

# Revised-Verbal Protocols: A Valuable Technique for Verbalizing the Students' Thoughts in Teaching-Learning Process

<sup>1</sup>Tomo Djudin & <sup>2</sup>Hamdani

<sup>1</sup>Physics Education Department of Education and Teacher Training Faculty,  
Tanjungpura University, Pontianak, Westkalimantan-Indonesia

<sup>2</sup>Mathematics Education Department of Education and Teacher Training Faculty,  
Tanjungpura University, Pontianak, Westkalimantan-Indonesia

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## ABSTRACT

This article presents the utilization of the 'verbal protocols' as a source of information about students' cognitive learning processes. This method calls upon students to talk their thoughts out aloud, during engagement in some learning activity. Although many researchers have used verbal protocols in their studies in many disciplines, however, the nature of verbal protocols and its implementation in the real classroom setting have not been known well by many teachers. The major concept of verbal protocols, the two perspectives, a brief theory of expertise, and the limitations regarding the verbal protocols will be main concerns in this paper. An explicit exemplar of revised-verbal protocols model in the learning of Doppler Effect is exposed at the last section of this paper

**Keywords:** Verbal protocols; Two perspectives; Risks and limitations; A revised model

## INTRODUCTION

Verbal protocols technique has been used in many disciplines for studying cognition, education and psychology [1][2][3]. An equivalent term of verbal protocols is thinking aloud procedure [4]. In this method, students are asked to verbalize simultaneously all thoughts as they complete a certain a learning task [5]. Abidin et al. [1] defined verbal protocols as the process of gathering data by requesting students to talk loudly what is going through their mind while they are in the process of tackling the learning task or solving the problem. It is also implemented to analyze the mental operations or knowledge representations responsible for the observed performance [6].

The use of verbal protocols technique will provide the two advantages. One major advantage is data drawn from verbal protocols provide the richest information regarding the contents of working memory during task execution [1]. Another advantage of verbal protocols analysis is that it provides sequential observations over time. As such, it reveals changes that occur in working memory over the course of task execution [2]. Verbal protocols technique has been used in many disciplines for studying cognition, education and psychology [1][2][3]. An equivalent term of verbal protocols is thinking aloud procedure [4]. In this method, students are asked to verbalize simultaneously all thoughts as they complete a certain a learning task [5]. Abidin et al. [1] defined verbal protocols as the process of gathering data by requesting students to talk loudly what is going through their mind while they are in the process of tackling the learning task or solving the problem. It is also implemented to analyze the mental operations or knowledge representations responsible for the observed performance [6]. The use of verbal protocols technique will provide the two advantages. One major advantage is data drawn from verbal protocols provide the richest information regarding the contents of working memory during task execution [1]. Another advantage of verbal protocols analysis is that it provides sequential observations over time. As such, it reveals changes that occur in working memory over the course of task execution[2].

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## **METHODOLOGY**

This paper is a literature review. According to Synder [10], the implementation of literature review method generally undergo the four basics steps, namely: designing, conducting, analyzing, and writing up the review. Ramdhani et al.[11] argued the more detailed steps involved in conducting a traditional literature review i.e. selecting a review topic, searching and choosing appropriate articles, analyzing and synthesizing the literature, and organizing of writing the review. In addition, this process will be developed from and synthesized based on my practical experiences.

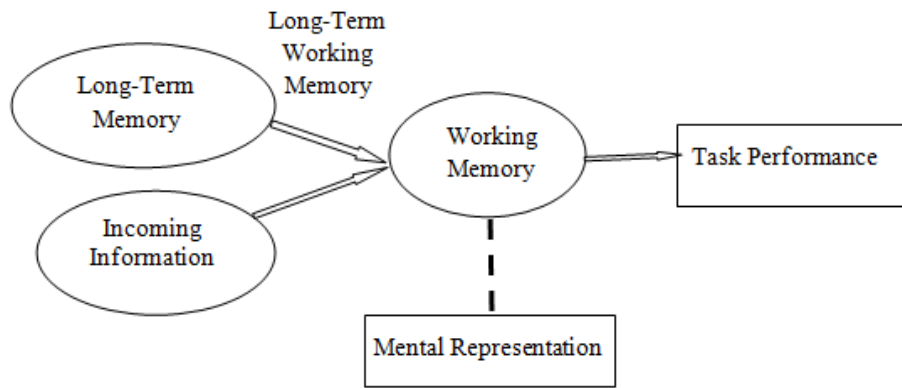
All practical steps mentioned above are mainly focused on the objectives of this papers for (1) reviewing the theoretical perspectives and empirical background of verbal protocols from the results of previous studies; (2) comprehending deeply the theories underlying verbal protocols; (3) indentifying some risks and limitations of using the verbal protocols; (4) designing a practical guidelines of implementation of verbal protocols method in the classroom; and (5) exposing an exemplar instructional practice of revised-verbal protocols in learning physics.

