Sentiment Analysis on Embedded Systems Blended Courses

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Abstract

Massive Open Online Courses (MOOCs) have been producing an electrified feeling in the academic circles since 2012. This was amplified once profit initiatives like Coursera and Udacity joined their forces with renowned universities like Stanford, Harvard and the Massachusetts Institute of Technology. This paper presents a modality of integrating Embedded Systems MOOCs into blended courses, but at the same time it provides an evaluation of this approach: the sentiment analysis technique. Such an evaluation not only reveals the polarity, but also valuable insights into improving the course content and integration of MOOCs into the intricacies of teaching embedded systems.

Keywords: Massive Open Online Courses (MOOCs), embedded systems, blended courses, sentiment analysis.

1. Introduction

Massive Open Online Courses (MOOCs) started to become a paradigm in higher education in 2012, when Coursera, edX and Udacity commenced the large scale promotion of open online courses. The lectures in this case may include videos, quizzes and online assessments, group discussions, but also peer review (Russell & Klemmer, 2013; Xia, 2015; Baran & Baraniuk, 2016). Even if initially MOOCs launched their journey as stand-alone courses, they started to be used in blended courses. Different approaches are available in scientific literature (Holotescu & Grosseck, 2014; Bicen & Ozdamli, 2014; Bruff & Fisher, 2013) which present a spectrum of courses that were taught in a successful mix between classical teaching methods and MOOCs.

One type of courses which is still underrepresented in the field of blended courses is that of embedded systems. Different methods and techniques have been researched in teaching state-of-the-art academic courses (Chirila & Ciocarlie, 2015), but also embedded systems courses in general (Bogdan, 2016; Malchow & Renz, 2016; Malchow & Bauer, 2016). Students not only have to understand and apply specific programming techniques (Babori & Fassi, 2016), but they also have to cope with specific notions like ports, analogue to digital converters, pulse width modulation, registers and so on. Students often tend to better understand a specific embedded systems concept when being explained by several persons, in different ways. This further helps them in practical activities and projects.

One state-of-the-art technique which is used to recognize and extract subjective information in different corpora is sentiment analysis (Cambria & Schuller, 2016; Tang & Wei, 2016; Schouten & Frasincar, 2016). This technique is currently applied to determine *"the attitude of a speaker or a writer with respect to some topic or the overall contextual polarity of a document"* (Charissiadis & Karacapilidis, 2016). The classification of polarity in a certain corpus is meant to determine if the opinion is positive, negative or neutral, so that a certain product is improved (Grimes, 2014). Such a technique has been successfully applied to analyzing reviews, texts, social media comments in order to make use of the results on a plethora of applications, especially brand decisions, customer service and marketing.

The aim of this paper is to understand, based on sentiment analysis, how students react to blending embedded systems MOOCs into embedded systems courses. The blending variant (Holotescu & Grosseck, 2014) is with no synchronization applied to Embedded Systems courses at "Politehnica" University of Timisoara, in Romania, third year of study. Based on the obtained results, different adjustments can be performed towards the practical blending process, but, above all, towards a better understanding of the notions by the students.

The rest of this paper is organized as follows: the second section presents relevant previous work, while section three offers the used methodology. The last section is offering the obtained results and conclusions.

2. Previous Work

This paper is dealing with two main themes: the first one, integrating MOOCs in Embedded Systems courses, and the second one, evaluating such a blending by means of sentiment analysis. Integrating MOOCs in blended courses has been successfully presented by several authors in their works (Holotescu & Grosseck, 2014; Bicen & Ozdamli, 2014; Bruff & Fisher, 2013), being applied to different courses such as Web Programming and Machine Learning. Holotescu & Grosseck (2014) develop and apply both the methodology and the modalities in which MOOCs can be integrated into blended courses are described. The pedagogical benefits of such a technique vary from learner-centric teaching, offering self-paced study, skills development for collaborative environments and also building skills for continuing and autonomous learning.

MOOCs evaluation has been treated in the literature from different angles. First of all, in Baran & Baraniuk (2016) is presented a very thought-provoking discussion about the future of MOOCs from both the time and economical points of view. In Lei & Hou (2016) is proposed a very interesting evaluation system based on facial expression. Each subject is given a certain number of tasks and the face reactions are being recorded. The reactions are further on analyzed based on seven emotional engagement attributes and three sentiment engagement attributes. In Pireva & Imran (2016) a Learner Decision Journey framework is proposed for analyzing MOOCs in order to generate future improvements.

