

Dynamic online homework system: An enabler of learning

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Abstract

This paper outlines the results of the implementation of an online homework system for a Business Statistics course in an undergraduate Commerce program. The findings show that as a result of this online system, students feel better prepared for tests, understand concepts better, receive timely feedback, discuss concepts with their peers, and generally have higher confidence in dealing with statistical concepts. In terms of performance, those with high marks on the online homework, also had high final grades.

Introduction

Business statistics courses have the distinction of being the least loved and most feared courses in the undergraduate commerce curriculum. These negative attitudes and perceptions influence both the grades in statistics courses and the propensity of students to use statistics in their business careers (Jordan & Stroup, 1984; Swanson, Meinert, & Swanson, 1994; Zanakis & Valenzi, 1997). This is indeed unfortunate for the ability to do statistical analysis is one of the skills most valued by business (Lane, Mansour, & Harpell, 1993; Philip & Schulz, 1994). Faculty teaching this subject is concerned about the high failure rates, high anxiety levels and general low performance of students in these courses. In response there has been much restructuring of curriculum and delivery modes in many commerce programs in order to address these performance issues (Zanakis & Valenzi, 1997). The purpose of this paper is to describe the impact of implementing an online homework system for Commerce students taking a required Business Statistics course on student attitudes, perceptions and performance in this course.

What is the dynamic homework system?

Professor Doug McKessock developed the online homework system for the first year Statistics course. It has the ability to grade over 8000 questions each week, which are used by over 700 students. The advantage of the on-line homework is that over 96% of the students are doing their homework online, getting almost immediate feedback (after the due date) and learning from their mistakes. The homework exercises are automatically graded, allowing the faculty to spend less time grading and more time teaching. The homework exercises include guided solutions and comments on their mistakes in order to help students understand and master the statistical concepts. Online homework exercises are drawn from each topic to test the students' understanding. All the questions are problem solving and the problem set is unique to each student. Providing and grading individualized homework on a regular basis and recording and reporting the results in real time using computers and the internet has successfully addressed the teaching/learning concerns. These are achieved by:

- Providing students with individualized questions that are different but similar will deal with the problem of copying answers while encouraging students to discuss methodologies.
- Providing access to individualized homework on the internet, having the computer mark and generate reports for the student with suggestions when wrong answers are encountered frees up class time and is in fact more personal.
- Intervention can be implemented or recommended as soon as deficiencies in a student's understanding of course content is detected and before they effect the learning of subsequent material or test results.
- If a homework question is done poorly by a large proportion of students, the professor can determine if adjustments to the current lecture are indicated or provide clarifications in a timely fashion.

Listed below is a simplified overview of the development process for each of twelve topics (see Figure 1):

- i. Using questions graciously provided by Professor Darryl Smith as templates created a web page using Frontpage¹ each containing several homework questions. Next the appropriate choices for dynamic content were made. Choices might include key words or values.
- ii. Excel² was then used to create alternative values and textual content for the dynamic part of the web page. Answers to the questions, tolerances and brief responses to be posted for incorrect answers were also determined/computed.
- iii. The dynamic content was then exported to Access³ database files that are easier to use on the server side. View Steps 1–3 via the Internet.
- iv. Dreamweaver⁴ was then used to add dynamic content to the question pages and modified to accept answers. Coldfusion⁵ was the server side program.
- v. The next step was to create what are usually referred to as templates that would accept the web page form inputs and ultimately evaluate them. Other templates to control the flow of user interaction and to deal with other tasks were also needed. View Steps 4–5 via the Internet.
- vi. Creating a logging in system and implementing as much security as possible was the next daunting task.
- vii. Finally, processes allowing the teacher to access the data were needed. Internet access was the logical method so I developed a set of processes to deal with teacher access and information analysis.

Ryerson University has provided us with access to two servers: river and firefly. The latter is the server for the ongoing live application; the former is our experimental site where we work out bugs and testing new applications.

When the students login the Homework System, they will see the main menu as shown in Figure 1. On the main menu the student has the options to select the following: “Choose a Topic”, “Get Questions”, “Check Marks”, “Get Report”, “logoff” or “Report a problem”. On the main menu, there is a table that displays information about the topic number, the availability of the topic, the deadline and the title of the topic.

