EduLite *Journal of English Education, Literature, and Culture*
Vol. 9, No. 2, August 2024, pp 73-87

E-ISSN: 2528-4479, P-ISSN: 2477-5304
http://jurnal.unissula.ac.id/index.php/edulite
DOI: http://dx.doi.org/10.30659/e.9.2.73-87

Think-Aloud Protocols in process studies revisited: Suggestions for veridicality

Sugirin, Jamilah, Joko Priyana, Indah Permatasari*
English Education Department, Faculty of Languages, Arts, and Culture, Universitas Negeri Yogyakarta, Indonesia

***Corresponding Author**
Email: indahpermatasari@uny.ac.id

Received:	Revised:	Accepted:	Published:
13 March 2024	29 June 2024	26 August 2024	31 August 2024

Abstract

Thinking-Aloud or Think-Aloud Protocols have been used to study thinking processes in varied fields such as psychology, business, sports, industry, and education. Recently, studies have tried to see its application in teaching in both offline and online modes. Despite its success, as demonstrated by these studies, controversies concerning the believability of thinking aloud and the process of reactivity have been raised. However, no explicit solution has been provided. In response to the issues, this paper critically reviewed examples of think-aloud protocols using Bowles's guide to TAP (2008). The results show that (1) problems of the reactivity process stem from the nature of the tasks given, and (2) to minimize the problems of reactivity, the TAP data collection procedure should move from the least to the most intervention of the researcher.

Keywords: *Think-aloud; think-aloud protocols; thinking processes*

INTRODUCTION

Since the initiation by its author, Wundt (1888), Thinking-Aloud (TA) or Think-Aloud Protocols (TAP) or Think-Aloud Method has recorded success in its application to reveal thought processes, i.e., the strategies used by subjects or the participants of the studies in performing the given task(s) (Goldstein, 2011). Interest in thought processes came out of the awareness that in order to help learners learn, it is not enough to understand the result or product of their thinking, but attending to their thinking or thought processes is paramount. By understanding their thinking processes, a teacher will be able to identify their way of thinking to come to the product of thinking, i.e., comprehension.

One way to examine thought processes in a thought process study is to ask the participants to verbalize what they have in mind related to a task performance. A task performance can be solving a mathematical problem, reading a text for comprehension, answering a multiple-choice test, etc. The thought verbalization is (audio- or video-recorded to allow for replay for later analysis purposes. To facilitate the analysis, the recorded verbalization is usually transcribed. It is this transcribed verbalization or transcription that is called verbal protocols. As Bowles (2015) claims, not all verbal reports are the

same; significant differences are present among them depending on the conditions in which the reports are obtained. Based on the time reference, verbal protocols can be *retrospective* or *introspective* (Guss, 2018). When reporting or expressing the thought processes takes place sometime, e.g., a few minutes after the task performance, the transcripts are called retrospective verbal protocols. When reporting or expressing the thought processes takes place while performing the task, the report transcripts are called introspective verbal protocols. It is these introspective verbal protocols or concurrent verbal protocols that are known as think-aloud protocols (TAP).

From her review of the literature, Charters (2010) has found that think-aloud research methods are supported by a strong theoretical foundation and give a valid data source about the participants' thought processes, particularly within language-oriented activities. However, due to possible variations in research purposes and, hence, data collection procedures, there can be differences in issues confronted.

In her second language acquisition (SLA) study, Bowles (2008) revived Ericsson and Simon's (1993) view, which made a distinction between reports that demand participants to verbalize merely their thought processes and those that ask participants to verbalize other measures, such as describing and justifying. Verbalizing thought processes is only called non-metalinguistic, and those asking for verbalizing descriptions and justifications are referred to as metalinguistics. Since the studies by Bowles (2015) contain verbal and non-verbal tasks, so the broader terms non-metacognitive and metacognitive are employed to provide the related description.

As Gass and Mackey (2000) and Bowles (2015) note, Ericsson and Simon (1993) have reminded us of the possible challenges to the validity of retrospective and introspective verbal reports. In regard to retrospective reports, the possible challenge to veridicality results from the condition that participants verbalize their thoughts sometime after task completion. This means there is a potential that retrospective verbal reports are not accurate reflections of the thinking processes of the participants as they cannot fully remember what they had in mind sometime after the task was completed. As a consequence, the reports may be incomplete and inaccurate. It is, therefore, important to seek answers to the following questions: (1) what are the actual problems existing in the think-aloud protocols that may threaten veridicality? Furthermore, (2) on the basis of understanding the actual problems and relevant theories and research results, what solution can be suggested to eradicate the threat of the existing problems?

