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Innovative Model for Student Project Evaluation Based on Text Mining

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Abstract

At present, there is a huge amount of unstructured documentation that is generated by students who study the course project management and evaluation. These unstructured documents cannot be used in direct processing to extract useful information or knowledge. At the same time, make use of them to assess student achievement. In this work, we propose text-mining techniques for the evaluation of the progress of student in a course project management and evaluation. The most straightforward approach is looking for the enrichment of the vocabulary, the casual and condition relations, and the structure of the terms in the different phases of the project. In our paper, we used text mining and the structure of the vocabularies as a tool to measure the success and the progress of the students. It is important to evaluate the effectiveness and efficiency of our approach. The experimental results illustrate an overall performance of project evaluation. By looking into the number of indexing terms, the causal relations and the positive conditional relations, and levels of the hierarchical structure of the terms there is an evidence from this research that the vocabulary enrichment had an impact on the students evaluation and learning ability.

Introduction

Students need evidence of their progress in their courses for Academic staff. Project Evaluation requires reporting the achievements of the progress of the project over the lifetime of the project, typically done on the different phases and at the end of the project Otieno (2000) & Patton (2002). The role of monitoring and evaluation is important in improving the progress in the project. Evaluation deals with questions of cause and effect. It is assessing, estimating the value, worth, or impact of an intervention.

Project evaluation is concerned with indicators setting and performance tracking along the life of a project. It plays an essential role to the success of any project and therefore demands special attention. At the heart of this process lies the structure and enrichment of the terms one has to take into account when performing the evaluation. While project evaluation is common, it has been difficult to automatically evaluate the progress of a project based on the documents, reports and presentations generated by the students to extract meaningful patterns and build structure of the terms from these reports. Text Mining can be defined as a technique which is used to extract interesting information or knowledge from the text documents which is usually in unstructured form Jusoh, & Alfawareh, (2012); Nasa (2012) & Akilan, (2015). We describe an approach of using text mining techniques and glossaries as tool for evaluating and supporting management and control of the project. Using text mining methods in our research provide us with an evidence that the vocabulary enrichment had an impact on attainment in the project evaluation.

In this paper, we divided the contents into six sections (1. Introduction, 2. An Overview of the Evaluation Model, 3 Literature Review, 4. Materials and Methods 5. Results and Discussion, and finally, 6. Conclusion). In the Materials and Methods section, we describe the methods and the methodology used to build the system, select the glossaries and use the text mining techniques to build the concepts hierarchy to support the indexing and student evaluation. Section 5 discusses an application to evaluate the progress of a project and measure the level of success for the student based on terms hierarchy, enrichment of vocabularies and casual relationships. The last section presents the conclusions.

An Overview of the Evaluation Model

The main aim of this research is to use information technology and text-mining techniques to help staff and students in evaluating their progress in the different phases of project life cycle. The course trains students how

to conduct and evaluate small project. In general, we offered the student a proposal for a project and the student will study the proposal and work on the analysis and implementation of the project. In the outline of the course, the student will implement project in three stages (Figure 1):

Phase 1 - Defining and preparing the “pioneering projects”

Phase 2 - Developing the "pioneering projects”

Phase 3 - Evaluating the “pioneering projects” and considering supports for replicating models

At these different stages, the student or the group of students presents many documents as deliverables and different documents at the end of each stage of the project. In order to measure progress in this course, we used the technique of text mining, quantitative and qualitative analysis and evaluation methods to assess the progress of the students in the course based on their deliverables.

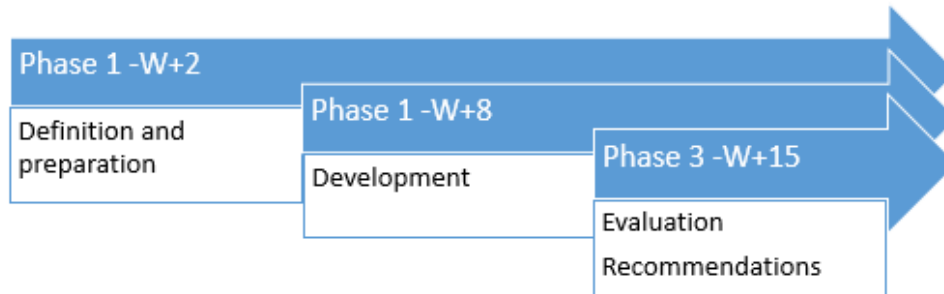


Figure 1. The 3 phases of the project

Literature Review

Different studies addressed and examined by several researchers in order to use indexing and text mining in different applications. Each study focuses on a special technique as an application for text mining. In the following paragraphs, we present a brief discussion for some related work achieved in this respect. The work of Rose (2010), Ventura (2014), Van Eck (2010), Abuzir.(2010), Abuzir (2014), Abuzir & Abuzir (2017) and Matsuo et al., (2014) present different automatic techniques to extract words from unstructured documents based on statistical analysis. The most common used statistical techniques are Term Frequency (TF) that counts the frequency of a term in the corpus, Document Frequency (DF) counts the number of documents where a term occurs and Term Frequency/Inverse Document Frequency (TF/IDF) as a measure that yields large values for terms that appear only in very few documents of the given document collection.