We have also posted a feedback form which we called survey to seek the students’ feedback on the Online Homework System. The pilot survey was implemented in the winter semester, 2005 but the actual implementation of the system was in the fall semester, 2004. The feedback form can be retrieved from the “Link to Survey” button. The participation of the survey is on a voluntary basis.

We also post important messages such as revised deadline on the top banner of the main menu. For example, if we have extended the deadline for Topic 8, the student will see the announcement on the top banner of the main menu screen after logging in.

If the student chooses to do the homework, he or she has to select the topic by clicking on the “Choose a Topic” field and then press “Get Questions” button to retrieve the questions. One day after the due date, the student may check the answers to the attempted topic by selecting the “Get Report” field. On this page, it will show the answers of the topic selected.

The student can view his or her results for all the submitted topics from the “Get Report” field. To logoff from the online homework system, the student simply clicked on “logoff” button. If the student encounters problem with the system, he or she can report the problem by selecting the “Report a problem” button.

1 Frontpage is Microsoft’s web page editor. Others could be used.

2 Excel is Microsoft’s spreadsheet program

3 Access is Microsoft’s program. Eventually Oracle databases will be used.

4 Dreamweaver is Macromedia’s powerful webpage editor which is useful for dealing with both sever side dynamic content and user side dynamic content

5 Coldfusion is Macromedia’s web page server. It is similar to PHP or CGI in its functionality.

QMS102 Winter 2005
Hi *Teacher2* !
The due date for Topic 8 has been extended.

March 14, 2005 To help us improve the teaching/environment for this course would you please complete the feedback survey as soon as possible. Thank you for your input.

[Link to Survey](#)

Choose a Topic
1
2
3
4
5
6

Then
[Get Questions](#)
or
[Get Report](#)

[Logoff](#)
[Check Marks](#)
[Report a Problem](#)

Topic	Date Available	Date Due No Late Submissions can be Accepted	
1	17/01/2005	21/01/2005	Measurement Scales
2	18/01/2005	25/01/2005	Stem and Leaf
3	25/01/2005	01/02/2005	% Frequency Distribution
4	25/01/2005	10/02/2005	Cumulative Relative Frequency, Ogive
5	01/02/2005	19/02/2005	Measures, Raw and Grouped
6	08/02/2005	04/03/2005	Measures of Variability, CV
7	15/02/2005	12/03/2005	Random Variable Measures
8	01/03/2005	19/03/2005	Binomial Probability, Expected and Standard Deviation
9	08/03/2005	22/03/2005	Poisson Probability
10	15/03/2005	29/03/2005	Normal, Inverse Normal
11	22/03/2005	05/04/2005	Normal, Inverse, Distribution of Sample Means
12	29/03/2005	12/04/2005	Control Charts

dd/mm/yyyy

Figure 1: Main menu of the online homework

In Fall 2004, we instituted an online homework requirement where the students completed 12 online problem sets over the course of the semester. Once the students selected the topic, a screen of questions will appear as depicted in Figure 2. The topic 3 questions are shown in Figure 2. Most of the questions are problem solving. The on-line problem set is unique for each student. Although the questions within a topic cover the same concepts, the data used in the problems are different, in order to discourage “free riding”, but at the same time to encourage discussion and mentoring among students. Every week a new problem set covering key aspects of the current concepts under discussion is available on-line. The students must complete the homework online by the deadline. After the deadline, individual marks, solutions to each student’s unique problem, and an explanation of the solution is revealed for each student by selecting the “Get Report” option as depicted in Figure 4. There is an option for the students to have their homework graded before the deadline by selecting the option “Mark answers” (as shown in Figure 3).

http://www.firefly.ryerson.ca/qms102homework/datecheck.cfm?tnum=3 - Microsoft Internet Explorer

QMS102 Winter 2005
Topic 3 Questions for *Teacher2*

1. The following data represent the amount (in litres) of soft drink in a sample of 50 consecutive 2-liter bottles. The results, listed horizontally in the order of being filled, were:

