Automated ICT Literacy Skill Assessment Using RateSkill System

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Abstract: ***Assessing school children' ICT literacy skill remains a problem. Children are different from adults in the way they use technology. For that reason, commonly used evaluation methods such as questionnaires and observations are not able to potray the competency level acquired by these children. This paper explores the possibility of using suitable tracing tool for capturing computing activities of school children. In this pilot study, nine school children who are e-book users have been selected. The log file produced by the tracing tool was then used to identify the patterns of ICT competency level among these e-book users. The results show the benefit of using the RateSkill as a computerized and automated ICT literacy skill assessment tool.***

Keywords: ICT literacy, Skill assessment, Computational tool, Computer competency.

1. Introduction

Nowadays, being an information and computer technology (ICT) literate or ICT competent is necessary. People with sufficient ICT literacy skills should possess both the knowledge and ability to use computers and the associated technology efficiently. In educational sector, Terengganu state government is investing considerably in promoting ICT literacy among pupils by supplying electronic books(e-book). It is a significant commitment towards achieving a fully developed nation through the Vision 2020 plan. Therefore, it is crucial for the pupils to be equipped withnecessary ICT skills in response to the workforce requirement.

In 2009, Terengganu has made its own history when 25000 units of e-books were distributed among Year 5 pupils in various schools. Being the first state in the Southeast Asian region and third in the world after Portugal and Venezuela, Terengganu continues its support in the effort to bridge the technology gap, bring equal opportunity for rural students to excel and give computer technology exposure to the pupil [12]. The pupils participated in this e-book project are expected to be far more computer savvy, well-rounded and very comfortable with technology [5]. However, the pupils in school vary in theircompetencies and capabilities in learning

to use computer technologies. With this diversity in mind, transforming them into a computer savvy group is not an overnight task.

In addition, from time to time, we need to assess their ICT literacy level or performance, so that once the pupils possess sufficient skills, they can confidently use the e-books or any computers as a learning tool. The importance of assessing or measuring user performance is pointed out by [16] who state that evaluating usability is useless if user performance is not measured. In[18] also stress the importance of evaluation as a fundamental process that is required in order to benchmark and improve current systems. Therefore, an evaluation in the form of a performance indicator of these pupils' ICT literacy skills should be made available to indicate their current ICT literacy level.

When carrying out evaluations of computer technology with children, it is worthy to note that children use technology differentlyfrom adults. For example, to evaluate entertaining and fun elements in children experience, commonly used evaluation methods are think aloud protocols, questionnaires and observations [1, 15].

In think out aloud protocols, users describe their experience by articulating what they are thinking, feeling, and experiencing in the session as they conduct tasks. Unfortunately, children did not frequently speak aloud, even when they had some problems and they always appeared eager to solve the problem on their own [4]. Sometimes, children often hesitate, struggle or become frustrated. Despite providing guidance and encouraging students to express what they think, the approach seldom works.

Using questionnaires has its own drawback since expecting the children to provide all answers is not a practical option. Children may become frustrated and have difficulty in understanding the questions being asked. Furthermore, for the purpose of replication, the questionnaires need to be re-evaluated and specified prior to dissemination [7]. Observation, on the other hand, influences the reaction given by the children. Children might behave differently because they notice that they are being watched and evaluated [15]. Consequently, the tasks performance may be affected.

Clearly, the previously mentioned evaluation methods are not able to portray the competency acquired by the pupils. The best measuring tool for ICT literacy skills among pupils remains a problem.Yet, the ICT literacy evaluation remains to be a challenging issue [9]. As mentioned by [10], there are two distinct components that should be evaluated when looking at ICT literacy i.e. awareness and competence. Awareness requires a person to have an understanding of how computers impact their day-to-day life as well as the larger society. Competence expects a person to be able to exhibit a hands-on expertise with a software application. Therefore, a performance-based evaluation is vital and neededwhich it can allow students to demonstrate their competencies in the given tasks.