D'Addio et al., (2014), used semi-supervised learning and sentiment analysis to automatically identify aspects that represent the different subjects of the reviews in order to be used by recommender systems. The work of Gwadera & Crestani (2009) presented a new technique for mining and ranking streams of news stories using cross-stream sequential patterns and content similarity based on event that happens at a specific time and place. The paper of Ramakrishnan et al. (2008), presented an extraction mechanism that generates structured representations of textual content. Their results show over 62% average precision across 8 relationship types tested with over 82% average precision for compound entity identification. Fragkou, (2015) presented techniques based on the combination of text segmentation and information extraction for identification of the various topics that appear in a document. Nogueira, (2011) in his thesis presented an automatic system for project submission and evaluation for programming courses. The goal of his work is to help both the instructor of the course and students, by automating most of the evaluation, managing the course and giving instant feedback to students on how well their solutions solve the problem given. Dascalu & Bodea, (2015) presented a module for formative e-assessment in a complex learning management system. Their system automatically evaluates the answers to open questions and provides feedback related to further reading or joining suitable expert communities. They use diverse ontology-related technologies and open-source tools. Brent. & Labuschagne, (2004) introduced a new framework to evaluate the sustainability of projects and technologies in the manufacturing sector by developing indicators that are relevant for the criteria of the sustainability assessment framework.

Most the previous works use automatic techniques to extract terms and use structured terms like ontology. Researchers have to build these structured terms by different ways to help them find the relationships and the semantics between the terms. Usually the construction process performed manually and needs a lot of work to

construct and maintain the list. In our approach, we used TF and lexico-syntactic techniques to extract terms as the first step. Later we used our tool Causal Relations Extraction Tool (CERT) and KH Coder to filter the list using the semantic relations and co-occurrence of the terms. The system shows more accuracy by measuring the precision. Therefore, the list and the structured list build automatically by our system without any prior knowledge about the domain. In this approach student can start their evaluation with the system without any previous knowledge. The system will update the list of the terms and the hierarchical structure of terms as new parsed documents. This is done automatically by the system. The system iteratively follow this procedure to update our list of terms and the structure of the lists. The system offer a friendly user interface to show results of the analysis of the content of the documents. Therefore, student and staff can see how they are doing progress in their project by looking at the deep of the hierarchical structure of the concepts they are using.

Materials and Methods

In our approach, we used reports and deliverable of the student's project as a source for extracting the keywords as terms. These documents represent the domain of the course Project Management and Evaluation. We used both statistical and lexico-syntactic techniques to extract the terms and the relationships between these terms. Such groups of related concepts/terms enabled us to either, evaluate and/or update the existing terms list in case these concepts are already defined in the list, or to enrich the existing list in case those concepts are not defined in the list. This is an iterative refinement process with the newly available documents or glossaries.

We used the CRET to identify important terms as well as their significant relationships (Abuzir, 2014). The following paragraphs describe the iterative approach that consist of subsequent parsing of the collection and the process of adding new keywords into the indexing terms list and finding the semantic relations as well as the statistical information about terms and relations Figure 2.

