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Verbalizer-visualizer preferences of engineering students: Validity and reliability

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Abstract: Learning content has several forms of presentation, both visual and verbal, but students have different characteristics in processing information depending on their learning preferences. Some students have difficulty processing information without knowing what to do. This happens because students do not yet understand the characteristics of their learning styles. This research aims to study the VVQ instrument used by engineering students by measuring the validity and reliability of the VVQ instrument used. This research uses a statistical quantitative method approach to measure the validity and reliability of the instrument. The instrument development process goes through three stages: analysis and formulation of a literature review, development of the VVQ instrument, and measurement of the validity and reliability of the VVQ instrument. Development of question items based on pre-arranged and customized content categories. The development of VVQ in this study shows the validity value of r_{count} > r_{table}, r_{count} > 0.1966 for each item, and the Person Moment (rxy) correlation is moderate (0.40 < rxy < 0.60) and high (0.60 < rxy < 0.80). This research instrument is reliable because the data shows Cronbach's Alpha value r_{count} > r_{table}; 0.817 > 0.6319, and the difficulty level is proportional (medium and high). The VVQ instrument achieves validity and reliability based on the analysis items that have been measured. The implications of this research significantly impact adjusting learning content to be more personalized based on student learning preferences.
Keywords: Visualizer-Verbalizer Preferences, Measurement Instruments, Validity, Reliability

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INTRODUCTION

Frequently, information is given in a combination of figures and text. The way of processing such information, either to process the figure or text first, differs among people. The delivery of information in a form that integrates figure and text is intended to provide detailed information in which text aims to give an explanation or additional information to the information given using a figure (Peterson, 2016). Information only presented in text requires a visualizer to give his best effort to process information verbally even though it does not fit his learning preference. So, he should try to maximize his understanding based on the text (Brunsting et al., 2013).

A student must understand the given learning contents to learn the information quickly. Information can be processed appropriately if presented in a form that conforms to the student's learning styles. Students can easily understand any information given during a learning process if it is adjusted to their learning style since each student with a different learning style shall process information differently (Fayombo, 2015). The presentation of information that conforms to the individuals' learning style could be understood and memorized easily. Therefore, the individual is expected to know his learning style to integrate it into his learning process to make it easier. Besides, he will also be able to solve any learning problems efficiently. The individual should use his dominant learning style in his learning process, which should be facilitated based on the fitness between his learning style and method (Zarei et al., 2015).

Learning styles, which were initially introduced by Felder and Silverman (1988) and revised by Felder (2002), have four dimensions, i.e., Active/Reflective, Sensing/Intuiting, Visual/Verbal, and Sequential/Global (El-Bishouty, 2019). The interpretation of the information is given through the Visual/Verbal dimension. The individual who tends to be a visual learner (visualizer) prefers information to be presented as a diagram, flowchart, or figure. In contrast, an individual who tends to understand verbally (verbalizer) prefers information to be written (Kolekar et al., 2017). Visualizers and verbalizers were separated from each other by using several measurements to identify students' learning preferences so that they could improve their learning achievement since the given information was adjusted to their learning styles.

The measuring tool utilized to identify visualizer and verbalizer preferences was adopted from Richardson's Visualizer-Verbalizer Questionnaire (VVQ). VVQ is often used to determine whether an individual is a visualizer or verbalizer by measuring his learning style preference. VVQ assesses an individual's consistency and preference in visual and verbal information processing. VVQ clarifies the individual as a visualizer if he tends to require visual aids in completing a task or a verbalizer if he tends to require written text in completing a task (Nafea et al., 2019). VVQ contains several questions that direct the individual to show his preference for visual or verbal dimensions to identify his dominant preference. An individual's preference for visual or verbal affects his learning process since a visualizer could understand the information given in figures more easily. In contrast, a verbalizer would better understand text information (Januchta et al., 2017).