Researchers in [8] insisted that the best technology evaluation method should incorporate multiple data sources, assess over time and focus on measurable skills. The evaluation method chosen must be able to capture the action in real-time that directly link to actual performance of the skill being measured. Therefore, in this paper, we propose a computational tool that can capture the pupils' interactions that could lead us to understand the skills of the pupil better. The captured interactions will be able to offer useful information about the paths or actions taken in order to complete the given tasks. Therefore, the proposed tool is an appropriate method to evaluate pupils' ICT literacy skills following an advice from the usability guru i.e. Jacob Nielson [13]. Nielson insisted that when working with users, we have to watch what users actually do, not what they say they do. Using the proposed tool, it enables to capture what users actually do when performing the given tasks.

This paper is organized as follows: Section II describes the RateSkill system. Section III presents the experimental setup. The analysis and discussion are described in Section IV, and conclusion in Section V.

2. The RateSkill System

The RateSkill system utilizes the characteristics of log files. The log files keep details of the user's activities into structured computer records. This means that log files are directly available for computational analysis which allows handling of a huge amount of data [2]. Using log file analysis for measuring computer skills has a number of advantages. First, recording is done without bias and second, it is technically easy. Most importantly, log file allows automatic computational analysis [11].

The implementation of RateSkill system are carried out in two main phases i.e. selection of an event monitoring and tracing tool; and the RateSkill prototype development. For the event monitoring and tracing tool, the researchers focused only on the freely and publicly available tools or freeware from the Web as shown in Table 1. Although commercial tools are also available, due to cost and time constraints,these commercial tools have been put aside for now. A total of nineteen freeware event monitoring and tracing tools were obtained. All the freeware, during the implementation, provide the log files that contain information about what action the user does and the navigational activities.

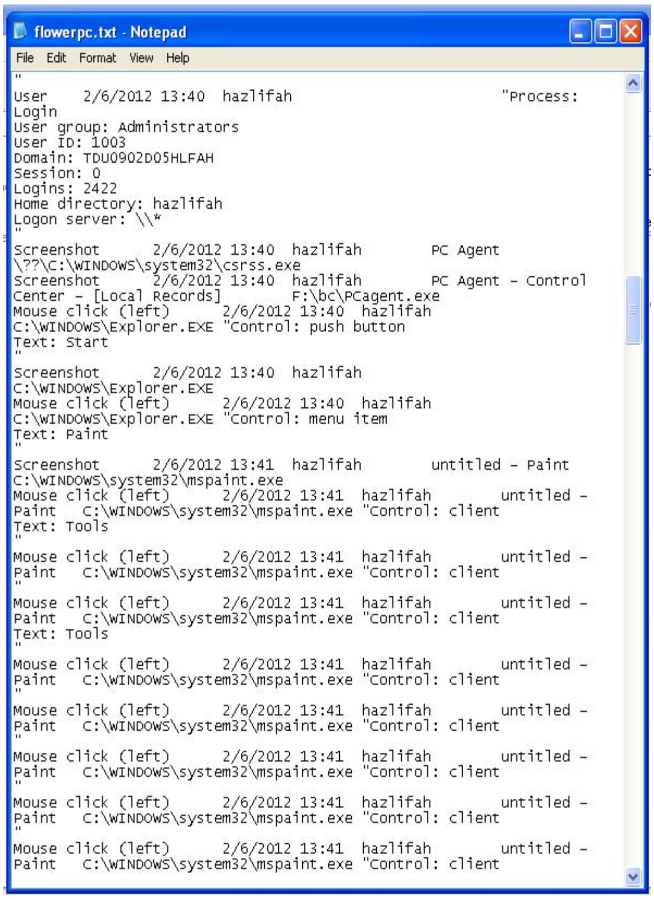
Table 1: The event monitoring and capturing tools and their sources

