Chen, W. et al. (Eds.) (2017). Proceedings of the 25th International Conference on Computers in Education.
New Zealand: Asia-Pacific Society for Computers in Education

A Tool for Data Acquisition of Thinking Processes through Writing

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Abstract: Unclear thinking is a great obstruction in outward communication, especially writing. In this work, we present a tool to support in becoming aware of one′s own thinking via writing. The tool is designed to slow down a writing task and spend more time in realising thinking by clarifying contents. Users are asked to express concepts of each clause and connection of clause to another. By letting learners to slow down and think more clearly about what to write, we expect that their thought will become clearer and thus will produce a better output. On usage, the tool records actions made in the tool and changes in revision. These details can assist a supervisor to realise the root of confusing thought and comment accordingly and pertinently. From an experiment, a written output made via the tool gained a higher quality comparing to an output written in traditional environment for each individual sample. We also found that the top rated written outputs via the tool were made after being clear on content declared with the tool requirement. This can be implied that awareness about thinking can help in improving their writing result. Last, samples revealed that using the tool can help them practising in becoming aware of thinking.

Keywords: Metacognition, writing skill, skill learning, awareness of though, collaborative tool

1. Introduction

Thinking is the most crucial process that human automatically and implicitly does in all activities. It is a core of our actions such as writing, creating, planning, etc. A thought produced from careful thinking processes such as a logical statement, riskless plan and design is considered to be better than a rush idea without thinking. However, thinking is automatic cognitive process and requires a practice and experience to get improved. One of common methods to improve thinking is to realise one′s own thinking within thinking processes. Thinking about thinking (metacognition) [Flavell, 1979] is one of higher-order thinking skills that can be used to clarify cloudy thoughts in thinking processes. Writing is a solid evident of one′s thinking [Brown, 1987] [Wong, 2005] since a written output such as an essay is a traceable evident that can reflect person′s thinking via a choice of words, style, and logical connection of sentences. A written piece lacking readability from poor discourse (unconnected statement or without direction in convincing) can be implied as confusion in thinking processes from its writer. This issue can often be seen from novice writers who do not excel in thinking or planning their thoughts while written outputs of veteran writers rarely display with this issue. Hence, the more the thinking is clear and connected; the better of the content can be expected.

In this paper, we aim to assist in clarifying one′s own thinking in cognitive processes. We hypothesise that the thinking can be much clearer if a person becomes more aware of own thinking and clearly realise in content of a though. We thus design a tool to help on declaration on a content produced while writing to help increasing awareness of thinking. Hence, users can practice to become aware of thinking and its content through writing. Similarly to our idea in concerning in thinking processes, there is a tool called Swan - Scientific Writing AssistaNt [Kinnunen et al., 2012] aiming to assist a user in writing focussing on fluidity of concepts. Its specification is to guide with the content, not the grammar

or spelling. The tool provided a predefined list of necessary contents for each section as a predefined structure of contents. This tool also includes a function for evaluation to detect fluidity of contents. Fluidity represents how well a text flows from sentence to sentence in which helps to connect content in unison. Though the tool promotes importance in connection of sentences, it does not practically aim on practicing in a cognitive process of becoming aware of thinking for self-clarifying in content for writing.

2. Design of the tool

The aim of this work is for students who lack awareness of their though/plan while writing. The main focus is to scope their content based on the thought/plan. Thus, the system is deigned as a supporting system to clarify their thought and collaborate with writing expert as a coach to guide through their expression. The system consists of three main functions as 1. Obtaining writing input from a learner, 2. Recording learner′s behaviour in writing and tracking their progress, and 3. Providing a reaction or a comment from a coach team. A layered architecture of the proposed system is sketched in Figure 1.

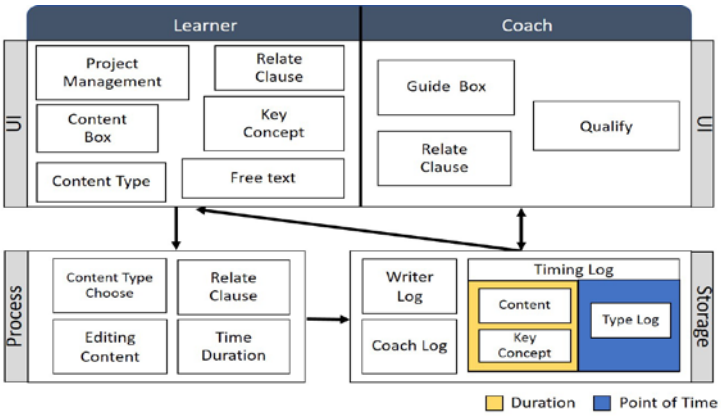

Figure 1. A layered architecture of the proposed training ground for metacognitive writing skill.