METHOD

In an attempt to resolve the emerging problems, some examples of studies implementing the think-aloud method are presented and reviewed, practices that are successful for the context of the related studies but that may generate problems related to the issues above in other studies are identified. Based on related theories and results of other studies, solutions to the problems (the concerns on validity and reactivity) are suggested by the presentation of data collection procedures that can minimize the process of reactivity as the source

E-ISSN: 2528-4479, P-ISSN: 2477-5304
http://jurnal.unissula.ac.id/index.php/edulite
DOI: http://dx.doi.org/10.30659/e.9.2.73-87

of inaccuracy. To confirm the accuracy of the review, the draft was cross-checked by another member of the research team familiar with think-aloud protocol studies.

RESULTS AND DISCUSSION

Findings based on critical reviews on studies employing the Think-Aloud Protocols

1. The actual problems existing in the think-aloud protocols that may threaten veridicality stem from varied purposes and tasks given complementary to the think-aloud task. These can be seen in the following studies.

Think-Aloud method as a tool for teaching online reading

Carioli and Peru (2016) use the Think-Aloud method as a tool for teaching online reading comprehension. The study aims to develop a Teacher's Guide to support late primary and secondary school teachers in preparing lessons for online reading by using a metacognitive technique of thinking aloud. The Think-Aloud Teacher's Guide has been developed based on the online reading model of instruction (Coiro, 2011). The model is intended to help the teachers focus on two prioritized skills: (a) how to locate the accurate response to a fixed question (Access) and (b) how to make a comparison of online information that expresses distinct ideas on a topic (Analysis). The processes of Access and Analysis are both contained in the three basic phases of the Think-Aloud: model demonstration, a practice run with guidance, reflecting on the experience, and cooperation in accomplishing the goal. This reflection enables teachers to point out that the same topic may mean different things as it depends on the writer's idea. Such a reflection can promote thinking critically as it makes a reader pause and contemplate, to find rationales, to alter attention focus constructing new hypotheses, and avoid automatic acceptance of what the media has written.

The think-aloud instructional model of reading comprehension has been developed with the considerations on the conditions of the language and contents of the prospective users (late primary and secondary school teachers). Portions of the models of thinking-aloud on Access and Analysis are provided in the following tables (Table 1 and Table 2).

Table 1. A model of think-aloud on Access

A Model Think-Aloud: Access	
1) The teacher chooses a topic and transforms it into a question	
Example: The Colosseum is one of the most famous Italian monuments. In this place, in the ancient times were held shows that we could condemn today. The cinema, the popular illustrations of the nineteenth-century novels and painting have imprinted in our minds the image of Christians abandoned to the ferocity of the beasts.	
"Is it true that the Colosseum was a place of martyrdom of Christians?"	
TA	Example of think-aloud statement (Teacher) *First I read the question carefully to figure out what I will have to look for (to clarify the purpose of online reading). The question begins with "Is it true that ..." Therefore, I think I will have to look for information to confirm or refute this assertion.*
2) The teacher makes a predictive inference on where he/she might find the information sought	
TA	*I am looking for historical information, thus it is likely that I will find it in an encyclopedia or in a website dedicated to this subject.*

While Access looks at the location of the accurate response, Analysis sets focus on comparing the online information that expresses distinct ideas on a certain topic. Modes of comparing may be synchronic (e.g. on topical themes, such as news stories, scientific topics, historical facts, etc.) or diachronic (e.g. on a historical fact reconsidered later with the coming of new findings, etc.). Hence, teachers model how to select the most significant portion of the online information, identify the writer's purpose, and summarize the writer's perspective. A model of think-aloud on Analysis is provided below.

Table 2: A model of think-aloud on Analysis

A Model Think-Aloud: **Analysis**	
1) The teacher chooses a topic and transforms it into a question	
Example: The horse race of medieval origin we know as Palio is primarily associated with the city of Siena where it is held twice a year. While, on one hand, the Palio is an attraction for thousands of visitors, on the other it inspires severe criticism.	
"In what ways do different authors describe the Palio of Siena?"	
2) The teacher reads the question and plans the path of online reading.	
TA	Example of TA (Teacher) *First I should read the question to figure out the goal of online reading. The question asks to analyze the way in which various authors describe the Palio of Siena. So I will have to compare different opinions from different websites. I am going to spend a bit of time to learn more about the authors in order to understand the reasons for their opinions.*

With the model demonstrated by the teacher, practice runs guided by the teacher, the students were actually building a system of regulating their reading techniques. This confirms the conclusion of several studies reviewed earlier that the think-aloud method is effective to empower students to nurture their self-

EduLite Journal of English Education, Literature, and Culture
Vol. 9, No. 2, August 2024, pp 73-87
E-ISSN: 2528-4479, P-ISSN: 2477-5304
http://jurnal.unissula.ac.id/index.php/edulite
DOI: http://dx.doi.org/10.30659/e.9.2.73-87

regulated reading (Azevedo, 2005; Coiro & Dobler, 2007; Afflerbach & Cho 2010; Coiro, 2011).