Name of Tool	Source
1. MyLastSearch	http://www.nirsoft.net/utils/mylastsearch.zip
2. IEHistoryView	http://download.cnet.com/IEHistoryView/3000-2381_4-10448770.html
3. AuditViewer	http://www.mandiant.com/products/free_software/mandiant_audit_viewer/download
4. IEcacheView	http://www.nirsoft.net/utils/iecacheview.zip
5. SysConc	http://minerva.ling.mq.edu.au/units/tools/SysConcWin.zip
6. SysFan	http://minerva.ling.mq.edu.au/units/tools/SysFan_for_Windows.zip
7. Mouse Clicker	http://www.softpedia.com/get/Tweak/System-Tweak/Mouse-Clicker.shtml
8. Mouse Machine	http://www.softpedia.com/get/System/System-Miscellaneous/Mouse-Machine.shtml
9. Mouse off road	http://mouse-off-road.en.softonic.com/
10. Mouse Odometer	http://download.cnet.com/Mouse-Odometer/3000-2072_4-10031901.html
11. Moustron	http://www.freewarepark.com/mousotron.html
12. My Mouse Meter	http://my-mouse-meter.en.softonic.com/
13. Usability logger	http://download.fyxm.net/download-now-Usability-Activity-Log-Office-tools-Other-Office-Tools-45917.html
14. MiniKeyLog	http://www.blue-series.com/en/mini-key-log-en/mini-key-log-download-en.html
15. PCAgent	http://www.blue-series.com/en/pc-agent-en/pc-agent-download-en.html
16. CamStudio	http://camstudio.en.softonic.com/
17. Wink	http://www.debugmode.com/wink/download.htm
18. Free Key Logger	http://download.cnet.com/Free-Keylogger/3000-2162_4-10419683.html
19. Actual Spy	http://www.actualspy.com/

For ease of evaluation, the researchers first identified the required scope that corresponds to the event monitoring and tracing tool. If a tool was found to possess the specified scope then a (✓) symbol would be given to it. Otherwise, a (✗) symbol would be given. The process is shown in the following screen capture in **Error! Reference source not found.**. In this phase, the researchers concluded that the PCAgent tool complied to all the scopes. Thus, the researches decided to use PCAgent for monitoring and tracing user's task events. An example of a text file using PCAgent tool is shown in **Error! Reference source not found.**.

	Date	Time	Windows Time	Program Path	Screen Shot	Send Report	Keystrokes	Action (closed @ run)	Mouse Click
Actual Spy	✓	✓	✓	✓	✓	✓	✓	✓	✗
Free Key Logger	✗	✓	✓	✗	✗	✗	✓	✗	✗
Mini Key Logger	✓	✓	✓	✓	✓	✗	✓	✓	✓
PC Agent	✓	✓	✓	✓	✓	✓	✓	✓	✓

Figure 1: Evaluation of publicly available event monitoring and tracing tools



```
flowerpc.txt - Notepad
File Edit Format View Help
"
User    2/6/2012 13:40  hazlifah                            "Process:
Login
User group: Administrators
User ID: 1003
Domain: TDU0902D05HLFAH
Session: 0
Logins: 2422
Home directory: hazlifah
Logon server: \\*
"
Screenshot      2/6/2012 13:40  hazlifah        PC Agent
\??\C:\WINDOWS\system32\csrss.exe
Screenshot      2/6/2012 13:40  hazlifah        PC Agent - Control
Center - [Local Records]        F:\bc\PCagent.exe
Mouse click (left)      2/6/2012 13:40  hazlifah
C:\WINDOWS\Explorer.EXE "Control: push button
Text: Start
"
Screenshot      2/6/2012 13:40  hazlifah
C:\WINDOWS\Explorer.EXE
Mouse click (left)      2/6/2012 13:40  hazlifah
C:\WINDOWS\Explorer.EXE "Control: menu item
Text: Paint
"
Screenshot      2/6/2012 13:41  hazlifah        untitled - Paint
C:\WINDOWS\system32\mspaint.exe
Mouse click (left)      2/6/2012 13:41  hazlifah        untitled -
Paint   C:\WINDOWS\system32\mspaint.exe "Control: client
Text: Tools
"
Mouse click (left)      2/6/2012 13:41  hazlifah        untitled -
Paint   C:\WINDOWS\system32\mspaint.exe "Control: client
"
Mouse click (left)      2/6/2012 13:41  hazlifah        untitled -
Paint   C:\WINDOWS\system32\mspaint.exe "Control: client
Text: Tools
"
Mouse click (left)      2/6/2012 13:41  hazlifah        untitled -
Paint   C:\WINDOWS\system32\mspaint.exe "Control: client
"
Mouse click (left)      2/6/2012 13:41  hazlifah        untitled -
Paint   C:\WINDOWS\system32\mspaint.exe "Control: client
"
Mouse click (left)      2/6/2012 13:41  hazlifah        untitled -
Paint   C:\WINDOWS\system32\mspaint.exe "Control: client
"
Mouse click (left)      2/6/2012 13:41  hazlifah        untitled -
Paint   C:\WINDOWS\system32\mspaint.exe "Control: client
"
Mouse click (left)      2/6/2012 13:41  hazlifah        untitled -
Paint   C:\WINDOWS\system32\mspaint.exe "Control: client
```

