Student Feedback on Online Learning by Using Sentiment Analysis: A Literature Review

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***Abstract*—The purpose of this study was to explore the implementation of sentiment analysis techniques on student feedback in an online learning environment. This research used the systematic literature review Methods on A Qualitative-Quantitative Continuum. The results of this study present several articles in the last six years period between 2014 - 2019. The number of articles obtained was 12 articles relating to student feedback analysis using sentiment analysis.**

Keywords—systematic literature review, sentiment analysis, student feedback

I. INTRODUCTION

The development of E-learning contributes to the equitable distribution of education globally. E-learning is a bridge of skill distribution that offers time and space flexibility. So, learning can happen anytime and anywhere. The use of E-learning is not only a substitute for traditional classroom learning but can be supplementary or complementary.

According to Brenan and Williams [1], almost all educational institutions collect various types of feedback to improve the quality of education provided, including teaching and learning processes, teaching materials and evaluations. The results of the feedback can be used as input in improving the quality of the existing learning process so that learning objectives can be achieved. Shankararaman et al [2] have proposed a framework for how qualitative and quantitative feedback can provide information for making decisions about improving teaching and learning processes and curriculum.

The use of feedback is not new, but unfortunately, the use of feedback, especially from users of E-learning has not been maximized especially if the form of feedback used is a qualitative open-ended question. Qualitative data analysis of feedback can still be done if the amount of data is still small so that it can still be calculated manually. Problems will arise if the amount of data becomes large. Therefore, we need an appropriate method that can analyze this open-ended question data. Text mining is one of the solutions used to analyze student feedback that is the open-ended question [2]. Research related to text mining is still relatively new, especially research related to qualitative feedback in use in the world of education [3]. The use of text mining in the commercial field is more motivating and used for marketing and media current social [4]. The approach is used to express hidden knowledge based on opinions.

The purpose of this study is to explore the implementation of sentiment analysis in analyzing student feedback in online learning. This research is a systematic literature review which combined the qualitative analysis. Furthermore, to make this research more focused on what sentiment analysis techniques are used to analyze student feedback.

II. LITERATURE REVIEW

A. Sentiment Analysis in Education

Sentiment analysis or better known as opinion mining is a science related to opinion. It is part of Natural Language Processing, a part of computer science and artificial intelligence that specifically relates to human-computer language interaction [5]. Specifically, Liu [6] defines sentiment analysis as a science that analyzes opinions, sentiments, evaluations, judgments, attitudes, and emotions towards a product service, organizations, individuals, issues, events, topics, and their attributes. Sentiment Analysis consists of Subjectivity and Polarity. Subjectivity is a sentence that expresses feelings, opinions or beliefs, while polarity is a sentence that expresses emotions, which can be of positive or negative value. An opinion can be categorized as a negative, positive or neutral opinion while expressing emotional feelings can be associated as an opinion [7]. They say a word can mean positive and can also mean negative depending on the context of the use of the word. Knowing the opinion or review of a product is the most important thing to determine the decision to be taken.

In general, in the business and government world, the use of feedback has long been used to obtain responses from users or customers who are intended to improve services. This form of response is to explore satisfaction or satisfaction with a product or service. Specifically, in education, feedback is needed to improve learning outcomes. Shankararaman [2] say the use of feedback can effectively improve teaching and curriculum which in turn can improve learning experiences and learning outcomes, so Shankararaman, et al share two questions related to a feedback used in education: (1) is a feedback can really improve teaching and curriculum; and (2) whether teaching and curriculum that has been improved can

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truly improve learning experiences and student learning outcomes. The essence of the answer to this question lies in the validity and reliability of the feedback and the selection of strategies to improve the teaching process based on the feedback received.