Think-aloud method in a quasi-experimental study

In a later study, Sönmez and Sulak (2018) attempted to examine whether employing the thinking-aloud method in teaching reading had any significant effect on the comprehension skills of 26 fourth graders of a primary school. This was a quasi-experimental study involving an experimental group (14 students) and a control group (12 students) of equal reading comprehension ability using a pretest and posttest design. After the pretest, the experimental group was taught using the think-aloud method, while the control group was taught using exactly the same reading materials without any use of think-aloud activities.

For the experimental group, the teacher demonstrated a model of thinking aloud while reading a text with five strategies intended to be taught in the reading class session (making predictions, creating mental images while reading, linking new information with previous knowledge, monitoring comprehension, and making corrections). An example of the teacher's think-aloud modeling of thought processes in reading comprehension is provided below.

Teacher's think aloud-modeling (Davey in Sönmez and Sulak, 2018)

1. Make predictions. (Show how to develop hypotheses.) "From the title, I predict that this section will tell how fishermen used to catch whales."
   "In this next part, I think we'll find out why the men flew into the hurricane."
   "I think this is a description of a computer game."
2. Describe the picture you're forming in your head from the information. (Show how to develop images during reading.)
   "I have a picture of this scene in my mind. The car is on a dark, probably narrow, road; there are no other cars around."
3. Share an analogy. (Show how to link prior knowledge with new information in the text.)
   "This is like a time we drove to Boston and had a flat tire. We were worried and we had to walk three miles for help."
4. Verbalize a confusing point. (Show how you monitor ongoing comprehension.)
   "This just doesn't make sense."
   "This is different from what I had expected."
5. Demonstrate fix-up strategies. (Show how you correct lagging comprehension.)
   "I'd better reread."
   "Maybe I'll read ahead to see if it gets clearer."
   "I'd better change my picture of the story."

With the example of thinking-aloud demonstrated by the teacher the students were expected to have a good understanding of the five steps exemplified and were required to have a practice run under the teacher's guidance. Upon understanding the five-step procedure the students were required to read each text used in the study following the learned steps of the think-aloud model.

The results of the study showed that (1) the students of the experimental group who used the thinking-aloud strategy in their reading class scored

significantly differently in the reading comprehension post-test compared with those in the control group who did not employ the think-aloud model, and (2) the gain scores of the experimental group students who were taught by the thinking-aloud strategy are significantly higher than those of the students in the control group. It can be concluded from this study that the think-aloud strategy can be implemented as an effective teaching method in developing the reading comprehension skills of primary school fourth graders.

Think-aloud method in sports study

Samson et al. (2017) have noted research studies providing proof of the validity of think-aloud verbal reports in the assessment of concurrent thinking processes while performing tasks in sports within a short period of time. However, there is a paucity of studies employing the think-aloud protocol recommended by Ericsson and Simon (1980, 1984, 1993) in task performance within a longer period of time, such as distance or endurance running. Besides, references on endurance running mostly rely on retrospective verbal protocols; hence, the think-aloud protocol promises a method of data collection which captures the process of thinking runners employ while running. The purpose of the study was to describe the runners' thinking processes while taking part in a long endurance run. The researchers expected that valid data on the process of thinking while performing a long endurance run might give the information needed by sports consultants to prepare runners mentally and emotionally.

Ten participants of the study were four females and 6 males, 29–52 years old, who had at least participated in one endurance run (26.2 miles), preparing for either a half-endurance run or longer. Verbalizing the runner's thought processes while running on the treadmill was used as think-aloud practice run. In the real-time long run, upon completion of the warm-up, participants were provided with the digital recording equipment (Olympus DS-4000), a microphone clipped to their t-shirt, and Spibelt around the waist to secure the recording equipment while running. The participants were free to decide the distance and the speed of their run. Upon the completion of the run, participants were to give a short account or impression on their run and their level of satisfaction with their performance. Line-by-line inductive content analysis model as used by Nicholls and Polman's (2008) was employed to analysis the think-aloud transcripts.

The findings show that qualitative analysis of transcripts produced three main themes describing runners' thinking processes while running: (a) Pace and Distance, (b) Pain and Discomfort, and (c) Environment. From the description of the three themes, there are four aspects referring to cognitive processes (Monitoring pace and distance, maintaining pace, alternating pace, and coping with pain), while the rest refers to affection (feeling of injuries, niggles, pains & discomfort, impression on geography & weather, and admiration for the environment, wildlife, traffic and others).

This study is an example of a study relying mostly on the think-aloud protocol analysis. The only task other than thinking-aloud was providing a brief summary on their run and the level of satisfaction with their performed run.