Figure 2: A text file produced by PCAgent tool

Next phase involves coding and implementation of the RateSkill to identify patterns of usage and user performance level. An interactive Java environment, BlueJ version 2.5.0 and Java(TM) SE Development Kit 6 Update 21 were used to implement RateSkill. BlueJ offers an integrated development environment (IDE) for the Java programming language, which is suitable for small-scale software development. Technically, the Class BufferedReader in the Java kit reads text from the log file, then buffers the characters to provide efficient reading of characters, arrays, and lines.

3. Methodology

3.1 Sampling

In this pilot study, due to various constraints especially time, cost and accessibility, the researchers adopted a non-probability convenient sampling technique. Using this sampling technique, the researchers hand-picked nine representatives who own e-books. These students were in standard five or six from various primary schools in Dungunarea. The rrespondents received their e-books while they were in standard four. Out of this, 6 were girls and 3 were boys.

3.2 Computing Tasks

In order to compose relevant computing tasks, the researchers made references to the available documentation on the web and also on the book titled published for the purpose of providing in-depth information on the ICT literacy transformation by the Terengganu State Government [14]. In addition, the researchers also refer to the guidelines addressed by [17] on the identification of tasks. According to them, the tasks chosen should be frequent tasks that are simple and quick to carry out such as in a word processor.

Hence, the researchers found that the following applications in the e-book are relevant and therefore are suitable to test the students' ICT skills. Those applications and their associated tasks are shown in **Error! Reference source not found.**.

Table 2: Selected applications and their associated tasks

Application	*Tasks*
"Al-Quran Digital"	1. Open "Al-Quran Digital" 2. Choose "Surah Al-Baqarah" 3. Close
Dekstop Gadget Gallery	1. Open Desktop Gadget Gallery 2. Add Picture Puzzle to desktop 3. Change picture to turtle 4. Close
e-Book	1. Open e-Book 2. Choose "*Tahun 4, Tahun 5* or *Tahun 6"* 3. Choose any textbook 4. Go to page 25 by type and enter
"Ikhwan Fardhu Ain"	1. Open "*Ikhwan Fardhu Ain"* 2. Choose Topic "*Tayamum"* 3. Choose sub topic "*Syarat"* 4. Close
"Fasohah Jawi"	1. Open "*Fasohah Jawi*" 2. Choose 1 3. Choose "*mengenal huruf*" 4. Close
Mozilla Firefox	1. Open Mozilla FireFox 2. Go to google 3. Search for "*orkid*" 4. Check the search result 5. Close
"*MyKamus 1Terengganu*"	1. Open *MyKamus 1Terengganu* 2. Search the meaning of the word "*suka*"
Paint	1. Open Paint 2. Draw circle 3. Color it 4. Save 5. Close
Windows Media Player	1. Open Windows Media Player 2. Play videos and pause or stop 3. Close
Notepad	1. Open Notepad 2. Type Hello World 3. Save 4. Close

In this study, data collection is acquired via observation and the generated log file. Observation is performed using the CamStudio application that allows recording of screen and audio activity on the e-book. The CamStudio creates AVI video files which allow the researchers to refer to the visuals to further analyze the respondent's reaction on the given tasks. A sample of AVI file is shown in **Error! Reference source not found.** where the respondent was performing the tasks for Paint application.

