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Paper ID #14995

Journey to Accreditation: Assessment Made Easy

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I have a Ph.D. in Computer Science, M.Sc. in Engineering, and B.Sc. in Electrical Engineering. Currently I serve as a Chair for Department of Computer Science, Information and Media Systems and Professor of Computer Science at School of Engineering and Computing, National University. I am also the Program Lead for MS in Information Technology Management and have also served recently as the lead for BSc in Information Systems, the co-Lead for MSc Computer Science and Program Lead for MSc in Database Administration programs. My association with ABET (Accreditation Board of Engineering and Technology) US dates back to 2001, as a certified program evaluator for BSc in Computer Science and BSc in Information Systems. At present, I am also serving as the Commissioner for the Computer Accreditation Commission (CAC). Previously, I have taught at 6 different countries for over 25 years. I have been privileged to be part of the DESY Group (Deutches Elecktronen Synchrotron), Hamburg Germany, as a research fellow, and worked with an MIT group, led by a Nobel laureate.

On the research side, I have been fortunate enough to secure a number of grants and have served on numerous international Ph.D. Thesis committees, been a member of the editorial boards for 7 international journals, and served as the Chair and Co-Chair for 12 international conferences. For recognition of my research activities, I have been invited to a number of international conferences as Invited Speaker, chaired panel discussions and numerous international conference sessions. I have served on more than 150 international conference program committees. Furthermore, I have published number of articles in peer-reviewed international journals and conferences. I am also an active member of ACM, ASEE, ASEE/PSW and CSAB.

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Journey to Accreditation: Assessment Made Easy

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Abstract

Assessment is a scientific measure for assessing learning abilities of students. It measures students understanding of concepts and/or procedures by having to show what students have learned. Data are continuously gathered, analyzed and used for decision making at the program and department level assessment. In addition, assessment of program learning outcomes are among critical components of an overall program review, evaluation and continuous improvement. Assessment of student outcomes and the individual course learning outcomes are among critical components of an overall program review, evaluation and continuous improvement. Faculty tend to seek the least time consuming, yet valid and meaningful ways to prepare for and collect data for assessment purposes. A common approach for applying assessment in a course is to employ embedded questions in the assignments, quizzes, lab exercises or/and exams. The purpose of these questions is to directly address a particular course learning outcome that in turn is linked to a program learning outcome. This practice is often used to evaluate the effectiveness of a course as well as to identify any need for course modifications and improvements. When assessment is in the form of a test, then the administration, collection and the final aggregate report generation becomes a times consuming task that often introduces delays in planning. In this paper we present a web-based software tool that is primarily designed and developed for automating the course assessment process. It automates the test creation, grading and the final report generation that can help save time, reduce errors and produce variety of report summaries for better decision making.

1. Introduction

In general an effort to improve program quality leads to the assessment of student learning in courses within a program. In addition at times assessment of student learning outcomes is also one of the requirements from stakeholders, regional and other accrediting associations [14]. On the other hand it is also understood that course wise assessment results also lead to educated decision making. Program quality improvement is one of the justification that is acceptable and appealing to faculty members that are resistant to any assessment activities. A thoughtful assessment design allows the program to interpret result and its influence on student learning. To achieve program improvement we need to precisely identify areas of improvement through assessment methods and make effective modifications to curriculum and pedagogy [17]. Traditionally, many faculty members do not have a full understanding of assessment and its importance. For faculty, program assessment is a term that often means lot more extra work that eventually means resistance. Therefore, it is essential that faculty and students understand how assessment

will help improve the contents of the courses and reinforce program[6]. In the past it was not un common that administrators or a group of faculty members, for the purposes of completing accreditation cycle, are assigned the task of planning assessment activities, collecting and analyzing assessment data, and reporting assessment results. However, to ensure good quality program, the program must plan and execute regular checks with long term goals[15]. Faculty members are now a days made more and more responsible for contributing to the design and implementation of program assessment plans [16]. These assessment results are later used to identify program weaknesses and strengths. The focus of this article[4] is on implementing a quality assessment process and method because it is a critical step in the chain of events leading to improved program and student learning. Article also reports that meta assessment model was used to recognize academic programs in which the assessment process had improved over a period of time. Through these efforts, authors also report that program's assessment environment and use of available resources were the major factors resulting in program improvement.