Teaching embedded systems topics has been quite largely presented in scientific literature. A very interesting paper is that of Baran & Baraniuk (2016) where the authors are largely describing their experience of developing signal processing MOOCs. The involved educators are coming from École Polytechnique Fédérale de Lausanne, the Massachusetts Institute of Technology and Rice University. In Bogdan (2016) a project for teaching embedded systems by e-learning techniques is presented. Such a solution can be applied to embedded systems-related industries, such as the automotive industry. In Malchow & Renz (2016) and Malchow & Bauer (2016) is presented the case of teaching different programming languages such as Java by using embedded systems devices (LEDs, sensors, development boards).

According to Grimes (2014) sentiment analysis can be used for business improving, based on customer experience, surveys, customer satisfaction and employee satisfaction. In this regard, textual data offers useful information on how a particular product has impacted a certain market, but most of all, how the product can be improved. The problem of analyzing individuals' sentiments based on their tweets is presented in Maharani (2014) and Gautam & Yadav (2014). The opinion is classified in sentiment classes, being used as a key factor in decision making. Such results can be used for customer review classification where the opinions are positive, negative or neutral. Relevant techniques and tools regarding sentiment analysis are presented in Cambria & Schuller (2016), while Tang & Wei (2016) provide a method to design neural networks for learning task-specific word embedding in order to take into consideration the sentiment transmitted by the text. In Schouten & Frasincar (2016) is presented an algorithm

which deals with aspect-level sentiment analysis. In this case the sentiment is aggregated on different entities being present within the analyzed text.

3. Methodology

This paper is presenting a modality in which embedded systems Massive Open Online Courses (MOOCs) can be integrated in a traditional course, but more important is offering a sentiment analysis research of the impact that this integration had upon students. The study is applied to Embedded Systems course which is taught at "Politehnica" University of Timisoara, third year of study. Two categories of students were involved: the on-site students and distance learning students. The first group is faced with a traditional approach of teaching a course (namely, face to face meetings, presentations and discussions) while for the second one, the platform which is used is called the Virtual Campus of "Politehnica" University of Timisoara (https://cv.upt.ro/course/view.php?id=1563). Messages, assisted activities, homework and so on were posted on the virtual space of the course. The topics of the Embedded Systems course vary from introductory elements (like ports, analogue-to-digital converters, pulse width modulation, buses etc.) to advanced ones (design, testing based on International Software Testing Qualifications Board certification etc.).

The goal of integrating MOOCs in traditional Embedded Systems courses is to broaden students' practical perception of embedded systems intricacies, but also to allow students to become aware of the MOOC technologies. Such integration would not be complete if the process itself is not evaluated (Bicen & Ozdamli, 2014), therefore the second major goal is to realize a sentiment analysis on the feedback received from the students. This way, not only can the polarity of such a blending be discovered, but also insights into further developing the course are reveled.

3.1. Research methods

The utilized research methods can be divided into two major tracks: activities pertaining to the MOOCs integration into the blended course and specific methods used to obtain the results of the sentiment analysis.

A. *Integrating Massive Open Online Courses into Embedded Systems courses*

The first meeting of the class for the blended course was meant to offer students a presentation on MOOCs. For distance-learning students a special activity was created, entitled MOOCs in Embedded Systems. As a mandatory activity, they were asked to enroll in such a course and complete at least 30% of the MOOC activities, counting to 20% of their final mark in the blended course. Further steps were taken in order to complete such integration.

a) MOOCs' selection: in the first lecture different MOOC platforms were presented, such as Coursera, edX, Udemy, but also MOOCs directories (https://www.mooc-list.com/?static=true) and students were asked to choose an embedded systems-related course. At the end of the activity a survey was conducted, which was the base of the sentiment analysis part. For those students who completed more than 60% of the chosen MOOC, the theoretical part of the blended course was recognized as passed.
b) Students were asked to actively participate in the MOOC's activities, without paying any course subscription, unless they desired to obtain a certification.
c) The students had to create a learning portfolio containing questions from the forums, quizzes, assignments, proof of lecture progress and so on. At the end of the activity, this portfolio was supposed to be submitted for evaluation.

B. *The methodology used to obtain the sentiment analysis results*

In order to perform the sentiment analysis, the following steps were followed:

a) One of the steps while integrating MOOCs in the Embedded Systems course was to complete an online English survey regarding the MOOCs in Embedded Systems activities. Special sections of the survey were designed in such a way so that students should be able to write large comments and feedbacks. This information represented the base for our sentiment analysis (corpus for analysis).
b) Giving the fact that the survey was conducted in English, further corrections were supposed to be applied.
c) In order to have a clear understanding of the sentiment of the students, different tools for sentiment analysis were searched. In this regard, we decided to analyze our corpus with the Natural Language Toolkit (NLTK) platform which is based on the Python programming language (NLTK, 2016), with Semantria, which is a software coming from Lexalytics (Semantria, 2016), and also with Vivekn (Vivekn, 2016). Another interesting sentiment analysis tool called SentiStrength is presented in Thelwall & Buckley (2012) and SentiStrength (2016), but it presents a limit towards the length of the analyzed text.
d) Obtain the positive, negative, neutral attributes from the above mentioned tools.
e) Based on the analysis from point c), obtain the areas where the course should be improved.
f) Based on the analysis from point c), obtain the main textual categories and a sentiment score for each category.
g) Perform a sentiment analysis of the tweets from Tweeter which are related with integrating embedded systems courses into blended courses.
h) Compare of the obtained results in point c) with the polarity obtained in analyzing the tweets.