2.113	2.114	2.099	2.126	2.065	2.057	2.052	2.044	2.036	2.038
2.031	2.029	2.025	2.029	2.023	2.020	2.015	2.014	2.013	2.014
2.012	2.012	2.012	2.010	2.005	2.003	1.999	1.996	1.997	1.992
1.994	1.986	1.984	1.981	1.973	1.975	1.971	1.969	1.966	1.967
1.963	1.957	1.950	1.948	1.947	1.941	1.941	1.938	1.893	1.864

a) Determine the frequency and percentage distributions below.
{-Leave lower rows empty if appropriate.}

Litres {Classes}	Number of Bottles	Percent
<input type="text"/> and under <input type="text"/>	<input type="text"/>	<input type="text"/> %
<input type="text"/> " " <input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/> " " <input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/> " " <input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/> " " <input type="text"/>	<input type="text"/>	<input type="text"/>

start | Microsoft Word | Netscape | Microsoft Excel | QMS102 Homewo... | http://www.firefly... | 1:36 PM Monday 3/21/2005

Figure 2: Online homework exercise for Topic 3

http://www.firefly.ryerson.ca/qms102homework/datecheck.cfm?tnum=3 - Microsoft Internet Explorer

2.012	2.012	2.012	2.010	2.005	2.003	1.999	1.996	1.997	1.992
1.994	1.986	1.984	1.981	1.973	1.975	1.971	1.969	1.966	1.967
1.963	1.957	1.952	1.953	1.947	1.941	1.941	1.938	2.193	2.164

a) Determine the frequency and percentage distributions below.
{-Leave lower rows empty if appropriate.}

Litres {Classes}	Number of Bottles	Percent
1.900 and under 1.950	4	8 %
1.950 " " 2.000	18	36
2.000 " " 2.050	19	36
2.050 " " 2.100	4	8
2.100 " " 2.150	3	6
2.150 " " 2.200	2	4
<input type="text"/> " " <input type="text"/>	<input type="text"/>	<input type="text"/>

b) What is the approximate shape of the distribution?
slightly skewed right

Continue Save Answers Only Mark Answers

start | QMS102 Ho... | http://www... | Netscape | Dynamic Ho... | Microsoft Po... | doug writeup | 11:22 PM Wednesday 9/28/2005

Figure 3: The solution for Topic 3

QMS102 Fall 2005
Topic 3 Report for Teacher2

Question	Your Answer	Correct Answer	Report
1.a.	1.900;1.950;2.000;2.050;2.100;2.150;	1.900;1.950;2.000;2.050;2.100;2.150;	Ok
	1.950;2.000;2.050;2.100;2.150;2.200;	1.950;2.000;2.050;2.100;2.150;2.200;	Ok
	4;18;19;4;3;2;	4;18;19;4;3;2;	Ok
2.b.	8;36;36;8;6;4;	08;36;38;08;06;04;	No, %: 8 36 38 8 6 4
	slightly skewed right	right	Ok

[Return to Topic Select page](#)

Figure 4: "Get Report" option

The "Get Report" option allows the student to view his/her performance on any topic he/she has completed (as shown in Figure 4). In this option, he/she can compare his/her answers with the solutions and comments. The students receive prompt feedback (within one day after the deadline) to encourage learning. Given the large class size of 680 students, the turnover of homework in one day is amazingly handled by the computer. It is also very expensive to mark homework manually. The computer has lowered the cost of grading tremendously.

QMS102 Homework - Microsoft Internet Explorer

QMS102
Fall 2005
Section: 000
Student: Teacher2, Teacher2

Topics Submitted:

Topic #	Topic Score	Homework Credit(s)	Comments
1	1	1	
2	0.928571428571	1	

No credit will be given for homework not submitted by due dates!

Exit

start | QMS102 Ho... | QMS102 Ho... | 2 Netscape | Dynamic Ho... | Microsoft Po... | doug writeup | 11:23 PM Wednesday 9/28/2005

Figure 5: "Check Marks" option

The student is able to check mark of the attempted topic by selecting the "Check Marks" field on the main menu. The student's marks for the attempted topics are displayed in Figure 5. In this report, the results are presented in the following manner; "topic number", "topic score", "homework credit" and "comments". The student receives one credit if he or she scores above 75% for each topic. Below 75%, they receive zero credit. The professor is able to monitor the student's performance weekly and give comments whenever necessary with regard to his or her performance. With weekly assessment, the professor can assessed the student's knowledge on key aspects of the current concepts. This is a good mechanism to track students with poor performance.