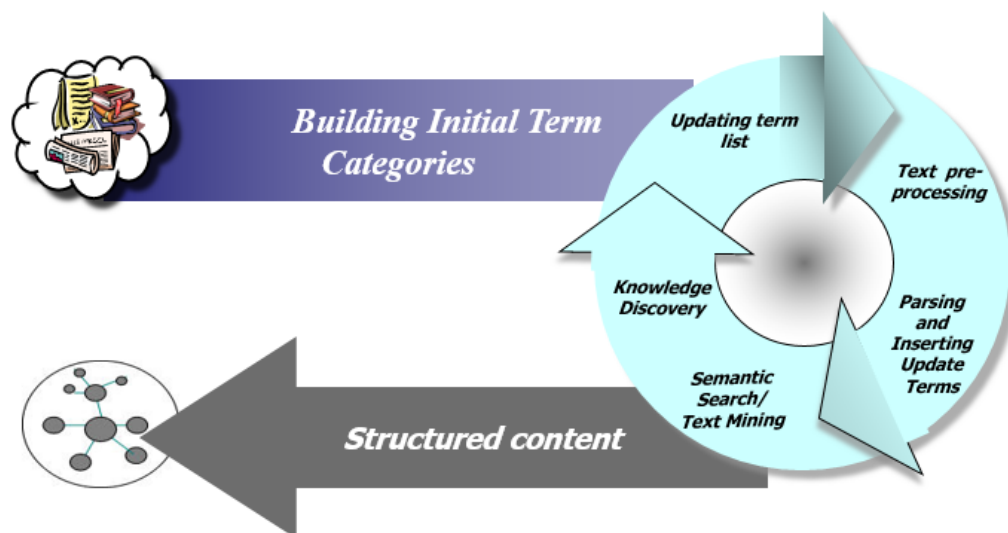


Figure 2. System architecture and the iterative process of updating term lists, semantic relation and statistical data

The course of Projects Management and Evaluation is an important one for all students in Computer Science degree and Management department. In General, students asked to submit different reports according to some requirements. To evaluate and grade the projects and the deliverables submitted by students, the instructor of the course evaluates the work of the students by looking at the reports, oral presentations and discussions. Currently, there are few automatic evaluation systems and they do not comply with the requirements of evaluation project courses automatically.

The main aim of this research is to build a system for evaluating the work of the students in the course of Project Management and Evaluation. The goal of the system is to support and help both the faculty who teach the course and their students, by automating most of the evaluation, management of the course and giving instant feedback to students on how well their reports and progress in the course. We used this model for both learning and automatic evaluation of student's performance in the course.

Before mining any text or terms, we perform certain pre-processing operations:

1. Removal of stop words
2. Tokenization
3. Morphological (stemming) removing the pre-suffix and post suffix
4. Phrase boundary identification (single and compound terms).

As a first step to extract the terms from the documents, we parsed the project proposal. Table - 1 shows a sample of the extracted terms and their frequency. We used this list to build the list of indexing terms. The list is a collection of terms and statistical information like frequency of terms. We gathered this information when we parsed student project proposal.

Table 1. A sample list of update terms and their frequency

Update Term	F	Update Term	F	Update Term	F	Update Term	F
shopping	17	mall	4	approach	1	goal	1
commuter	8	purpose	4	attribute	1	information	1
thesis	7	datum	3	awareness	1	interview	1
location	6	author	2	background	1	matter	1
people	6	context	2	branding	1	maximisation	1
order	5	customer	2	character	1	municipality	1
research	5	field	2	collection	1	part	1
term	5	method	2	commute	1	respondent	1
benefit	4	reason	2	conclusion	1	result	1
definition	4	source	2	decision	1	sample	1
home	4	activity	1	age	1	statement	1

In our example, terms like thesis, author, home, new, etc., would be considered as general terms. These terms would not select as an indexing terms. The first step was to eliminate these terms from the list. Table– 2 shows the update list after removing the noisy terms. Later, we used the filtered list of terms to update our list. We iteratively followed the previous procedure to update our list of terms.

Table 2. A filtered list

Update Term	F	Update Term	F	Update Term	F	Update Term	F
shopping	17	field	2	collection	1	maximization	1
commuter	8	method	2	conclusion	1	municipality	1
people	6	reason	2	decision	1	part	1
order	5	source	2	age	1	respondent	1
benefit	4	activity	1	goal	1	result	1
mall	4	awareness	1	information	1	sample	1
purpose	4	branding	1	interview	1	statement	1
customer	2	character	1	matter	1		

At the same time, we used KH Coder as a tool to construct the co-occurrence between terms and the hierarchy relationships between terms. By using this tool all terms and their relations are directly visible. Figure 3 shows the co-occurrence model of our terms when parsing the proposal for the student. We built a system that meets the requirements of the automatic evaluation of the course using text mining; the system is fast and is easy to use. Comparing the system with the manual work of evaluation, the constructed system is more fast and easy to use. Both Staff and Students can use the system very easy, they can import their documents into the system and it will do all the analysis and present the analysis by statistical information and by graphical visualization. Thus, users can get feedback on their work by looking to the different graphical presentation of the content of their documents. Moreover, the system is efficient and is able to support instructors and students in the process of the automatic evaluation of their works. We used Recall and Precision measurements to measure the accuracy and the efficiency of the system. We calculated Recall and Precision using the following equation (1) and (2). The system shows high precision result for the terms extraction and semantic relations. Based on equation (3) we can find the average f-measure, which is 85% (Figure 4).

