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Analyzing instructional quality and students' reviews of massive open online courses (MOOCs) through systematic and sentiment analyses based on Big data

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Abstract: Online education has gained increasing attention from researchers in different fields. Because it expands learning space and has a great impact on teaching methods and education models. In China, the popularity and advocacy of MOOCs are also evident. While MOOCs also face several challenges with low engagement, satisfaction, and utilization rate of high-quality online resource. There is limited study in the areas of analyzing instructional quality of MOOCs. The study, based on the observation for management specialty on CUM, aims to investigate the instructional quality of MOOCs through capturing and analyzing learner reviews from CUM. Combining both quantity and qualitative method, the study integrates word frequency analysis, semantic analysis, and sentiment analysis on learner reviews to present an learner-centered analysis. We can obtain the fundamental situation of the instructional quality of online courses, identify learners' needs, and present suggestions for improvement.

Keywords: Instructional quality; MOOCs; Big data.

1. Introduction

Online education has gained increasing attention from researchers in different fields. Because it expands learning space and has a great impact on teaching methods and education models. The Ministry of Education advocates providing a distance education environment by online platform for students that were left at home, especially due to the influence of the global pandemic in 2020. While all-media teaching application also face several problems and challenges with low engagement, satisfaction, utilization rate of high-quality online resource, and under-developed management strategies. It is worth considering that how the quality of online courses is. Under the background of quality improvement as the theme of higher education in China, it is necessary to pay attention to evaluating the quality of online courses and presenting comprehensive opinions for quality improvement by using quality information.

With the rapid development of the Internet, some universities have established their own MOOCs (Massive open online courses) platforms to offer online courses. In China, the popularity and advocacy of MOOCs are also evident. By 2020 October, 540 million people have enrolled in more than 34,000 MOOCs provided by thirty platforms in China (Zou, 2020). MOOCs take true advantage of the Web, which integrate courses from different universities and allows learners to choose the courses they are interested in without the restriction of time and space. Therefore, MOOCs offer opportunities for people to achieve knowledge access, knowledge storage, and knowledge application. It breaks the constraints on learning ability, teaching resources, personal educational background, and lowers the threshold for people to have access to higher levels of education (Yuan et al.,2013).

The advancement of information technology such as big data, text mining techniques in the field of education, provides opportunities for the application of learners' learning evaluation results on the platform. The learners' learning processes on the platform can be recorded and analyzed, and the program managers and instructors can easily track learners' learning processes (Fu et al., 2019). User reviews are one of the user-generated content (UGC) on the Internet. Under the background of big data technology, a certain amount of UGC are utilized to dig out effective information such as hot-spot issues and group attitudes. Therefore, we selected management specialty courses in MOOC platform as the sample of this study. Through systematically sorting out, summarizing the reviews of management specialty courses, we can obtain the fundamental situation of the instructional quality of online courses, and identify learners' needs. This study utilized big data analysis method, using data collection from MOOC platform in China. Through fetching learner reviews from videos, interactions, community of learning, we presented an analysis of instructional quality of MOOCs for management major.

The purpose of this study is to (1) investigate the instructional quality to identify problems; (2) present suggestions for improving the instructional quality of online courses; (3) present a learner-centered analysis of learner reviews so as to better identify their needs.

2. Literature review

According to the theory of Total Quality Management (Feigenbaum, A.V., 1991), the quality of product includes not only the static characteristics of product, but also the whole process of quality formation such as design, production, use and auxiliary. Online course as a special product, its instructional quality should include static quality reflected by its characteristics, and dynamic quality reflected by teaching effect. Specifically, static teaching quality refers to the quality of pre-course design including course plan, syllabus, standard, and content, while dynamic teaching quality refers to the quality of in-progress implementation and post-course evaluation (Xiao et al., 2019). In the construction stage of online course, researchers generally regarded online course as a complex of learning content and learning activities, and the survey of online course quality was comprehensively