The tool is separated into three parts. The first part is a user-interface designed to get a writing input along with its information and to communicate among learners and coaches. Secondly, The process is for detecting learners′ behaviours and managing writing inputs. Last, the storage is designed to record the writing and comments with traceable records, and the records can be generated into a log for reference and recall. The tool is designed to handle a writing piece as project based; thus, a learner can focus into their writing task. However, the system allows users to access contents in their authorised projects as reference and example.

2.1 Design of User-interface

Since there are couple of roles involved in the usage and different in their task, we separately design each user-interface (UI) for each role. User roles in this work include learner, coach and admin. The first and foremost role in this work is learner. Learners are to use the system as a ground to provide their writing and its information. The key of comprehensibility is to realise the thought while writing. We therefore design to get an input in smallest context based on action (verb) as a clause. At first, learners have to select an overview of a content regarding to standard sections of publication such as *introduction*, *methodology* and *experiment*. The input of learners consists of information mentioned in Table 1.

Table 1: Learners′ input and its details

Input type	Description	Possible value/ Example
Content	Writing in a clause level	Free text in a clause level: *you can see many of write with no metacognitive skill (an example from actual writing input that may not be grammatically and rationally correct)

Type	Type of intention selected from a predefined list (one choice)	• Fact
		  o General Fact
		  o Specific Fact
		  o Detail Fact
		  ▪ Providing Definition
		  ▪ Example
		• Proposed Statement
		• Opinion
		• Evidence
		• Condition
		• Reason

Key Concept	Summary of concept	Short text to represent the core concept of the clause.
Related	Indication of relation to another clause	Numeral index pointing out a relation of a current clause to an existing clause – only need for some types such as example, reason and condition
Free text Comment	Text to remark or communicate to coach	Additional free text to convey note to coach or as a remark

2.2 Behaviour Detection and Log Generation

To monitor writing for metacognition, writing behaviour is a key to determine learners' thinking process. We design the tool to record not only writing content but also an interaction of learners in giving a writing input. For a learner side, the detection of interaction includes a timestamp of actions and an order of given input types. These data can inform how long the content have been created, user s' thought before, after, in between writing and an overview of behaviour. By combining these data to a quality of writing content judged by coach, we can understand learners' psychological process in writing and infer a type of behaviours. For example, if a learner had written the clause for 15 seconds but spent time in selecting a content type for more than 30 seconds after finishing writing and the content is obviously confusing, it can be roughly inferred as 'the learner did not think before writing and was not aware of what to express'. Therefore, the tool is designed to record details given in Table 2 as behaviour data.

Table 2: Data of interactions from learners in using tools

Detection type	Interacting with Input type	Recoding information	Description
Timestamp	Typing in Writing panel	• Start time • End time	Calculation for a duration of writing content
	Clicking Dropdown of content type	• Start time • End time	Calculation for a duration of selecting a content type from the list
	Typing in Key concept panel	• End time	Recording time a key concept is provided
Order of Action	Writing panel, Dropdown of content type and Key concept panel	• Order of action	Recording order of actions based on time and duration

The captured behaviour data are to record for each of content given via the tool. They are recorded along with the given clause for both new clause and edition. The content and behaviour are recorded in a database, and they will generate to two types of a log detail, i.e. a content log and a full log. A content log is a history of only writing for each clause. A full log includes both content and behaviour details. On a coach side, it is possible for a writing project to have two or more coaches. All given comments and decision of passing status from all involved coaches are recorded with a timestamp for managing consequence into a comment log stored in a database. For a learner, they are able to view details in both a content log to track a change in their writing and a comment log of the current project. Learners are also allowed to access a content log of his/her past project(s). For coach side, involved coaches are authorised to access on a full log to monitor writing result and behaviour to determine learner's writing thinking process. Moreover, a coach can view a comment log to observe comments from other coaches.