E-ISSN: 2528-4479, P-ISSN: 2477-5304
http://jurnal.unissula.ac.id/index.php/edulite
DOI: http://dx.doi.org/10.30659/e.9.2.73-87

Anyhow, this study has been successful in achieving the goal, revealing the runners' thought processes while participating in the long-distance run.

Think-aloud method in an online study

Due to Covid-19 constraints for face-to-face communication, a sudden jump in communication technology has triggered newly-conceived ideas about the use of online research method which will benefit researchers as well as research participants. Research data collection using questionnaires through email messages or interviews by telephone have been common within the last two decades, but the use think-aloud method online has been rarely conducted.

Considering the success stories of using think-aloud method in both research and teaching, and being constrained by inability to reach research participants for face-to-face communication, Alhejaili et al. (2022) conducted an online pilot study to answer two research questions: (1) How think-aloud (TA) study could be conducted online, and (2) What would the benefits and challenges of remote data collection be.

To achieve the objectives the study used five (5) nursing students for pilot and fourteen (14) nursing students to participate in actual online TA. The information in regard to TA and what was expected of the students were explained to the participants. Using a session over Internet Protocol (SoIP) apps by Microsoft Teams (MTs) the researcher presented nine clinical statements to be responded as online TA tasks. For each statement a PowerPoint slide popped up to expose the statement with direction to respond by formulating a clinical decision to a patient's need. Then, the participant sought to get relevant proof-based information. Following this task were semi-structured interviews to identify strengths and weaknesses of the procedures of the online think-aloud activities.

The overall results show that online think-aloud has, to some degree, facilitated data collecting processes commonly used in conventional qualitative studies. However, there can be some highly in-depth research areas needing face-to-face encounter that cannot be replaced by an online think-aloud session. Inability to see the real environment at the participant's site may raise a question whether there are conditions that may affect the participant's thinking-aloud. In other words, the doubt about veridicality stands.

From the data presented above it is clear that the root of the controversies related to the effects of reactivity in the think-aloud protocols are due to different purposes of implementing the think-protocols. Variations also happen in other tasks complementing the think-aloud task such as retellings, a reading comprehension test, and an in-depth interview.

2. Based on understanding the actual problems, relevant theories and research results, what solution can be suggested eradicate the threat of the existing problems?

In response to the second question, particularly when data collection involves methods other than thinking-aloud task, the sequence of data gathering must move from the least to the most possible intervention of the

researcher or other conditions. For example, in efforts to reveal the comprehension strategies of nine under-graduate students of an English education study program in Yogyakarta, the team of researchers in the current study employed think-aloud tasks complemented with retellings, multiple choice test, and semi-structured interview based on the MC test results. To anticipate the effects of reactivity, the data collection procedure must follow the sequence of the activities from the least to the most possible intervention to the participants' thought processes. The stages consist of:

a. Think-aloud task: After being given explanation that the participant is expected to tell everything going on in the mind while trying to comprehend the text given, having clear understanding of what to do, the participant starts a practice run using a text which will not be used in the real think-aloud task. When the practice run is considered appropriate, the actual thinking-aloud begins. The only intervention taking place is the raising of the "KEEP TALKING" sign to remind to talk when the participant keeps silent within more than ten seconds. The instruction is given in English but when needs arise important points can be repeated in Indonesian. The participant may report in English or Indonesian or in both, whichever makes reporting comfortable.

b. Text retelling: Upon the completion of the think-aloud task, the participant is provided with an opportunity to reread the text for approximately five minutes to look over the text material in order to reassemble a complete, coherent version from the fragmentation that might have resulted from the continual interruption in the reading task. Then the researcher asks the participant to retell as completely as possible everything he/she remembers about the text. However, referring to text is not allowed during the retelling. If the researcher feels that the retelling is not clear or too brief, the researcher may ask for clarification. Retelling is not merely meant for checking text comprehension, but it can also reflect the participant's creativity in text reconstruction that may involve adding or changing information for the purpose of making it complete (Katamadze, Tavadze, Diasamidze, I. (2022). Retelling can also strengthen text recall and, hence, consolidate comprehension (Wilson, Gambrell, & Pfeiffer, 2015).

c. Multiple-choice test: the objective of the test is to check the degree of text comprehension. After thinking-aloud and retellings (getting more intervention) the participants are expected to have a comprehensive and deeper understanding of the text or texts at hand. The MC test also functions to check the participants' strategy dynamics in text understanding through questions which may facilitate or confuse their already achieved comprehension.

d. Semi-structured interview: the stage at which the participants get the most intervention. In the interview, the researcher tries to dig deep the participants' line of thoughts leading to understanding or misunderstanding of the text, understanding the questions, ways of coming to the selected option in answer to an MC test question. This way, the researcher can reveal the overall understanding of the text, the questions, the options provided, and the reason

E-ISSN: 2528-4479, P-ISSN: 2477-5304
http://jurnal.unissula.ac.id/index.php/edulite
DOI: http://dx.doi.org/10.30659/e.9.2.73-87

for selecting an option so that the comprehension strategies used by the participants can be clearly revealed from varied angles.