Providing feedback in the learning process in a way that can truly improve learning outcomes [8]. Also, according to the Center for Innovation in Research (*https://cirt.gcu.edu/*), in addition to feedback learning outcomes can increase student involvement in learning. Hatziapostolou and Paraskakis [9] conducted a study related to the impact of a formative learning process feedback through the Online Feedback System. The results showed significant results that increased student learning outcomes. In addition, Trusca [10] in his research examined the benefits of formative feedback given to students in a teaching and learning process. In his writing, feedback consists of formative feedback and summative feedback, but formative feedback will greatly contribute positively to: (1) providing opportunities for students to improve themselves in learning; (2) increasing student confidence; (3) choosing learning strategies to be used by next teacher / lecturer; and (4) self-regulated development of students. To make formative feedback effective when fulfilling the requirements of time, constructive, motivational, personal, manageable and directly related to the assessment criteria and learning outcomes directly related to the assessment criteria and learning outcomes [9].

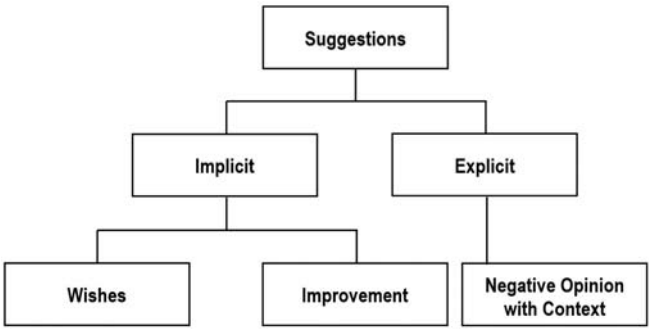

Fig. 1. Suggestion type

Summative feedback is generally the final of learning so that the feedback will be obtained in the form of suggestions for future improvement. Fig.1 shows the type of advice obtained from students. Suggestions are divided into two, namely implicit and explicit [2].

B. Sentiment Analysis Techniques

In analyzing sentiments there are two approaches, namely the statistical and semantic approaches [11]. According to Collomb et al [12], there are several techniques used in analyzing sentiment analysis. This document is intended to demonstrate by example how to construct your own document. However, there are a few details where this document does not follow the correct style.

C. Machine Learning

This technique is used to classify and predict an opinion whether positive or negative, which consists of supervised learning, unsupervised learning and semi-supervised learning [13]. Samal and Panda [14] add reinforcement learning, learning to learn, transduction as a technique in machine learning. There are several examples of supervised learning techniques that have shown good performance in analyzing sentiment, namely Naive Bayes, Support Vector Machine (SVM), Random Forest, and Neural Networks [15]. But the success of this supervised learning approach depends very much on the quality of the training dataset. While the unsupervised learning approach does not require training datasets.

D. The Lexicon Based Approach

The lexicon-based approach consists of a dictionary-based approach and corpus-based approach which employs statistical or semantic methods in order to find the sentiment polarity [7]. A lexicon-based approach, which employs a dataset which contains opinions and some linguistic rules to identify the semantic orientations of product features in opinion sentences, is proposed [16]; [17].

The sentiment category of a product feature in a particular opinion sentence is determined by aggregating the semantic orientations weighted with inverse word distances of surrounding opinion words [18]. Application of a lexicon is one of the two main approaches to sentiment analysis and it involves calculating the sentiment from the semantic orientation of words or phrases that occur in a text [19]. Many works in the literature of sentiment analysis take lexicon-based approaches [19]. For instance [16]; [20] use WordNet to extend the relation of positive and negative words to other related lexical units. Lexicon Based approaches are confidential into Dictionary-based and Corpus-based methods.

The dictionary-based approach finds the opinion of original words, and then searches the dictionary for their antonyms or synonyms. But the corpus-based approach starts with a list of seed opinions and then finds another opinion in a big corpus to try help finding opinion words in context [21].

