Developing Intelligent Adaptive Virtual Class Model (IAVCM) System based on Tokenization

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Summary
This study aimed to develop an Intelligent Adaptive Virtual Class Model (IAVCM) System. IAVCM based on Adaptive Virtual Class Model (AVCM) which was introduced by Jabari [1] in 2014. The aim of our study is to enhance the AVCM system to be Intelligent by using machine learning model. The main goal of our system is to convert the chat tool in the virtual class room from normal chat tool to educational one, by modeling the text and mining the context. IAVCM is a client/server system that works in two modes; the training mode and the use mode. By the end of the chat session the learners will be evaluated using three ways including: chat context analysis, time spend in the chat and peers evaluation. The system consists of different components that offer the needed services for the experts to feed the system in order to make it intelligent one. The main services include; course management, Language management, experiments management, Tokenization engine, Keywords Auto Leveling Algorithm (KALA), Students profiles, and chat management. In our system we develop a machine learning model to evaluate our system. Two dataset were used, one set to train the model and another that is unseen testing set used to predict the model consistency. The system support multi languages including English, Arabic and Indonesian. The system trained and evaluated by applying 60 chat sessions for 120 students for four different courses in Arabic language.

Key words:
Adaptive E-learning, AVCM, Tokenize, IAVCM, Text modeling.

1. Introduction

In the last few years e-learning became one of the main research fields and it became one of the common tools for modern educational systems. Many Organizations, schools, Companies and Universities started to use e-learning in their educational systems[2],[3]. Many online platforms were built to offer high quality online courses for the learners. Considering the fact that there are differences between the learners and their requirements and capability, the concept of Adaptive e-learning was founded and it leads to the development of adaptive e-learning systems to provide learning materials considering the learners capability[4].Virtual classes technology is one of the synchronous technologies that are used in the e-learning systems and offers different services for the learners including normal chat tool. In 2014 Jabari [1] introduced a new adaptive model named Adaptive Virtual Class Model (AVCM). In our study we enhanced the AVCM system by developing a machine learning model in order to convert it to intelligent one, to model the chat text and to convert the chat tool to be effective educational one. This paper presents the background and the theoretical framework of our study including e-learning concept, AVCM, Machine learning and text modeling. The study introduces the main components of the IAVCM system consisting of IAVCM modes and a new Algorithm named Keywords Auto Leveling Algorithm (KALA), and the last part of this paper will discuss the results using this system.

2. Background

2.1 E-learning

E-learning field has grown fast in the last few years. Many organizations, Universities, schools and companies started to use it in their educational systems [5].

In 1999, the term “e-learning” was known for the first time when it was utilized at a CBT systems seminar. Previously, other words were used to describe e-learning such as “virtual learning”, and “online learning”.

The first distance course experience was taught by Isaac Pitman in 1840’s [6].

E-learning started to become more interactive in different fields such as industries in addition to the education since 70s. The Open University in Britain used the advantage of e-learning for their distance courses. Course materials were provided by post and correspondence with tutors was via mail [6]. With the using of the Internet, the Open University became popular as faster correspondence with students via email and other e-learning available models.

E-learning tools became very common in late 20th century as many people have computers in homes, virtual learning

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began to truly thrive, with people get access to online information and e-learning opportunities.

In early 90s, several schools, companies and Universities started to offer online courses via the Internet that brought education to the people. Users stated to get the advantages of the e-learning, as a flexible with low cost way of learning [6].

In 21st century e-learning started to be used in the training of the employees and to improve the industry knowledge to the workers in different businesses. The e-learning made it easy for people to get online degree at flexible time, place with high quality [15]. In addition to the cost effectiveness, e-learning has no boundaries, no restrictions and education is more fun.

Virtual classes are a Synchronous type of e-learning that offers different services to the teachers as well as to the learners. The services include; Application , files, desktop sharing, live video streaming , public and private text chat, quizzes, Electronic whiteboard and polls, Recording of the Class and Access to persons with disabilities. In our research we will focus in the students chatting model in the virtual classes [7].