A learning process will be effective if the information is given by the learner's learning style so that he can have a better memory of the information rather than if he processes the information not by his learning style. An individual who tends to be a visualizer has a detailed memory for information in the form of figures., In contrast, a verbalizer tends to process details in detail in text. Identifying an individual's learning preference is crucial in the learning process since it could help them learn effectively and responsibly. An individual's attitude in processing information is based on his preference without any assistance from others. The students are always trying to understand new information quickly, even though the information is not to the learning style, so the information received cannot be processed in detail.

The VVQ was originally used to measure individuals' preferences in understanding information either visually or verbally; it assesses individuals' preferences in visual and verbal dimensions. VVQ measures the bipolar dimension from cognitive style to assess individuals' preferences to the way of processing the given information. The classifications of visualizer-verbalizer are generally obtained to measure individuals who tend to be visualizers or verbalizers, so the VVQ needs to be developed in terms of the characteristics of the delivered information. Several investigations doubt the validity of VVQ without any adjustment to the given information type, with the underlying assumption that it only measures the entire construction so that it requires high concentration (Campos et al., 2004). Hence, an adjustment of information characteristics is initially required according to the given information or the language used. A VVQ adjustment to the learning concept could give the individual a better understanding, especially of figures, since figures deliver information that indirectly results in a correct perception of the concept. Visual cognitive style develops better when learning content is presented as a combination of static text and images (Koć-Januchta et al., 2019). Visual objects such as symbols or signs enable individuals to have more specific activities regardless of the learning model. Visual objects in engineering are standard signs/symbols that could assist the individual in processing information. Visual and text objects differ significantly since the visual information process connects data, while the text aims to eliminate failed information transmission.

Determining Visualizer–Verbalizer Questionnaire (VVQ) Categories

The VVQ developed by Richarson (1977) contains fifteen questions (Kirby et al., 1988) and then redeveloped into forty-four questions that accommodate each of the four dimensions of learning styles (Active/Reflective, Sensing/Intuiting, Visual/Verbal, and Sequential/Global) or eleven questions for each dimension (Supangat & Saringat, 2022). Several categories were added in the verbal and visual delivery of the contents. VVQ adopts the visualizer–verbalizer dimensions by considering the categories the questionnaire can develop, as shown in Table 1.

Table 1. Visualizer-Verbalizer Categories

Category	Answer Item
Think	A picture
	Words
New Information	Pictures, diagrams, graphs, or maps
	Written directions or verbal information
Focus	Pictures & charts
	Text
Teachers Activity	Put diagrams
	Explain content
Memory	Object seeing
	Voice hear
Direction	Picture
	Text Instruction
Teacher explanation in class	Remember picture
	Instructional
Data Type	Chart & graphs
	Text & Summary
Sensory	What looked like
	What was said
Media	Based on pictures
	Based on text
Object Placement	Readily and relatively accurate
	With difficulty and without much detail
Doing Task	Work Scheme
	Work Sequential
Imagination	Work Illustration
	Work Instruction
Mental Image	Image Flowchart
	Schematic work process
Guidance	Read Instruction
	Illustration help
Explanation	Visual Demonstration
	Verbal Explanation

Visualizer – Verbalizer Preferences

The visualizer–verbalizer dimensions categorize preferences based on an individual's tendency to have either a visual or verbal learning style. Visualizers tend to prefer information in the form of figures rather than texts. They choose graphics, diagrams, or figures added to text-based content, while verbalizers process information from text-based content, not figures (Baukal & Ausburn, 2014). When information in the form of a figure and text is given, a visualizer will choose the figure that is relevant to the content and make it a basis of visual memory. At the same time, verbalizers will choose relevant words as a basis to form verbal memories. Then, the text base is used as a verbal representation, and the image base is used as a visual representation. The individual chooses relevant information from text and illustration selectively. When an individual obtains information for the first time in the form of an illustration image and text, he has a selective process in choosing relevant information from the presented image and text information. The chosen text and image become databases where the text will be the text base, and the illustration (chosen image) will be the image base. The text (verbal code) and image (image code) will then be verbal and visual models. Such verbal and visual models are the focus of the process. Even though the information is presented in separate codes, such as text and illustration, as shown in Figure 1.