Discussion

For think-aloud reports the challenge to validity may not be related to accuracy, as verbalizing and performing a task are concurrent. The problem may stem from the question whether verbalization at the same time with task completion can be reactive. It is questionable whether performing an additional task does not alter cognitive processes and can provide a true thought reflection (Ellis, 2001; Jourdenais, 2001).

In line with the doubt, Ellis (2001) and Jourdenais (2001) put forward, Fan et al. (2020) have reported that think-aloud participants can have less comfort when they are asked to verbalize thinking processes when a task is complicated. When the task is lengthy, verbalizing thought processes can cause a fatigue. Another threat a researcher faces is creating a favorable atmosphere and a neutral condition that encourages participants to perform an honest thought verbalization. This is a challenge to respond as participants possibly express something nice and are reluctant to criticize, which may prevent the researcher from identifying problems that may be in existence (Fan et al. (2020).

In response to the concern about the effects of reactivity, Bowles (2015) has collected reviews of some studies from 1993 to 2001. These studies are taken from varied fields involving different types of participants and tasks. In spite of these clearly heterogeneous backgrounds, the studies reviewed indicate a highly similar pattern of findings, very close to those hypothesized by Ericsson and Simon (1993). Of the ten studies, nine (90%) indicated that verbalizing was non-reactive for accuracy and five (50%) showed that verbalizing was reactive for latency (time spent for a problem solution). Merely one study reported verbalizing to be reactive for both accuracy and latency. It can be concluded from these studies that verbalizing the thought processes while performing a task was non-reactive for accuracy and showed that verbalizing was reactive for latency (longer time spent for a problem solution).

In reviewing later studies, Bowles (2015) looked at the studies from different angles, attending to varied subjects for the think-aloud task, varied complexities of the think-aloud task, and different languages used in reporting, and even highlighting researchers coming from different schools of thought. For example, researchers representing a cognitivist or information processing angle are inclined to look at thinking-aloud method as tracing the thinking processes participants focus on during a task performance (Swain, 2006). Therefore, thinking-aloud is viewed as an entry point into thinking processes and can be employed as a means of collecting data. Investigators representing the view of sociocultural theory uphold a basically distinct perspective of thinking-aloud, following Vygotsky's (1987) work. In Vygotsky's perspective, thoughts are not only conveyed in words; thoughts exist through the thoughts themselves. For these investigators, verbalizing may lead to learning and, therefore, verbalization can change the process of thinking.

Referring to Swain's (2006) study, a review Bowles (2015) conducted, think-aloud study using experimental and control groups found that the think-

aloud group participants scored higher in text comprehension than those in the silent (non-think-aloud) group. The result showed that the think-aloud process was reactive to accuracy in a positive way, i.e., the think-aloud group learned through the think-aloud process. This result suggests that verbalizing thinking processes has facilitated form learning, at least as measured by receptive tests (Bowles, 2015). In other words, think-aloud protocols can be implemented as a means of instruction, such as for improving learners' performance in receptive skills (listening and reading). This conclusion is in line with Preece et al. (2015)'s claim that think-aloud protocols are often taught in Usability Experience (UX) courses to train professionals. This was later confirmed by Rahmi's study (2020) on her evaluation of the usability of webshare features.

The varied implementations of the think-aloud reports in this article show that despite some controversies arising, this way of reporting the thought processes has high acceptance and beneficial initially for research but later on for teaching as well. Most of the studies reviewed have shown the accuracy of the think-aloud reports in revealing what is actually going on in the participants' thought processes (Charters, 2010; Samson, et al., 2017; Goldstein, 2011). The reviews on the implementation of think-aloud reports collected by Bowles (2015) show that 90% of the studies implementing think-aloud protocols have no problem with veridicality. This means that think-aloud reports cause no effect of reactivity and accurately represent what the participants have in mind while performing the think-aloud tasks. The effects of reactivity happen on latency or solution time, i.e., the participants indeed spend longer time on problem solution or task performance.

As Gass and Mackey (2000) and Bowles (2015) note, Ericsson and Simon (1993) have reminded the possible challenges not only to the validity of retrospective but also introspective verbal reports. Ellis (2001) and Jourdenais (2001) note that the problem may stem from the question whether verbalization at the same time with task completion can be reactive. It is questionable whether performing an additional task does not alter cognitive processes and can provide a true thought reflection. Fan, Shi, and Truong (2020) have reported that think-aloud participants will have less comfort when they are asked to verbalize thinking processes if the task is complicated, and when the task is lengthy, verbalizing thought processes can cause a fatigue.

