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SA-E: Sentiment Analysis for Education

Nabeela Altrabsheh, Mohamed Medhat Gaber, Mihaela Cocea
*School of Computing, Buckingham Building,
LionTerrace, Portsmouth, Hampshire, PO13HE, UK*
E-mail: nabeela.altrabsheh@port.ac.uk, mohamed.gaber@port.ac.uk,
mihaela.coccea@port.ac.uk

Abstract. Educational data mining (EDM) is an important research area that is used to improve education by monitoring students performance and trying to understand the students' learning. Taking feedback from students at the end of the semester, however, has the disadvantage of not benefitting the students that have already taken the course. To benefit the current students, feedback should be given in real time and addressed in real time. This would enable students and lecturers to address teaching and learning issues in the most beneficial way for the students. Analysing students' feedback using sentiment analysis techniques can identify the students' positive or negative feelings, or even more refined emotions, that students have towards the current teaching. Feedback can be collected in a variety of ways, with previous research using student response systems such as clickers, SMS and mobile phones. This paper will discuss how feedback can be collected via social media such as Twitter and how using sentiment analysis on educational data can help improve teaching. The paper also introduces our proposed system *Sentiment Analysis for Education (SA-E)*.

Keywords. Education Data Mining, Sentiment Analysis, Naive Bayes, SVM, Student Response Systems

1. Introduction

Educational Data Mining (EDM) is application area of data mining that is developed to address problems in education. Addressing such problems can lead to helping students who need advice, removing and adding material to the unit according to students comprehension and finding students opinions about the course. Feedback in education can be categorised in to: 1. Feedback from the lecturer to the students, this is for the self improvement of the students; 2. Feedback from the students to the lecturer, this allows them to guide the lecturer into teaching the course in ways they understand best.

Student Response Systems (SRS) is used for feedback in the classroom, given by students to the lecturer, via devices such as clickers and mobiles. However SRSs fall short to provide detailed feedback about what might have gone wrong. Social media can be a good tool for students to provide such detailed feedback. Among those media comes Twitter. Twitter can provide students with a convenient way to express their feedback in free text. This paper will show that using Sentiment Analysis on students feedback provided by Twitter has many advantages. This is not the first time twitter has been used to take students feedback. In [1] Twitter was used and the lecturer had to analyse the results, which caused work overload on the lecturer.

Sentiment Analysis is a field that works on making sense out of textual feedback and opinions. Opinions can be negative or positive, different emotions can be associated with

those opinions. Emotions can be negative such as confused, bored, and irritated an example for this is I do not know [2]. Positive emotions such as confident and enthusiastic can be expressed such as when students writes in a louder style such as bold writing [2]. Neutral feedback is when a student does not express negative or positive emotion [2]. Different techniques have been used in sentiment analysis and a few have proved to give superior performance such as Naive Bayes (NB), Max Entropy (MaxEnt) and Support Vector Machines (SVM).

The paper is organised as follows. Section 2 will focus on student feedback throughout the lecture and discuss the disadvantages of clickers and Short Message Service (SMS). Section 3 will highlight the advantages and disadvantages of the sentiment analysis techniques mentioned above and discuss more about sentiment analysis. Section 4 will show how both areas can be combined and what can be implemented. Finally the paper is concluded with a summary and future directions to work in Section 5.

2. Students Feedback

Students feedback is important because it can help the lecturers understand the students learning behaviour. Sometimes students do not understand what the lecturer is trying to explain, thus by providing feedback students can indicate this to the lecturer. Students feedback can also help in understanding different issues that students have including the students not understanding the lecture.

Feedback needs to be taken in order to make improvements in teaching [5]. If the students do not participate in giving feedback then there is no way in finding out if the teaching needs improvement. Students often act as observers in the classroom and expect the lecturer to feed them with information, this is a problem especially for international students that have come from different backgrounds and experienced different teaching methods. Student engagement is important in education and one way of measuring it is through participation [6]. The traditional way of students asking questions is raising their hand to ask, although this way does not suit everyone such as shy people. A study about student engagement [6] showed that participation was lower by means of raising hands compared with the use of clickers, meaning that clickers are more popular with students than raising hands as means of engaging in learning. Another disadvantage to hand raising is that students can look to see other responses before making a response and copy from other students [7]