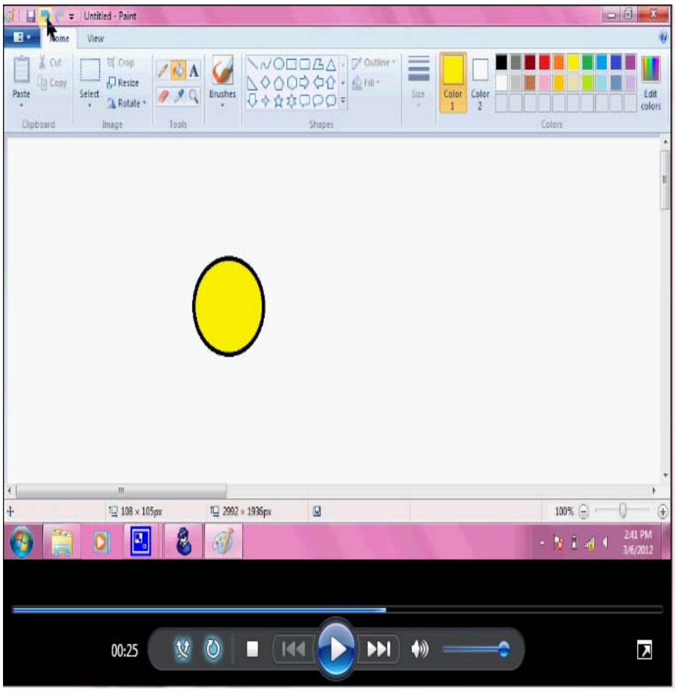


Figure 3: Sample of AVI file of a respondent

4. Analysis and Discussion

The aim of the analysis is to identify different respondent groups i.e. novices, intermediate and experts. The main assumption is that experts are able to complete all the given tasks faster than novices. **Error! Reference source not found.** shows the results for each respondent based on the amount of times (in seconds) spent to complete each task.

Table 3: Results based on the amount of times for each task

Task	1	2	3	4	5	6	7	8	9	10	
Benchmark	Expert's Response Time (in seconds)										Avg
	28	27	37	45	27	79	64	55	54	31	45
Respondents	Respondent's Response Time (in seconds)										
Student 1	159	164	376	171	78	197	131	152	0	0	143
Student 2	92	33	99	135	47	104	74	158	57	22	82
Student 3	80	67	122	91	100	74	68	107	78	125	91
Student 4	58	64	53	105	47	119	72	144	95	167	92
Student 5	89	94	89	111	56	150	120	79	143	150	108
Student 6	41	30	47	52	27	70	52	61	79	114	57
Student 7	178	119	175	63	175	78	61	87	155	69	116
Student 8	82	23	56	83	69	181	179	62	49	27	81
Student 9	99	337	184	171	82	276	99	308	128	614	230

Considering the response time or the completion time into the proposed performance metric has its own challenge. In most literature, the response time refers to the time taken for the web server to complete its request from the clients. The work on the duration metric is still limited. Even if it has been reported elsewhere, the analysis method was still not thoroughly discussed. Nevertheless, the researchers continue to search for the right analysis regarding the response time in the context of assessing ICT competency level. However, in this paper, for the purpose of convenient reporting, the researchers decided to classify the mean response time into a one-minute interval as shown in Table 4.

Table 4:A one-minute interval classification

Response Time(in seconds)	*Competency Level*
45-60	Expert (E)
61-120	Intermediate (I)
121 onwards	Beginner (B)

The benchmark for the expert level for all the tasks has been performed by one of the researchers with an average response time of 45. Thus, in the one-minute interval the researchers used the above classification criteria to indicate the respondent's competency level.

Next, **Error! Reference source not found.** shows the number of correct actions performed by each respondent in completing each given task.

Table 5: The number of correct actions to complete each task

Task	1	2	3	4	5	6	7	8	9	10	
	(Total Correct Moves)										
	4	6	4	6	3	5	4	5	4	3	Accuracy
Respondents	(Respondent's Correct Moves)										(%)
Student 1	4	6	4	6	3	5	4	5	4	3	100
Student 2	4	6	4	6	3	5	4	5	4	3	100
Student 3	4	6	4	6	2	5	3	5	4	2	93
Student 4	3	0	4	6	3	2	3	2	3	0	59
Student 5	4	0	4	6	3	2	3	2	3	0	61
Student 6	4	0	4	6	3	5	3	3	4	3	80
Student 7	3	6	4	6	3	5	2	2	4	2	84
Student 8	4	0	4	6	3	5	3	0	4	3	73
Student 9	4	6	0	6	1	5	3	1	0	0	59

The accuracy of correct moves for each user is obtained by the following equation (1)

$$\sum_{i=1}^{n} A = \frac{\sum_{j=1}^{m} p}{q} \qquad (1)$$

where n is the total number of respondents, p is the total number of correct moves for all the task, and q is the number of expected moves.

For each user, the percentage of accuracy was calculated as shown in **Error! Reference source not found.**.

