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MASSIVE OPEN ONLINE CHALLENGES IN EDUCATION: USING VARIOUS ANALYTICS TO EVALUATE THE SUCCESS OF A MOOC

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INTRODUCTION

The world today is witnessing an increasing interest in Massive Open Online Courses (MOOCs). This new form of Technology-Enhanced Learning (TEL) is in the spotlight, particularly when it comes to the topic of the evolving nature of higher education learning (Shrader, Wu, Owens-Nicholson, & Santa Ana, 2016). Advocates of MOOCs propose that open courses are being celebrated because they make education accessible to all with their wide and free of charge reach (Lewin, 2012; Wulf, Blohm, Leimeister, & Brenner, 2014). On the other hand, opponents of MOOCs focus on the lack of empirical evidence to support TEL as the promised advancement to 21st-century pedagogy (Wei-Ping, Ping, & Si-Yuan, 2016). They suggest that the scale of pedagogical improvements offered and provided by MOOCs has been modest with mixed results regarding successes in meeting the needs of the diverse and changing forms of learning. This report will attempt to list best practices and target the advantages of MOOCs as a valid means for online teaching and learning.

There is no doubt that creating a well-designed MOOC is an interdisciplinary effort emanating from the input of various specialties and disciplines. While this report strongly advocates for the creation of MOOCs as yet another opportunity in this day and age to democratize teaching and learning, it also assesses the ways in which MOOCs could be more successful in doing so. In that sense, the goals for this paper are twofold. One is to describe the approach to utilizing different analyses to assess the success of a MOOC, with some comments on the variety of aspects of this methodology. Basic types of analytics used and their purpose in assessment of a MOOC are described then illustrated in this paper. These include descriptive, diagnostic, predictive, and prescriptive analytics. In addition, the authors also evaluate the overall design, user experience and satisfaction of a MOOC course offered by the United Nations Environment Programme and delivered by Concordia University. A plethora of information rising from learners' interactions with each other, the system, and the content is included in this report.

The data collected for this report was based on:

- Registration information retrieved from the Open EdX Platform, which was the MOOCs Learning Management System (LMS);

- Results of the online Likert survey questionnaire delivered to all participants at the end of the course offering;

- Predictive multivariate statistical analytics;

- Google Analytics reports;

- Qualitative, open-ended comments from users/learners;

- Final report from the Implementation and Support System (ISS) Officer responsible for student correspondences.

The following variety in data was collected and analyzed to contribute and ensure the comprehensiveness of this evaluation report.

DESCRIPTIVE ANALYTICS

Descriptive analytics inform the reader what has happened such as past action. In that respect, they give hindsight. They provide the stakeholders with real life data on what has happened. Descriptive analytics could be helpful in revealing patterns. They might be helpful when used alongside diagnostic analytics to reveal predict or even recommend best practices. In this report, descriptive analytics were extracted from three different sources: the learning management system (LMS), Google analytics (GA), as well as survey questionnaire submitted electronically to all users.

a. Enrolments. According to the Open EdX Platform data report, the number of enrolled students: 3117

b. Certificates issued. According to the Open EdX Platform data report, the number of certificates issued: 278

According to the platform registration data and the difference in the number of certificates issued, the attrition rate was: 91.08 percent. This low completion rate is typical for MOOC courses because users tend to exit for multiple reasons. Survey data indicate that users quit the course because of lack of time, or simply because the course did not serve their interest. However, the exit survey numbers completed in this round are very small (N=3). Hence, the results are inconclusive.

c. Age. Based on the Google Analytics reports, the age of users who are producing traffic on the website are as follows:

Age Range	Percentage
25-34 age range	35%
35-44 age range	19%
45-54 age range	12%
18-24 age range	21%
55-64 age range	9%
65 plus age range	4%

Table 1. Age of Users

It appears the majority of users are around 25- 34 years. Also, survey reports answered by 218 participants indicated that 1% of users are under 17 years old.

d. Gender. Based on the Google Analytics reports, 60 percent of the traffic is done by female users while male users appear to be doing 40 percent of the traffic.

e. Referrals. Google Analytics reports shows most of the traffic (75 percent in total) is coming from direct course link (users typed in "environmentacademy.org") and through organic search results (users clicking on "environmentacademy.org" from search results). Twenty-five percent of the traffic appears to be coming from referrals, such as third party websites and social network sites.