## **RESULTS AND DISCUSSION**

Based on the content-analysis method, there are five pivotal insights regarding the verbal protocols presented in this paper; (1) two dominant perspectives of verbal protocols; (2) theory of expertise; (3) risks and limitations of using the verbal protocols; (4) practical guidelines of implementation of verbal protocols method in the classroom; and (5) an exemplar of revised-verbal protocols in learning physics. The results will be discussed as follows:

### **The Two Psychology Pectives of Verbal Protocols**

What do verbal protocols address? To respond to of this inquiry, I refer the two recognize viewpoints of human discernment: data handling hypothesis [12] as illustrative of suspecting in intellectual science, and a sociocultural hypothesis of psyche [13]. As per data handling hypothesis [12], think a louds are a report of the (oral) substance of momentary memory, and address a hint of the intellectual cycles that individuals take care of while doing an errand. Abualrub et al.[9] brought up that admittance to memory structures is upgraded by a brief that guides in the review of data. As per Ericsson and Simon [12], an immediate encoding of the idea and reflects intellectual construction and goes to what data while playing out their undertakings by utilizing the procedures and the surmisings drawn from data. Thusly, verbal protocolss give the proof from which models of human intellectual preparing are created. The model of data handling hypothesis of human comprehension is displayed in Figure 1.



**Figure 1. Information Processing in Task**

(van de Weil, 2017: 114)

Figure 1 illustrates how both incoming information in long-term memory continuously interact to determine the content of working memory in task performance. The capacity of working memory is enhanced by retrieval cues that directly access the relevant parts of experts' knowledge in long-term working memory, enabling them to coordinate thoughts and actions in cognitive processing. The evolving mental representations in task performance reflect the content of working memory [12].

The hypothesis of sociocultural of brain manages the connection among language and thought. In this point, language is an info and yield module for comprehension. This view, notwithstanding, is being tested even inside the intellectual sciences contended that idea itself is generally autonomous of the method for its transmission from one psyche to another. Vygotsky [13] accepted that thinking isn't just communicated in words; it appears through them and goes through many changes as it transforms into discourse. Vygotsky [13] asserted that the most common way of delivering thinking into discourse isn't just a question of memory recovery, however an interaction through which thinking arrives at another degree of explanation. Smagorinsky [14] expressed that assuming reasoning becomes rearticulated through the course of discourse, the conventions isn't just delegate of significance. It is, fairly, a specialist in the creation of significance.

In a sociocultural hypothesis of brain, verbalization is imagined as an instrument that empowers changes in comprehension. As per Isenberg [15], discourse (through a course of disguise) comes to manage, coordinate, and center a person's own psychological exercises. Discourse additionally assists us with concentrating, screen and control our conduct. Language is a device which allows our psyche to participate in an assortment of new intellectual activities and controls. The convergence of language with the exercises of psyche took into account the mutual information development. Vygotsky [13] contended that understudies develop their own insight through the social communication in their current circumstance.

Verbal protocols can impact intellectual cycle in three ways [4]. To begin with, the course of verbalization itself changes thought, set importance, and make a noticeable antique. Besides, as a noticeable antiquity can be reflected upon, addressed, controlled, and rebuilt. Furthermore, thirdly, disguise of this currently contrastingly comprehended externalized relic might happen. What this suggests is that verbal protocols not just conceivably change thinking, focussing it in exceptionally explicit ways, yet additionally are the wellsprings of changes in perception [16].

