Very High
A17	Development drawing topics are the most difficult topic in Form 5.	4.25	0.72	Very High
A18	Visualization skills are important to master the topics of Auxiliary Views and Development Drawings	4.51	0.56	Very High
Overall		3.32	0.65	Moderate

4. Conclusion

The conclusion of the study has supported that the level of visualization skills in TCG subjects is at a moderate level and there is a need to develop a model of visualization skills that focuses on visualization activities because visualization ability is a skill that can be taught and improved. The development of the Visualization Skills model can apply elements of fun so that students are not stressed and interested in mastering topics that require a high level of Visualization Skills such as auxiliary views, isometric drawings, oblique drawings and development drawings. Among the main fun elements identified through literature highlights and DSKP that can help to improve visualization skills are interactive teaching and learning methods, the use of the latest ABBM, the application of the latest AR technology, motivation and interest in students to improve visualization skills based on aspects of sketching and communication. Therefore, the application of fun elements is able to improve visualization skills in TCG subjects where visualization skills are important for students in technical courses, especially in the field of engineering to understand important topics in engineering drawings such as orthographic projections, isometric drawings, hidden views and sectional views is very critical because it represents the foundation of engineering drawing education.

Acknowledgement

This article is part of a research study entitled "Development of Technical Communication Graphic Subject Visualization Skills Model Based on Middle School Fun Elements" carried out by researchers under the supervision of the Faculty of Technical and Vocational Education, Sultan Idris Education University. This study was sponsored by the Education Sponsorship Division, Ministry of Education Malaysia through the Federal Training Grant program (FTG).

References

Abdul Khader, A. A., & Brahadeeswaran, D. (2018). Validation of knowledge based tutoring system developed for teaching basic engineering drawing concepts. *International Journal of Civil Engineeringand Technology*, *9*(1), 702-712. Retrieved from http://iaeme.com/Home/issue/IJCIET?Volume=9&Issue=1

Ali, D. F., Omar, M., Sunar, M. S., Zaid, N. M., Ibrahim, N. A., & Surif, J. (2022). AREDAPPS: Mobile augmented reality development and learning framework based on augmented reality technology for engineering drawing course. In *Springer eBooks* (pp. 322–335). https://doi.org/10.1007/978-3-030-99188-3_20

Ali, N., Samsuri, S., Seman, M., Brohi, I., & Shah, A. (2018). Preliminary study for customer's online shopping satisfaction from security perspective. *International Journal of Engineering &*

Technology, *7*(2.34), 64. https://doi.org/10.14419/ijet.v7i2.34.13914

Blanca, M., Arnau, J., López-Montiel, D., Bono, R., & Bendayan, R. (2013). Skewness and kurtosis in real data samples. *Methodology*, *9*(2), 78-84. https://doi.org/10.1027/1614-2241/a000057

Bougie, R., & Sekaran, U. (2019). *Research methods for business: A skill building approach*. John Wiley & Sons.

Creswell, J. W. (2014). *Educational Research: Planning, Conducting and Evaluating Quantative and Qualitative Research* (5th ed.). Pearson Education Inc. USA.

Farzeeha, A., Mokhtar, M., & Omar, M. (2017). Spatial Visualization Ability Among Engineering Students In Malaysia. *Man In India*, 96.

Hair, J. F., Babin, B., Money, A. H., & Samouel, P. (2003). Essentials of business methods research. *Hoboken, NJ: Wiley*.

Hair, J. F., Money, A., Samouel, P., & Page, M. (2019). Essentials of business research methods. https://doi.org/10.4324/9780429203374

Johannis, N., Yassin, M., Shafie, M., Said, O., Ariffin, A., Rahman, M., … & Sidi, M. (2020). Assessing hiking preparedness and the need of hiprep-my model development among Malaysian hiker: a pilot study. Attarbawiy *Malaysian Online Journal of Education*, *4*(2), 35-40. https://doi.org/10.53840/attarbawiy.v4i2.39

Kementerian Pelajaran Malaysia (2017). DSKP KSSM Tingkatan 5 Grafik Komunikasi Teknikal - BPK Melalui capaian internet pada 25 Oktober 2021: http://bpk.moe.gov.my

Kementerian Pendidikan Malaysia. (2017). Kurikulum Standard Sekolah Menengah Grafik Komunikasi Teknikal. Dokumen Standard Kurikulum Dan Pentaksiran Tingkatan 4.

Khoo, S., Zaman, H., Mohamad, U., & Ahmad, A. (2023). Evaluation of the visual learning application for mathematics using holography display for the topic on shape and space. *Joiv International Journal on Informatics Visualization*, *7*(1), 249. https://doi.org/10.30630/joiv.7.1.1679

Mariano, R. P., & Tantoco, L. F. (2023). Assessment of Employability Skills of Technical-Vocational Education and Training (TVET) Graduates: Basis for an Enhancement Program. *International Journal of Multidisciplinary: Applied Business and Education Research*, *4*(5), 1734-1747.

Marji, M. S., Musta'amal, A. H., & Derasid, N. A. C. (2019). Kajian Keperluan Modul Keupayaan Visualisasi Bagi Subjek Grafik Komunikasi Teknikal. *Proceedings of The 1st TVET*, 0.

Mehmood, K. K., Batool, F., & Sheikh, N. A. (2020). Enhancing organizational performance through social media use and knowledge management. *IBT Journal of Business Studies*, *16*(1), 193-210. https://doi.org/10.46745/ilma.jbs.2020.16.01.13

Omar, M., Ali, D., Mokhtar, M., Zaid, N., Jambari, H., & Ibrahim, N. (2019). Effects of mobile augmented reality (mar) towards students' visualization skills when learning orthographic projection. *International Journal of Emerging Technologies in Learning* (Ijet), *14*(20), 106. https://doi.org/10.3991/ijet.v14i20.11463

Ramlie, M., Tahir, H., & Shuib, A. (2018). The importance of perception and imagination in designing 3d image. *Idealogy Journal of Arts and Social Science*, *3*(2), 215-222. https://doi.org/10.24191/idealogy.v3i2.63

Richey, R. C., & Klein, J. D. (2014). *Design and development research: Methods, strategies, and issues*. Routledge. https://doi.org/10.4324/9780203826034

Saedah, S., T. L. A. Muhammad Ridhuan, and M. R. Rozaini. "Pendekatan Penyelidikan Rekabentuk dan Pembangunan (PRP): Aplikasi kepada Penyelidikan Pendidikan." Tanjong Malim, Perak: Universiti Pendidikan Sultan Idris (UPSI) (2020).

Sawant, S. N., Ghatage, P. S., & Patil, S. K. (2023). An attempt to enhance the visualization, imagination and drawing skill of freshman engineering students through problem based learning

approach. *Journal of Engineering Education Transformations*, *36*(Special issue), 106-110. https://doi.org/10.16920/jeet/2023/v36is2/23015

Taber, K. S. (2017). The use of cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, *48*(6), 1273-1296. https://doi.org/10.1007/s11165-016-9602-2

Tschannen-Moran, M., & Gareis, C. R. (2004). Principals' sense of efficacy. *Journal of Educational Administration*, *42*(5), 573-58.

Tumkor, S., & deVries, R. H. (2015). Enhancing spatial visualization skills in engineering drawing course. In *2015 ASEE Annual Conference and Exposition Proceedings*.

Zuraida, R. L. (2021). Validity and Reliability of Mathematical Visual Literacy Skills Based on Avgerinou's Vilual Literacy Index. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *12*(3), 1102-1121.