2.2 Adaptive Virtual Class Model (AVCM)

In [24] Jabari constructed a methodology and framework for adaptive virtual classroom. He put three main facilities in this framework to serve the intelligent learning. They are 1) Adaptive presentation, 2) Adaptive testing and 3) Adaptive chat. In order to perform these three models it was needed to design several models as the following [24],[1]:

1. Domain Model (DM): describes the construction and sequencing of the course.

2. Student Model (SM): describes the characteristics of the student.

3. Activity Model (AM) : describes the activities which should be performed by the student during the course .

4. Resource Model (RM): Describes the resources of the activities.

5. Nodes Selector: Tool for selecting the teaching materials objects.

6. Concept Score Evaluator: used to evaluate a student in one concept

7. Cognitive Style Evaluator: used to discover the student cognitive style.

8. Chat Room Interface Adapter: used to tune the chat room interface according to the student cognitive style.

9. Peer Evaluation: used to evaluate the peer student in a chat session [1].

2.3 Machine learning

The programming of the computers to optimize a performance by using past experience example or data is called Machine learning. Machine learning in strongly needed in cases in which we can't write computer program to solve the problem. It is necessary in the cases in which human is unable to explain their expertise or if they don't exist [70].Nowadays, we have application for the machine learning in different fields like the commercial systems for recognizing handwriting and speech, Analyze the past sales data to learn the behavior of the customers, Robots learn and analyzing the huge data in bioinformatics to extract the knowledge [9], [10].

Currently, the ability to store, process a huge amounts of data is available, as well as to access it using the networks from far locations. With this a huge amount of data which stored in digital devices with gigabytes size daily in many companies like the sales shop network, we need to analyze this data and to turn it into information that can be useful [9] , [10].

Actually in the cases of selling where we can't know who will like to buy exact product, and in the cases that we know there is no need for analysis the data. Because of that we mine the past data to extract information that can answer similar questions, and predict the behavior of the customers. As example, the customer’s behavior in not completely random, when they buy Coca-Cola they will buy chips. By the analyzing that data we can fine that there is patterns in it, and by this we can mine it and expect the products that the customers will buy for example. This process that explains the data we observe, we can't identify it completely, but we can create a good and useful estimate. This estimate will not explain everything, but it will account for some part of the data and we can detect definite patterns. This is the function of machine learning. We can use these patterns to make predictions [9], [10].The machine learning is part of artificial intelligence, not just a database problem. Ina changing environment, the systems to be intelligent must have the ability to learn and adapt changes and the designer needs to offer solutions for all situations. Many problems in speech recognition, vision, and robotics Machine learning helps to find solutions for them. One example is faces recognition that uses the pattern recognition [10].

The theory of statistics in building mathematical models in machine learning is making inference from a sample. The role of computer science is divided in two categories: First, in training, we need algorithms to solve the optimization problem, for massive amount of data storage. Second is

needed for algorithmic solution in an efficient way. In certain applications, the efficiency of the learning or inference algorithm is important as it predict accuracy. In machine learning both are necessary for complete solution of the model. They are different machine learning algorithms including:

Supervised Learning: "In supervised learning, the aim is to learn a mapping from the input to an output whose correct values are provided by a supervisor"[9],[10].

Unsupervised Learning: In unsupervised learning, there is no specific supervisor for input data. The aim is to find regularities in the input. There is a structure to the input space such that certain patterns occur more often than others, and sometimes doesn't exist. In statistics, this is called density estimation [10].

Regression: "If the output space is formed by the values of continuous variables, for instance the stock exchange index at some future time, then the learning task is known as the problem of regression or function learning " [11] [7]. A few examples of regression to predict the value of shares in the stock exchange market and to estimate the value of a physical measure are related and categorized in regression [12].

Reinforcement Learning: Reinforcement learning has its roots in control theory. It deals with scenario of a dynamic environment in state-action-reward triples as that of data. The reinforcement learning no optimal action exists in a given state as it is in supervised learning, but the learning algorithm must identify an action in order to maximize the expected reward over time. The concise description of data is the strategy that maximizes the reward over others.