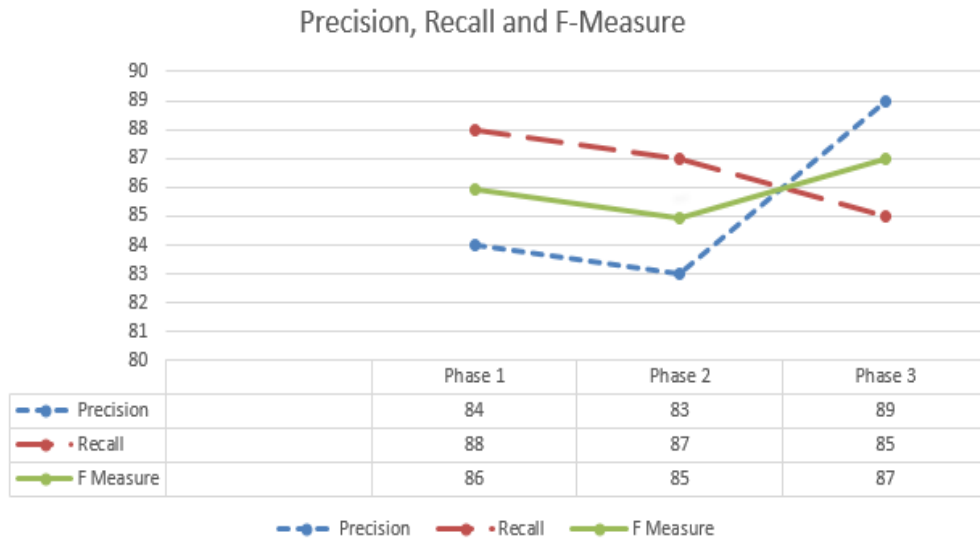


Figure 4. Precision, recall and f-measure

$$Recall = \frac{NR}{(NR + NRNR)} * 100\% \tag{1}$$

$$Precision = \frac{NR}{(NR + IIR)} * 100\% \tag{2}$$

$$F - Measure = \frac{Recall * Precision}{(Recall + precision)} \tag{3}$$

Where,

NR = number of relevant terms or relations retrieved.

NRNR = number of relevant terms or relations not retrieved.

IIR = number of irrelevant terms or relations s retrieved

IRR = number of relevant terms or relations retrieved

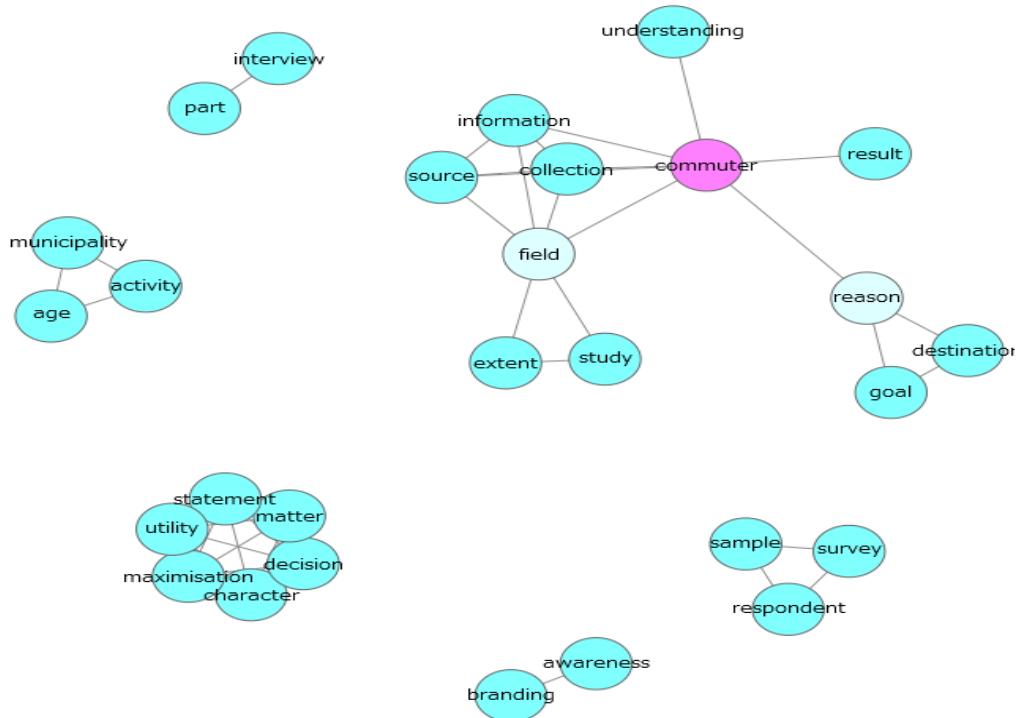


Figure 3. KH Coder co-occurrence network for the terms extracted from the first draft proposal of the student