### **A Brief Theory of Expertise**

Verbal protocols have been used extensively in the study of expert versus novice task performance across a variety of domains [5][12][17]. Knowledge about expert and novice problem-solving processes has implications for developing and assessing pedagogical practices e.g.in studies of the steps of problem

solving and conceptual change. Due to the specific perspectives in the literature about the differences between expert and novice vary from domain to domain, some generalities across domains can be made. Experts have more knowledge and more highly organized knowledge structures within their domains than do novices. The processes by which they solve problems and accomplish tasks within their domains of expertise also differ [12]. Ericsson and Simon [12] confirmed that skilled performance and experience alone are not enough to become an expert. Individuals must be able to go beyond mastery and contribute their creative ideas and innovations to the task at hand. It takes amount of years of practice and experience to gain routine behavior and full automaticity. Experts should be counteracted by gaining high-level control of performance that allows further improvements to be made.

In the line of the theory of expertise, I summarized the characteristic of experts as follows: (1) have a large and well-developed knowledge-base that allows fast and accurate performance in routine situations; (2) In more complex situations, they can apply their knowledge flexibly when trying to understand the situation and decide upon further actions; (3) have developed rich and coherent knowledge structures that allow immediate access to the relevant knowledge, strategies, skills, and control mechanisms; (4) reflect, monitor, and adapt carefully their performance in an ongoing process and outcomes that might be improved; (5) accommodate their knowledge and skills by means of study, practice and experience; and (6) enhance learning from their experiences by seeking feedback. Clearly, experts have more knowledge and more highly organized knowledge structures within their domains than do novices. Finally, keep in mind that becoming an experts requires the individual motivation to improve his/her own performance and invest effort in deliberate practice [12][18].

### **Risks and Limitation of Verbal Protocols**

Albeit verbal protocols and verbalizations in plan studies are by and large acknowledged, and viewed as somewhat level headed, it isn't without debate [6]. Ciu and Shu [5], for instance, expressed the three of dangers of utilizing this strategy as an apparatus for gathering research information, for example time and asset seriousness; information legitimacy; and investigation of assignments not helpful for verbalization are portrayed beneath.

**Time and asset escalation:** Verbalization tests are viewed as requiring additional time and assets than different techniques, e.g., pen-and-paper tests. Test meetings should be led separately; meetings should be recorded and accordingly translated; and records should be coded, or deciphered, before the primary investigation. To forestall predisposition, free transcriptionists and coders are employed, adding to the cost and lead-time associated with directing verbal conventions tests. An immediate outcome of expanded time necessities is that verbalization explores frequently have a more modest example size. A study of plan and critical thinking concentrates on utilizing verbal conventions tests shows ordinary example sizes range from one to 10 members [8].

**Information legitimacy:** Another impediment is the un accurateness of verbal reports. Verbal reports and real accounts of the occasions are regularly not really match. There are likewise worries that discussing the assignment will change the errand. Notwithstanding, these worries can be kept away from if verbal reports happen "fit", right away. As indicated by Ericsson and Simon[12], quick verbalization precisely depicts the undertaking and doesn't adjust the assignment being considered. Quick verbalizations are totally drawn from momentary memory, otherwise called working memory, don't need reproduction or recovery from long haul memory. Along these lines, there is no danger that recollections and realities can be changed. Modified recollections because of recreation and recovery are regularly an issue in sometime later detailing.

**Errand not helpful for verbalization:** now and again, assignments can't be expressed precisely in light of parallelism and automaticity. Since verbalization is sequential, expressing may urge members to change an equal assignment to a sequential errand with the goal that it very well may be expressed successively.

Automaticity of an undertaking happens as aptitude is acquired through practice and information is moved to long haul memory, making the robotized cycle blocked off to verbalization [16].

As recently expressed, verbal conventions information is expected as unadulterated portrayals of intellectual cycles. A few specialists, in any case, have started to recognize that conventions information and thinking measures are not exclusively intellectual, yet that they are socially arranged exercises [2]. Smagorinsky [14] affirmed that perception is treated as an intra-individual association, this is difficult to detach insight from its social climate. The properties of verbal reports as socially developed information have regularly been ignored in the exploration interaction. Via cautiously controlling the social collaboration that is expected to happen, they guarantee that this “issue” could be decreased or regularly dispensed with.