Students lack of participation is a common concern for educators [6]. In large classes it may be time consuming if every person needed one question then not much material will be covered. In [6] the author attempted to find out how student response systems impact student learning in large lectures [6], where students have less chance to ask questions because of the class size [8]. Lack of participation could be from students not paying attention. Students can be daydreaming due to having difficulty in maintaining attention throughout classes [7]. Some interesting results showed that students that participate in class achieve better results than students who do not [9]

Feedback can be collected through a variety of SRSs, including clickers and mo-bile phones. However, in addition to specifically asking for feedback lecturers can ask students questions and students can ask lecturer questions. Therefore, SRS devices can help in communication between the lecturer and student. One common disadvantage of SRS is the cost of the clickers and mobile phones, but nowadays it is very rare to find a student

without a mobile so there is not an extra cost for the student or the university. The following subsections present in more detail three types of SRS: Clickers, Mobile Phones and Social Media.

2.1. Clickers

Clickers are handheld devices which usually contain one or more buttons. In [10] study, the clickers that were used had one button which was labelled yes and this button was used to respond to the lecturers enquiries. The lecturer explained how the clickers are used and then throughout the lecture the lecturer asked the students questions for instance if they were ready for the lecture to be continued and if they understood a certain point.

One of the many advantages of clickers is allowing students to focus longer on the material and learning it by participation instead of focusing on taking notes throughout the entire lecture [7]. On the other hand, in addition to cost, clickers have the disadvantage of students losing them, breaking them or forgetting to bring them to class. Moreover, clickers can distract students in class [6]. To solve the problems of clicker cost and the limited information derived from the data mobile phones came as an alternative solution.

2.2. Mobile phones

Mobile phones are popular with students, with 98% of students owning a mobile phone [11]. Students usually leave their mobiles on throughout class, therefore being able to use them for feedback. However, students can also use mobile in other activities such as sending messages to their friends [11], [12]. One example of students wrongly using their mobiles is flooding the system with inappropriate messages [12]. The use of mobile phones in the classroom also has some negative outcomes or distractions such as students phones ringing during class. Feedback can be taken from mobile phones using applications and text messages which are presented in more detail below.

2.2.1. Clicker Application

An example of Clicker Application is found in [13]. A study that analysed the feedback of the students via mobile phones this project name is Crowd Feedback. The students could post feedback about the lesson and the lecturers phone would buzz if something interesting was found from feedback analysis. The system was not only giving feedback for the lecturer but for students as well in order for them to interact and know what each of the children comprehended. The system also showed that the students had given feedback all throughout the lecture and that there were two high "dislike" peaks. Further study can be done to find out what had gone wrong at those two times. The paper acknowledges that feedback would be more beneficial if it were richer than just providing yes and no answers. As clicker application solved the solution to the cost of devices it still did not solve the fact that the data received from the students was limited. There is need for students to write sentences to give a cleared feedback and SMS solved this problem.

2.2.2. Short Message Service (SMS)

The idea of collecting feedback through SMS in the education system was proposed in [14]. In their research they created a model that collected learning feedback from the students via SMS messages. One aim to their system is to improve the delivery of the

lesson by finding out students opinions. Although the system had many benefits they found that taking feedback via SMS had many flaws such as the limitation of the message space to a certain amount of characters and incomplete SMS due to this limitation. Other downsides to this project found were the spelling mistakes that the audience texted, this was solved by a model called the corrected model. The corrected model corrected text to similar words such as slp to sleep. Another model that they created was the sentiment model. This model implemented sentiment mining on the correction model to find interestingness and divide the concepts into true and false. Although words can have different meanings and can be positive and negative according to the student involved.

One aspect that the authors [14] did not take into consideration is the cost of the SMS texting service, [15] suggested lowering the cost barrier may help in increasing feedback in lectures. Also the authors in [14] tested the students feedback at the end of each lesson, this is great for improving the lectures over time as the lecturer can modify the teaching after receiving this feedback in the next lesson, however this would be more effective if the feedback was throughout the lesson in timescales to insure that students get the greatest possible out of each lesson. It was suggested in [14] that including timestamp and the date with the feedback can help monitor the improvement of teaching over time. Such a trend analysis would be a useful tool for lecturers that would help them improve their teaching.