The problem of reinforcement learning deals to map situations to actions, to get the maximum a given reward. Opposite to supervised learning task, the learning algorithm is not told which actions to be taken in a given situation. But, the learner is assumed to gain information about the actions taken by some reward not necessarily arriving immediately after the action is taken which differentiate it from supervised learning. [12].

2.4 Text Modeling

In [13] Hanini and others extracted a mathematical equation to model the student performance in the adaptive chat room .They continued deeply to model the student performance by studying each part of the giving course . In [26] they also discussed the text modeling in the adaptive chat room.

In [1], the researcher discussed a model for monitoring the text and expressions used by the student during the educational chat session with his colleagues about a particular topic assigned to be discussed during a particular session. Monitoring is done through text modeling process by evaluating the expressions used by the student within the session time. This method is used to improve the general idea of the educational Chat among students and make it formalized which will lead to make the students behave more seriously during chat session. Experiments performed as well as previous studies have produced mathematical equations based on the parameters extracted by analyzing and mining the messages submitted by the peers. To perform the text modeling in chat room [1], the researcher divided the text used in the chat room into eight main categories in addition to one category for unused words. These categories are named levels; each level has its own weight in the text final model [14].

The levels are shown in Table 1[1].

Table 1: Levels of chat text

Category	Level	Target Tag
Main concept	Level 1	Self
Related directly to the main concept	Level 2	Self
Useful words	Level 3	Self
Positive expressions	Level 4	Both
Agreement expressions	Level 5	Both
Enquiry expressions	Level 6	Both
Respect expressions	Level 7	Self
Negative expressions	Level 8	Peer
Unused expressions	Level 9	Both

3. Intelligent Adaptive Virtual Class Model (IAVCM) System

Intelligent Adaptive Virtual Class Model (IAVCM) is intelligent client/server software for modeling the chat text in the virtual class room based on Tokenization. It works in two modes, System training mode (system Knowledge Building) and system use mode as shown in Figure 1.

3.1 IAVCM Main Components

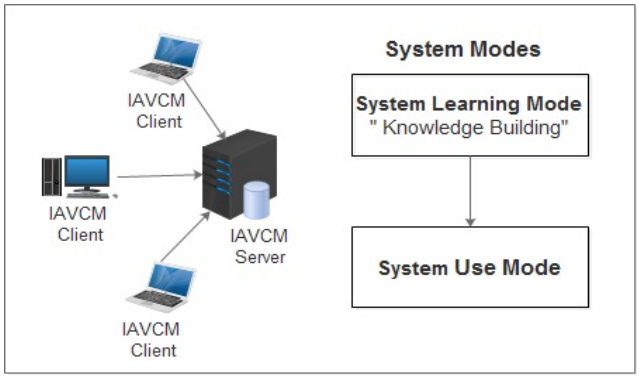

Fig. 1 IAVCM Client Server Model & Modes

IAVCM consists of different components that include courses management, language management, experiments

management, student's profiles, Machine learning Model, tokenization engine, key words auto leveling algorithm (KALA) and chat management. Figure 2 shows the system main components.

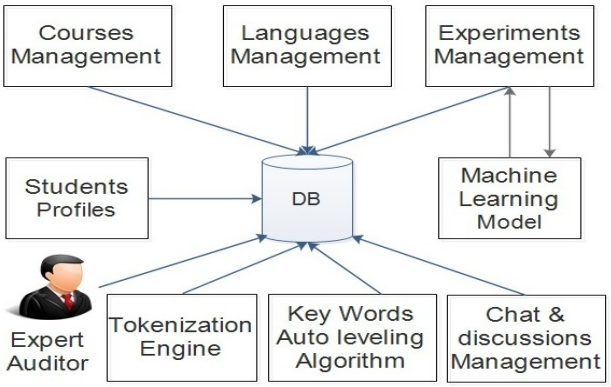

Fig. 2 IAVCM Main Components

The courses management aims to manage the courses in the system by adding the following for each course; course topics, course concepts, course terms, course terms description and text script for each concept. Figure 3 shows the IAVCM system's main interface.