As per socio-social scholars which depends on crafted by Vygotsky, discernment isn't separated from social settings yet rather comprises a socially arranged action which has establishes in members' social history. Smagorinsky [14] fought that the investigation of perception can't be isolated from its social and social connections. Hence, the issue of legitimacy of verbal protocols has additionally been addressed by different scientists. Specifically, the issue of reactivity, that is, the impacts of revealing of considerations on the sources' intellectual cycles, has been examined.

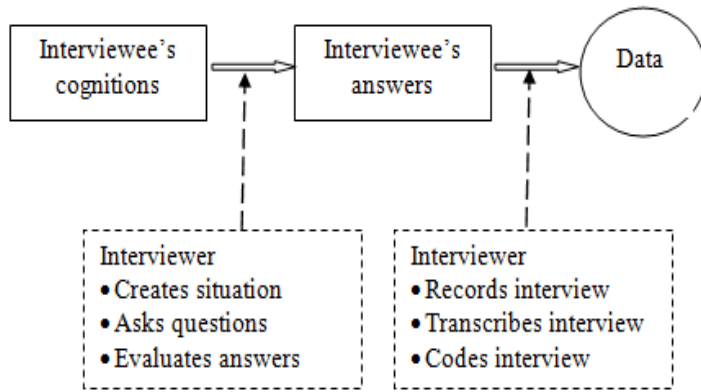
One more restriction in verbal conventions examination is the un completeness of the information gathered [19]. Cowan and Cherry [19], for instance, contended that the cycles of delivering verbalizations might have required the member to settle on choices concerning what to report. Members seem to have chosen particular kinds of data to report. The general fulfillment of verbally process information relies upon what data members select. Some past examinations have brought up that in friendly or intuitive nature of the conventions, the conceivable impact of the conventions on an assignment is gotten from the members are occupied with, and it is potential for inadequate information. He reminded that it is significant that we gather and analyze verbal report information cautiously and with regard for conceivable reactivity, just as to their status as a social build.

### **How to Use the Verbal Protocols in the Classroom**

At the point when this strategy is carried out in the study hall, understudies should say so anyone can hear all that goes through their psyches while doing an assignment. They are told not to decipher or investigate their reasoning. Earlier thought ought to be given to the manner in which guidelines are to be passed on to understudies. A guidance from a facilitator to “continue to talk” while the understudy played out an undertaking likely would not change the perspective. A guidance may require clarification from the understudy, by telling “why you did this,” would intercede in the intellectual cycle by invigorating a response to clarify an activity. On the off chance that verbal protocols are requested from understudies after culmination from assignments, it is ideal if verbalization very quickly follows the undertaking [1].

All verbal conventions meetings, as displayed in Figure 2, were sound recorded, translated, and coded. Record incorporated the specific expressions of the members. Moreover, highlights that show stops, delay, accentuation, various tones, or inflections were incorporated. No pre-fixed coding plan was utilized to examine the information. There are three of the informational collections, which had been translated, and did an underlying coding by recognizing normal examples and topics. The examples that were identified with any methodological issues in verbally process information and those that appeared to clarify intellectual cycles of impression of refusals. At the point when fundamental, the sound recorded information again and applied to code by changing the record. he classes included data identified with the members' view of discourse acts, for example, foundation information utilized in assessing reactions, wellsprings of that information, elective reactions, and methodological issues in regards to the survey, just as data identifying with the social idea of the conventions [17].





**Figure 2. Session of Verbal Protocols Analysis**

(van de Weil, 2017)

Explicit teacher modeling helps students understand what is expected of them through a clear example/model of a skill or concept. When a teacher provides a easy to follow procedure for solving a problem, students have a memorable strategy to use for approaching a problem on their own. The verbal protocols approach aims to elicit the inner thoughts or cognitive processes that illuminate what is going on in a person's head during the performance of a task, for example solving a problem. Ericsson and Simon [12] proposed the method for verbal protocols analysis in the classroom is following:

1. The student's verbalisations are transcribed into a protocols and the problem solving process and protocols are analysed to extract the vocabulary of objects and relations needed to define the problem.
2. The protocols is then segmented, each segment corresponding to a statement.
3. The list of actions used to encode the segments can be extracted from the elicited vocabulary or from a pre-determined coding scheme.
4. There can be several levels of analysis. The episodes and actions can be aggregated (which is often the case in design studies), for example. In order to ensure reliability, the coding should be done.