E. The Rule-based Approach

Rule based approach is used by constructing numerous rules then tokenizing each sentence in documents to classify the word that has a positive, neutral, or negative meaning. A rule has an if-then relationship consisting of antecedents and those associated with the consequence [22]. The purpose of this approach is shallow parsing and is twofold: high speed of processing and flexibility to the unknown, potentially integrated, spoken utterances [23]. Rule-based systems [17]. Applied both on plain texts and on POS-annotated texts, they usually rely on lexicon sentiment relating lexical units to sentiments. They usually present good precision results but require a big set of rules to get a great recall.

F. Statistical Methods

There are many challenges to analyse the sentiment analysis on the review product surveys. Those are the synonymy, polysemy, sarcasm, compound sentences, and unstructured data [24]. Many researches in the field of text mining have been focused to overcome the synonymy and polysemy challenges due to these types of sentences can easily be found in corpus. One of the approaches that can cope with the synonymy challenge is Latent Semantic Analysis (LSA). This approach applies a mathematical representation of the dataset in analyzing sentiment. LSA explores and finds the relationship between words in a document based on their occurrence. Therefore, LSA creates semantic space between associated words [25].

Despite lexical based approach, statistical approach is part of feature selection method. Feature selection is used to optimize the accuracy of sentiment classification techniques

by reducing the irrelevant attributes in documents [26]. Term Frequency Inverse Document Frequency (TF-IDF), Information Gain (IG) and Chi Square are methods of feature selection. TF-IDF is a weighting process that represents term frequency based on documents and term vectors [27]. However, according to Tan and Zhang [28], Information Gain and Chi Square are algorithmic methods used for feature selection that provide better performance.

III. METHOD

The approach used systematic literature review [29] which combined qualitative explanations related to the description of the use of sentiment analysis techniques for student feedback in online learning.

The detailed objectives of this research were reflected by the following research questions (RQ):

- RQ1: Which are the algorithms used in the sentiment analysis for student feedback in online learning?
- RQ2: What are the purposes of implementing sentiment analysis for student feedback in online learning

This study collected literature using a search engine with the keyword "Sentiment Analysis of Student Feedback in Online Learning" from various sources both journals and proceedings published between 2014 - 2019. The criteria for the selected article were full paper and full access articles. The data is then processed with the PRISMA Protocol © (see Fig. 2).