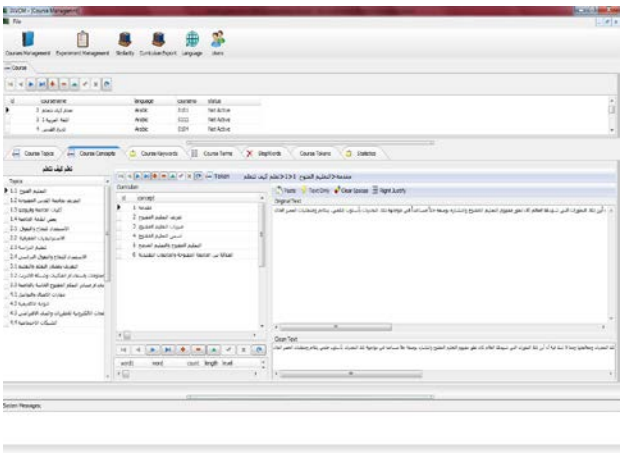

Fig. 3 IAVCM Main Interface

The system supports multi languages and in the language component stop words are added with four keywords levels as following:

Level 4: Positive expressions.
Level 5: Agreement expressions.
Level 6: Enquiring expressions.
Level 7: Respect expressions.
Level 8: Negative expressions.
Stop words list

Figure 4 show the language screen.

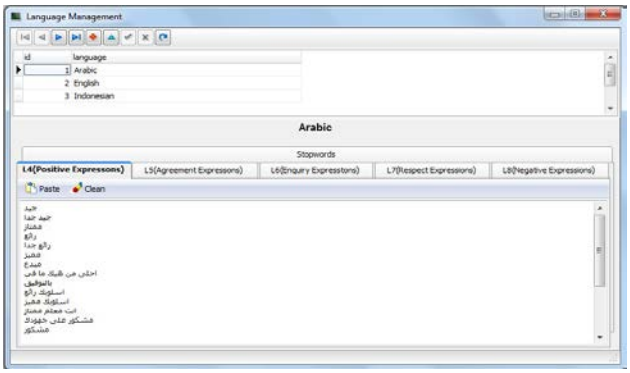

Fig. 4 Languages screen

The designed system includes experiments management components. It includes: create the experiment and assign its discussion topic, assign the chat room, determine the chat session time and date and activate the chat room. All the experiments will be linked to the Machine learning model for evaluation.

Our goal is to build a machine learning algorithm capable of detecting and evaluating new unseen experiments. In the machine learning phase, we split the experiment into tow datasets including: training dataset used to train the model, and the unseen testing set used to predict the consistency.

Students' Profile component stores the students information such as grades and the chat sessions evaluation. In the IAVCM, we came with our own Tokenization engine which tokenizes both the course curriculum script and the chatting scripts. It can tokenize multi languages. Key words auto leveling algorithm (KALA) is a new algorithm that we created to classify the token keywords to the 9th key words level. The chat & discussion management component aims to manage the output of the chat sessions in both the training and system use phases.

3.2 IAVCM in training mode (system Knowledge Building)

The IAVCM system main process starts in the system training mode which aims to build the system's knowledge for the courses. The expert starts the first process by adding the courses using the courses management component. Then, for each course we add the course topics, course concepts, course terms and course terms description. Finally, the text scripts for the concepts are added. Figure 5 below shows the main system process in the training mode.

In order to use the text scripts for the machine learning, we transform it to vector. All the script will be tokenize using tokenization engine, and the output will be Tokenized words list. The aim of the our research is to convert the AVCM system to be intelligent by using the idea of the tokenization and classify the tokens in 9th keywords levels as shown in Table 1.