Unfortunately, achieving any level of assessment is not an easy task, a commonly known obstacle is faculty resistance because they feel overwhelmed by assessment work. In this paper we present a web-based tool that is designed and developed for automating assessment related activities. It automates test creation, grading and the final report generation that can help save time, reduce errors and produce variety of report summaries for better decision making. This paper discusses the design and development of a database driven, web-based tool for generating, correcting and reporting assessment activities.

2. Accreditation Requirements

Assessment is considered as a process that will identify, gather, and prepare data according to ABET 2016-2017 Criteria for Accrediting Computing Programs. The assessment process uses applicable direct, indirect, quantitative and qualitative measures as appropriate to the outcome being measured. On the other hand the evaluation is a process for interpreting the data as well as evidence that has been accumulated through assessment processes. It is during this phase that it is determined to what extent student outcomes are being attained. Finally the results of the analysis and evaluation of assessment data results in decisions and actions regarding program improvement. ABET commission has eight general criteria for accrediting computer related programs and three additional program specific criteria. Each program accredited by an ABET commission must satisfy every criterion that is in the general criteria as well as specific program criteria. In this paper we in particular focus on the following two criterion;

> **Criterion 3. Student Outcomes:** The program must have documented student outcomes that prepare graduates to attain the program educational objectives. There must be a documented and effective process for the periodic review and revision of these student outcomes.
>
> **Criterion 4. Continuous Improvement:** The program must regularly use appropriate, documented processes for assessing and evaluating the extent to

which the student outcomes are being attained. The results of these evaluations must be systematically utilized as input for the continuous improvement of the program. Other available information may also be used to assist in the continuous improvement of the program.

3. Assessment Process

Assessment is a scientific measure for assessing student's learning abilities. It measures students understanding of concepts and/or procedures by having them show what they have learned. At the program and department level assessment data are continuously gathered, analyzed and used for decision making. Assessment of student outcomes are among critical components of an overall degree program review, evaluation and continuous improvement. Faculty tends to seek the least time consuming, yet valid and meaningful ways to prepare for and collect data for assessment purposes. A common approach for applying assessment in a course is to employ embedded questions in the assignments, quizzes, lab exercises or/and exams[1]. The purpose of these questions is to directly address a particular course learning outcome that in turn is linked to a student outcome. This practice is often used to evaluate the effectiveness of a course as well as to identify needs for course modifications and improvements[2].

For program improvement it is important that assessment should provide a logical process for all the stakeholders such as faculty, students and accreditation requirements so that knowledgeable decisions could be made regarding program improvement. However, changes in the curriculum are always based on the results of assessment, so quality of assessment results are of great importance which in turn is dependent on the process of assessment. The development of a quality assessment process makes faculty members in the program trust their assessment results. Accreditation bodies in general stress that for conducting systematic assessment it is important to make sure that the entire effort is not only designed by faculty but also faculty driven with least involvement from administration[7]. It is also important that focus of assessment is not an individual student or individual faculty member but rather group of students or group of faculty. It is also worth noting that assessment is a continuous process and should be carried out in a very systematic way with data collected, analyzed and evaluated over a long period of time for trend analysis. SPICE documents includes guidelines for designing and conducting such an assessment (ISO/IEC15504-3:2005)[8]. According to authors[7] the intended purpose of developing an assessment strategy is three-fold:

1. To further improve student outcomes (SOs)
2. To inform all relevant parties of any issues that can impact program learning outcomes and student learning
3. To provide guidelines for correcting any weaknesses in student outcomes.

The relationship between different stages or steps of the assessment process are shown in figure 1. Course-embedded assessment methods would provide evidence of student learning most conveniently, since this method makes use of coursework already in place

for assessment[5]. It is easy to collect evidence for assessment in preselected courses so the faculty will then consider how to evaluate student achievement of skills in these courses. This will help to identify classes in which appropriate assignments are already part of the curriculum, usually in a class in which the student outcome was a primary emphasis of the course. In this way, it is made sure that assessment is not an additional burden to the faculty. We would also like to agree with authors[9] that state that the best source of curriculum change seems to be the competent and experienced faculty who review courses and curriculum on their own and propose curriculum and courses changes both small and revolutionary.

