Improving Teaching - Learning Process using Bloom’s Taxonomy and Correlation Analysis

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Abstract— Bloom’s Taxonomy can be used to understand and measure how much critical thinking skills developed in a student. Educationalists in past had suggested to apply bloom’s taxonomy to improve student’s performance in a course. This paper will investigate the impact of bloom’s taxonomy in introductory computer programming course to improve student’s learning experience and performance. Result from controlled experiment shows that by applying Bloom’s Taxonomy in Teaching-Learning process improves the performance of students significantly by providing an appropriate feedback(s) to the instructor about student’s progress in their course. This helps instructors to concentrate more on the area(s) where students are weak in their course as compared to the students learning with traditional in-class teaching methodology. The Text extraction and Text classification algorithm is introduced in this paper. Pearson’s Co-relation analysis performed using IBM SPSS tools to find out the relationship, if any, among the various levels of Bloom’s Taxonomy.

Keywords— Bloom’s Taxonomy, Correlation Analysis, Teaching-Learning, Text classification, Text extraction.

I. INTRODUCTION

The primary focus of education and class room teaching should be on mastery of subjects and the promotion of higher forms of thinking, rather than simply an approach of transferring facts. As a teacher, we ask many questions to our student every day. All these questions are not from the same level. It is been observed that some questions are very easy to answer at the same time some questions may require a great deal of thinking.

In class, teaching has an objective to aid students with better understanding of concepts and to escalate their thinking abilities in a course. Due to high number of students and lack of time for instructors in each class, instructor fails to ask about performance/issues from each student in their course. Sometimes students repeat the answers of other students, in such a situation it becomes very difficult for a teacher to evaluate the students. There’s no empirical evidence to show that an instructor could track the performance of students without physically communicating with them one-to-one. In 1956, Benjamin Bloom and his colleague’s give the Taxonomy, which can be used by a teacher to frame the questions, so that maximum learning happens by the students, this taxonomy is known as Bloom’s Taxonomy. It is a classification of educational objectives [1].

II. BLOOM’S TAXONOMY

Benjamin Bloom has given six different levels of cognitive stages in learning. The lowest level is the simple recall or recognition of facts, through increasingly more complex and abstract mental levels, to the highest order. At each level Bloom defined some keywords which can be used to frame the question as per different cognitive levels of Taxonomy. Taxonomy is revised by his student Anderson in 2001[2]. Anderson made some significant changes to original Taxonomy. New levels are renamed as Remembering, Understanding, Applying, Analyzing, Evaluating and Creating.

The six levels of Bloom’s Taxonomy are:

- **Remembering**: Whether the student can recall or remember the information(Keywords: list, define, name, state, describe, recall, tell)
- **Understanding**: It might possible that student know the facts but whether he has actually understand the meaning of the information or he/she is able to explain ideas or concepts(Keywords: explain, translate, summarize, classify.)
The model of Bloom's Language Processing act lays executive levels. If the external elements and corresponding keywords are used on these questions, which belongs to remembering level. As above question contains the keyword List, the keywords available in C++ language. The keywords are

- Creating: Can the student create new product or point of view from the things he has understood?

Each level, i.e. keywords suggested by Bloom's Taxonomy, were selected. These were the multiple choice questions. Each question contains some keywords as per the keywords stored in database for respective levels. If the extracted keyword matches the one which is saved in database then that question categorizes into that level.

The questions are added to database one by one. While adding, the text extraction system extracted the keywords and stored them in an array. The levels and corresponding keywords are then retrieved from database. For each level the corresponding keywords are matched with the extracted keywords stored in array, if there is a match then that question allotted to that particular level. The whole process is given in text extraction and text classification algorithm.

Algorithm:

```
set variable level to null
read input question into variable Q
read levels L and corresponding keywords K from database for each level L and keywords K in L
    do split question Q and store in array W[ ]
    split keywords K and store in array k[ ]
    for each keyword k in array k[ ]
        do for each word w in array w[ ]
            if keyword k is equal to word w, then
                set level = L
                set question level to L in database
                end if
            end for
        end for
    end for
```

C. Conducting the Online Exam

After adding all the questions, the framework is tested on total of 49 students of computer science and engineering second year students. The students register themselves on framework and took part in test. They answered all the questions one by one. At the end of the test, their individual score card is generated and shown to them. After evaluating the result, the students came to know about their strengths and weaknesses in each level of Taxonomy. After analysis of overall class result students and instructor came to know that there are some students which are very good in some level, while they are very weak in other levels.

Final score of all the students is calculated and exported in excel data sheet for further processing. Next, to find the relationship between different levels correlation analysis is performed using the IBM SPSS Statistics Tool, in SPSS Pearson's correlation is applied.