Results and Discussion

We used our tool CERT to parse the documents and index them (Abuzir, 2014). The indexing and retrieving processes we used in our research are based on the hierarchical structure of the terms. Table-3 and figure-5 show different numbers of keywords, concepts and roots (nodes at the highest level in the hierarchy of the concepts). In table-3, keywords represent the number of keywords and main roots in our list. Indexing result shows how many keywords and concepts were used in the indexing process for each phase.

Table 3. Statistical information about usage of indexing terms

Step number	Indexing list		Indexing Result	
	Number of keywords	Number of Roots	Number of Keywords used in indexing	Number of concepts used in indexing
Phase 1	17	4	10	0
Phase 2	102	5	97	21
Phase 3	191	8	38	5

The second part of table-3, the Indexing result; shows how many keywords and concepts were used in the indexing process for each phase. For example, in phase 1 the system finds 10 keywords out of 17 in the document. In the second phase there are only 102 keywords were founded in the documents collection. In our collection, the documents in the second phase were emails and the power point presentation. In the third phases our collection are the delivery and the power point presentation. Because of that, we have a high number of terms used in indexing.

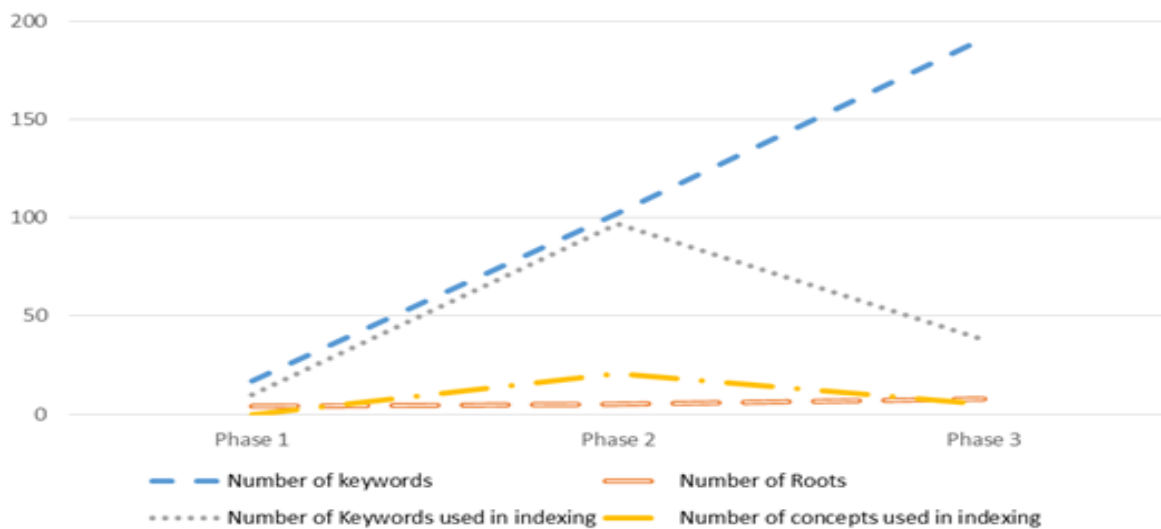


Figure 5. Statistical information about the indexing terms

Figure-5 shows that the number of keywords used in the indexing is increasing. As the number of keywords used in indexing is increasing, we used more keywords and concepts to represent the content of the reports. The number of the root terms is stable. So, next to the analysis about the number of keywords and concepts extracted from the repeated indexing in the different phases of the project, the number of relations existing between the individual terms within the list can be considered. A basic evaluation is given about the causalities and conditions that exist in the different reports of the student. In our approach, we gathered the necessary quantitative data related to the causal and conditional relation, statistical information will be exposed here, about what kind of relation are represented in students reports, and the frequency and evolution are reflected on this matter throughout the different phases

Table 4. Total number of causal relation in the different phases of the project

	Phase1	Phase2	Phase3
Total number of Causal Relations	124	898	2016

Although tables 4 and 5 show that the size and the number of the terms are increasing during the 3 phases, the number of keywords and concepts, casual relations and conditional relations that were retrieved in the indexed reports, is proportionally seen high in phase3. Figure 5 shows the degree of positive conditions (IF Condition)

through the progress of the project. We illustrated the total number of causal relations and conditions relations in figures (6 and 7) and Tables (4 and 5).