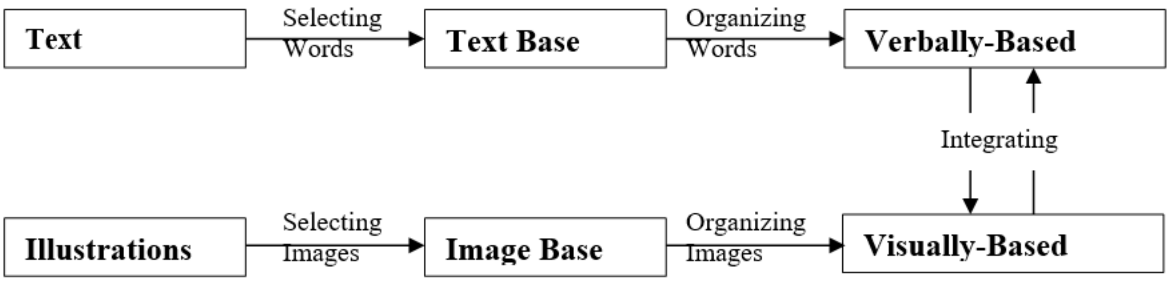

Figure 1. Image and Text Representative

Currently, there has been a lot of development of digital and text-based learning content. Several studies say that engaging in digital learning positively influences interest (X. Liu et al., 2020). Digital-based learning is believed to improve student learning outcomes (Ismiyati et al., 2022). Digital learning content development is utilized optimally and provides space for teachers to present content more interestingly and easily (Tuharea et al., 2023). Attractively designed learning content can increase student interest (Kurniawan et al., 2022). In addition, learning packaged by integrating audio and video is believed to increase learning motivation and critical thinking skills (Sarwinda et al., 2020). However, not much learning content is personalized based on visual-verbal preferences. It requires the development of visual-verbal preferences to provide guidance on adjusting content accordingly.

METHODS

Participant

A hundred (100) students (Male = 69, Female =31) from engineering students at one of the Universities at Malang, East Java, Indonesia, participated in this study. Data were collected in one week—the demography of participants is shown in Table 2.

Research Procedure

The instrument development framework generally consists of literature review analysis and formulation, instrument development, and instrument validity, which are detailed in 3 steps.

Development of the VVQ instrument consists of 3 steps (S1, S2, S3): determining the categories of the instrument, developing the VVQ instrument, and measuring the validity and reliability of the VVQ instrument, as shown in Figure 2. The first step (S1) is analyzing the original VVQ instrument by analyzing the literature describing and conducting the literature review process on several previously developed VVQ instruments. In addition, a link among the objectives of this research into content is established by appropriating categories and scales of the VVQ instrument. Then, create statements questions item by category that has been compiled. Each category is developed into questions about participants' preferences for the information presented in visual or text form. Step 2 (S2) is the development of the VVQ instrument. The process of instrument development consists of four steps: (a) to analyze data and scales of measurement, (b) to develop VVQ question item, (c) to determine the questionnaire format of VVQ, and (d) to appropriate Questions to Computer Network Course content. Step 3 (S3) is the validity and reliability of the VVQ Instrument. Validity is established using field tests and Pearson's moment correlation test statistical analysis. Reliability of the VVQ instrument using a pilot test is carried out to indicate the measuring instrument's accuracy. Statistical Analysis analyzes data collected from the pilot test - Cronbach's Alpha Reliability.