measured from two dimensions of course resource quality and course implementation quality (Chen et al., 2003). Then, in Excellent Courses construction stage of " the Project of teaching Quality and teaching Reform in colleges", the evaluation indicators of excellent courses in web-based education presented by the Ministry of Education become main criteria to measure the level of online teaching quality. With the development of online education in recent years, there are more and more domestic researches examining the instructional design quality of MOOCs. Most existing studies regarding to instructional quality on MOOCs, tend to focus on four major areas: 1) curriculum resources; 2) curriculum implement; 3) learner experience; 4) platform guarantee. Among them, the quality of curriculum resources is mainly measured from static course elements such as curriculum design, teaching staff, technical strength, and course content (Yao et al., 2017). As Huang et al. (2017) pointed out in the research, the indicators of curriculum implement mainly include specific teaching process and teaching effect. Learner experience and platform guarantee both investigate the quality of MOOCs from the perspective of learners (An & Zhang, 2018). The methods of surveying instructional quality mainly include observation, text analysis, and indicator system method. The most common application is the combination of evaluation indicator system and questionnaire at present (Yang et al., 2019). As reviewed above, the studies in instructional quality of MOOCs became one of hot issues concerned by researchers in educational technology field, and the perspectives of which show the characteristics of diversification and deepening.

MOOC platforms have witnessed dramatic membership growth in recent years. However, studies are still insufficient to provide comprehensive insight into instructional quality of online courses in MOOC platform. The data of MOOCs generally fall into three categories: structured, process, and result data (Zhao et al., 2017). However, the current data statistical analysis function of MOOC platform is limited to simple statistics and presentation. The program managers and instructors can understand the percentage of each chapter' s video viewing and task completion in the system. Analyzing the relevant literature, several studies have applied big data technology to evaluate the instructional quality of MOOCs. Zhao et al. (2017) used the big data of MOOC platform to analyze learning behavior and teaching behavior in multiple dimensions, and constructed a relatively comprehensive evaluation model of learning quality and teaching quality. Fu et al. (2019) compared the data analysis function of common online learning platforms which mainly focus on data collection of teaching process including reading rate of traditional course materials (e.g., lecture notes, slides, filmed videos, reading materials), passing rate of assignments and quizzes, and learners' comments. These studies, using data analysis methods, adopted quantitative analysis of instructional quality and offered relatively little insight into learners' thoughts and behaviors. Wang et al. (2021) conducted a sentiment analysis for learner comments of 18 course in MOOC platform. The research results revealed that learner sentiments were positively correlated with the quality of instructional design, while little attention was paid to analyze high-frequency words of learner reviews.

In terms of the research perspective, existing research on the instructional quality of online courses mainly focused on instructional conditions and process. Although satisfaction of learners has gained increasing attention from researchers, there is limited study in the areas of learner experiences and learner perspectives of MOOCs (Veletsianos et al., 2015). From the perspective of learner, combining both quantity and qualitative analysis, the study integrated word frequency analysis, semantic analysis, and sentiment analysis of learner reviews of management specialty course from MOOC platform to analyze the instructional quality of online course, and present suggestions for quality improvement.

3. Methodology

This study follows the following scientific logical order: theoretical research, empirical study, and suggestions for improvements. Through capturing and analyzing the reviews left by learners after learning course on MOOC platform, this paper conducts an empirical study on the instructional quality of management specialty course from MOOC and presents relevant suggestions for improvement.

3.1. Big data analysis

Big data analysis refers to capture and analyze video, interaction, reviews and other data. Different from traditional questionnaire survey, data collection from MOOC platform covers a wider range of MOOC learners, which can help find main effect from the data.

3.2. Word frequency analysis

As a relatively elementary and effective text mining method, word frequency analysis is mainly utilized to count the number of times of words in the text materials, identify the keywords and core information hidden in the text content.

3.3. Semantic analysis

Based on word frequency analysis, semantic analysis focuses on the relationship between words. This method can deconstruct the syntax and concept of text content so as to identify their meaning and associations between text words.

3.4. Sentiment analysis

Sentiment analysis is a computational approach of identifying sentiment of opinions, and classifying a text into one of the positive, neutral, and negative emotional categories. Sentiment analysis can provide consumers' comprehensive evaluation of products or services efficiently, which has been successfully used in many studies that investigated social media. Sentiment analysis also is used as an invaluable tool for identifying markers of emotional responses to crisis (Wang et al., 2021), and problems that lead to negative reviews.