Six percent of the users' traffic from the 25 percent total referrals (social network sites referral and third party referrals) appear to be coming from Concordia website, amounting to 1.5 percent from the overall traffic.

In addition, 5 percent of the overall traffic appears to be coming from social network sites. From those, 77 percent seem to be coming from Facebook, 14 percent from Twitter, 6 percent from LinkedIn and 3 percent from Pocket. This corresponds to the following: 3.85 percent overall traffic appear to be coming from Facebook, 0.7 percent overall traffic from Twitter, 0.3 percent overall traffic from LinkedIn and 0.15 percent overall traffic from Pocket.

f. Top 10 countries. Based on the Google Analytics report, the location and percentage of traffic from users appear to be originating from the following top 10 countries:

Country	Percentage
Canada	12%
Kenya	9%
USA	8%
Philippines	7%
UK	4%
India	3%
South Africa	3%
Mexico	3%
Australia	2%
Latvia	2%

Table 2. Top 10 Countries

g. Education background. Based on the survey reports when participants were asked: *What is the highest degree or level of schooling you have completed?* 217 participants answered as follows:

Schooling Degree	Percentage
High school	5%
College degree	5%
Trade/technical/vocational training	3%
Associate degree	1%
Bachelor's degree	35%
Professional degree	4%
Doctorate degree	12%
Other	2%

Table 3. Highest Degree of Schooling

It appears the majority of users (more than 80%) completed a higher level of education. The majority of users completed a Bachelor's Degree or even a Master's Degree.

h. Employment status. Based on the survey reports, when participants were asked: Are you currently…? 212 answered as follows:

Employment Status	Percentage
Full-time employed	46%
Part-time employed	14%
Self-employed	12%
Student	21%
Retired	1%
Professional degree	4%
Out of work	3%
Other	3%

Table 4. Employment Status

It appears that the majority of the users (60%) were full-time employed or part-time employed.

i. Specialties. Based on the survey reports, when participants were asked: What is your education/work specialty? 210 participants answered as follows:

Specialty	Percentage
Agriculture and natural resources	25%
Engineering	13%
Social sciences and history	5%
Biological and biomedical sciences	11%
Education	12%
Business, management, marketing	10%
Out of work	3%
Other	24%

Table 5. Education and Work Specialties

It appears that almost half of the users have a specialty in the sciences since 25% of users came from Agriculture and natural resources field, 13 % from Engineering, 11% from biological and biomedical sciences

h. ISS officer feedback. **In this section, all comments and encountered difficulties from users that contacted the help desk are compiled via a theme-based analysis. The salient categories of comments are as follows:**

1. Technical issues. Upon reviewing the file of students who contacted the support services for help, 17 students reported encountering technical issues influenced by the learning system. Examples of these technical problems were printing the certificate, errors posting on the discussion board, and issues viewing pins on the interactive map.

2. Course navigation. 12 students experienced difficulties navigating the course or misunderstanding the procedures to obtain their course grade. Also, students contacted the support services because they were unsure how fast to progress through the course, and some misunderstood that the final exam was open for the duration of the course (not on a specific date). Other students found the interactive map to be complicated and overloading with information (not enough filters).

 Last but not least, some students had trouble finding the following in the course: where to view and print their certificate and where to register for the MOOC.

3. Missing required technical configurations. Missing plug-ins and slow Internet connections were reported to support services by eight students. These issues afforded the users a lower level of quality and accessibility to course components.

DIAGNOSTIC ANALYTICS

Diagnostic analytics inform and give stakeholders insights and in-depth exploration of what has happened and specifically why it has happened. The result usually is an analysis report. Diagnostic can sometimes be combined with descriptive analytics to reveal predictive or even prescriptive analytics. Diagnostic analytics inform the readers why things have probably happened in the past.