Based on the experiments for four different courses in Arabic. The total number of the tokens is 36,589 keywords for the four courses. It was big challenge for us and it leaded us to come with what called Auto Keywords Leveling Algorithm (KALA), which will be used by the system to make auto leveling for the keywords.

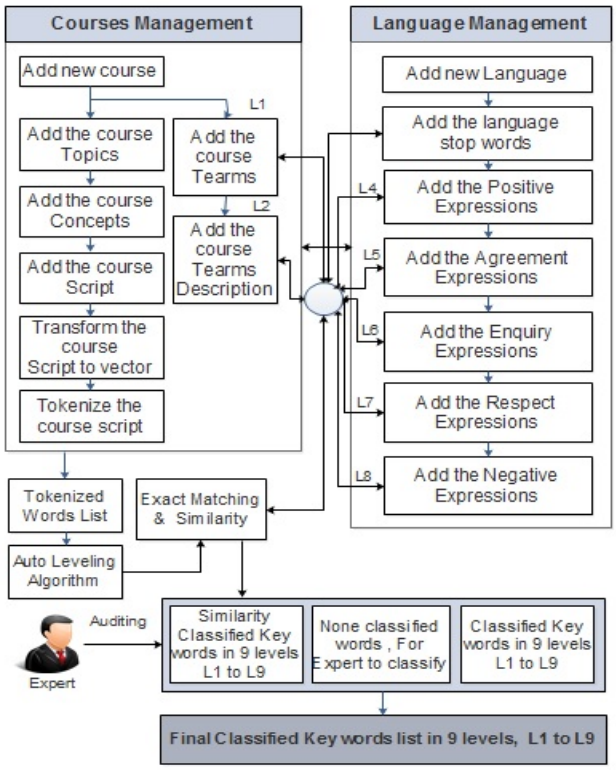

Fig. 5 Tokenization and key words Auto leveling process

The system uses the exact matching search, and the similarity search to find the suitable level for the token. For similarity search the system uses pool of similarity Algorithms including: Trigramm, Like, SoundEx, Metaphone and levenshtein. The system calculates the average for the result of the fifth algorithms, if the Average is greater or equal 0.75 the word appears and is classified, otherwise it will be discarded.

The Expert will audit the results of the auto leveling, the similarity, and none classified words that are left for the expert to classify. By the end of this process the system will got the final classified keywords list in 9th levels.

This process is applied in two phases. The first one is for the curriculum script, and the second is for the chatting experiments that are linked to the machine learning model. By the end of the training and testing experiments, the status of the course will be "Ready to use" and the system will be ready to use by the learners in the System use mode.

3.3 The Keywords Auto Leveling Algorithm (KALA)

KALA Algorithm is a new achievement that allows the system to make the Auto Leveling for the tokenized keywords. As shown in Figure 5, Kala works in five phases. In the first phase KALA will search for the keyword in the stop words list of the language, if it is found in it, it will be discard, because the stop words are not calculated in the evaluation. If the keyword is not found, KALA will make the exact matching search.

In phase 2, KALA will search in the course terms list, if it is found the word will be classified in Level 1, and if not, it will search again in Level1, if it founded then it will be level1 and if not founded, KALA will search in terms description, and level2 , the same steps will be done respectively from L3 to L9. Then Kala will apply the Similarity search for level1, and level2, and the base values for the similarity will be 0.75.

If the keyword is not found in any of the mentioned levels the keyword will be listed in what is called empty list that is for none classified keyword, these keywords are left for the expert to be classified manually. Figure 6 shows KALA algorithm.