4. Data collection and screening strategy

4.1. Data collection and preparation

The study involved collecting learner reviews on all finished courses of management from Chinese University MOOC platform (CUM, https://www.icourse163.org/) with JAVA coding. The categories of database include course name, total score, number of comments, text content and score of each review, and whether it is excellent courses or not. Data was collected in June 30, 2021. This scraping process resulted in 302 courses with a total of 160045 learner reviews. All information accessed from the course website was examined in detail. First, we cleaned the unwanted records and removed

user names, garbled words, and punctuators. Then, the study, using jieba tokenizer, separated each review into word units, and removed senseless conjunctions based on stop words from jieba. Based upon data characteristics, we also loaded manually summarized user dictionary in part, such as merging "likes" and "like".

4.2. Word frequency analysis of management specialty courses

After excluding common and ambiguous words, the top 148 most frequently discussed words were obtained by using jieba tokenizer. We finalized the word library consisted of the top 50 most mentioned keywords. Table 1 lists these 50 keywords, along with their ranks, number of reviews. The feature words of management specialty are mainly based on nouns, adjectives and verbs. Topping the list is the percentage of nouns, with the words of "teacher", "course", "knowledge", "content", reflecting learners' perception of their distance learning experience. The adjectives mainly include "good", " practical ", "clear" and other words, reflecting learners' subjective feeling and the overall good impression. The three words most mentioned in verbs were "learn", "explain" and "acquire", reflecting learners' motivation for knowledge access and knowledge storage.

Table 1. Top 50 most mentioned keywords

Rank	Keyword	Reviews number	Rank	Keyword	Reviews number
1	Teacher	25313	26	Like	2387
2	Course	16905	27	Time	2366
3	Learn	11947	28	Vivid	2332
4	Teach/Explain	10927	29	Interesting	2149
5	Knowledge	9652	30	Special	2097
6	Content	7490	31	Currency	1905
7	Good	5427	32	Manage	1825
8	Acquire	5192	33	Accessible	1799
9	Know	4999	34	Hope	1781
10	Practical	4427	35	Student	1701
11	Obtain	4151	36	Combine	1698
12	Clear	4121	37	Information	1675
13	Example	3748	38	Theory	1502
14	Various	3631	39	Problem	1460
15	Help	3577	40	Video	1455
16	Entrepreneurship	3561	41	Understandability	1388
17	Great	3533	42	Inspire	1372
18	Communicate	3337	43	Reasonable	1324
19	Detailed	3246	44	Deserve	1282
20	Feeling	3230	45	Actuality	1269
21	Thank	3211	46	Life	1266
22	Course content	3174	47	value	1260
23	Way	3071	48	Comprehensive	1256
24	Understand	2950	49	teaching	1212
25	Live	2598	50	Analyze	1173

4.3. Semantic analysis

Based on high-frequency words obtained from above analysis, we constructed a semantic network graph, as presented in Fig 1. The words in the center of network graph are mostly nouns, such as "teacher", "knowledge" and "course", which are highly correlated with other words. These keywords reflect the aspects considered by most learners when they evaluated courses. The words on the secondary circle of network graph, spread around above keywords, such as "worth", "value", and "various", which reflect that learners attach importance to knowledge access from online courses. When learners' needs for knowledge access are met and satisfied, they may think the online course is worth learning, which may further motivate them to express positive reviews. While there are also some words with emotional color on the outer edge of network graph, these sparsely connected nodes do not mean that the words are unimportant, such as "good", "interesting" and "liked", which reflect learners' positive attitude towards course teaching quality. The words on outer circle complements and enriches that of core circle and the secondary circle. The semantic network graph defined by the three-level circle structure, reveals comprehensively the overall reputation of learners on management specialty course, further helps identify instructional problems and present suggestions for quality improvement.