D. Interpreting the individual student result:

The result generated after completion of test of one student is shown in Fig. 2. The chart shows the marks obtained by a
single student in different level of Bloom’s Taxonomy. It is clear from the result that the student is good in remembering level, means he/she can remember the things taught in a class. His understanding level is not that much good, and he is also not able to apply the facts and the things which he has understand. He is quite good in analyzing and evaluating the things. And in creating level he has also score very less marks. So, overall he needs to improve applying, understanding and creating level. If he will improve understanding and applying level, the creating level will automatically get improved.

E. Interpreting the class result:

Fig. 3 shows the overall performance of the whole class in a test. It is clear from the class result that most of the students are good in remembering. Some students are good in analyzing and evaluating. The understanding and creating level of all the students in a class is very weak. If someone has not understood the actual meaning whatever was taught in a class, then he/she can not apply that in a real situation. Similarly if someone is not able to apply, he/she cannot be so creative in programming. So, from overall class result it is very clear for the teacher of the class, that he/she should concentrate more on understating, applying and creating level. He should ask question in a class which emphasizes more on these levels.

F. Architecture Diagram

The complete working of the framework is summarized in architecture diagram, Fig. 4.

From architecture diagram the notable points are:

- Collection of questions is performed
- Text extraction and classification system categorizes all the questions as per the levels of Taxonomy
- Online assessment framework produces the appropriate feedback in form of result to students and teacher, and correlation analysis identifies the relationship among the levels of Taxonomy

V. TOOLS AND TECHNOLOGY USED

This section describes the tools and technology used to develop the framework in brief.

**ASP.NET 4.0**

ASP.NET is used by the programmers to build server side web applications and web services. ASP.Net support many languages which are built on top of .Net framework.

**Microsoft C#:**

Microsoft C# (C Sharp) is a strongly typed, multi-paradigm, object oriented, simple and modern general purpose programming language which supports .NET framework. It
supports exception handling, multithreading and all other object oriented features.

**Microsoft Visual Studio**
Visual Studio is an Integrated Development Environment. It has many unique features which helps the programmer in creating any .Net application.

**Microsoft SQL Server**

MS SQL is a Relational Database Management System(RDBMS) developed by Microsoft. It is one of the most popular database management systems available. MS SQL server is highly reliable, fast and easy to use. It has a simple and user friendly environment for creating and manipulating database, and integrating with Visual Studio.

**Microsoft Chart Controls 4.0**
Microsoft chart controls are used to generate the different charts. It offers a wide variety of charts to select the one which user requires for viewing the data in chart form.

**VI. CORRELATION ANALYSIS**

IBM SPSS Statistics Tool is used for correlation analysis, it is a software package used for statistical analysis.

**Pearson Correlation:**
It measures the degree of the linear relationship between two variables. By linear relationship we mean that the relationship can be well characterized by a straight line. Positive correlation means higher score on variable A are associated with higher score on B, also true for lower values. Negative relationship means higher scores on A are associated with lower scores on B. The correlation coefficient r may take any value from 

\[-1.0 \leq r \leq +1.0\]

For interpreting the result hypothesis have been made that students those who have score less marks in understanding level, have also score less marks in creating level. So we can say that there is a positive correlation between these two variables.

The value of correlation coefficient between understanding and creating level is .566, and the correlation is significant at 0.01 level. We can conclude that there is a statically significant correlation between understanding and creating level. Students whose understanding level is good are also good in creating level, and students who are weak in understanding are also weak in creating level.

Another hypothesis have been made that students who get good marks in remembering level also score good marks in evaluating level, it is also a positive correlation with correlation coefficient value of .544, but the correlation is not significant.

**CONCLUSION AND FUTURE WORK**

This paper presents the automatic classification of exam questions as per the Bloom’s Taxonomy and produces the feedback to student and teacher which improves the overall teaching-learning process. The framework is able to extract the questions and then categorize them into appropriate level as per the Taxonomy. The framework is tested on students to identify the cognitive level of the students. After appearing in the test, students get their result in form of charts. Overall class result is generated for all the appearing students, which helps in deciding/changing the strategy for a teacher so that maximum learning happens in a class. Pearson’s correlation is performed using IBM SPSS statistics tool to identify linear relationship between different levels of Bloom’s Taxonomy.

The instructor of the class can make the decision after reviewing the correlation results and accordingly he can decide his strategy. The overall Teaching-Learning process is improved with respect to individual student result and overall class result.

In future, categorization of students according to the wrong answers given by them in level or question and automatic text suggestion as a feedback for student and faculty emphasizing what action they should take will be done.

**REFERENCES**