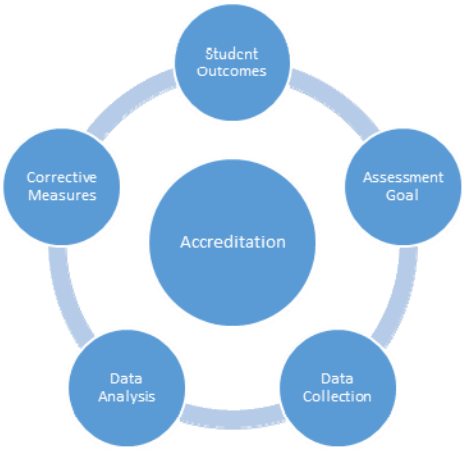

Figure #1: Assessment steps

In this paper we discuss the design and development of a database driven, web-based tool for generating, correcting and reporting on assessment activities. The web based assessment application can help simplify the entire assessment process, data analysis as well as report generation. Students are simply guided to a web page, where they take the assessment test online. An assessment test for a given course consists of a collection of questions, one question for each objective in the course. The test is automatically graded and scores are reported back to students as well as collected for later analysis and report generation.

4. Assessment Tools

The assessment tools we discuss in this paper are independent of Learning Management System (LMS) and should not be confused as another LMS. The way this tool works will keep confidentiality of student information intact. Authors in[11] report on the development of a tool that can be used by faculty to plan assessment activities in their courses. In order to make assessment related activities more appealing faculty is advised to explicitly link assessment tasks to students' future workplaces, involve students in assessment processes and to employ many types of assessment tasks[18]. [12]Reports the use of e-Portfolio in an educational context. The process of collecting and selecting items for the e-portfolio is stress-free because users can hold, organize and reorder contents easily and quickly whenever there is a need. An advantage of E-Portfolio is that user can re-work various components of the portfolio ant time. As a method of end-of-course assessment, e-

portfolios provide many opportunities to integrate all of the student's work, individual or group, on the course and to link new ideas with the student's existing knowledge.

Many faculty members select a checklist as the most effective and efficient type of tool[13]. The reason for liking this tool is that for a single skill faculty in small amount of time can quickly assess many students. However, in this case the skill to be assess needs to be defined clearly to establish whether students have successfully accomplished this skill or not. Since students simply state "Yes" or "No". The flaw in this type of assessment tool is that the recorded result will only inform about the success or failure of the skill without any details that would lead to improvement.

Faculty in many universities have tested and used a wide range of assessment methods to determine whether students were attaining prescribed educational goals. In larger universities with many concurrent sections of the same course the logistics of distributing the assessment test and then collecting individual student grades is a hassle in and of itself. Combine this with the complex task of comprehensive data analysis and report generation and soon you realize the extent of the challenge and time commitment for completing this task. This scenario can become overwhelming, and often does, when you consider that in many universities the lower division courses are often taught by part time adjuncts who may not have been trained on the assessment process and tend to lag behind and require clarifications and periodic reminders. Unfortunately, achieving any level of assessment is not an easy task. A commonly known obstacle is faculty resistance because they feel overwhelmed by assessment work. A web-based tool that's designed and developed for automating the assessment therefore will be a great help. The assessment software may be helpful in automating the test creation, grading and the final report generation that can ultimately save time, reduce errors and produce variety of report summaries for better decision making. Many of the critical data components and attributes of the tests can be stored in a backend database for later use in queries.

Among the items tracked by the assessment tool are number of learning outcome in each course, the text for each outcome and questions relevant to each outcome, the count on the number of appearances of a given question in assessment tests, and the number of times a question was answered correctly by students. It is assumed that each course can have up to a maximum of 10 outcomes. An assessment test will have a question for each outcome, therefore making 10 the maximum number of questions in each assessment test. To take an assessment test, students are directed to a web page, where they enter their class code, instructor name and other key information for storage in the database

The assessment application is capable of generating an aggregate report on the performance of the students on an assessment test. Currently the report consists of a tabulated result of the students' performances that includes the percentage of correct responses to each question, a list of course outcomes and the corresponding questions appearing on the assessment tests and the cumulative frequency of the appearances of individual questions and the number of times they were correctly answered. The assessment tool presented in this paper is an accurate, and easy to use tool for automating the course outcome assessment. Course outcome assessment tools can save time and

improve the accuracy of the results. Furthermore, the timely report generation can greatly help to guide decision making.