Algorithm 1 : Keywords Auto Leveling Algorithm

```
for each token T in DataSet D
  {
    //Phase one: Stop words
      {
      if T in [StopWords] then discard
      }else
    //Phase two: Exact matching
      {
        level= { L1 , { T ,in terms
                      { T ,in keywords L1
               { L2 , { T ,in term discribtion
                      { T ,in keywords L2
               { L3 to L9 , in keywords L3 to L9 respectively
      }else
    //Phase three: Similarity matching
      {
        level= { L1 , { T ,similarity ⩾ 0.75 in terms
                      { T ,similarity ⩾ 0.75 in L1 keywords
               { L2 , { T ,similarity ⩾ 0.75 in terms description
                      { T ,similarity ⩾ 0.75 in L2 keywords
      }else
    //Phase four: Not exist
      Add to empty list //manual leveling
  }
```

Fig. 6 KALA Algorithm

3.4 IAVCM in use mode

After the training and testing phases end, the course will be ready to use by the learners. The learners can start the chat session, and by the end the learners will be evaluated by three types of evaluation that are; Peers evaluation, time evaluation and chat text context evaluation. The chat script will be tokenized, then the keyword will be counted for each level and will be evaluated based on mathematical formula, since each level has different weight. The total grade for the learner will be the sum of the three evaluation grades. The learners' grades will be saved in the student's profile and will be updated. Figure 7 shows the system process in the Use mode.

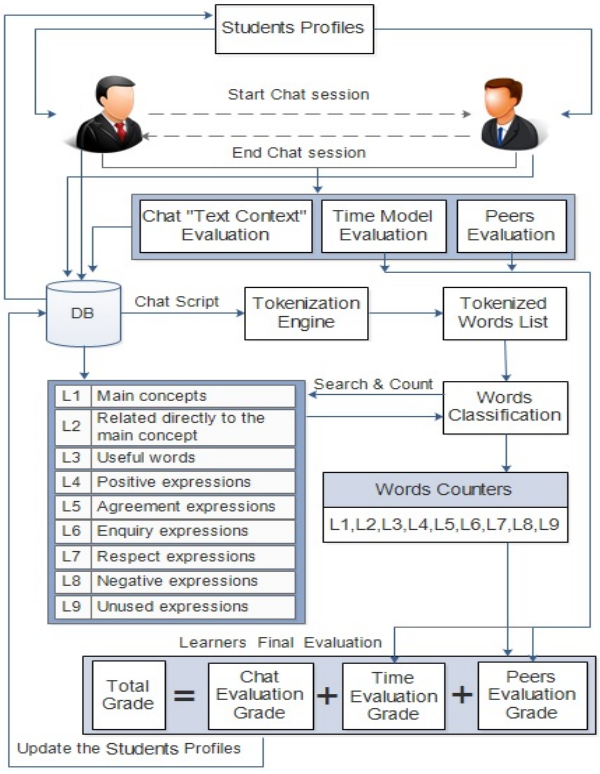

Fig. 7 IAVCM Process in the System Use Mode

4. Results and Discussion

The results of the experiments show that the IAVCM system is a promising one; in our experiments we apply the system for four courses in Arabic language at Al-Quds Open University in Palestine. In the training process we feed the system with the courses topics, concepts, terms, terms description and the curriculums scripts. The IAVCM system tokenized the curriculums scripts, and the total number of the tokens was 36,589 as shown in Table 2.

Table 2: Courses tokenized keywords number

Course	Total Number of Tokens
Computer 101	7,187
Arabic 101	9,148
Jerusalem History	10,843
Learn how to learn	9,411
Total	36,589

This big number of keywords that need to be classified into 9th levels as shown in Table1 was a serious challenge. We work hard to meet this challenge by creating the Key Words Auto leveling Algorithm (KALA) that automatically classifies the keywords into their correct level. Kala Algorithm is a good solution and makes the IAVCM a smart system. The expert auditing process for the result of the tokenized topics improved the result of KALA Algorithm. The result of using KALA Algorithm for one unit for three courses is shown in Table 3.

