IEEE Access
Multidisciplinary | Rapid Review | Open Access Journal

Received May 25, 2020, accepted June 3, 2020, date of publication June 8, 2020, date of current version June 26, 2020.

Digital Object Identifier 10.1109/ACCESS.2020.3000787

The Impact of MOOC Instructor Group Diversity on Review Volume and Rating— Coursera Specialization as an Example

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This work was supported in part by the Chinese National Social Science Fund Thirteenth Five-Year Plan Education Topic under Grant BFA180064, and in part by the Shanghai Philosophy and Social Sciences Project under Grant 2016BGL002.

ABSTRACT Massive open online courses (MOOCs) have attracted increasing attention. Instructors, as an important component of MOOC online collaboration, have not received sufficient attention. Therefore, this paper constructs a hierarchical linear model (HLM) with time variables to study how the instructor group diversity of Coursera specialization affects group performance and how the instructor group diversity of the specialization changes with time. This paper chooses instructor groups of all Coursera specializations from May to October 2018 as the empirical research object, obtains 397 specialization courses, and calculates and analyzes the research object. The results show the following. (1) The duration difference in the continuous opening course by instructor group has a significantly negative impact on the review volume and rating of the specialization, but the negative impact gradually decreases up to a point. Beyond that point, the review volume and rating increase with the increase in duration difference in the continuous opening courses by instructor group. (2) The difference in the teaching field by instructor group has a significantly positive impact on the specialization review volume, but the positive impact gradually decreases up to a point. Beyond that point, the specialization review volume decreases with the increase in the difference of the instructor group teaching field. Unexpectedly, the difference in the instructor teaching field has no significant impact on the specialization rating. (3) In a specialization, the duration difference in the continuous opening course by instructor group decreases significantly over time, as does the difference in the teaching field. Therefore, some suggestions are proposed for the future construction of Coursera specialization.

INDEX TERMS Educational technology, management information systems, online communities/technical collaboration.

I. INTRODUCTION

MOOCs (Massive Open Online Courses) bring opportunities and challenges to global higher education and will profoundly change the competitive mode of the globalization of higher education. They provide a strategic resource related to the development of national education [1]. Since 2012, Coursera, Udacity and edX have emerged as the three major MOOCs [2], [3]. With the vigorous development of MOOCs, many scholars have studied MOOCs from different aspects since 2009 [2], [3].

Since March 2014, Coursera has opened more than 400 specialization courses, covering almost all subject areas, providing systematic knowledge services for beginners to deeply study knowledge in a certain field. Coursera specialization courses consist of a set of related courses that are categorized by a topic or discipline. Each specialization is provided by the instructor group from a well-known university or research institution. And the instructor group means a group of instructors on one course. Additionally, the instructor group plays a key role in the teaching design, teaching interaction and curriculum quality control of the specialization [4], [5]. However, research on MOOC instructors is mostly from the individual aspect of instructors, ignoring the collaboration, diversity and dynamics of the MOOC instructor group.

Therefore, this paper takes the MOOCs instructor group as the research object, constructs a hierarchical linear model

The associate editor coordinating the review of this manuscript and approving it for publication was Pasquale De Meo.

(HLM), selects the instructor group of the specialization to conduct empirical research, and explores the effect of instructor group diversity on the course evaluation and its trend over time. Theoretically, this study expands the theoretical basis of MOOC instructor group diversity research, and practically, this study provides suggestions for the construction and development of MOOC specialization.

II. LITERATURE REVIEW

This paper will first review the research domain of MOOCs and propose the necessity of instructor group research. It will then review group diversity as the theoretical basis of MOOC instructor group diversity research and finally summarize the HLM and develop the theoretical support as the research model of this paper.

A. MOOC RESEARCH DEVELOPMENT

According to the literature Review of research progress of MOOCs [2], [3], the strands of MOOC research can be divided to the first strand of MOOC research (2009-2011), the second strand of MOOC research (2012-2013), the third strand of MOOC research (2014-2016), and the fourth strand of MOOC research (2017-current).