For this specific MOOC, diagnostic analytics were extracted from the online survey distributed to all participants to explore the perceptions of the users towards global course effectiveness, courses ease of use, quality of course content, application of knowledge gained from course content, technical issues faced during course, affordances of online and open course accessibility as well as gathering open comments.

a. Global course effectiveness. According to the survey results, when students were asked about their perceptions of global course effectiveness, the majority had a positive experience (Refer to Table 7 titled *Composite Variable & Internal Reliability Results* in the Appendix). In fact, 153 students answered the following statements related to courses global course effectiveness were as follows:

1. Excellent course. More than 96% agreed or strongly agreed that this course was excellent overall.

2. Increased knowledge. More than 99% agreed or strongly agreed that overall, their knowledge of the subject matter has increased because of this course

3. Recommend to others. More than 98% agreed or strongly agreed that they would recommend this course to others

b. Course's ease of use. According to the questionnaire results, when students were asked about their ease of use in manipulating the course, the majority agreed that they had a pleasant experience (Refer to Table 7 titled *Composite Variable & Internal Reliability Results* in the Appendix). In fact, 153 students answered the following individual statements related to course's ease of use as follows:

1. Navigation. More than 94% agreed or strongly agreed that they understood how to navigate the course's format from the beginning.

2. Clarity. More than 97% agreed or strongly agreed that the course content was designed and presented in a clear manner.

3. Presentation. More than 97% agreed or strongly agreed that the overall presentation of the course content was helpful to them.

4. Support. More than 95% agreed or strongly agreed that the Help and FAQ pages were useful.

c. Quality of course content. **According to the survey questionnaire results, when students were asked about their perception of quality of the course content, the majority perceived the course content to complete the course as useful (Refer to Table 7 titled Composite Variable & Internal Reliability Results *in the Appendix). In fact, 153 students answered the following statements related to courses quality of course content as follows:**

1. Course objectives. More than 99% agreed or strongly agreed that the course objectives were clearly stated at the beginning of the course.

2. Course outline. More than 97% agreed or strongly agreed that the course outline was concise, complete and included all of the information relevant to the course.

3. Knowledge quests and module quizzes. More than 93% agreed or strongly agreed that the knowledge quests and module quizzes helped me pass the final test

4. Discussion board. More than 85% agreed or strongly agreed that the Discussion Board facilitated and added to the interaction between students

5. Interactive map. More than 80% agreed or strongly agreed that the Interactive Map was a very useful tool for the course.

6. Course materials. More than 91% agreed or strongly agreed that they saved the course materials (e.g. pdfs, study guides, etc.) to their computer for future reference.

In addition, when participants were asked: *which elements of the course was the most helpful to them*, 167 users answered as follows:

Course Elements	Percentage
Written components of the modules	72%
Study guides	56.89%
Resource sheets	50.90%
Lecture videos, clips, movies	69.46%
Discussion Board	24.55%
Interactive map	23.95%

Table 6. Written Components of the Modules

The majority of users seem to have found the written components of the module the most helpful (72% percent). They also found the lecture videos, clips, and movies helpful (69.46%) as well as the study guides and resource sheets (56.89% and 50.90% respectively).

d. Application of knowledge gained from course. **According to the survey questionnaire results, when students were asked about their long-term knowledge gained from the course, the majority agreed they improved their knowledge on the subject (Refer to Table 7 titled Composite Variable & Internal Reliability Results in the Appendix). In fact, 153 students answered the following statements related to courses their application of knowledge gained from the course as follows:**

1. Work. More than 96% agreed or strongly agreed that they plan to use what they learned at their current work position.

2. Thesis. More than 69% agreed or strongly agreed that they plan to do their thesis (BSc, MSc, PhD, etc.) based on what was learned in the course.

3. Project. More than 79% agreed or strongly agreed that they plan to initiate a project based on what they learned.

4. Studies. More than 83% agreed or strongly agreed that they plan to use what they learned in their current studies.

5. Advanced course. More than 84% agreed or strongly agreed that they plan to pursue the advanced-level course.

e. Technical issues faced during course. **According to the survey results, when students were asked about technical issues faced during course, the majority agreed they did not face many technical problems (Refer to Table 7 titled** Composite Variable & Internal Reliability Results *in the Appendix).* **In fact, 153 students answered the following statements related to technical issues faced during Course as follows:**

1. Website. More than 98% agreed or strongly agreed that the course website was always available.

2. Personal computer. More than 86% agreed or strongly agreed that the computer used to access the course website had all the necessary software to run the materials.

3. Technical difficulties. More than 66% disagreed or strongly disagreed that they experienced technical difficulties that hindered their enjoyment of this course.

f. Affordances of Online and Open Course Accessibility. **According to the questionnaire results, when students were asked about their perceptions regarding the affordances of online and open course accessibility, the majority agreed that it was important for this course to be free and accessible to all (Refer to Table 7 titled** Composite Variable &**

Internal Reliability Results *in the Appendix). In fact, 153 students answered the following statements related to affordances of online and open course accessibility, as follows:*

1. No fees. More than 97% agreed or strongly agreed that it was important for them that there were no fees for this course.