2.3. Social Media

It would be easier to compare between tweet or Facebook posts especially with the social networks becoming the most popular communication nowadays. Social media is popular, statistics show that 93.5% of 18 year olds and 95.4% of 19 year olds in the USA were found to use social networking on a regular basis [1]. 52.1% of academics in 2010 say that they have used Twitter [1]. In addition to that over 470 universities worldwide are using social networks such as Facebook and Twitter to communicate with students [1].

From Twitter advantages in education is that students are familiar with the tool and training will not be needed [1]. Another great benefit to using twitter as feedback is that it is free as twitter can be opened from the their own mobiles on the university wireless network. Twitter has some disadvantages such as it being a distraction for the students or the lecturer to have to multitask [8]. Also the tweets appear sequentially so the lecturer has to read from the beginning to understand what is going on therefore time loss happens [8]. Twitter solved the issue of the SMS cost issue as it is a free tool that anyone can use and students can access it via the universities network. The characters are limited which can be seen as an advantage to students using as less words as possible and this makes them focus on the important words to create a sentence as meaningful as possible. Some of the disadvantages where that the lecturer has to scroll through the tweets in order to understand the students opinions and analyse the text manually. This is where Sentiment Analysis for Education tool will help as the lecturer will only have to stop a minute every 20 minutes for the student to post their tweets and the tool will analyse the results and return them immediately.

3. Sentiment Analysis

Sentiment Analysis also known as subjectivity analysis, opinion mining, and appraisal extraction [16] is an application of natural language processing, computational linguistics

and text analytics to identify and retrieve certain information from the text, this is done by studying the subjectivity or the opinion. When looking for the success of a product it is important to know what features the user liked or disliked, the term for this is feature extraction. Sentiment polarity is usually either positive or negative but polarity can also be expressed as a range such as how much the user liked the product this range can be into an n-point scale, e.g., very good, good, satisfactory, bad, very bad [17]. Finding positive and negative words without the n point scale is easier than trying to determine the weight of that word. Sentiment analysis can also be used to extract different users emotions from the text such as Love, Joy, Anger, Frustration, and Neutral [18]. Subjectivity and emotion are two close concepts subjectivity represents facts and also emotion, feelings, views and beliefs. [19] found that sometimes positive words can be put into negative reviews and vice versa. They also found that different users have different opinions about positive rooms some like it to be clean some like it to be big so there is a variety in what people put as negative and positive but in the end a pattern can be made to find that most people like a certain characteristic and then it can be positive. The word can have a positive meaning in some ways and negative in other ways such as the word small it can be negative if describing a hotel and positive if describing a mobile. It was found through tests that sentences do matter in the sentiment and a word by itself can be positive or negative according to the sentence it is put in.

Reviews are affected by students emotions [20] and this is why it is important to understand if the students are struggling in the course and what they dislike about the course. [18] looked into emotions of the e-learners through their texts this allows us to break the distant of emotions between the e-learner and the lecturer. [18] found that most of the research that has been done toward the e-learners cognition and not their emotion or sentiment, the distant between the lecturer and the student is a main cause for this. The facial expression plays an important role in understanding the persons emotions. E-learning has rarely any face to face communication unless the lecturer and student have both equipped web cam and this is why there is need to understand the students text and to analyse it to find what the students feelings are toward the lecture and this will hopefully improve from the quality of teaching.

Analysing text can help the lecturer understand the student more carefully , the emotion types in [18] were categorised into Love, Joy, Anger, Frustration, and Neutral. The student can express his feelings in short expressions or words. [18] created patterns to find what words are associated more with emotions, they also give solutions to relieve the e-learner such when an e-learner typed that he is depressed because his supervisor does not like his report. Table 1 shows the adjustment strategy to help the user:

Table [1]: Example to E-learners Emotion

Event set	emotion	Sentiment adjustment strategy
criticized by teachers	frustration	Suggest him to communicate with the teacher
Blamed by teacher	frustration and anxiety	Say something like that you had done your best, so dont blame yourself
Yelled by teacher	frustration	Tell him that Experience is the mother of wisdom, do a better job next time

3.1. Sentiment Analysis Techniques

The most common technique in sentiment analysis are Naive Bayes , Maximum entropy and Support vector machine. These features have been proved to work well with sentiment data and have been used and praised in the following: 1: Joachims, 1998 cited in Prabowo and Thelwall, 2009; 2: Pang, Lee and Vaithyanathan, 2002; 3: Vachaspati and Wu 2012; 4: Go Bhayani and Huang 2009 and 5: Lu, Peng, Li and Ahmed, 2006.