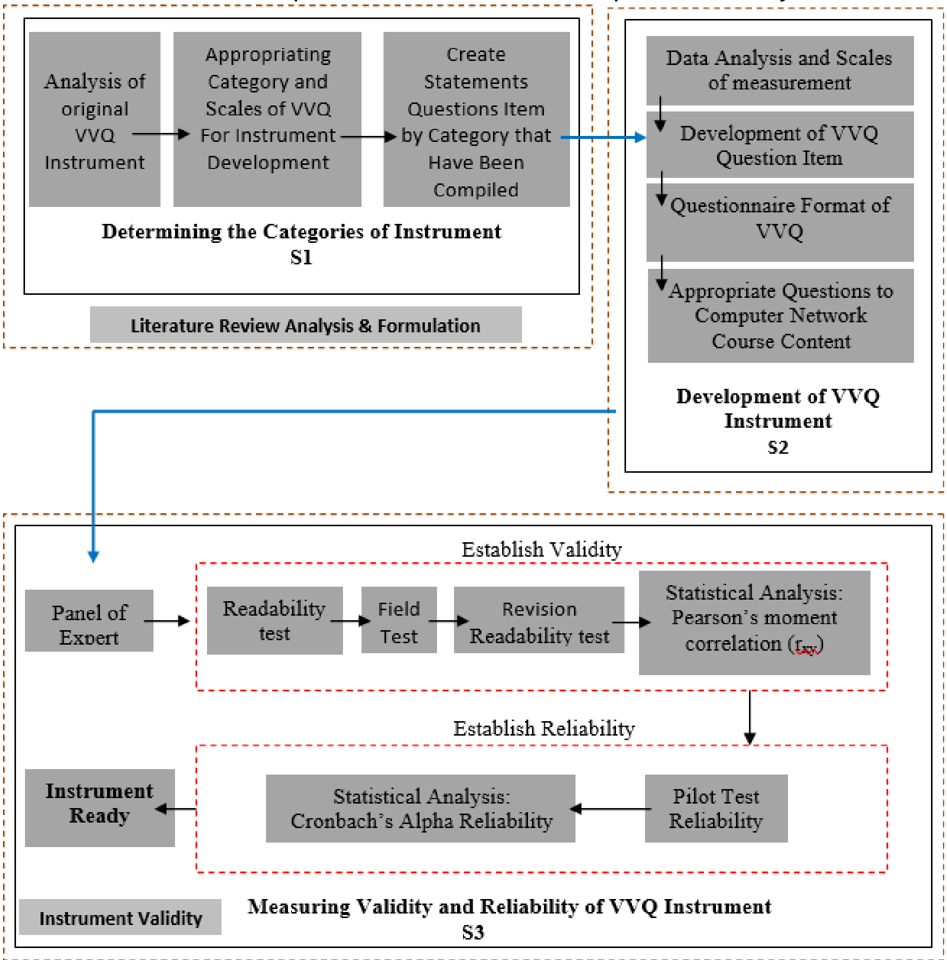

Figure 2. Framework for VVQ Instrument Development

So far, the development focuses on the diversity of the questions and has not been adjusted to the content that the participants learn. Therefore, the VVQ questions were classified based on the main ideas of the questions. All of the participants who answered the questionnaire consisted of demographic questions and sixteen VVQ item questions that have been developed. The questionnaire was presented online, and the participants were given a link to access the questionnaire. Instrument. VVQ is developed from the original VVQ by taking points from each question presented and creating categories based on those points. The following process defines the categories for the VVQ development reference and obtains 16 categories of VVQ question items (shown in Table 1). Questionnaire material is customized based on con-tent from computer network material. The VVQ question used in this study has been tailored to the needs of Electrical Engineering students as an instrument that measures visualizer–verbalizer preferences, especially in Computer Networking courses. Each question provides two options, i.e., (a) and (b), where the (a) answer tends to represent the visual dimension and the (b) answer tends to represent the verbal dimension. Each option will represent the dominant preference of a visualizer and verbalizer. In this research, the authors explain each question to ease the process of answering the questionnaire and reduce any misperception of the given question.

Analysis Technique

Data analysis in this research used SPSS (Statistic Package for Social Science) software version 24 to measure the validity and reliability of VVQ instruments. The validity level was measured by testing the $r_{count} \geq$ table of each question, where α=5%. The reliability level was tested if Cronbach's Alpha value was higher than the r_{table} with a 5 % level of significance, and the difficulty level of each question was measured by determining the instrument's quality and item distribution frequencies.

RESULT AND DISCUSSION

Demography of Participants

The demography of participants was used to collect information such as the gender and study program of each student. Table 2 presents the sample distribution based on gender: male students were 69 %, and female students were 31 %. The informatics engineering study program students consist of 74 % male and 26 % female students, while the broadcasting engineering program students include 59 % male and 41 % female students. The research samples were selected by simple random sampling using an online questionnaire. The VVQ was presented online, and students should complete the VVQ in one week, as shown in Table 2.