Cowan [20] listed several suggestions have been proposed for increasing the likelihood of obtaining verbal protocols data that provide valid information about the contents of working memory under normal task conditions are as follows:

1. Gather verbal protocols data during students are performing the task to be completed.
2. Ask students to verbalize their thoughts that occur while completing the task. The students also need to comprehend type of information they faced that enable to plan an appropriate strategy to solve the problem.
3. Make sure that the students that task performance is their primary concern and that thinking aloud is secondary. If, however, a subject is silent for a relatively long period as compared to others during task execution, prompts such as "keep talking" may become necessary.
4. To reduce as much as possible the conversational aspects of the think-aloud task, the researcher should try to remain out of the subject's point of view.

### **An Exemplar of Revised- Verbal Protocols in Teaching-Learning of Physics**

There are at least two fundamental justifications for why the educator should reconsider and alter the verbal conventions procedure in the study hall has a lot of understudies. To begin with, directing meeting considers, as like in verbal conventions, has specific drawbacks. It tends to be expensive just as very

tedious, cause inclinations, and give less secrecy, which is a major worry for some understudies [17][23]. Second, specialists in intellectual hypothesis concurred that intellectual interaction, similar to all the other things, without a doubt can be improved by rehearsing or preparing and express demonstrating [24][25]. Teachers need to give unequivocal guidance on the utilization of verbal conventions systems. Educators can raise the level of understudies' idea in their study halls by displaying the actual cycles. Techniques to empower verbally processing when tackling the issues, reflecting understudies' thoughts back to them or rewording them to incorporate explicit reasoning words (like arranging, methodology, steps to be taken, and so on), explaining reactions and questions, and having understudies incorporate how they tackled the issues as a piece of bigger tasks.

Here we offer the learning syntaxes of the revised-verbal protocols model that has six operational phases described as follows:

Phase 1: Teacher should model explicitly the steps in solving a word by talking aloud procedures.

Phase 2: Student practice to complete the task individually by selecting thinking strategies deliberately

Phase 3: A pair-students share the ideas of the solution of the task.

Phase 4: A chosed-student of the pairs ask to solve and also model explicitly the steps in solving a word by talking aloud procedures before the class in the white board.

Phase 5: Teacher provide a corrective feedback

Phase 6: Teacher evaluate the students' competency by providing another problem

At the last section of this paper, we would like to expose the modeling the verbal protocols procedures in the process of solving a word problem of physics: *Doppler Effect*.

### **A problem of Doppler Effect:**

*A police car is chasing a speeding Porsche 911. Assume that the Porsche's maximum speed is 80.0 m/s and the police car's is 54.0 m/s. At the moment both cars reach their maximum speed. What frequency will the Porsche's driver hear if the frequency of the police's car siren is 440 Hz? Take the speed of sound in air to be 340 m/s. (Answer: 400 Hz, taken from: Walker [26])*

### **Teacher asks students:**

Teacher: "How can we solve the problem? What the basic concepts are involved? Do you still remember the formula? What does it mean?"

*(Intended students' answers)*

Student-1 : "Doppler effect is defined as the increase or decrease in the frequency of sound heard by an observer due to the movement of either the source of the sound or the observer."

Student-2 : "The equation for the Doppler effect is:

$$f_o = \frac{(v \pm v_o)}{(v \pm v_s)} f_s$$

*(Teacher responses and asks students)*

Teacher: “Well, what is the knowledge (our existing mathematics knowledge) that might be applied connected to the concepts (problem) we are facing? Can you explain it?”

*(Intended students' answers)*

Student-3: “There are some basic concepts in mathematics related to the problem). In this case, proper fraction :

$$\frac{a}{b} = \frac{\text{numerator}}{\text{denominator}}$$

where  $a, b \in \text{Real}$ , and  $b \neq 0$

Teacher: “ Good, anybody can explain the value of the fraction?”

Student-4:” The fraction has value as follows :

1. Equal 1, if the numerator is equal to the denominator
2. More than 1, if the numerator is higher than the denominator
3. Less than 1, if the numerator is smaller than the denominator.”