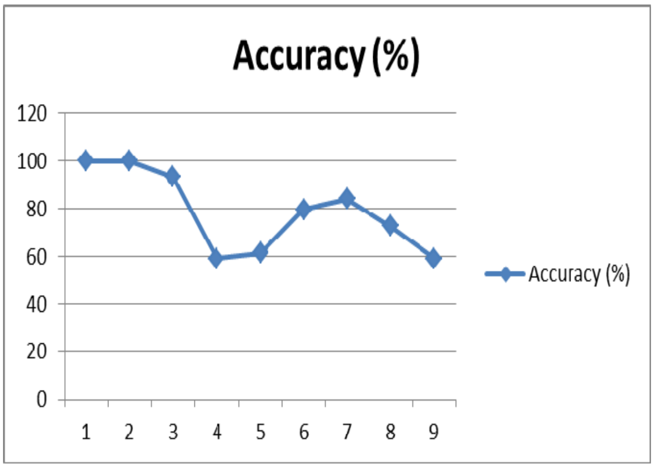


Figure 4: Percentage of accuracy for all respondents

At this stage, the researchers referred to the work of [6] who measure the expertise level using a percentage approach. It proposesa Point-Based Semi-Automatic Expertise (PBASE) classification method that classifies users' expertise level based on users' interaction in the knowledge portal and users' rating. Using two parts i.e. a z-score measure of automatic classification and a manual classification of users' rating, PBASE method takes the averages of these two parts as the users' level of expertise. Users are classified as beginner, intermediate and expert based on the accumulated points. The mapping of the z-score measures into a five-point scale is shown in Figure 4.

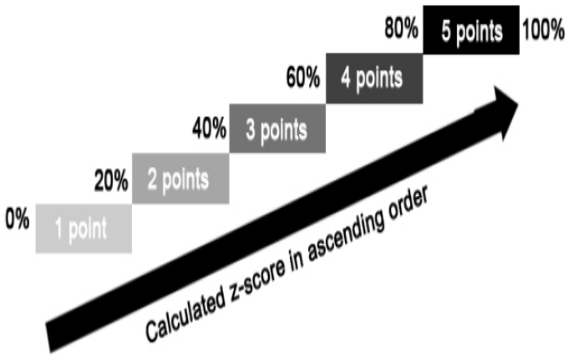


Figure 5: Z-score measures

Here, the final points determine the expertise level; expert (4 or 5 points), intermediate (2 or 3 points) and beginner (0 or 1 points). However, in this paper the classification would be slightly different as shown in Table 6.

Table 6: Percentage measure classification

Percentage Measure (%)	*Competency Level*
80-100	Expert (E)
40-79	Intermediate (I)
0-39	Beginner (B)

Looking at the above justifications, the results for all respondents are summarized in Table 7.

Table 7: Summary of results for all nine respondents

Respondents	Accuracy (%)	Level	Response Time	Level
Student 1	100	E	143	B
Student 2	100	E	82	I
Student 3	93	E	91	I
Student 4	59	I	92	I
Student 5	61	I	108	I
Student 6	80	E	57	E
Student 7	84	E	116	I
Student 8	73	I	81	I
Student 9	59	I	230	B

From Table 7, the researchers notice that there are discrepancies between the expertise level arising from the accuracy percentage and the response time. For example, for Student 1, the accuracy factor classifies him as an expert, while the response time factor classifies as a beginner. Clearly, a better mechanism and a more thorough analysis need to be carried out in order to blend these two factors together into one performance metric. Hence, in this research, the expertise level is based solely on the percentage of accuracy, omitting the response time. In this case, the response time factor will be seriously considered in our next research.

5. Conclusion

In this paper, the benefit of using the RateSkill as a computerized and automated ICT literacy skill assessment tool has been proven and discussed. Since the intention is to evaluate the ICT literacy skills of the pupil, it makes sense to assess the pupils using computer rather than typical pencil and paper test.

Becoming a fully developed nation as aspired by the Malaysian' Vision 2020 can only be made possible with a technologically literate and critically thinking workforce. Thus, being able to identify student ICT literacy skill levels would be specially helpful in planning meaningful activities and providing necessary technological support for incompetent students. This step is crucial in preparing the students to be technologically equipped prior to entering the workforce.

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