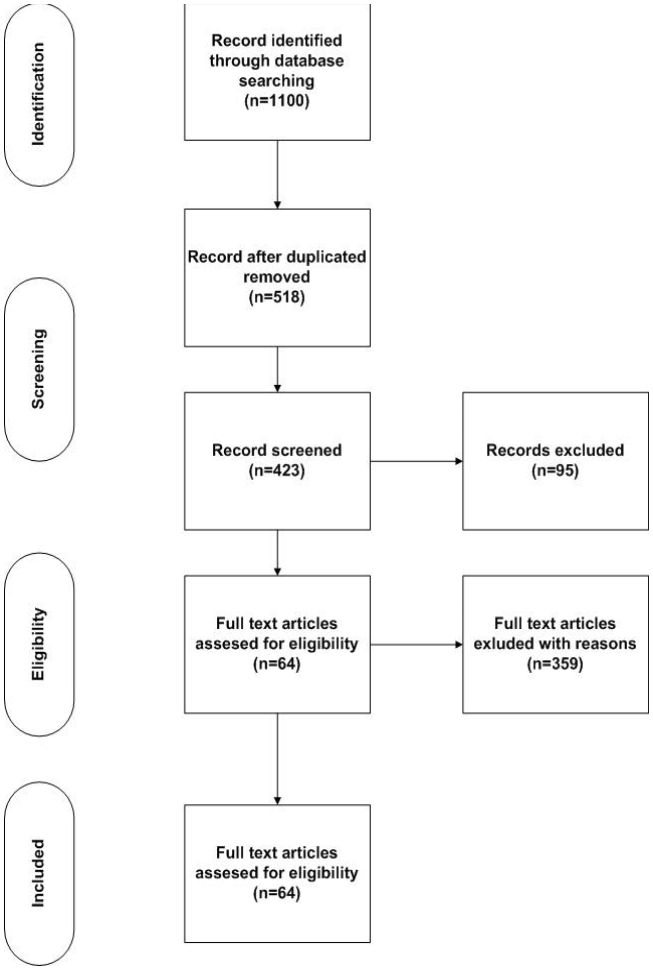

Fig. 2. Flow diagram showing a phase of studies' selection

In the systematic review process, the authors use the PRISMA protocol to produce a transparent picture of the review process. There are four stages during this protocol. The primary stage during this protocol is identification. The author uses the Sagepub database, Emerald and Google Scholar to look for articles with the keywords "Student Feedback on Online Learning" and "Using Sentiment Analysis". In this first process, the authors get 1100 article titles that match these keywords. Still, within the identification stage, the following step is to find a (double published) by using the Mendeley software, the 1100 titles are exported by the author within the RIS format, then inserts into the Mendeley software to look for duplication. in this process there have been 582 articles that were duplicated, then from that result, we merge that resulted in only 518 articles.

The second stage is screening, out of 518 existing article titles. The screening step tries to spot whether all the titles of the article are the results of research or not. The limitation utilized in this text is that the article used is the results of research, both qualitative and quantitative. During this process 95 articles were obtained which were the results of reviews, books, or literature reviews and were not the results of research, in this stage, we conducted an abstract study. So, 423 articles are going to be obtained which can be accessed within the next stage.

The next stage is eligibility, this stage provides a limit on the literature review determined by observing the complete text of the article, whether there is compatibility with the keywords and methods used. This stage we involve reviewers whose task is to spot comprehensive compliance with the bounds that we specify. There were 423 articles obtained in the previous stage. From the results of the review, we got 64 articles that fit the criteria.

The final stage during this process was selecting 64 articles, then they were filtered by using some criteria and finally found 12 articles that match the standards to be analyzed.

IV. RESULTS AND DISCUSSION

Based on the process of selection of this study (see Figure 3) found there are few articles discuss the topic "analysis of student feedback on online learning using sentiment analysis". Table 1 is a collection of research conducted in the last six years between 2014-2019. The number of articles obtained was 12 articles relating to sentiment analysis for student feedback in online learning.

Currently, the implementation of sentiment analysis in education is aimed at exploring the hidden knowledge of comments that are open-ended questions [2]. Generally, these comments are given during the final evaluation of learning as student feedback. Student feedback in a learning process is very important to know student responses to lectures that have taken place. This is intended to help teachers/lectures understand student learning behavior, how far they understand the material that has been given [7].

Twelve articles were identified using the systematic procedure as the most relevant research to sentiment analysis for student feedback in online learning. The answers to the Research Questions (RQs) are obtained through in-depth analysis and exploration of the selected articles.

RQ1: What are the objectives of analyzing students' feedback by using sentiment analysis?