4. The results obtained from the sentiment analysis point of view

From the two specializations where the integration of MOOCs into blended courses was applied (on-site and distance-learning), a total number of 72 students were enrolled in this activity; 57 students (79.16%) chose to complete the survey. In order to determine the sentiment analysis from the corpus collected during the students' survey, the proposed steps from the previous section were implemented.

Table 1. Polarity results from different tools

#	Used tool	Positive	Neutral	Negative
1	Natural Language Toolkit (NLTK)	x	-	-
2	Semantria	x	-	-
3	Vivekn	x	-	-

In Table 1 the results from NLTK, Semantria and Vivekn are summarized. It can be seen that the polarity of the corpus is positive for all three tools. The students appreciated the blended course and MOOCs integration as a positive experience. A special case is that of SentiStrength whose results are not relevant giving the fact that only one sentence at a time could be analyzed. In Figure 1 the Semantria output is presented, having a positive polarity, with a score of 0.218. What is interesting to note here are the keywords extracted from students' feedback. They noticed the integration of MOOCs in the Embedded Systems course as positive due to the fact that the new information is perceived as easier and the gained knowledge seems to be valuable. Students are affected by too many concepts and also by the idea of paying for the course.

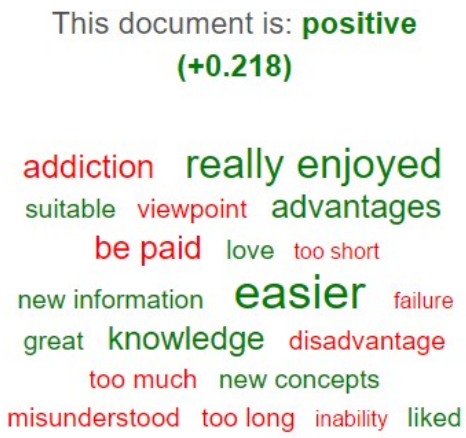

Figure 1. Semantria result

Figure 2. Twitter sentiment analysis results

Extracted themes	Evidence	Sentiment
study program	7	+0.67
rapid assimilation	7	+3.46
detailed explanations	7	+2.70
gained knowledge	7	+1.13
unconstrained stop	7	+0.84
practical part	7	+1.15
backtracking Information	7	+0.34
helpful information	7	+0.80
dynamic allocation	7	+0.60
cost aspect	7	+3.98

Figure 3. Sentiment analysis on extracted themes

Figure 3 is presenting the sentiment analysis results from the point of view of the themes extracted from the corpus. The same preoccupation for the cost of the course is revealed, but this time the fact that MOOCs are free is appreciated. Students perceive that an integration of MOOCs into blended courses leads to a rapid information of the topics, such a feature receiving a high positive score of +3.46. The detailed explanations in this blended approach received a positive impact from the students with a total score of +2.70, but also the gained knowledge is among the most highly rated corpus themes.

In order to validate our results, the next step was to extract the sentiment analysis from Tweeter's tweets (Figure 2) which are based on blending embedded systems-related courses. The obtained polarity is positive, so this results shows not only that students appreciated this in a positive manner, but also that the proposed technique for integrating MOOCs into embedded systems courses is a viable one.

5. Conclusion

This paper presents a modality in which specific Massive Open Online Courses (MOOCs) can be integrated into a blended Embedded Systems course in a non-synchronous way. Such a field of study possesses different challenges in terms of theoretical notions, but also practical appliances. At the same time, embedded systems are the motor which is developing the Internet of things and smart cities, so great concern is devoted to how students perceive different techniques of teaching embedded systems, like the one presented in this paper. In order to evaluate this technique, this paper is using sentiment analysis offering the polarity, but also information on how the course can be improved. The obtained results are very encouraging since the students had a positive polarity to the integration of MOOCs in Embedded Systems courses, and their answers also showed which parts need further consideration.

References

Babori, A., Fihri Fassi, H., Hariri, A., Bideq M. (2016). *An e-Learning environment for algorithmic: toward an active construction of skills*, World Journal on Educational Technology, 8(2).

Baran, T., Baraniuk R., Oppenheim A., Prandoni P., Vetterli M. (2016). *MOOC Adventures in Signal Processing*, IEEE Signal Processing Magazine, 33(4), 62 - 83.