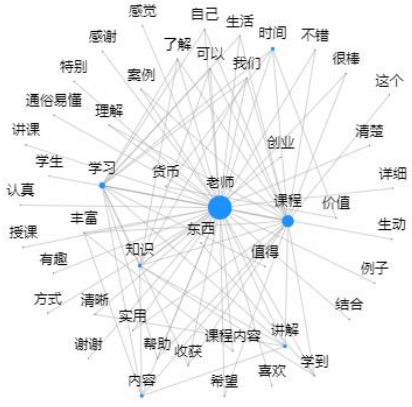


Fig.1 Semantic network graph

4.4. Sentiment analysis

The study, using AI open platform provided by Baidu, take a sentiment analysis of learner reviews. We randomly selected 100 reviews for artificial sentiment judgement, and these results are 92% consistent with those provided by AI open platform. Considering the data characteristics, we adjusted

the effect of above analysis through customization. The results of sentiment analysis are shown in Table 2,3,4, where 0 represents negative reviews, 1 represents neutral reviews, and 2 represents positive reviews. This process analyzed 131288 learner reviews. Among these reviews, 99974 reviews (76.15%) are positive, 24650 reviews (18.78%) are neutral, and 6664 reviews (5.08%) are negative. Hence, the management specialty course win the good overall of reputation. The sentiment component generated by learners after learning the courses is mainly positive sentiment, which is also consistent with the conclusion that word frequency analysis mainly consists of positive words. But more attention should be paid to the reviews that represented negative sentiment. Learners gave negative comments on the courses, to large extent, because the course do not meet the learners' needs.

Table 2. Sentiment analysis

Sentiment type	Number of reviews	% of the total
Positive	99974	76.15
Neutral	24650	18.78
Negative	6664	5.08

Table 3. Level of positive sentiment

Level	Number of reviews	% of the total
Normal (0-10)	49163	37.45
Medium (10-20)	30683	23.37
High (20 and above)	20128	15.33

Table 4. Level of negative sentiment

Level	Number of reviews	% of the total
Normal (0-10)	4985	3.80
Medium (10-20)	1334	1.02
High (20 and above)	74	0.06

5. Discussion

The study, based on the observation for management specialty on CUM, aims to investigate the instructional quality of MOOCs through capturing and analyzing learner reviews from CUM. From the perspective of research method, we combined both quantity and qualitative method, which capturing learner reviews with java coding and adopting text mining through big data technology. In term of research perspective, different from previous studies that adopted data statistical analysis, the study integrated word frequency analysis, semantic analysis, and sentiment analysis on learner reviews to present an learner-centered analysis so as to better known learners' thoughts, and concerns.

Based on the results of above analysis, we present the following suggestions. Firstly, one good suggestion for the MOOC Program Manager is to use online questionnaire after learners look each course that can know the overall student learning perception and satisfaction. Secondly, the analysis system provided by MOOC platform is limited to data statistics and display at present. In the future, the data from MOOC platform should cover more learning behaviors, such as number of, time of, and click action of watching course materials. Thirdly, high dropout rate always is one of challenges that MOOCs face. Though negative reviews (5.08%) were the least represented in the sentiment analysis, analyzing specifically these negative reviews helps figure out reasons for dropout.

Finally, quality management is an ongoing process instead of focusing on the final evaluation results. Different from traditional offline courses, online courses can achieve delicacy management based on MOOC platform (Zhao et al., 2017). Although for most MOOC video lectures, the instructors do not have the opportunity to receive feedback from the learners in any form while recording (Doherty et al., 2015). Continuous assessment of instructional quality should be conducted throughout the whole learning process (Zhong & Wang, 2019). For instructors, big data analysis for instructional quality is helpful and timely to adjust and improve the design and instruction of course.

Limitations existed in the present study. First, the study investigated the overall reputation of MOOCs quality based on learner reviews that were concise and short on detail. The assessment of MOOCs quality needs to conduct a multi-dimensional analysis framework. Yang et al. (2019) presented a series of standards to evaluate MOOCs quality, which include course content resource, teaching design method, teaching activity evaluation, team support service, teaching effect influence, and course platform guarantee. Future research can design a multi-dimensional research approach to collect learner reviews about MOOCs quality. Second, the study just captured and analyzed text content of learner reviews. Future research about instructional quality of MOOCs should capture muti-dimensional data from MOOC platform, such as number of "likes", percentage of task completion and course completion. More attention should be paid to the reviews that get more "likes", which directly reflect the number of people that agree with the review. The number of "likes" can be considered as the reference points for investigating the quality of MOOCs. Finally, due to negative reviews only accounted for 5.08% of the total sample, the keywords regarding negative reviews do not appear in the semantic network graph. Further, more research should focus on the reason why learner's dropout through the concrete analysis of negative reviews.

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