1) THE FIRST STRAND OF MOOC RESEARCH (2009-2011)

During this period, MOOCs were proposed to be divided into two categories: cMOOCs and xMOOCs. Research on cMOOCs pays attention to the generation and transmission of information, connect lecturers and learners worldwide through a common topic, and allow learners to build their own learning network and knowledge system through online communication [4]. Research on xMOOCs is based on behavioral learning theory, which believes that knowledge is a specific combination of responses. Most human learning is operational learning. Therefore, learning reinforcement is an important means of forming operational conditioning. It can strengthen and supervise learning through teaching arrangements [5].

2) THE SECOND STRAND OF MOOC RESEARCH (2012-2013)

The study of MOOCs in this period has entered a more detailed research strand [6]. The research includes the following: (1) a comparison between cMOOCs and xMOOCs in terms of curriculum openness and teaching mode; (2) the application of MOOCs in a specific subject, such as the combination of MOOCs with offline computer courses and college English courses, the application of MOOCs in university libraries, as well as the curriculum design and structure of MOOCs; (3) MOOC user portraits, such as the cities in which most users are located and the causes of user aggregation, and the motivation and continuance intention of MOOC use; (4) challenges encountered by MOOCs, such as low completion rates, high costs of starting courses, lack of a mature business mode, and lack of teaching methods, among others.

3) THE THIRD STRAND OF MOOC RESEARCH (2014-2016)

During this period, research on MOOCs mainly focused on the following three aspects. (1) Using learners as research objects, their use behaviors, motivations, and learning preferences, among others, are examined using social network analysis to analyze the interaction behavior of learners in the curriculum forum [7]. (2) Based on the characteristics of MOOCs, the research focuses, on the one hand, on the teaching evaluation methods, curriculum evaluation methods and curriculum environment of MOOCs, and on the other hand, the evaluation methods of students' learning level. (3) The research studies the impact of MOOCs on educational and economic aspects. (4) The research examines teaching interactions, teaching professionalism and teaching experience from the perspective of MOOC instructors [8] and explores open education resource sharing models [9].

4) THE FOURTH STRAND OF MOOC RESEARCH (2017-CURRENT)

The research focuses on (1) emphasizing the importance of interactive behavior of curriculum forums on the construction of learners' knowledge, and the impact of interactive behavior of curriculum forums on learning outcomes, combining big data, mining potential problems in forums, and providing timely intervention solution for instructors [10]; (2) using professional curriculum evaluation tools to evaluate learners' learning effects [11]; (3) using machine learning tools and natural language processing techniques to conduct semantic analyses of student evaluations, judging the willingness of students to participate in continuance learning [12]; (4) the copyright issues that restrict the development of MOOCs with the growing number of MOOC platforms and users, which have also aroused researcher's attention [13], [14].

5) SUMMARY OF MOOC RESEARCH

Through the above four strands of research [2], [3], it can be observed the followings.

First, most research takes the student group as the main research object and examines the learner's behavior, motivation, satisfaction, interaction behavior, learning persistency and learning evaluation, as well as the MOOC content and context.

Second, in MOOC instructor research, although some studies have used MOOC instructors as research objects [15], quantitative analyses of MOOC instructor research are lacking, especially for instructor group research, an important group component of the specialization courses of MOOCs.

Therefore, this paper takes the instructor group of the specialization as the research object and explores the influence of instructor group diversity on the course evaluation.

B. GROUP DIVERSITY THEORY AND RESEARCH ON INSTRUCTOR GROUP DIVERSITY

Current theories for group diversity research mainly include the information decision theory proposed by Williams & O'Reilly in 1998 and the socialization theory proposed by Hogg & Terry in 2000. Information decision

theory proposes that diverse groups have more resources, including more comprehensive knowledge and information, while background differences between members provide different perspectives and views [16]. The theory of socialization derives from the study of social psychology. It is believed that individuals entering social categories will be depersonalized, seeing themselves as members of the category and generating social identity for the groups to which they belong [17]. At present, research on group diversity has more comprehensively integrated two theories and conducted in-depth analyses of the impact of group diversity [18].

Instructor group diversity research mainly focuses on the instructor groups in traditional offline classrooms. It uses qualitative research methods. For example, from the perspective of behavior and psychology, it discusses the roles of instructors in different scenarios, and it locates and reconstructs the roles of instructors. Furthermore, it makes suggestions and explores how to achieve good teaching results by changing the instructor role [19]. A small number of studies have used quantitative research methods to explore the impact of instructor group diversity on the performance of the instructor group. For example, research has confirmed that the relationship between age and performance has an inverted U shape [20]. The differences between the individual instructors due to the knowledge background and diversity of experience are positively correlated with the performance level [21].