5. Database for the Assessment Application

The backend relational database system supporting the assessment application has 4 main relations, namely the Course, Objective, Question, and SLOAT tables. The relationship among these relations is shown in figure 1.

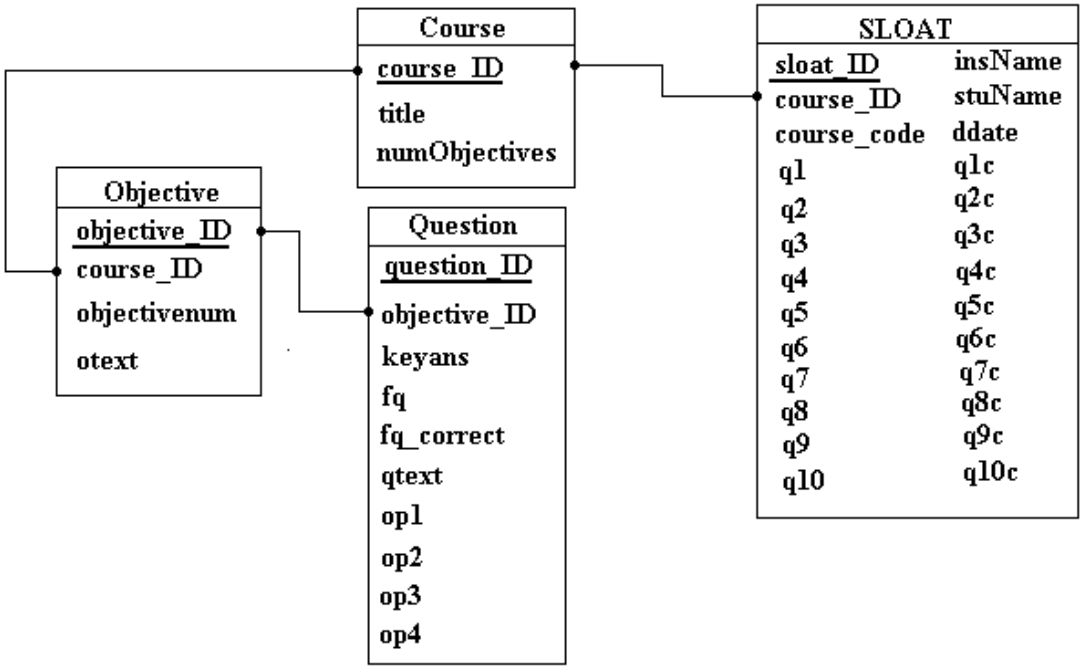

Figure 2 - Database schema for the assessment application

Among other relations, course relation keeps a record of course and number of outcomes in each course. Objectives relation keeps a record of all the objectives and the objective number. Each object in the course has number attached to it for identification. Question relation keeps a record of all questions in all courses. It has a field for question text, the possible 4 answers, and correct answer and also fields that keep track of how many times the question appeared in tests and how many times it was answered correctly. SLOAT relation has records of tests. Each test has up to 10 questions, as pilot study. For example, q1 indicates which question is picked and q1c filed is true if it is answered correctly. The overall design of the relations was based on the hierarchical relationship among the main entities of the application. In our design a course is allowed to have one or more objectives. Associated with each course objective is one or more multiple choice question(s). Multiple choice questions have 4 options for possible answers. An assessment test for a given course consists of a collection of questions, one question for each objective in the course. Some of the important attributes tracked by the application are number of objectives in each course (numObjectives), the text for each objective (otext) and question (qtext), the count on the number of appearances of a given question (fq) in assessment tests, and the number of times a question was answered correctly

(fq_correct) by students. The SLOAT table stores an instances of an assessment test as a record, it is assumed that each course can have up to a maximum of 10 outcomes. An assessment test will have a question for each outcome, therefore making 10 the maximum number of questions in each assessment test.