Carioli and Peru (2016) used Think-Aloud method as a tool for teaching online reading comprehension, while Sönmez and Sulak (2018) attempted to examine whether employing the thinking-aloud method in teaching reading had any significant effect on the comprehension skills. Both studies provided think-aloud models in different ways. Carioli and Peru (2016) started modeling by providing a short passage, followed by asking a question based on the passage, and demonstrating a thinking-aloud in response to the question based on the short passage provided. In the case of Sönmez and Sulak's (2018) study, because the reading class session was intended to teach five reading comprehension strategies (making prediction, creating mental images while reading, linking new information with previous knowledge, monitoring comprehension, and making correction), the model provided explicitly demonstrated expressions used to make prediction, create mental images, link

E-ISSN: 2528-4479, P-ISSN: 2477-5304
http://jurnal.unissula.ac.id/index.php/edulite
DOI: http://dx.doi.org/10.30659/e.9.2.73-87

new information with what is already known, monitor comprehension, and make correction.

At the stage of modeling, students are provided with strategies for reading online. They listen to the teacher's demonstrating strategy verbalization followed by guided practice in which the teacher encourages the students to practice the assigned task under independent control. Thus, students play a more active role and are engaged in an increasingly autonomous way in the application of strategies previously acquired, working alone or in small groups. This enables the students to develop their self-regulated learning (Azevedo 2005; Coiro & Dobler 2007; Afflerbach & Cho 2010; Coiro 2011) which is highly required for independent reading strategy development (Coiro & Dobler 2007; Coiro 2011; Ebner & Ehri, 2013).

For the purpose of teaching, the models may suit the purpose except that it may limit the space for creativity. The students may stick to the models and take time to deviate from them in order to read naturally. With proper guidance, however, teacher's modeling as demonstrated in Sönmez and Sulak's (2018) study has met the teaching objectives. For research purposes, however, providing such explicit models may generate an effect of reactivity, an effect that causes an inaccurate representation of what the research participants have in mind (Gass & Mackey, 2000; Ellis, 2001; Jourdenais, 2001; Bowles, 2015). Intensive and lengthy modeling may lead research participants to merely parrot the thinking-aloud model in their task performance.

In the field of sports study, Samson, et al. (2017) targeted to reveal three main themes of runners' thinking processes while running: Pace and Distance, Pain and Discomfort, and Environment. Out of these three themes, four aspects refer to cognitive processes (Monitoring pace and distance, Maintaining pace, Alternating pace, and Coping with pain), while the rest (feeling of injuries, niggles, discomfort, impression on the sites, weather condition, and admiration for the environment) refer to affection.

Viewed from Bowles's (2015) review findings, the study by Samson et al. (2017) confirm Ericsson and Simon's (1993) predictions that verbalizing thoughts per se, without the requirement to verbalize justifications, should provide a fairly pure reflection of thought processes. In other words, verbalizing justification, admiring environment, expressing satisfaction, all tend to cause reactivity and the thinking-aloud reports may not fully represent what is actually going on in the runner's mind.

Newell and Simon (cited in Guss, 2018) developed think-aloud protocols or the think-aloud method originally to study problem-solving, i.e. cognitive problem solving strategies – strategies in solving mathematical problem. Solving problems such as those of runners in endurance running (Samson et al., 2017) can be said to be easier to imagine. For instance, hearing foot steps behind, one can imagine what a runner would do: change pace, avoid other runners to take over, or remain at the current pace to prepare for the next sprinting, etc. But studying reading such as reading comprehension, reading comprehension strategies, and online reading studies involve more abstract thinking and creation of more mental images. In other words, the latter seems to be more complicated than the former.

AUTHOR STATEMENTS

Author 1 provided the source, collected and analyzed the data, and wrote the findings and discussions together with Author 2. Author 3 proofread the article drafts several times before submission. Author 4 checked the manuscript with the journal template and submitted the first draft, and resubmitted the second draft after being revised by Author 1.

ACKNOWLEDGEMENTS

We would like to thank the article's reviewers for their constructive feedback. Our thanks also go to the Rector of Universitas Negeri Yogyakarta for the opportunity and funding to conduct the study and the undergraduate students of the English Language Education for the contribution through their participation in the series of TAP data collection in the study.

CONCLUSION

Think-Aloud Protocols (TAP) has recorded success in its application to reveal the strategies used by subjects, the participants of the studies in performing the given task(s). However, a number of studies reviewed have shown that due to different purposes, tasks, and the presence of complimentary methods, there have been controversies in regard to veridicality. In response to the issues, particularly when data collection involves methods other than thinking-aloud, the sequence of data gathering must move from the least to the most possible intervention of the researcher or other intervening conditions. Despite the success stories of the implementation of think-aloud protocols in varied fields of studies, care must be taken to assure the congruity of the purposes, the think-aloud task, and other tasks complementary to the think-aloud task. The data collection procedure should consider the correct sequencing of the tasks to anticipate the potential effects of reactivity.