In the Coursera specialization, the instructor group shows great differences with respect to age, education, teaching experience and research fields, but little research has been conducted to examine the diversity of the instructor group [10]. For quantitative research on population diversity, some scholars have used HLM to explore the impact of group diversity on group performance [22]. HLM is also often used to study problems in the field of education. Therefore, this paper intends to use HLM to analyze the diversity of the instructor group in the Coursera specialization.

C. HLM

In empirical education research, the data often exhibit a hierarchical structure. For example, if traditional regression analysis methods are used in research with factors that affect student performance, it is impossible to distinguish the influence of classes on students. Additionally, if the class is analyzed, the effects of individual differences in the same class are ignored. Because traditional regression analysis lacks the consideration of data layering characteristics, in 1992, Professor Stephen W. Raudenbush of the University of Michigan proposed HLM to solve such problems [23]. HLM has been widely used to study problems in the fields of education, psychology and public transportation [24], but the application of HLM to online education is less common.

III. RESEARCH HYPOTHESES

A. SPECIALIATION COURSES

Coursera specialization courses of MOOCs consist of a set of related courses that are categorized by a topic or discipline. Each specialization course is offered by a group of outstanding instructors from the same well-known university or research institution, such as Stanford University, Duke University, University of Michigan, Minnesota University and Google Cloud, among others.

The order of the course design in the specialization is generally from simple to complex in a sequential manner. Additionally, students must complete each course in the specialization to obtain the corresponding certification. To allow all learners of a specialization course to complete the internalization of learning activities in practice, most of the specialization course will choose the case that fits the practical situation or the project of the enterprise for the learner to consider to complete the graduation project design. Therefore, the specialization courses focuses on high-quality education resources in a certain field, providing rich and complete learning resources and project practice experience [25].

B. CLASSIFICATION AND EFFECVIENESSS OF THE INSTRUCTOR GROUP DIVERSITY OF THE SPECIALIZATION

In the classification study of group diversity, scholars have proposed a variety of classification methods, among which the method proposed by Harrison and Klein is generally recognized and cited for the classification of group diversity [26]. Based on the MOOC instructor group of the specialization course, first, ''separation'' describes the differences between the concept and attitude of the group members. It belongs to the deep psychological characteristics and cannot be obtained through the web mining MOOC platform. Therefore, this article does not adopt the separation diversity dimension of the MOOC instructor group. Second, ''not equivalent'' refers to the differences in teaching experience and professional titles of instructor group members. In terms of teaching experience, instructors of MOOC special courses can accumulate online teaching experience through continuous teaching MOOCs. Therefore, this study uses the duration difference of continuous teaching MOOCs to indicate the online teaching experience difference of instructor group members in the specialization [27]. In terms of professional titles, although research on offline instructors has demonstrated a greater influence of instructors with higher professional titles [28], in the MOOC context, with subjects having the theme of learner completion, satisfaction and continuing intention to use, the instructor title has no influence on learners [29]–[31]. In addition, there are many kinds of instructor titles of specialization courses in Coursera, and it is difficult to accurately quantify them. Thus, professional titles of instructors are not used for ''not equivalent''. Finally, ''diversity'' refers to the different disciplines of the course offered by different instructors in the Coursera specialization. The discipline categories reflect the teaching field of instructors. Therefore, this paper uses the discipline diversity of instructor teaching to indicate the discipline difference of the course.

C. CALIBRATION OF INSTRUCTOR GROUP DIVERSITY IN THE COURSERA SPECIALIZATION

At present, there are large differences in the selection of group diversity, but most studies use group performance as a diversity calibration [32] to explore the effect of the diversity of offline work groups on group performance. In recent years, more research has explored the diversity of online community groups and the impact of group diversity from open source platforms on group effectiveness [22].

The course evaluation after instructor knowledge transfer, counselling and interventions has demonstrated the learner's recognition of the instructor teaching [33]. The review volume and rating of the Coursera specialization reflect the learners' trust of group teaching; therefore, this study selected the review volume and rating of the specialization for calibration of the instructor group diversity.