Table 2. Sample distribution based on student gender and study program (n=100)

	Broadcasting Engineering		Informatics Engineering		Total	
	n	%	*n*	%	*n*	%
Male	19	59%	50	74%	69	69%
Female	13	41%	18	26%	31	31%
Total	32	100%	68	100%	100	100%

Note. n = number of participants

Measurement of the VVQ instrument

Validation of an instrument

All data was processed via a statistical analysis that started by calculating Pearson's moment correlation (rxy) (Pearson Correlation) and continued by measuring the instrument validity coefficient (r_{count}). The r_{count} result was compared with the r_{table} on a α significance level (α = 0.05), with the value of the n data, where if the $r_{count} \geq r_{table}$, the instrument shall be considered as valid, but if the $r_{count} < r_{table}$, then the instrument is considered invalid (Brace et al., 2016; McCormick et al., 2017). The results of the instrument validity test are shown in Table 3.

Table 3. Results of Pearson's moment correlation

Question (Q)	Pearson Correlation (σxy)	Status of Validity
Q1	0.404	Valid
Q2	0.435	Valid
Q3	0.484	Valid
Q4	0.647	Valid
Q5	0.675	Valid
Q6	0.557	Valid
Q7	0.667	Valid
Q8	0.557	Valid
Q9	0.546	Valid
Q10	0.559	Valid
Q11	0.375	Valid
Q12	0.473	Valid
Q13	0.400	Valid
Q14	0.596	Valid
Q15	0.447	Valid
Q16	0.551	Valid

If several participants, n = 100, and the r_{table} with α=5 %, then df = n-k = 100-2 = 98, and the r_{table} value = 0.1966 (df= degree of freedom; k= number of the independent variable). The result of the person's moment correlation (shown in Table 3) shows that the questions from Q1 to Q7 are valid because of the $r_{count} \geq r_{table}$. Q1 = 0.404 ≥ 0.1966; Q2 = 0.435 ≥ 0.1966; Q3 = 0.484 ≥ 0.1966; Q4 = 0.647 ≥ 0.1966; Q5 = 0.675 ≥ 0.1966; Q6 = 0.557 ≥ 0.1966; Q7 = 0.667 ≥ 0.1966; Q8 = 0.557 ≥ 0.1966; Q9 = 0.404 ≥ 0.1966; Q10 = 0.559 ≥ 0.1966; Q11 = 0.375 ≥ 0.1966; Q12 = 0.473 ≥ 0.1966; Q13 = 0.400 ≥ 0.1966; Q14 = 0.596 ≥ 0.1966; Q15 = 0.447 ≥ 0.1966 and Q16 = 0.551 ≥ 0.1966. The instrument validity was determined according to Pearson's moment correlation (rxy) shown in Table 4.

Table 4. Classification of instrument validity

	Classification of Validity
0.80 <rxy< 1.00	Excellent Validity
0.60 <rxy< 0.80	Valid
0.40 <rxy< 0.60	Average Validity
0.20 <rxy< 0.40	Low Validity
0.00 <rxy< 0.20	Critically Low Validity
rxy< 0.00	Invalid

The research findings pointed out that the rxy of the Q4, Q5, and Q7 was classified as excellently valid since it met the 0.60 <rxy< 0.80 classifications and while the Q1, Q2, Q3, Q6, Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15, and Q16 were categorized as averagely valid since they met the 0.40 <rxy< 0.60 classifications. The classification of validation could determine the validity of each proposed item of the question, as shown in Table 5.