*(Teacher continues asking questions to promote cognitive process the fraction concept to Doppler effect)*

Teacher: “Excellent, can you use the alternative values of the fraction related to Doppler effect concept? Simply stated, what is the conditions for the increase or decrease in the frequency of sound heard by an observer? Anybody has alternative answers?”

Teacher:” a. If value of the fraction is 1 than there is no Doppler effect occurring. In another word, the frequency of sound heard by an observer is similar to the frequency of source ( $f_o = f_s$ ). It means that both source and observer are at rest or have the same velocity.

1. If value of the fraction is more than 1, than Doppler effect occurred. In this case, the numerator is larger than the denominator. Or, the frequency of sound heard by an observer is higher than the frequency of source. It means that one of the them or both overtake (the observer and source are approaching each other).
2. If value of the fraction is less than 1, than Doppler Effect occurred. In this case, the numerator is smaller than the denominator. Or, the frequency of sound heard by an observer is less than the frequency of source. It means that one of the them or both keep away”.

*(Teacher explicitly models students on the steps)*

Teacher : “Well, next step is what are you supposed to do for finding a right solution?”

As we know that the equation for the Doppler effect is:

Read the problem carefully, and sense the problem.

Based on the problem, we know:

$f_s$  is the actual frequency of the source = a police car's siren = 440 Hz

$v$  is the speed of sound = 340 m/s



$v_s$  is the velocity of the source = police car maximum speed = 54.0 m/s

$v_o$  is the velocity of the observer = Porsche's maximum speed = 80.0 m/s

Find: what is the observed frequency = frequency will the Porsche's driver hear?

Does the Doppler effect occur? How about the frequency of sound heard by an observer? Can you explain it?

*(Teacher guide and model explicitly the strategies in front of students on the whiteboard)*

Teacher: "To comprehend the problem deeply and find the solution, because of no picture presented, we first sketch (figure out) the free body-diagram.

Based on the diagrams or figures you have made, what is the signs of  $v_o$  and ? Why do you give the signs for the formula?"

*(Intended students' answers)*

Student-5: " $v_o$  is – (negative), observer keeps away from the source  $v_s$  is – (negative), source approaches the observer is the speed of sound 340 m/s

$f_s$  is the actual frequency of the source = 440 Hz

Teacher: "O.K, Can you find solution; the frequency that the Porsche's driver hears?"

*(Teacher verbalize thinking strategies find the solution)*

$$f_o = \frac{(v \pm v_o)}{(v \pm v_s)} f_s$$

$$f_o = \frac{(340 - 80)}{(340 - 54)} 440 \text{ Hz}$$

$$f_o = 399.9 \text{ Hz}$$

$$f_o = 400 \text{ Hz}$$

So, the frequency the Porsche's driver will hear is 400 Hz

*(Again, teacher promotes thinking process by guiding the students to check the solution)*

Teacher: "Is it a correct solution? Is it intelligible? Explain your answer!"

Student 6:" I think that the solution is correct and quite intelligible. Because, as we know that speed of Porsche (80.0 m/s) is larger than the police's car (54.0 m/s). We can say that Porsche keeps away from the police's car.

The frequency of sound heard by an observer is smaller than the frequency of source: Mathematically, if value of a proper fraction is less than 1, than the numerator is smaller than the denominator. It is accordance with the signs of the computation."

Teacher: “Very good, next time you should practice to solve more problems by using these strategies to enhance your skills.”

(Then, teacher provide students another individual problem to complete. And, the next phase of learning syntaxes).

## CONCLUSION AND SUGGESTION

Verbal protocols technique has been shown to provide unique and valuable insight into the cognitive processes that individuals used in a variety of settings. Nevertheless, this technique will never replace any traditional research design i.e a pencil-paper test, an experimental design, a survey method. It is most effective when it is used in conjunction with data from a variety of methods. Further research is required to reach the conclusions about its actual effectiveness over traditional research techniques. Teachers who are interested in using verbal protocols technique in the classroom consisting of a big amount of students should revise and modify this technique. The six learning syntaxes of the a revised-verbal protocols model offered in this paper are quite rational to implement.

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