D. HYPOTHESIS OF THE INFLUENCE OF INSTRUCTOR GROUP DIVERSITY ON THE REVIEW VOLUME AND RATING

Based on above findings, this study divides the diversity of the instructor group in the specialization into the diversity of the duration of the continuously live course and the diversity of the teaching field. The review volume and rating of the specialization are used as the criteria for the performance of the instructor group. Therefore, this study examines the impact of instructor group diversity on the review volume and rating of the specialization, as well the change in instructor group diversity over time.

1) THE INFLUENCE HYPOTHESIS FOR THE DURATION DIFFERENCE IN REVIEW VOLUME AND RATING

Studies have demonstrated differences in the time input of group members, which reduce communication and integration within group members, increase contradictions within groups, and in particular lead to some task-oriented group conflicts [21], thus gradually become prominent in contradictions. In this case, members who spent more time would selectively ignore information and opinions from new members, thus reducing the output of the group. For example, after studying the impact of differences in the time input of group members in Wikipedia, it was found that the difference in time input would positively affect the collective output to a point, beyond which the group output would be reduced with an increasing time input difference. Some studies have also shown that if both members who continue to input for a long time and members who continue to provide input for a short time exist, then the increase in the input time difference will allow the group to complete the group task in a more innovative way, thereby improving the group performance [22].

The instructor group of the specialization is guided by teaching tasks and accumulates teaching experience through continuous teaching input. Different teaching inputs for the instructors are limited by their own vigor and capability, which affects the learners' evaluation and recognition of their teaching behavior [18]. Therefore, as the duration difference of the continuous opening course increases, the learner's evaluation and recognition of the teaching group will also decrease; however, as the difference continues to expand beyond a certain level, the instructor group of longer continuous opening courses have sufficient time and experience to improve the quality of the specialization, which may improve the evaluation and recognition for the instructor group. In the specialization, the evaluation from learners is reflected in both the overall review volume and rating. Therefore, this paper proposes the following hypotheses.

Hypothesis 1: There is a curvilinear relationship between the duration difference and the review volume. Increases in duration difference lead to a decreasing review volume. Increasing the duration difference of the continuous opening course beyond certain levels will increase the review volume.

Hypothesis 2: There is a curvilinear relationship between the duration difference and the rating. Increases in the duration difference lead to a decrease in the rating. Increasing the duration difference of the continuous opening course beyond certain levels will increase the rating.

2) THE INFLUENCE HYPOTHESIS OF THE PROFESSIONAL DIVERSITY ON THE REVIEW VOLUME AND RATING

Different professional fields of the instructor group member will increase the breadth and depth of group information acquisition and improve the work efficiency of the group [34]. Therefore, the diversity of the professional or interest field among the instructor group members has a positive impact on instructor group performance, and the higher the diversity of professional or interest fields, the greater is the contribution of the instructor group member to group goals or tasks, correspondingly improving the group performance [35]. In some online autonomous organizations, such as Wikipedia, the greater the interest diversity, the higher is the group performance. However, when the interest diversity exceeds a certain level, many different opinions may conflict with or contradict each other. Additionally, the group member may be overwhelmed by large amounts of information, which in turn leads to a decline in group performance [22].

The professional fields of the instructor group differ in the Coursera specialization. Some specializations in interdisciplinary fields require instructors with different professional backgrounds. As a result, there are different teaching fields in the instructor group. The learner's evaluation of the specialization is an intuitive response to the teaching effect. The difference in the instructor group due to the diversity of the knowledge background is positively correlated with the teaching evaluation [36]. Therefore, this paper proposes the following hypotheses.

Hypothesis 3: There is a curvilinear relationship between professional disparity and the review volume. Increases in professional disparity lead to increases in the review volume. Increasing professional disparity beyond certain levels will decrease the review volume.

Hypothesis 4: There is a curvilinear relationship between the teaching field disparity and the rating. Increases in professional disparity lead to an increasing rating. Increasing professional disparity beyond certain levels will decrease the rating.