TABLE I. COLLECTIONS OF SENTIMENT ANALYSIS FOR STUDENT FEEDBACK RESEARCH

Studies	Algorithm Used	Data Source	Description
Colace et al [30]	A probabilistic approach based on the Latent Dirichlet Allocation (LDA)	75 students used Moodle for share comments	A system detects students' emotional feelings about several topics, then teacher adjust the learning strategy
Ortigosa et al [31]	Lexical-based and machine-learning	Facebook users comment data through an application developed under the name Sentbuk. Every 1000 comments collected randomly for positive, neutral and negative categories.	A system can detect emotional changes of students at any time through sentiment analysis. The data are displayed graphically every week
Kaewyong et al [32]	Lexicon-based approach	The dataset used was 1,148 student feedback from 30 teachers from RateMyProfessors.com	Assessing teacher performance by analyzing students' freestyle comments.
Kagklis [33]	Statistical Analysis	The data set used is a data forum consisting of 64 postgraduate students at the Hellenic Open University. Forum activities include starting a topic, creating discussion threads and exchanging messages.	Analyzing student participation in online forums through the messages posted using sentiment analysis and student interaction is calculated through social network analysis techniques.
Ullah et al [34]	Support Vector Machine, Maximum Entropy, Naive Bayes, Complement Naive Bayes	The dataset was collected from Facebook with a total of 1036 data consisting of 641 positive data, 292 negative data and the rest were neutral.	Analyzing student's feedback by using several techniques in sentiment analysis. The result is Support Vector Machine and Maximum Entries are the best models for feedback analysis.
Aung [35]	Lexicon based approach	Three comments to test sample calculation	Evaluating the level of teaching performance from students' textual feedback comment.
Gottipati et al [2]	Natural Language Processing and Text Analytical Methods	The student feedback questionnaire is administered online using in-house "FACETS" system in Singapore Management University	Proposing a conceptual framework for student feedback analysis
Gutiérrez et all [36]	Support Vector Machine and Random Forest	This study collected 1040 comments by using SED and Twitter.	Comparing the performance of the algorithm between SVM and Random Forest in making classification of teachers' performance.
Kousalya [37]	Combination of machine learning and lexicon-based approaches	Students' feedback collected through online.	Classifying students' feedback based on polarity by using several sentiment analysis techniques and as a result, random forest classification technique has achieved the best accuracy
Dsouza et all [38]	Support Vector Machine, Multinomial Naïve Bayes Classifier, and Maximum Entropy	The student feedback collected using google form.	Sentiment analysis of student feedback by using several techniques and the multinomial naïve Bayes classifier algorithm performs better compared to the SVM and Maximum Entropy
Kandhro et all [39]	Statistical Analysis: Long Short-Term Memory Model (LSTM)	3000 students' feedback provided at the end of 30 courses conducted during the year 2017 and 2018 respectively.	Evaluating teacher performance using the students' feedback by using Long Short-Term Memory Model and it has prospective to overcome several flaws in traditional methods
Lin et all [40]	Naive Bayes, Support Vector Machine, Logistics Regression, Gradient Boost Decision Tree	3,926 dataset records from postgraduate the evaluation system of Beijing Institute of Technology (BIT)	Evaluating teacher performance based on students' short review. The traditional knowledge-based approach was used to analyze the emotion of student review.

Based on 12 articles that had been collected, three objectives of analyzing students' feedback by using sentiment analysis can be concluded, namely detecting students' emotional feeling, analyzing student's participation, and evaluating teacher performance. The Visualizing as shown in Fig. 3.

RQ2: Which are the algorithms used in the sentiment analysis for student feedback in online learning?

Determination of student feedback was done by statistical analysis methods, natural language processing, lexical-based, machine learning and support vector machines. The statistical analysis method processes the amount of student participation in e-learning interactions. Natural language processing uses a conceptual framework to process student feedback. Whereas machine learning uses predictive rules. The next two methods, namely lexical-based and machine vector support, respectively use emotional changes and better performance to process student feedback. The determination of emotional feelings is mostly done by using the latent self-allocation approach, naïve Bayes and machine learning. Whereas in the process of the predictive textual content sentiment using lexical-based methods, machine learning, support vector machines, and naïve Bayes. The approach as shown in Fig. 4.

V. CONCLUSION

Since the internet era is growing, online surveys are common practice to gain user opinions, as well as online surveys that are conducted in education such as e-Learning. This research was focused on reviewing the use of sentiment analysis techniques on students' feedback in online learning settings.