6. Implementation

Building of any web based application with database connectivity requires the selection of a few products such as a database management system and a program or a scripting language to communicate with the database. We have chosen open source MySQL 5.0, a very fast, robust system as our relational database management system. This system is easy to configure and learn. We use PHP 5.0 for the server side scripting. PHP is efficient with native connections available to many database systems[3]. PHP is free and its syntax is primarily based on C. PHP was designed for use on the web, consequently it has many built-in functions for performing many useful web related tasks.

7. The overall structure of the application

The Course, Objective and Question table were populated by storing multiple insert commands in plain text in a .sql file and then executing the commands using *source <filemane>*, which executes commands read from a file. Currently the creation and development of an intuitive, user friendly interface for the purpose of populating the database tables is underway. Initially all tables, except the SLOAT table, are populated and have valid records. To take an assessment test, students are directed to a web page, where they enter their class code, instructor name and other key information for storage in the database, see figure 3.

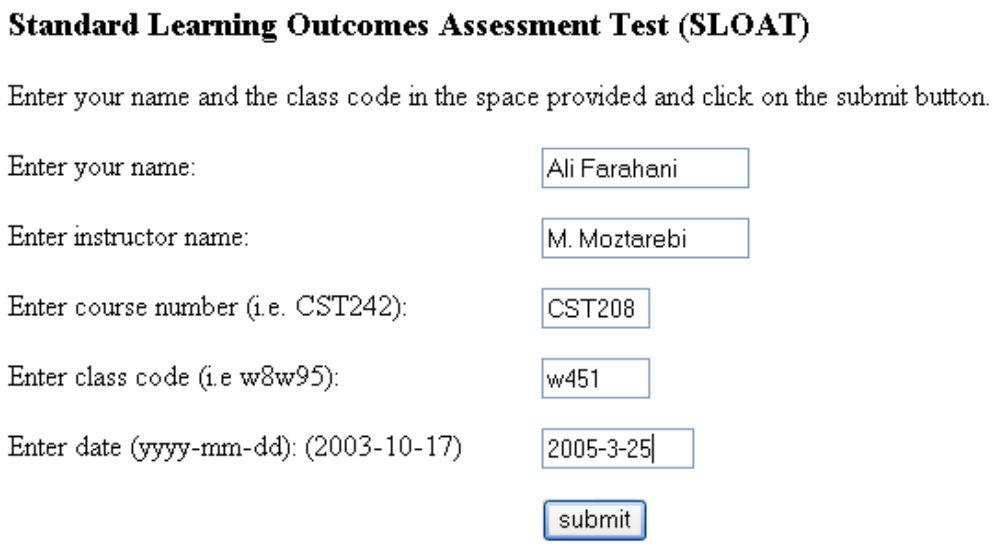

Figure 3 – Start page

Once the submit button on this page is clicked, the information on this page is send to the *generatetest.php* file on the web server for further processing and eventual generation of a randomly selected set of questions. In fact, for each outcome in the course, one question is randomly chosen from the set of questions specifically created to address that outcome. So, it is expected that students in a class will be taking different tests. A sample assessment test is shown in figure 4.