QMS102 **Homework Problem Report**

Lastname: Teacher2
 First Name: Teacher2
 Student Number: ●●●●●●●●
 Section:
 e-mail: * *required*
 phone:
 Incident Date: Wednesday, September 28, 2005
 Approximate Time: 11:27:24PM

Topic Specific Problem Topic #:

My answer was right but it was marked wrong.
 Question #: "1.a." or, "2.a.c. 3." etc.

Technical Problems. You should attempt to submit your solutions well before the due date. If you have problems storing or submitting you should contact your TA or Instructor during office hours.

Other. Elaborate below.

Elaborate/Other useful Details:

Figure 6: "Report a Problem" option

We also have an option for students to report problem that they may encounter using the online homework system (as shown in Figure 6). There are three choices in which the student can select from, namely: (1) my answer was right but it was marked wrongly, (2) technical problem, and (3) other.

When the student logged out from the online homework system, he or she will see a page with extra materials on statistics with web links (see Figure 5). The students are encouraged to provide and share the links with each other. The professor and software developer validate the links posted by students.

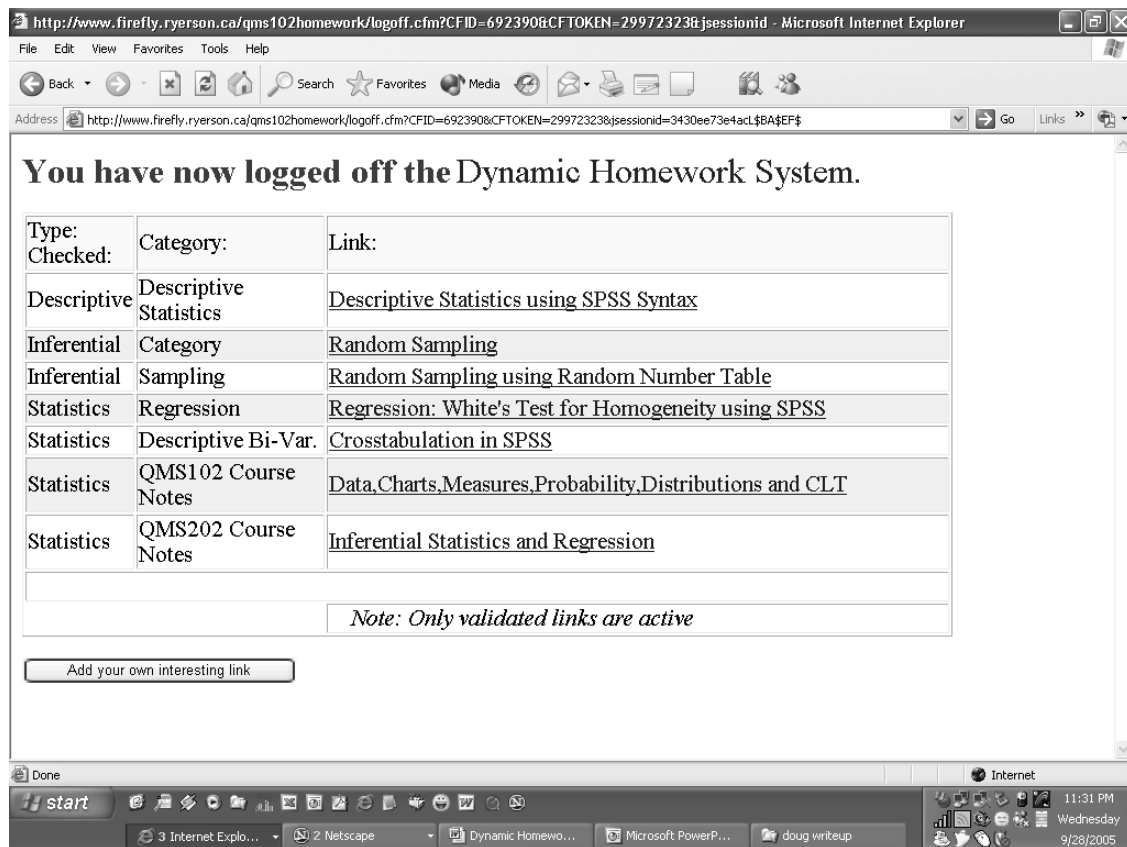


Figure 7: References and extra materials for students

Method

Using a variety of software (including Frontpage, Excel, Dreamweaver and Coldfusion) Professor Doug McKessock developed an online homework system with dynamic content and the ability to grade over 8000 individualized questions, and provide immediate feedback, not only to students about their mastery of a statistical concept, but also to the professor.