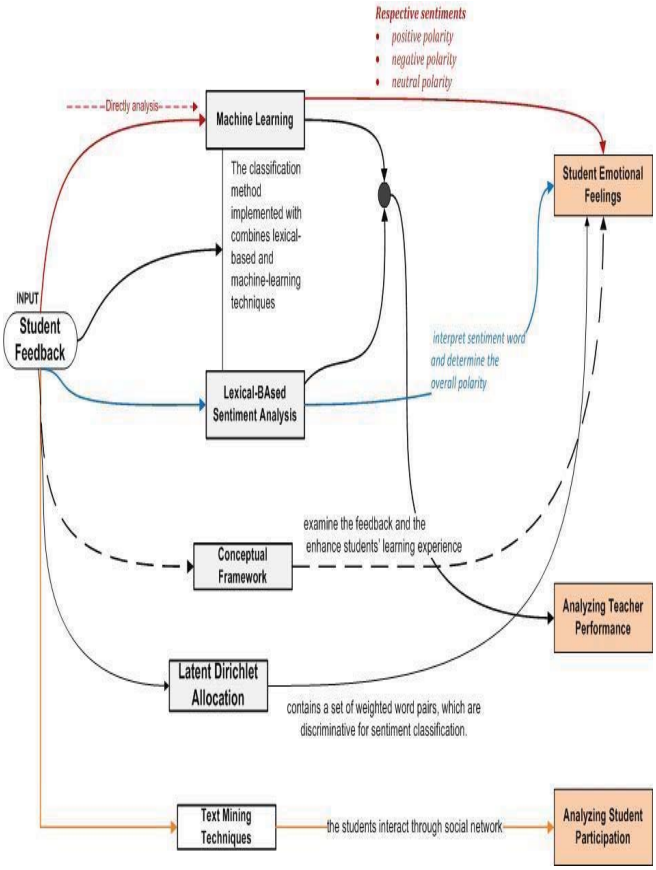

Fig. 3. Visualizing of students' feedback objectives

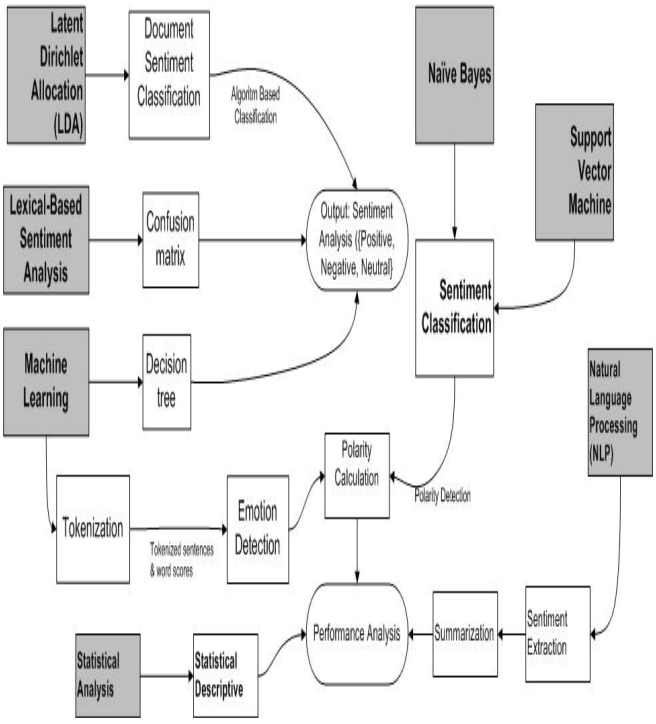

Fig. 4. Visualizing of alghoritms used

Sentiment analysis can build a system to recognize and extract students' feedback. Currently, the implementation of sentiment analysis in education was aimed at exploring the existence of hidden knowledge from comments that are open-ended questions. The sources of feedback are forums, blogs, social media, and sites which contain reviews. The sentiment analysis transforms information from unstructured to more structured data.

This research found 12 articles by using systematic literature review approach. From these articles, the objectives of the implementation of sentiment analysis techniques on students' feedback concluded, namely detecting students' emotion feeling, analyzing student's participation, and evaluating teacher performance. Various sentiment analysis techniques were employed. Each sentiment analysis method has its advantages depending on the process and research objectives to be achieved.

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