Table 5. Total number of if and if not conditions in the different phases of the project

	Phase 1	Phase 2	Phase 3
If	0	36	248
If not	0	3	7

During the process of indexing the documents collection of the project of the student using CERT Tool, the number of keywords and the relationships between them increased. At the same time, the number of levels in the structure hierarchy of the terms increased (Appendix1 and 2). There are seven levels in the hierarchy in phase three. As the number of keywords, relationships and the levels are increasing the more the indexing list can represent the domain.

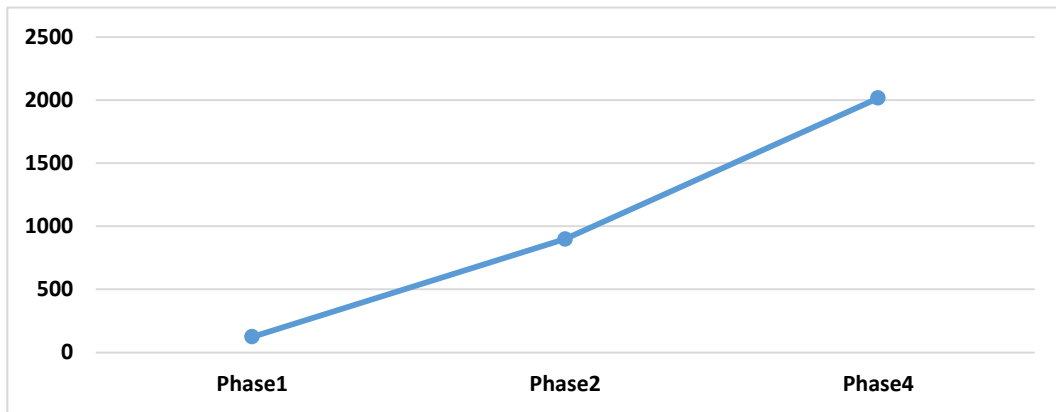


Figure 6. Total number of causal relation

There is evidence from this research that the vocabulary enrichment had an impact on student’s writing and speaking ability. The findings suggest that on average the project had a positive impact on the writing ability of the students in the project. However, our estimates are statistically significant so we are able to conclude that the vocabulary enrichment and the complexity of term structures were caused by the project phases rather than occurring by chance. This reflects the deep understanding of the students and their abilities to write.

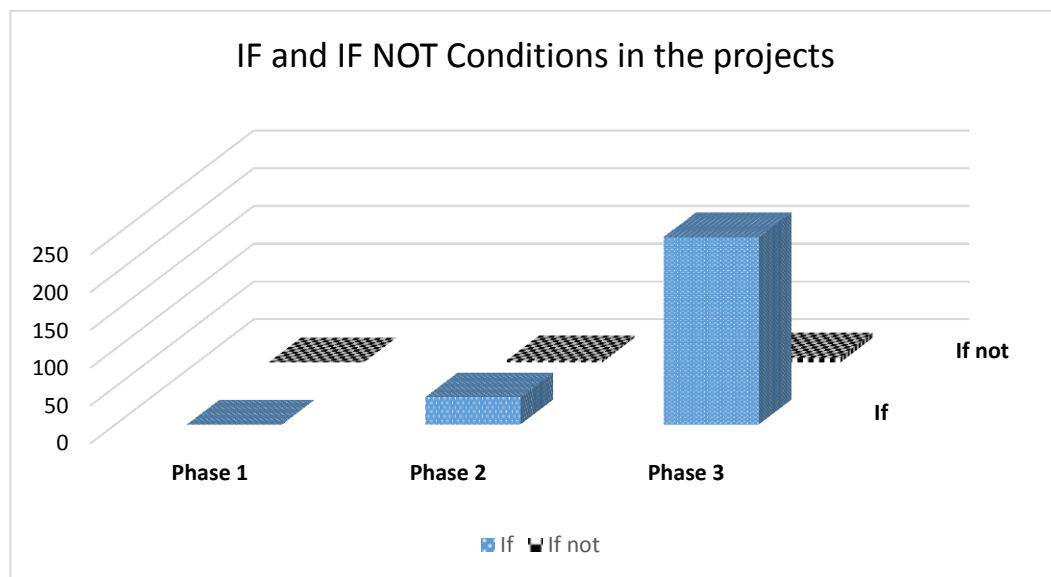


Figure 7. Total number of conditions

This evaluation reports that students gained the confidence required to engage in the different activities, and that their writing and speaking skills improved.