REFERENCES

Afflerbach, P. A., & Cho, B. Y. (2010). Determining and describing reading strategies: Internet and traditional forms of reading." In Wolfgang Schneider (Ed.), *Metacognition, Strategy Use, and Instruction* (pp. 201–255). Guilford Press.

Alhejaili, A., Wharrad, H. & Windle, R. (2022). A pilot study conducting online think aloud qualitative method during social distancing: Benefits and challenges.*Healthcare 2022, 10*, 1700. https://doi.org/10.3390/healthcare10091700

Azevedo, R. (2005). Using hypermedia as a metacognitive tool for enhancing student learning? The role of self-regulated learning. *Educational Psychologist, 40(4),* 199-209.

Bowles, M. A. (2008). Task type and reactivity of verbal reports in SLA: A first look at an L2 task other than reading. *Studies in Second Language Acquisition*, 30 (4).

E-ISSN: 2528-4479, P-ISSN: 2477-5304
http://jurnal.unissula.ac.id/index.php/edulite
DOI: http://dx.doi.org/10.30659/e.9.2.73-87

Carioli, S. & Peru, A. (2016). The Think-Aloud approach: A promising tool for online reading comprehension. *Journal of Media Literacy Education 8(1)*, 49-61

Charters, E. (2010). The use of think-aloud methods in qualitative research: An introduction to think-aloud methods. *Brock Education Journal 12(2)*, 68-82.

Coiro, J. (2011). Talking about reading as thinking: Modeling the hidden complexities of online reading comprehension. *Theory Into Practice, 50(2),* 107–115.

Coiro, J., and Dobler, E. 2007. Exploring the online reading comprehension strategies used by sixth grade skilled readers to search for and locate information on the internet. *Reading Research Quarterly, 42(2)*, 214-257.

Davey, B. (1983). Think aloud-modeling of the cognitive processes of reading comprehension. *Journal of Reading, 27(1),* 44-47, 1983.

Ebner, R.J., & Ehri, L.C. (2013). Vocabulary learning on the internet: Using a structured think-aloud procedure. *Journal of Adolescent & Adult Literacy*, *56*(6), 480-489.

Ellis, R. (2001). Introduction: Investigating form-focused instruction. *Language Learning, 51*(Suppl. 1), 1– 46.

Ericsson, K. A., & Simon, H. A. (1993). *Protocol analysis: Verbal reports as data*. MIT Press.

Fan, M., Shi, S., Truong, K. N. (2020). Practices and challenges of using think-aloud protocols in industry: an international survey. *Journal of Usability Studies Vol. 15, No. 2*, 1 Feb 2020, pp. 85-102.

Goldstein, E.B. (2011). *Cognitive psychology: Connecting mind, research, and everyday experience. Third edition*. Wadsworth.

Gov. UK. (2021). Guidance. *Think aloud study: qualitative studies. How to use a think aloud study to evaluate your digital health product*. Gov. UK.

Guss, C.D. (2018). What is going through your mind? Thinking aloud as a method in cross-cultural psychology. *Sec. Cultural Psychology Volume 9* – 2018. https://doi.org/10.3389/fpsyg.2018.01292

Hasibuan, S., Puspita, H., & Arasuli, A. (2022). An analysis of reading strategies used by the fourth semester students of English Education Study Program in Muhammadiyah University. *Journal of English Education and Teaching, 6(1),* 73–88. https://doi.org/10.33369/jeet.6.1.73-88

Hesse-Biber, S. (2015). Introduction: Navigating a turbulent research landscape: Working the boundaries, tensions, diversity, and contradictions of multimethod and mixed methods inquiry. In Sharlene Hesse-Biber & R. Burke Johnson (Eds.), *The Oxford handbook of multimethod and mixed methods research inquiry* (pp.xxxiii-liii). Oxford University Press.

Jourdenais, R. (2001). Cognition, instruction, and protocol analysis. In P. Robinson (Ed.), *Cognition and second language instruction.* Cambridge University Press.

Katamadze, N., Tavadze, L., & Diasamidze, I. (2022). The role of checking retelling in teaching English. *IJAEDU- International E-Journal of Advances in Education, Vol. VIII, Issue 24*, December 2022.

Liu, P., & Li, L. (2015). An overview of metacognitive awareness and L2 reading strategies. *The Routledge International Handbook of Research on Teaching Thinking.* R. Wegerif, L. Li, & J. C. Kaufman (Eds.), pp. 290–303, Routledge.

Malek, H. B., Berna, F., and D'Argembeau, A. (2017). Reconstructing the times of past and future personal events. *Memory 25,* 1402–1411. https://doi.org/10.1080/09658211.2017.1310251

Maslawati, M., Hamdan, N. A., Shaharuddin, S., & Khalid, F. (2015). Hypermedia reading strategies of TESL undergraduate students in Malaysia. *Turkish Online Journal of Educational Technology*, *Special Issue 1 for IETC 2015*, pp. 301-310.