2. Open access. More than 98% agreed or strongly agreed that it was important for this course to have open access.

3. Online learning. More than 99% agreed or strongly agreed that online courses are convenient and a flexible way to learn.

g. Qualitative open-ended feedback. **With regards to the additional narrative from students regarding suggested improvements to the course or technical difficulties encountered while taking the course, the following results emerged from a theme-based analysis of the comments at the end of the questionnaire. The salient categories of comments are as follows:**

Theme 1: No complaints to report. 79 students commented that there were simply no problems to report. Many praised the content of the course, saying it was thorough and enjoyable. Students also thanked and congratulated the contributors to this course asking for other similar classes to be created.

Theme 2: Complaints related to students' technological infrastructure. *Overall,* 20 users' comments fell under this theme. 13 out of 20 students reported having Internet connection issues due to their geographic location. Other students mentioned that they were logged out of the course frequently due to inactivity, and/or they lacked the software needed to view the course materials.

Theme 3: Recommended improvements. *17* students suggested course recommendations. The latter fell under two sub-themes: content-based, and technology-based improvements. Regarding content-based suggestions, students expressed the need to have more interaction between a subject matter expert and the students via the discussion board. Other students suggested that they would like the course modules to cover more geographical regions, and discuss more concepts related to the ecosystem sustainability. Technology-based recommendations included students suggesting to have the course more mobile-friendly, or to have an app to access the course via mobile phones. Improvements to the interactive map and discussion board were also suggested.

Theme 4: Complaints regarding technical issues encountered. 16 users' comments were regarding technical issues encountered. Users stated that the interactive map and discussion boards would not work properly on certain browsers and/or were not user-friendly. Other users commented that the certificate was hard to print, and some users had trouble with links or videos not loading.

PREDICTIVE ANALYTICS

Predictive analytics inform the reader what is likely to happen and give foresight on trends, clusters, exceptions and the like. Predictive analytics explain what might have happened. For this specific MOOC, predictive analytics were extracted by applying multiple regression models to data derived from the online survey. In fact, predictive the factors impacting global course effectiveness were derived. Table 8 titled **Factors Impacting Global Course Effectiveness** *in the Appendix displays the unstandardized regression coefficients (B) and its corresponding standard error, the standardized regression coefficients (β), R^2 and adjusted R^2. The adjusted R^2 value of 0.55 indicates that more than a half of the variability in global course effectiveness is predicted by the perception of the participants regarding how the course provided them with expert knowledge on the subject, how helpful the overall presentation of the course content was to them, the application of knowledge gained from the course and the advantages that online and open access learning offer to MOOC users worldwide.*

Results showed that, for students, a positive impression of course effectiveness is most strongly predicted by how helpful was the overall presentation of the course content (β= .302, p<0.005), as well as the application of knowledge gained from the course (β=.258, p<0.001), with the advantages of online and open access MOOC courses (β=.257, p<0.001) and having expert knowledge on the subject(β=.249, p<0.001). For students, perceptions of clarity of course contents (β= .082, p not significant), perceptions of how helpful the course quizzes and knowledge quests were with regards to learning the course material (β= -.009, p not significant), as well as how useful were the FAQ and help pages (β= .002, p not significant), their perceptions of the course's ease of use (β= -.110, p not significant), and perceptions of technical issues and mishaps faced during the course (β= .077, p not significant), did not predict a positive impression of course effectiveness.

Prescriptive Analytics

Prescriptive analytics usually consist of a list of recommendations to take to optimize the course. Prescriptive analytics pave the way for optimization. They determine subsequent actions to be taken. For this specific MOOC, prescriptive analytics were extracted from user feedback to make the course a better course. Recommendations emanating from user feedback included the following:

Recommendation 1. As the interactive map was a feature highly useful to 80% of the users, a tech recommendation needs to be added to that course element including optimal browser to be selected. In addition, more filters should be added to improve the search and to minimize the amount of "pins" found on the map. A standard picture size could also be embedded, so the dimensions of the post are all the same.