In [21] Naive Bayes gave good accurate results when implemented on reviews, and blog posts. As for Lexical method it varied, and gave good and bad results. SVM method was used for reviews, and alone it showed small accuracy but when accompanied with Naive Bayes or Lexical methods the results become higher. Therefore, to summarise it is better to combine the methods to get better accuracy results. The research showed that[21] had different results with[22] which claimed that SVM is the best classifier after comparing the Naive Bayes and the SVM classifier. And [23] concluded that the three classifier he used, Naive Bayes, maximum entropy and SVM had similar performance. in [31] the best results was found with the SVM classifier, comparing the same three classifier and [22] also said that although SVM is the best classifier there are some differences in the overall performance.

3.2. Features

After deciding which technique to use features that will be considered in the experiment should be decided. Features allow a more accurate analysis of the sentiments, and for a more detailed summarization of the results [21]. These are some features that can be used :

1. Term Presence and Frequency : the frequency of the word and the presence of some words.
2. N-grams: position of the word and taking one two or three words.
3. Part-of-Speech: Adjective are good indicators that there is some kind of opinion
4. Syntax
5. Negation: Negation is flipping the positive into negative or negative to positive, Negators can affect the word and make it the opposite Examples to some negators are not, none, nobody, never, and nothing [24], problems with negation could be: a. Include the negation to a term close to negation such as like and not , the location sometimes affects this like including not at the end [21] ; b. Negating the sentiment in the sentence such as No wonder everyone loves it. [21] Some examples of negators from [24] are shown in Table 2:

Table [2]: Negator Examples

Example	Negation
Nobody gives a good performance in this movie.	Nobody negates good
Out of every one of the fourteen tracks, none of them approach being weak and are all stellar.	None negates weak
Just a V-5 engine, nothing spectacular	Nothing negates spectacular

3.3. Data Source

The internet has become a main source for the users to express their opinion . More users

are willing to express their opinions online [25]. This has a good advantage as more opinions can be extracted from a wider source. Social networks has been used in data mining for many years.[26] gave some good advantages in using twitter such as twitter is up-to-date and reflects the current news and events happening around the world. For this project the data has to be in real-time and twitter will be used

3.4. Pre-processing data

After obtaining the data from the source, the data has to be pre-processed before the sentiment analysis stage this is to increase accuracy and to reduce error in the data. Pre-processing can be discovering emoticons, words in upper case, removing stop words, removing unnecessary punctuation, finding exclamation marks or question marks, and removing inconsistent casing of letters [27].

4. Sentiment Analysis in Educational Data

Sentiment analysis has not been implemented on the educational sector yet. When combining these areas together education can be improved by saving time in analysing real-time feedback. Students can use twitter to express their opinions about the lecturer for example the lecture can change the pace of the lecture [28]. When finding out students opinions over time intervals the lecturer can alter teaching style according to the results, repeat a part that the majority of the students did not understand and answer any questions without the need for student to interrupt the lecturer. The following areas will be discussed in the framework: 1. The method used to send feedback; 2. The time slots in the lecturer and how to post feedback 3. The Techniques used to analyse the feedback 4. The results

4.1. SA-E System Architecture

The research steps will be implemented in the classroom as followed: Students will provide feedback to the lecturer via social networks such as twitter. The reason that social networks will be the source of data is because it is free and popular among students nowadays. In 2010 Twitter had 106 million users, and 180 million visitors every month [29]. Twitter company revealed that 300,000 new users were signing up every day and that it received 600 million queries daily through its search engine. 37 % of Twitters users used their phone to send messages [29].This will overcome the problems of SMS being expensive or clickers giving limited feedback.