Table 5. Results of validity classification

Question (Q)	Pearson Correlation (rxy)	Classification of Validity
Q1	0.404	Average
Q2	0.435	Average
Q3	0.484	Average
Q4	0.647	Excellent
Q5	0.675	Excellent

Question (Q)	Pearson Correlation (rxy)	Classification of Validity
Q6	0.557	Average
Q7	0.667	Excellent
Q8	0.557	Average
Q9	0.546	Average
Q10	0.559	Average
Q11	0.375	Average
Q12	0.473	Average
Q13	0.400	Average
Q14	0.596	Average
Q15	0.447	Average
Q16	0.551	Average

The probability value (Sig. 2-tailed) resulted from each score correlation, which showed a total score lower than α =0.05.

Reliability of instrument

The instrument reliability test was conducted to determine the consistency and stability of the questions or the instrument level. The reliability test was performed by comparing the alpha value of each variable with the Alpha (Al-Azawei et al., 2015). As the measuring tool, the questionnaire must have a high level of reliability, which process would be done after the questionnaire was declared valid. The instrument reliability test was performed using the Cronbach's Alpha method, where the questionnaire would be considered valid if the Cronbach's Alpha score was higher than the r_{table} with a 5 % significance level (Lee et al., 2017).

Table 6. Reliability Statistics

Cronbach's Alpha	n of Items
0.817	16

The reliability statistics can be seen from the result of Cronbach's Alpha value = 0.817, which is higher than the r_{table} value = 0.6319 with α = 5 % significance level, df = n-k = 16-2 = 14, so that the instrument used was declared as having excellent reliability (shown in Table 6).

The level of question item difficulty

The assumption used to determine a good instrument is an instrument that has a balanced degree of difficulty from all questions. A balanced difficulty degree will result in an understandable instrument so students can complete it correctly. The degree of difficulty is classified as follows: Difficult (0.00 < Index < 0.20); Medium (0.21 < Index < 0.70; Easy (0.71 < Index < 1.00). The difficulty level of each question can be seen from the Mean values in Table 7.

Table 7. Mean values of question item difficulty

		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
N	Valid	100	100	100	100	100	100	100	100
	Missing	0	0	0	0	0	0	0	0
	Mean	0.57	0.46	0.54	0.83	0.79	0.74	0.73	0.74
		Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
N	Valid	100	100	100	100	100	100	100	100
	Missing	0	0	0	0	0	0	0	0
	Mean	0.55	0.81	0.87	0.54	0.47	0.49	0.57	0.79

Table 7 presents a medium level of difficulty from question Q1=0.57; Q2=0.46; Q3=0.54; Q9=0.55; Q12=0.54; Q13=0.47; Q14=0.49; Q15=0.57 while a high level of difficulty is found in question Q4=0.83; Q5=0.79; Q6=0.74; Q7=0.73; Q10=0.81; Q16=0.79.

The instrument used in this research has suitable results for validity tests, reliability tests, and tests on the difficulty level. Thus, it is suitable as a VVQ preference applied in Computer Network courses for Electrical Engineering students. Visual-verbal cognitive style influences the learning process based on the type of visualization and text modality presented in the learning material (Koć-Januchta et al., 2019).

Research Instrument Development

VVQ development can be performed by using categories as the criteria. The development of question items that adjusted to the computer network course content is shown in Table 8.

Table 8. Visualizer – Verbalizer Questionnaire Rubric

Category	Question (Q)	Multiple Choice Answers	Pearson Correlation (count)
Think	Q1: The course content on computer networks always reminds me of	The forms of computer networking hardware and software The explanation of the functions of computer networking hardware and software	0.404
New Information	Q2: Every time I find computer networking hardware/software, I will first	Look for the work chart of the computer hardware/software Read the manual book of the hardware/software	0.435
Focus	Q3: Computer networking content is presented in a worksheet. I will first learn	The image of computer networking The explanation of the working system of the computer network	0.484
Teacher Activity	Q4: I prefer explanations of computer networking content to be given in the form of	Image Text and detailed explanation	0.647
Memory	Q5: Relating to the theory of computer networking configuration explained in the previous session, I can easily recall	The image of the computer networking configuration The definition and explanation of computer networking configuration	0.675
Direction	Q6: In order to get an understanding of computer networking configuration, I prefer to learn an installation manual in the form of	A configuration image An explanation sequence of the configuration	0.557
Teacher's explanation in class	Q7: I can better understand the content of computer networking configuration if the teacher/lecturer provides explanations in the form of:	A configuration image An explanation sequence of the configuration	0.667