Table 3: KALA Algorithm – empty key word improvements

Course	**Computer 101**		**Arabic 101**		**Jerusalem history**	
Total Empty Words	700		269		830	
Tokenize Transaction	Empty words count	Improvement %	Empty words count	Improvement %	Empty words count	Improvement %
T1	677	3%	231	14%	762	8%
T2	671	4%	169	37%	731	12%
T3	643	8%	82	70%	705	15%
T4	490	30%	58	78%	685	17%
T5	459	34%	47	83%	627	24%
T6	423	40%	36	87%	627	24%
T7	405	42%	28	90%	616	26%
T8	318	55%	17	94%	581	30%
T9	274	61%	0	100%	553	33%
T10	253	64%			543	35%
T11	185	74%			525	37%
T12	172	75%			496	40%
T13	167	76%			481	42%
T14	152	78%			477	43%
T15	120	83%			446	46%
T16	88	87%			423	49%
T17	77	89%			399	52%
T18	76	89%			330	60%
T19	52	93%			312	62%
T20	33	95%			246	70%
T21	33	95%			246	70%
T22	13	98%			229	72%
T23	0	100%			137	83%
T24	0	100%			129	84%
T25					115	86%
T26					40	95%
T27					40	95%
T28					6	99%
T29					0	100%

The results show that KALA succeeded to classify the majority of the keywords for the courses. In some little cases it classifies some words as empty keywords that mean the expert has to decide their level manually. The expert will audit the empty keywords and classify them to the correct level manually and respectively for the topics. The result shows that the system start to learn from this process and the number of empty key words start to

decrease. Figure 8 shows the improvements of the empty keywords.

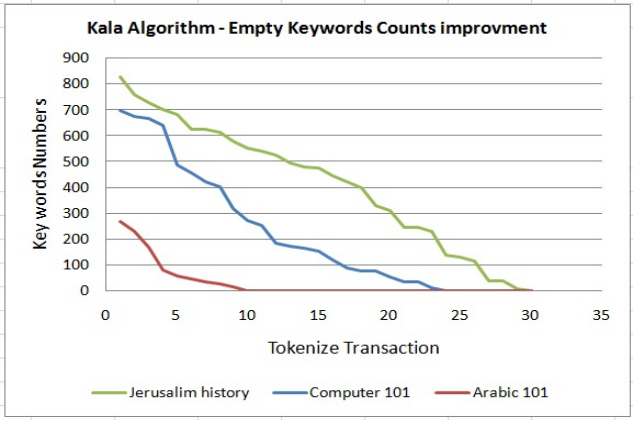

Fig. 8 Languages screen

We can see that after each audit process done by the expert, the number of the empty keywords decrease. In figure 8 above we can note that the number of the empty keywords for the three courses decreased till became zero that means that the system learns and no more empty words a pear.

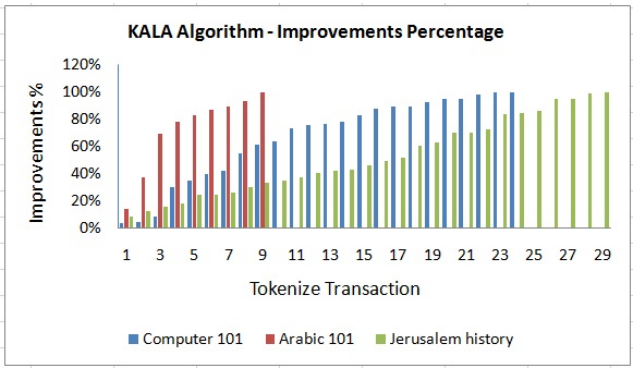

Fig. 9. Empty key words Improvements Percentage

Figure 9.above shows that the percentage of the empty words improvements start to raise till 100% percent. These results represent the experiments for one unit for three courses.

It indicates that the system gives good results, and KALA performance was perfect that make the system smart. We apply the system for three courses with 60 chat sessions for 120 students.

5. Conclusion

We can summarize that we developed Intelligent Adaptive Virtual Class Model (IAVCM) System, based on tokenization, and machine learning model. We came with new algorithm called Keywords Auto Leveling Algorithm (KALA) that classifies the tokens to the levels automatically. The result of the algorithm was promising. IAVCM as intelligent system offers different management services for the expert to feed the system and to manage the courses easily. The chat services offer the learners flexible chat tool that is easy to use and we could convert it to be a real effective educational one.

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