The students feedback can be taken at anytime in the lecture but there will also be time slots chosen by the lecturer according to stop point which he thinks that the previous topic will follow on to the next topic. The time slots can also be randomly chosen at a 20 minute time slot to insure that students understand every part of the lecturer and that they will not get lost in understanding any part of the lecture. The lecturer can also change the slots while giving the lecture according to the results, so for example if the students had not understood a part the lecturer may decide to put more slots at the next part of the session to make the students understand more. Within a amount of time if the lecturer found that

students are often finding difficulty in one part then he may decide to explain it in another way. Time series is an important part in this project, students may show a high response within a certain time, this can be traced back to find what went wrong at the time, and why students are not understanding a particular module and many more. After a certain time patterns can be derived from this data and future students will have an even better education.

Students feedback will be pre-processed and then analysed via Naive Bayes and Support Vector Machine individually or combined. These techniques were chosen because they have been proved to work well with reviews and educational data. This will analyse that the document phrase and this is the post or tweet as a whole is positive or negative. There could be positive words in negative reviews and vice versa, this will be looked into as well. The raw data will be pre-processed to insure the quality of the data. Then different features will be applied to insure that the focus is going to the correct part of data. The features will be decided throughout experiments. The results will be passed through an application where the lecturer can decide to act according to the results.

After obtaining the results verification methods can be applied to assure that the sentiment analysis has been a success. From these methods can be exploring students facial expressions to find if students emotions match with the results obtained. The lecturer can ask questions to insure that the students responses are correct. The results will be kept for further study and other use will be made out of the data by analysing it over long periods of time.

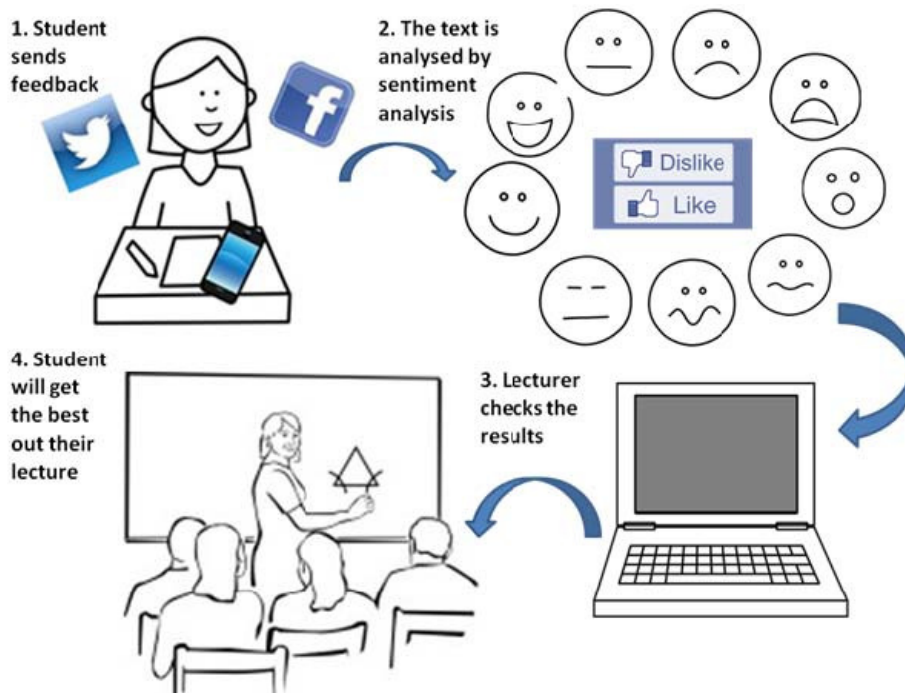


Figure 1: SA-E System Architecture

Sentiment Analysis in the education sector can be a wide area and hold many possibilities. Although this paper has only shown a few points on how this can be implemented, there can be further points that can be researched. Figure 1 shows SA-E Architecture.

This paper provides the reader with a new perspective that can open areas of research in educational data mining. This can be achieved with the adoption of the fast growing area of Sentiment Analysis.

5. Conclusion

In this paper, a brief background of educational data mining and sentiment analysis was presented including different methods for collecting feedback from students. We noted that the adoption of the emerging area of data mining sentiment analysis in educational systems has a great potential. Sentiment analysis techniques were explained briefly with a comparison, and it was decided that Naive Bayes and SVM techniques were superior for education data [21]. We have also discussed how these two could be combined for the analysis of students feedback in real-time. We have introduced our system architecture termed Systems Analysis for Education (SA-E). The realisation for SA-E opens the door for a potentially fruitful application of sentiment analysis.

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