Morrow, L. (1988). Retelling stories as a diagnostic tool. In reexamining reading diagnosis: new trends and procedures, eds S. M. Glazer, L. W. Searfoss & M. Lance, *International Reading Association*, Newark, DE, pp. 128-49.

Nicholls, A. R., & Polman, R. J. (2008). Think aloud: Acute stress and coping strategies during golf performances. *Anxiety, Stress & Coping, 21*, 283–294.

OECD. (2021). 21st-Century readers: Developing literacy skills in a digital world. *https://www.oecd.org/publications/21st-century-readers-a83d84cb-en.htm*

Ortlieb, E. & Norris, M. (2012). Using the think-aloud strategy to bolster reading comprehension of science concepts. *Current Issues in Education*, 15(1), 2012.

Parise, A., and Güss, C. D. (2006). *TAP: A thinking-aloud analysis program.* University of North Florida.

Pratama, M. I. F., Az-Zahra, H. M., & Setiawan, N. Y. Evaluasi usability menggunakan metode think aloud dan heuristic evaluation pada aplikasi mobile Padiciti," *J. Pengemb. Teknol. Inf. dan Ilmu Komput., vol. 3, no. 9*, hlm. 8390–8399, 2019.

Preece, J., Rogers, Y., & Sharp, H. (2015). *Interaction design: Beyond human-computer interaction.* Wiley.

Rahmi, L. (2020). Evaluasi usability fitur webshare pada aplikasi Share It menggunakan metode Thinking-Aloud. *Ultima InfoSys-Jurnal Sistem Informasi, vol. 10, no. 2*, hlm. 111–118, 2020. https://doi.org/10.31937/si.v10i2.1199.

Rehman, A.U., Khan, K., Almas, A., Mohamad, M., & Ismail, N.H. (2020). Teachers' teaching reading strategies at public elementary schools in Haripur District. *Creative Education, 11*(4), April 2020.

E-ISSN: 2528-4479, P-ISSN: 2477-5304
http://jurnal.unissula.ac.id/index.php/edulite
DOI: http://dx.doi.org/10.30659/e.9.2.73-87

Reinhart, A. (2022), Think-aloud interviews: A tool for exploring student statistical reasoning. *Journal of Statistics and Data Science Education, 30*(2), 100-113 https://doi.org/11310.1080/26939169.2022.2063209

Samson, A., Simpson, D., Kamphoff, C., and Langlier, A. (2017). Think aloud: an examination of distance runners' thought processes. *Int. J. Sport Exerc. Psychol. 15,* 176–189. https://doi.org/1612197X.2015.1069877

Sebele-Mpofu, F. Y. (2020). Saturation controversy in qualitative research: Complexities and underlying assumptions. A literature review, *Cogent Social Sciences, 6:1*, 1838706, http://doi.org/10.1080/23311886.2020.1838706

Sönmez, Y. & Sulak, S. E. (2018). The effect of the thinking-aloud strategy on the reading comprehension skills of 4th grade primary school students. *Universal Journal of Educational Research* 6(1), 168-172.

Sugirin. (2002). Think-aloud protocol analysis, a path to process studies: what, why and how. *The 50th TEFLIN International Conference: Asian Odyssey 2002: Explorations in TEFL, 29-31 Oct. 2002.*

Sugirin. (2023). *A study on reading strategies of undergraduate students of English Education*. Research report, Universitas Negeri Yogyakarta.

Sulistiya, M., et al. (2021). Penerapan metode think aloud untuk evaluasi usability pada website Dinas Pendidikan dan Kebudayaan Kota. *Jurnal Telematika, Vol 16*, No 1 (2021).

Sya'roni, M. I., Kharisma, A. P., & Amalia, F. (2018). Perbandingan hasil metode evaluasi usability antara heuristic evaluation dengan think aloud pada kasus web Filkom Apps untuk mahasiswa. *J. Pengemb. Teknol. Inf. dan Ilmu Komputer, vol. 2,* no. 2, hlm. 674–678, 2018.

Wang, Y. H. (2016). Reading strategy use and comprehension performance of more successful and less successful readers: a think-aloud study. *Educ. Sci. 16,* 1789–1813. https://doi.org/10.12738/estp.2016.5.0116

Wilson, R. M., Gambrell, L., & Pfeiffer, W. R. (2015). The effects of retelling upon reading comprehension and recall of text information. *The Journal of Educational Research 78(4),* 216-220. https://doi.org/10.1080/00220671.1985.10885604

Wundt, W. (1888). Selbstbeobachtung und innere wahrnehmung [Self-observation and inner perception]. *Philos. Stud. 1,* 615–617.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.