During the Fall semester of 2004 the first of two required Business Statistics courses was taught by two professors. Both used the same textbook, taught the concepts in the same order and gave the same tests and examinations to their classes. However, one professor used the online homework system (class size 617) and the other did not (class size 69). Although not an ideal experimental-control group design because of the number of other variables that were not controlled that could have influenced final grades, we did compare these two classes on their performance in the first Business Statistics course.

The same course was offered in the Winter semester of 2005, and because the final examination has not yet been taken, the focus of this part of the study is on the attitudes and perceptions of students participating in the online homework system. Out of 68 students enrolled in the course, we have 41 students participated in the survey of attitudes toward this system. The survey was not offered in Fall 2004.

Results

Impact of online homework on students' performance

Interestingly, as Table 1 shows when we compare the grade distribution for the class without online homework and the class with online homework, there is a significant difference ($p < .06$), but in the opposite direction to what was anticipated. Significantly fewer students in the class without online homework have failing grades when compared to the class with online homework.

Table 1: Comparison of grade distribution in class without online homework and class with online homework in 2004

Final grade	Online homework	
	No (n= 69)	Yes (n=617)
A	10.1%	9.4%
B	17.4%	29.3%
C	30.4%	24.3%
D	24.6%	14.4%
F	17.4%	22.5%

Because of this surprising finding, we then tested for within subjects' performance; that is we examined whether students with high marks on the online homework also had high final grades. Pearson's correlation coefficient (0.444) is significant at 0.01 level ($p < 0.000$). This suggests that the online homework certainly benefited some of the students. What is difficult to evaluate, however, is cause and effect. Do students with better final grades do better on the online homework because they are more capable students? Alternatively, does the online homework help students get better final grades and without having completed it, they would have gotten lower final grades? The next section on student perceptions and attitudes toward the online homework attempts to understand the role, if any, of online homework on grade attainment.

Students' satisfaction and perception of the online homework system

The results of the survey indicate that more than half the students (64%) are satisfied with the online homework ($\chi^2=2.951$, $p < 0.086$). The online homework system appeared to motivate peer learning and consultation in that 58% of the students report working together 2 to 3 times during the semester on the assigned homework; 27%, 4 to 5 times, 10%, 6 to 7 times; and 5%, more than 7 times. In terms of the Website itself, 51% rate the overall content above "good" and 42% rate it as average. Only 7% say it is below average. Overall 61% of the students would recommend the online homework to a friend. The results of student's perception on the usefulness of the online homework are summarized in Table 2 and Figure 6. We use a 5-point scale to measure the student's perception, that is, 5 means 'strongly agree', 4 means 'somewhat agree', 3 means 'neither agree nor disagree', 2 means 'somewhat disagree' and 1 means 'strongly disagree'. Overall, the scores (shown in the Radar Chart, see Figure 6) are all above 3 which means that most of students perceive that the online homework is useful in helping them feel better prepared for writing tests, understand concepts, receive timely feedback, generate discussion of statistics among peers, develop good study habits and promote higher confidence in dealing with the statistical concepts.

Table 2: Student's perception on the usefulness of the online homework

Features	Mean	Std. deviation
Better prepared	3.39	1.412
Helps understanding the concepts	3.53	1.358
Timely feedback	3.88	1.122
Classmates helpful	3.85	0.882
Good study habits	3.61	1.202
Confident about the statistical concepts	3.73	0.975

Much has been made in the literature about the distinctions between deep and surface learning (Entwistle, 1997; Prosser & Trigwell, 1998). The online homework system is focused on encouraging deep learning in that students have to understand the concepts in order to answer the questions. Because each question is generated individually, peer help has to be at a conceptual level, because the right answers can't simply be copied from one student to another. This online system also seems consistent with scaffolding (supporting a learner from one level to another) (Bliss & Askew, 1996) in that students are faced with incremental conceptual challenges and they have access to peers for help (Vygotsky, 1978). Another important feature of the online system that supports deep learning is immediate feedback. This feature is essential to help the learner confirm understanding of the new knowledge (Svinicki, Hagen, & Meyer, 1996). Having frequent homework assignments as part of a formative assessment strategy provides important feedback that can be used to further develop learning (Hyland, 2000).