Bicen, H., Ozdamli, F., Uzunboylu, F. (2014), *Online and blended learning approach on instructional multimedia development courses in teacher education*, Interactive Learning Environments, 22(4), 529 – 548.

Bogdan, R. (2016), *Guidelines for developing educational environments in the automotive industry*, 1st International Conference on Smart Learning Ecosystems and Regional Developments, Timisoara, Romania.

Bruff, D. O., Fisher, D. H., McEwen, K. E., Smith, B. E. (2013). *Wrapping a MOOC: Student Perceptions of an Experiment in Blended Learning*, Journal of Online Learning & Teaching, 9(2).

Cambria, E., Schuller, B., Xia, Y., Havasi, C. (2016). *New Avenues in Opinion Mining and Sentiment Analysis, IEEE Intelligent Systems*, 28(2), 15 - 21.

Charissiadis, A., Karacapilidis, N. (2015). Strengthening the Rationale of Recommendations through a Hybrid Explanations Building Framework, Proceedings of the 7th KES International Conference on Intelligent Decision Technologies, 311 – 325.

Chirila, C.-B., Ciocarlie, H., Stoicu-Tivadar, L. (2015). *Generative Learning Objects Instantiated with Random Numbers Based Expressions*, BRAIN - Broad Research in Artificial Intelligence and Neuroscience, Bacau, Romania, 6(1-2), pp. 1-16.

Gautam, G., Yadav, D. (2014). *Sentiment Analysis of Twitter Data Using Machine Learning Approaches and Semantic Analysis*, Seventh International Conference on Contemporary Computing, India, 437 - 442.

Grimes, S., (2014), *Text Analytics 2014: User Perspectives on Solutions and Providers*, Alta Plana, available at: http://www.digitalreasoning.com/resources/Text-Analytics-2014-Digital-Reasoning.pdf

Holotescu, C., Grosseck, G., Creţu, V., & Naaji, A. (2014), *Integrating MOOCs in Blended Courses*, 10th International Scientific Conference eLearning and Software for Education, Bucharest, Romania, ISSN 2066 - 026X.

Lei, C., Hou, X., Kwok, T. et. al. (2015), *Advancing MOOC and SPOC Development Via a Learner Decision Journey Analytic Framework*, IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE), United International College, Zhuhai, China, 149 -156.

Maharani, W. (2013), *Microblogging Sentiment Analysis with Lexical Based and Machine Learning Approaches*, International Conference of Information and Communication Technology (ICoICT), Indonesia, 439 - 443.

Malchow M., Renz J., Bauer M., Meinel C. (2016), *Improved e-learning experience with embedded LED system*, Annual IEEE Systems Conference (SysCon), 1 – 6.

Malchow M., Renz J., Bauer M., Meinel C. (2016), *Enhance embedded system e-learning experience with sensors*, IEEE Global Engineering Education Conference (EDUCON), 175 - 183.

"Official site of SentiStrength", [Online]. Available: http://sentistrength.wlv.ac.uk/, accessed 15 November 2016

"Official site of NLTK", [Online]. Available: http://www.nltk.org/, accessed 15 November 2016

"Official site of Semantria", [Online]. Available: https://www.lexalytics.com, accessed 15 November 2016

"Official site of Vivekn", [Online]. Available: http://sentiment.vivekn.com/, accessed 15 November 2016

Pireva, K., Imran, A., Dalipi, F. (2015), *User behaviour Analysis on LMS and MOOC*, IEEE Conference on e-Learning, e-Management and e-Services, Melaka, Indonesia, 21 -26.

Russell, D., Klemmer S., Fox A., Latulipe C., Duneier M., Losh, E. (2013), *Will massive online open courses (MOOCs) change education?*, In CHI '13 Extended Abstracts on Human Factors in Computing Systems (CHI EA '13), New York, USA, 2395-2398.

Schouten, K., Frasincar, F. (2016), *Survey on Aspect-Level Sentiment Analysis,* IEEE Transactions On Knowledge And Data Engineering, 28(3), 813 - 830.

Tang, D., Wei, F., Qin, B., Yang, N., Liu, T., Zhou, M. (2016), *Sentiment Embeddings with Applications to Sentiment Analysis*, IEEE Transactions On Knowledge And Data Engineering, 28(2), 496 - 509.

Thelwall, M., Buckley, K., Paltoglou, G., (2012), S*entiment strength detection for the social Web*, Journal of the American Society for Information Science and Technology, 63(1), 163-173.

Xia, B.S. (2015), *Benefit and Cost Analysis of Massive Open Online Courses: Pedagogical Implications on Higher Education*, International Journal of Cyber Behavior, Psychology and Learning, 5(3), 47-55.