Category	Question (Q)	Multiple Choice Answers	Pearson Correlation (count)
Data Type	Q8: Some data is presented in the measurement result, and I tend to understand the data analysis more quickly in the form of	Chart and graphic Detailed text	0.557
Sensory	Q9: To identify problems in preparing computer networking design, I pay more attention to	Computer configuration image Written instruction in computer networking design	0.546
Media	Q10: The media used to learn the theory of computer networks should be in the form of	Computer networking simulation image Manual book of computer network	0.559
Object Placement	Q11: The object that provides information on computer networking contents should be in the form of	A true and correct image A detailed text	0.375
Doing Task	Q12: The workflow of the computer network designing process can be quickly followed if it is accompanied by	Work chart Work procedure	0.473
Imagination	Q13: Before doing technical work, I tend to check	The illustration of the work The procedure of work	0.400
Mental Image	Q14: The interpretation of the order of the components that need to be prepared to arrange a computer network can be understood more easily if it is explained in the form of	Workflow image Systematical work procedure	0.596
Guidance	Q15: When obtaining information on new networking hardware/software for the first time, I try to find	Supporting illustration Written instruction	0.447
Explanation	Q16: I can understand the content more quickly if the teacher/lecturer	Explain by providing a demonstrating image Explains the work procedure in detail	0.551

*Where n = 100, the r_{table} with α=5 %, and df = n-k = 100-2 = 98, the r_{table} value = 0.1966 ; $r_{count} \geq 0.1966$

Developing VVQ by customizing the question items based on categories from the original VVQ and computer network content and performing validity and reliability testing on the VVQ that has been developed. Statistical analysis helps determine the validity and reliability of VVQ instruments by using Pearson Correlation, Sig. (2-tailed) (C. Liu et al., 2019; Martin et al., 2018), Cronbach's Alpha and Distribution of Frequencies. The study found that the instrument used is valid with the value of the correlation moment Pearson > table = 0.1966, and the instrument's reliability with the value of Cronbach's Alpha = 0.817> r_{table} = 0.6319. In subsequent research, the measurement of visualizer-verbalizer preference is considered by considering gender differences as demographic information (Toomey & Heo, 2019). In this study, VVQ preferences would be developed to accommodate how information is processed based on visualizer-verbalizer preferences in computer networking courses. VVQ preferences were used to classify an individual's tendency to be a visualizer or verbalizer. Determining an individual's visual and verbal preferences aims to determine individual learning styles. Learning preferences in the course in which VVQ can measure content technology yields higher values of visualizer and verbalizer than other fields of courses. The options of the types of information for visualizer and verbalizer encourage a better understanding of people with different learning styles. It is necessary to select a proper form of information to accommodate visualizers and verbalizers since it can be adjusted to their learning styles (Petsas et al., 2023). The course content on computer networking presents several components in the form of configurations, symbols, and codes, each containing technical information. The presented technical information should be able to be understood entirely. In the learning process, the student often faces difficulties understanding a configuration or symbol and needs additional information in the form of texts. Thus, a reference to the form of contents is necessary. This research aims to obtain proper VVQ preferences during Computer Networking. The quality of the research instrument determined the quality of data collection. Hence, this research required validity and reliability tests on the VVQ instrument.

CONCLUSION

This research aims to develop the VVQ instrument and the measurement of its validity and reliability. The VVQ instrument was made by adopting the most recently developed VVQ questionnaire with various adjustments to the questionnaire items. Such adjustments were made based on the categories in previous VVQ and then adjusted to the need and aim of this research to determine the tendencies of learning style preferences as visualizers or verbalizers of the Electrical Engineering students. The VVQ developed in this research has proportional validity, reliability, and difficulty to the proposed questions. The finding of this research is the development of a VVQ instrument used to determine the preferences of visualizers and verbalizers in computer network courses. The results of this research can be developed to meet the needs of other courses by modifying the questions based on the underlying categories.

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