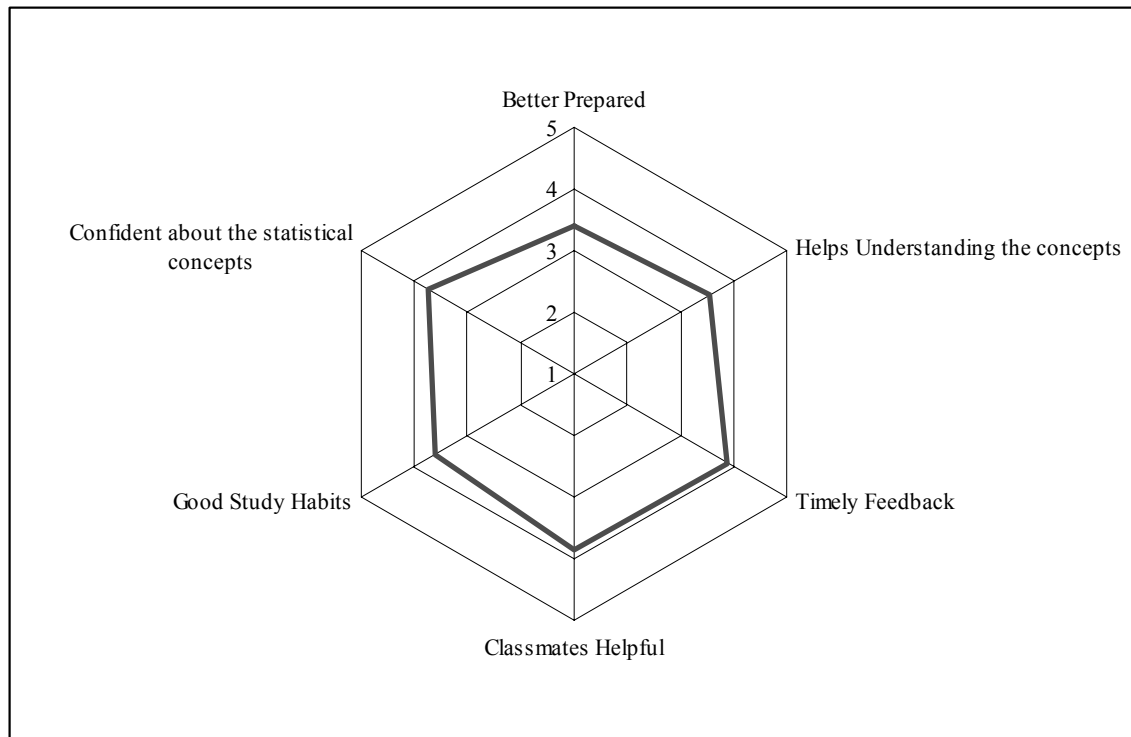


Figure 6: Radar Chart on Students' perception on the usefulness of online homework

Conclusion

The online homework system with its dynamic content features seems to have potential for encouraging and enhancing deep learning among undergraduate commerce students in business statistics courses. This Web-based system enables learning through individualized content, immediate feedback, incremental concept development, and a favourable environment for peer assistance. Both students and professors benefit in that students achieve enhanced understanding, which seems to translate into better performance at least for those who are diligent about completing their homework. Professors also attain immediate feedback about whether students have understood a particular concept before moving onto another topic. This allows review and revision to occur sooner rather than later in the semester. In addition, because these homework exercises are marked online, professors have more time to provide one-on-one assistance for the students who require that level of help. This type of dynamic system has particular application in a large class setting where students can be anonymous and it is more difficult for professors to identify conceptual difficulties and to get feedback from students about their understanding other than traditional tests and examinations. Future improvements to the system may include the utilization of a variety of other multimedia resources such as video, the introduction of comprehensive gradebook tracking, and setting up the option for self-paced learning.

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