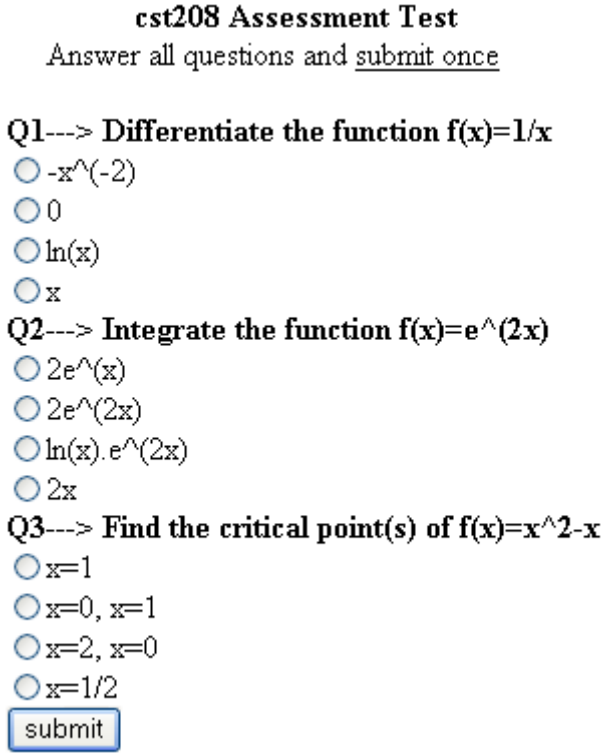

Figure 4 – A sample assessment test

The submission of the assessment test activates the *correcttest.php* file that resides on the server. The PHP's SESSION command is used to pass critical information from the *generatest.sql* file to *correcttest.php* .The answer key (anskey) to each question is stored in the Question table, therefore the assessment test is automatically corrected and a short report is immediately forwarded back to each student. Data pertinent to the assessment test such as the questions, student responses, and the instructor name are stored in the SLOAT table for later access and retrieval.

The assessment application is capable of generating an aggregate report on the performance of the students on an assessment test. Currently a simple web page similar to that shown in figure 3 allows an instructor to enter the class number and code to activate the *querysloat.php* file, which is responsible for constructing a comprehensive report about the assessment test by making multiple queries from the database.

8. The course outcome assessment report

The SLOAT table is the primary source of data for generating an assessment report. Currently the report consists of a tabulated result of the students' performances that includes the percentage of correct responses to each question. This report can assist in measuring the overall student achievement of the individual course outcome. For example, the sample report in figure 5 indicates that only 25% of students correctly answered question three on the assessment test which is assessing the third course outcome.

Course Learning Outcomes Result:cst208--ww28			
Student Name	**q1**	**q2**	**q3**
Student 1	1	1	0
Student 2	0	0	1
Student 3	1	1	0
Student 4	0	1	0
Total	2	3	1
	50.0%	75.0%	25.0%

Figure 5 - A portion of an assessment report

A second, more detailed, table is generated by the assessment report that displays a list of course outcomes and the corresponding questions appearing on the assessment tests, see figure 6. This table provides information on the cumulative frequency of the appearances of individual questions and the number of times they were correctly answered, not shown here. This allows for the comparison of the results with those from other classes

objective	**Question**
Be able to differentiate functions	Differentiate the function f(x)=x
	Differentiate the function f(x)=1/x
	Differentiate the function f(x)=5x^2
Be able to integrate functions	Integrate the function f(x)=2x
	Integrate the function f(x)=e^(2x)
	Integrate the function f(x)=1/x
Apply derivative techniques in curve sketching	Find the critical point(s) of f(x)=x^2-x

Figure 6 – outcomes and their corresponding questions

9. Conclusion

Unfortunately, achieving any level of assessment is not an easy task. A commonly known obstacle is faculty resistance because they feel overwhelmed by assessment related work. In this paper we presented a web-based tool that is designed and developed for automating assessment related activities. The faculty teaching courses used for this paper and using these tools were very cooperative and appreciated and found it very useful, thus reducing faculty resistance to assessment. The database driven, web-based assessment tool automates the test creation, grading and the final report generation that can help save time, reduce errors and produce variety of report summaries for better data analysis and decision making for program improvement. Students are simply guided to a web page, where they take the assessment test online. An assessment test for a given course consists of a collection of questions, one question for each outcome in the course. The test is automatically graded and scores are reported back to students as well as collected for later analysis and report generation. At present unfortunately the tool is not capable of handling descriptive questions.

Among the items tracked by the assessment tool are number of learning outcome in each course, the text for each outcome and questions relevant to each outcome, the count on the number of appearances of a given question in assessment tests, and the number of times a question was answered correctly by students. It is assumed that each course can have up to a maximum of 10 outcomes. An assessment test will have a question for each outcome, therefore making 10 the maximum number of questions in each assessment test. To take an assessment test, students enter their class code, instructor name and other key information for storage in the database. The assessment application is capable of generating an aggregate report on the performance of the students on an assessment test. Currently, the report consists of a tabulated result of the students' performances that includes the percentage of correct responses to each question, a list of course outcomes and the corresponding questions appearing on the assessment tests and the cumulative frequency of the appearances of individual questions and the number of times they were correctly answered. The assessment tool presented in this paper is an accurate, and easy to use tool for automating the course outcome assessment that can save time and improve the accuracy of the results. Furthermore, the timely report generation can greatly help to guide decision making.

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