Recommendation 2. To have the certificate available to download as a PDF in order to have it in a good resolution

Recommendation 3. To include a more robust and clean FAQ embedding and adding to it issues related to possible technical issues faced

Recommendation 4. To better guide the students in terms of time management and progress updates, include an agenda with guidelines on which chapters to do each week

CONCLUSIONS AND FINAL RECOMMENDATIONS

While online courses attract a variety of profiles, it is important to take into consideration the catering of these courses to employed individuals. 72% of the population who took this particular MOOC were either employed full-time or part-time or self-employed, making learning at unconventional hours of the day and the manageable chunking of content necessary to move along one's education path. Of course, in these regards, MOOCs allow for self-paced learning, from wherever and whenever. Progress tracking, chunking and small wins become thus essential to the design.

That being said, the MOOC was more than just fitted to the learner's schedule and learning style, it was relevant to their educational and career needs. It came at the right time with the right packaged information. This MOOC's analysis had overall learner satisfaction skyrocket, with more than 96% of learners agreeing or strongly agreeing that this course was overall excellent and more than 98% agreeing or strongly agreeing that they would recommend this course to others due to their increase in knowledge for having taken the course. Surveys, generally indicated that learners are planning on using their newly acquired knowledge and that the expert knowledge transmitted was relevant to their field of work. The predictive statistical modeling thus went further by bringing the conclusion that this MOOC was more than just accessible, it was meaningful to users.

It is clear that the pedagogical formula, online design, and learning tools were supporting the meaning learners' found behind their knowledge acquisition. Future MOOC development will further explore the online features and functionalities to best maximize learning online.

APPENDIX

Composite Variables & Internal Reliability Results

Composites	Inter-	Cronbach's
Student-Related Composite Variables (N=153)		
Quality of Course Content	.154 to .591	.737
The course objectives were clearly stated at the beginning of the course.		
The course outline was concise, complete and included all of the		
The knowledge Quests and module quizzes helped me pass the final		
The Discussion Board facilitated and added to the interaction between		
The Interactive Map was a very useful tool for this course.		
I saved the course materials (e.g. pdfs, study guides, etc.) to my		
Average		
Course Ease of Use	.222 to .588	.683
I understood how to navigate the course's format from the beginning.		
The Help and FAQ pages were useful.		
The course content was designed and presented in a clear manner.		
The overall presentation of the course content was helpful to me.		
Average		
Application of Knowledge Gained from Course	.396 to .664	.836
I plan to use what I learned at my current work position.		
I plan on doing my thesis (BSc, MSc, PhD, etc.) based on what I learned		
I plan on initiating a project based on what I learned.		
I plan to use what I learned in my current studies.		
I plan on pursuing the Advanced course.		
Average		
Technical Issues Faced During Course	.258 to .450	.570
The course website was always available.		
The computer that I was using to access the course website had all the		
I experienced technical difficulties that hindered my enjoyment of this		
Average		
Global Course Effectiveness	.700 to .719	.880
Overall, this course was an excellent course		
Overall, my knowledge of the subject matter has increased as a result of		
I would recommend this course to others.		
Average		
Affordances of Online Learning and Open Accessibility	.506 to .804	.834
It was important to me that there were no fees for this course.		
It was important that this course had open access.		
Online courses are convenient and a flexible way to learn.		
Average		

[1] Response measured on a four-point scale from strongly disagree (1) to strongly agree (4);

Table 7. Composite Variables & Internal Reliability Results

Predicted Variable: Students' Perceptions of Course Effectiveness (Composite)

Factors (including both Questionnaire Items and Composites)	B	SE B	β
The course content was designed and presented in a clear manner. [1]	.073	.092	.082
The knowledge quests and module quizzes helped me pass the final test. [1]			
The Help and FAQ pages were useful. [1]	.002	.078	.002
The course provided knowledge for experts. [1]	.183	.046	.249***
The overall presentation of the course content was helpful to me. [1]	.263	.086	.302**
Course's ease of use. *(Composite)*	-.132	.210	-.110
Application of knowledge gained from course. *(Composite)*	.207	.055	.258***
Technical issues faced during course. *(Composite)*	.065	.053	.077
Affordances of online and open access courses. *(Composite)*	.291	.077	.257***
R^2	.58		

*$p < .05$ **$p < .005$ ***$p < .001$

[1] Response measured on a four-point scale from strongly disagree (1) to strongly agree (4)

Table 8. Factors predicting composite variable of students' perceptions of global course effectiveness (N=153)

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