Conclusion

This research presents the rationale and requirements for student evaluation system, the state of the art of the systems currently used, the architecture and the implementation details of a new system that complies with the requirements. In this paper, we discuss an approach supporting project evaluation and control based on text mining and information retrieval techniques. In our approach, we used several techniques to measure the project progress for students based on the measurements of using terms, casual and conditions relations, and the complexity of the structure of indexing terms. We used the frequency of terms (TF) and the complexity of the indexing list as a tool to measure the success and the progress in the project. The increased number of terms, the complexity of the hierarchical levels and the increasing number of relationships between terms and the positive conditions used in the different phases of the project are a good evidence of success for progress of the project.

The promising results and measurements of the statistical results in our study considered as good evidence of success for the progress of the project. As the results show, students start using more specific and general terms to represent their concepts or describe the project. The number of hierarchical levels increased in the third phase. This evaluation reported that students gained the confidence required to engage in the different activities, and that their writing and speaking skills improved. This research and results confirm the challenges of integration and optimal exploitation of such a system in the learning management system, stressing that mapping among the concepts to be evaluated through the evaluation criteria is not currently a direct solution.

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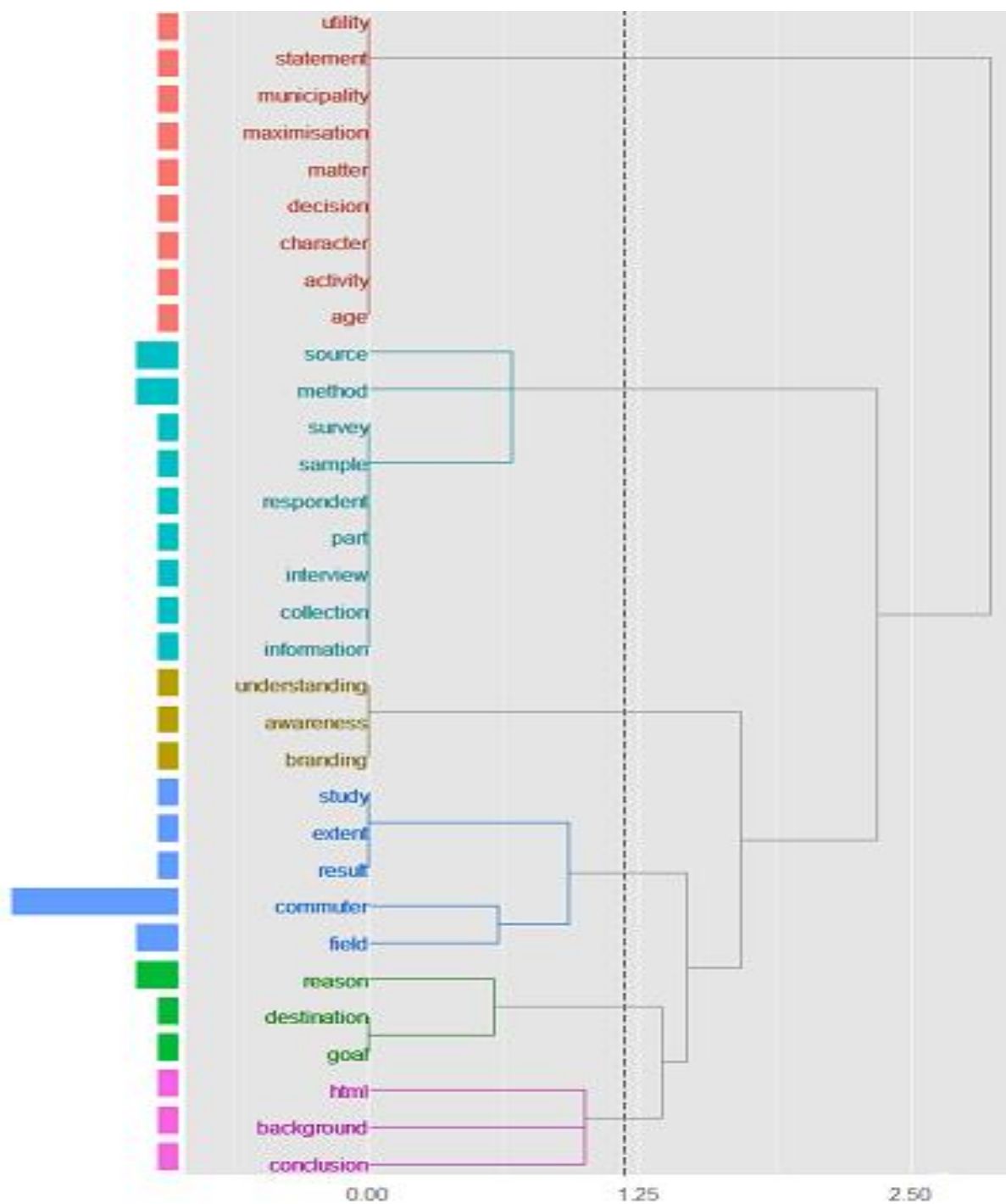
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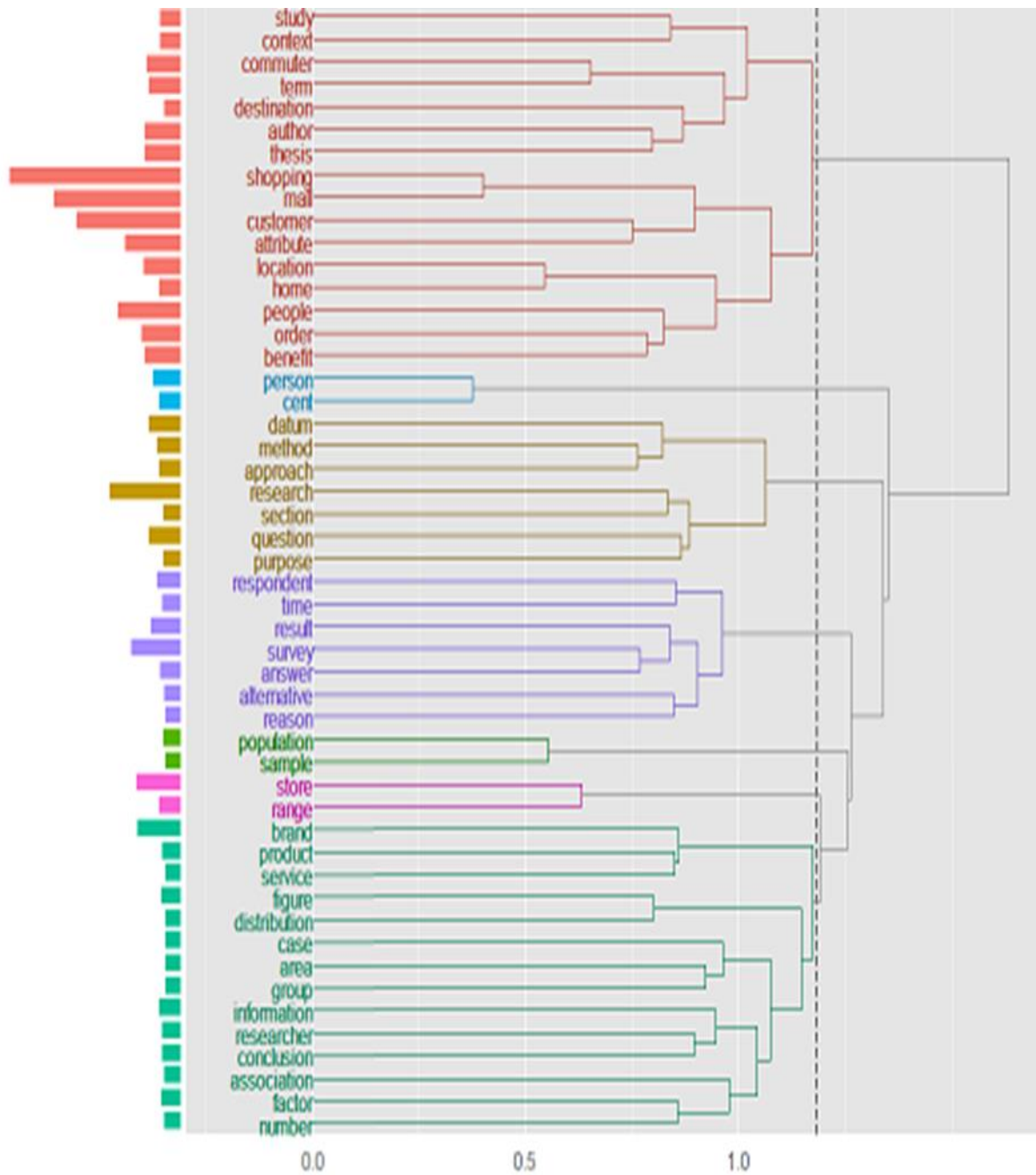
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Appendices



Appendix 1. KH coder hierarchy for the first phase



Appendix 2. KH coder hierarchy for the third phase