3. Evaluation and Discussion

For evaluating usefulness of the proposed tool, an experiment in usage was set up. The main focus is to compare how learners perform in writing within and without an environment that they are forced to slow down their thinking about what to write via the tool. Moreover, we also want to study how effective in writing by pointing out the misconception in thinking via a strict environment to explicitly mention their idea/thought (from the tool) can bring.

The participants were ten volunteer Thai graduate student and two experienced researchers. The students had completed their thesis topic examination. The chosen experienced researchers had published over 15 academic publications and exceled in guiding for paper writing. Learners were asked to write two contents: 1) an abstract of their thesis topic via the tool and 2) a short summary of their related work via a normal word processor (without the tool). The writing pieces must be in proper English in technical language and was limited to 20 clauses in total. All learner samples past English standard qualification from their respective university and have an average of TOEFL score in PBT about 450 points. In this experiment, revision of each clause was limited to 3 times at most since we did not intend to see how fast learners can improve, but how the tool affects learners. The samples were randomly split into two groups. The first group is to use the tool for writing abstract first and write a short summary later in one-week interval while the second group did in vice versa.

Coaches were instructed to give only guidance within a scope of idea/thought. We observed the usage with two observers and recorded their actions through a log generated by the tool. Learners were allowed to access to previously made thesis reports for referencing. There was no time limit for completing the task. For coaches, each clause in every revision was rated for two aspects as follows. 1) Matching of content and given information (key concept and content type) and 2) Properly connecting idea/thought in logical relation leading to the objective.

The scale was from 1 (worst) to 5 (best). For the first aspect from the writing without the tool, a key concept and content type were asked later after finishing the experiment for rating. Figure 2 shows average rates for each learner from the first aspect and second aspect, respectively. The bars of each learner represent an average rate of all the initial clauses (before revision from obtained comments) in comparison to a writing piece made via the tool and via common word processor.

From the results in Table 2 and 3, we found that the rates of the two writing piece made via the tool were higher. Based on samples' ability, we can see that learner id#4 and id#9 were above average since their rates were the tops, and their writing pieces were over moderate in both setup environments. However, they eventually gained higher rates for the piece they made on our tool, especially for the aspect of properly connecting though to the objective. We also noticed that low proficient learners such as id#3 and id#10 gained a significantly increasing rate for the aspect of matching content to their thought. In terms of statistics of writing result and process, the notable details are summarised into Table 3. We found that learners spent more time when using the tool to generate a clause. With the intention for a writer to slow down process to collect their thought, we found the usage results compromised with the aim. By combining results from Table 3 and Rated results, we noticed that a time spent in thinking about content type and key concept individually affected the rated results except for learner#4. After interviewing, we realised that the id#4 was different than other and can be recognised

as an outlier who had experienced in writing several publications beforehand while other learners are fairly new to the task.

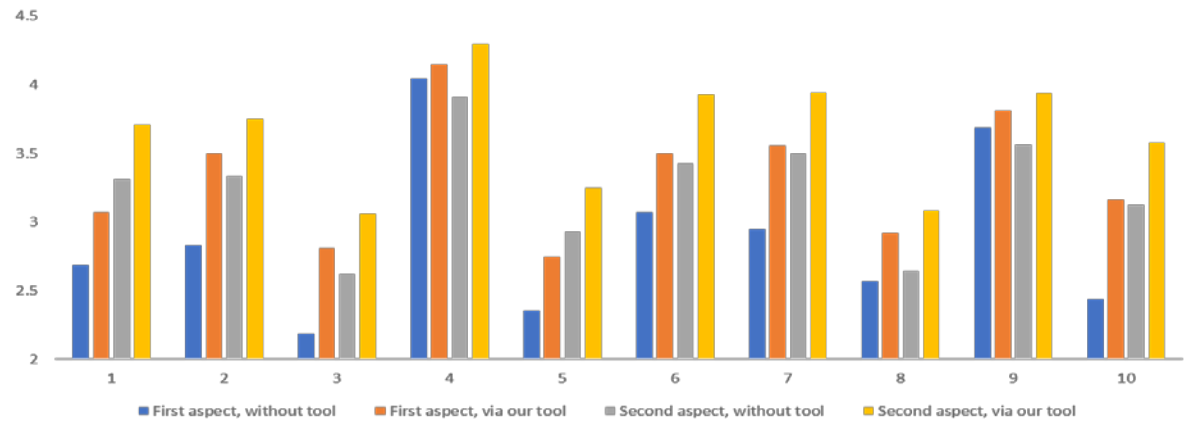

Figure 2. A comparison of rated results regarding from coaches.

Table 3: Statistical details of writing results

		Learner id									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Abstract (a piece with tool)	Clause amount	7	8	8	10	6	7	9	6	8	6
	Total time (s)	620	688	491	489	593	611	583	771	654	466
	Average time per clause	88.57	86.00	61.38	48.90	98.83	87.29	64.78	128.50	81.75	77.67
	Median time per clause	68	69.5	54.5	44.5	95.5	88	60	101.5	77.5	72.5
Short summary of related work (a piece without tool)	Clause amount	8	9	8	11	7	7	10	7	8	8
	Total time spent (s)	572	480	354	498	521	424	512	388	410	373
	Average time per clause	71.50	53.33	44.25	45.27	74.43	60.57	51.20	55.43	51.25	46.63
	Median time per clause	50.5	34	39.5	44	74	61	50.5	52	51.5	44.5

To analyse further, we then looked into behaviour log generated by the tool. We surprisingly learned that 93% of clauses having selected for *content type* and *key concept* before writing content obtained an average rate from two coaches as 4 and higher. Furthermore, learners with an average low rated result (id#3, id#5 and id#10) decided to fill writing content before providing content information. Eventually, they averagely spent about 52, 66, 64% of time respectively for writing and the rest of time for selecting *content type* and providing *key concept*. These patterns indicated that clear thinking about what to express apparently affects a quality of writing. In addition, a declaration of idea/thought can help to scope one thought and should be done before writing.

In the view of revision and improvement, we examined clauses that obtained a moderate rate and lower (under 3.0 rated) for analysis. The total clauses were 56 clauses from the tool and 73 clauses from not using the tool. All revisions made via the tool were found to be received all same rate or

improved rate. On the other hand, 26 from 219 of revisions from base 73 clauses from not using the tool (3 revisions limited) were worsen in rate while the rest was either the same or slightly improved. By asking coaches for a reason behind the worsen rate, they stated that the revision did not align with the comments and revised to another topic illogical and unrelated to surrounding context. Despite being guided by the same set of coaches, the decrease in rate implied that writing for novices without the strict environment to explicitly declare their thought can lead to confusion in thought. Moreover, unclear thought of a writer may bias and cloud a reception of incoming comments leading to interpret comments into another topic.

From interview after use, volunteered coaches mentioned that the tool impressively provided an insight detail of writing behaviour. The *full log* occasionally helped them to understand the learners thought and the cause of confusing expression in text. They gave an example that most times, when learners having trouble by spending a lot of time in selecting *content type,* the writing result would eventually become confusing and unclear. They also suggested that it could be more helpful if the tool can detect actions in depth such as there are whole-deletion for rewriting from a start or how long and how many times a learner does a consequence of 'typing-pausing-deleting'. In the view of learners, we severally received a feedback that the tool helped them in collecting thought to prevent swaying in thinking. Seven learners mentioned that using the tool was a good practicing for becoming aware of thinking and collecting their thought since asking to provide content details prevented them to carelessly write without thinking. Six of learners also mentioned that they learned about importance of thinking/planning about goal.

4. Conclusion

This paper proposes a tool to assist in writing process for academic publication. The tool is designed as a strict environment for learners to become aware of their thought in writing process. To improve metacognitive skill in writing, explicit declaration of thought is asked to accompany each written clause. The tool promotes a collaborative interaction between learners and coaches to improve writing piece together. In usage, a learner as a main author provides a thought of what to express while a coach as a supervisor can instruct the flow of content and comment on content by considering thought and output. Moreover, the tool can generate a log including track change and behaviour in writing process. The behaviour can be used to hint about writer's state of mind in writing. From an experiment, results implied that an environment of the tool helped to clear writers' thought and improve their writing in terms of what to convey and logical connection. Additionally, behaviour log can help to track changes made for revision and study for writing actions to understand the root of misconception from a writer.

To improve the tool, we plan to include more detection on users' actions on the tool such as counting on amount of deleting action and pause time while typing. These details can help a supervisor to learn more on a thinking process of learners; therefore, they can be suggested accordingly for sustaining improvement. Moreover, we plan to generate a flow of thought from the entire section to represent a connecting of thoughts from a writer. These connected thoughts can help to define another level of writing quality and can also be used to demonstrate an exemplar of good writing in logical connection among section from existing publication.

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