E. HYPOTHESES FOR INSTRUCTOR GROUP DIVERSITY OVER TIME

The role of group diversity may change over time, and long-term employment may change the group diversity [37]. For example, organizational demographic statistics theory believes that the distribution of organizational population depends on member selection and personnel policy adjustment; thus, both recruitment and dismissal will affect the duration and resource allocation of organizational members; moreover, the attractive-selection-conflict framework illustrates that members of the organization tend to be homogenous over time [38], [39].

The MOOC instructor group of the specialization tends to attract members with similar goals or interests, and after observing group activities, potential members determine whether there is a good fit with the group goals. After joining the group, the group member will choose partners if they continue to collaborate. When a member believes that there is no match with the group, the member will withdraw. Although the member may leave the group for various reasons, studies have shown that members with more differences are more likely to leave [37]. Therefore, this paper proposes the following hypotheses:

Hypothesis 5: The duration difference of the continuous opening course significantly declines over time.

Hypothesis 6: The professional disparity significantly declines over time.

IV. DATA COLLECTION AND PROCESSING

A. DATA COLLECTION

As one of the three internationally recognized MOOC platforms, Coursera has opened more than 400 specialization courses since March 2014. It covers almost 11 disciplines in Coursera. Additionally, the specialization has undergone adjustments and updating. A specialization program usually consists of 3-10 courses. This paper creates a longitudinal dataset of Coursera specialization, setting 2 weeks as the data observation period, and each observation unit represents the relevant data of a Coursera specialization in a certain period of time. All the Coursera specialization data has been collected by Python from early May 2018 to the end of October 2018. After eliminating the missing data, the obtained longitudinal data set contains 13 time periods and 397 specializations, with the discipline classifications shown in TABLE 1.

TABLE 1. Discipline classifications of the specialization.

Category	Number	Percentage
Business	134	33.69%
Computer Science	93	23.34%
Data Science	49	12.47%
Social Science	25	6.37%
Personal Development	22	5.57%
Language learning	22	5.57%
Physical Science and Engineering	16	3.98%
Information Technology	14	3.45%
Art and Humanities	11	2.65%
Biology	6	1.59%
Mathematics and logic	5	1.33%

B. RESEARCH VARIABLE SETTING

1) DEPENDENT VARIABLE SETTING

As described in section 3, this article uses the review volume and rating of the specialization as the calibration for group diversity, as shown in Eq.1 and 2.

$$Review_{it} = \frac{\sum_{j=1}^{N} Raview_{ijt}}{N} \quad \text{(Eq. 1)}$$

$$Rating_{it} = \frac{\sum_{j=1}^{N} Rating_{ijt}}{N} \quad \text{(Eq. 2)}$$

In observation unit t, Eq.1 indicates that the review volume of the i^{th} specialization is calculated by the aggregate average review volume of N courses of the specialization; Eq.2 indicates that the rating of the i^{th} specialization is calculated by the aggregate average rating of N courses of the specialization.

2) INDEPENDENT VARIABLE SETTING

Since the coefficient of variation proposed by Allison and the Blau index proposed by Blau are widely accepted measures of diversity [40], this paper uses these two indicators to measure the duration difference in the continuous opening course and the difference in the teaching field by the instructor group.

The coefficient of variation is mostly used to calculate the diversity of continuous variables. The calculation of the duration difference in the continuous opening course by the instructor group is shown in Eq.3. In observation unit t, $T_{imean,t}$ represents the mean value of the duration in the continuous opening course of N coursers in the i^{th} specialization, and T_{ijt} represents the duration in the continuous opening of the j^{th} course. Among them, the duration of the i^{th} course is calculated by the time difference between the start time of the course and the observation unit with units of days.

$$TENURE_{it} = \frac{\sqrt{\sum_{j=1}^{N} (T_{ijt} - T_{imean,t})^2}}{T_{imean,t}} \quad \text{(Eq. 3)}$$

Courses included in each Coursera specialization may belong to different discipline categories, which reflect the difference in the teaching field by the instructor group. In the observation unit t, the Blau index calculation for the instructor group diversity in the i^{th} specialization is shown in Eq.4, and P_s indicates the proportion of the course belonging to the S^{th} discipline category of the total number of courses in the specialization. K represents the total discipline category

of all courses.

$$Blau_{it} = 1 - \sum_{s=1}^{K} P_s^2 \quad \text{(Eq. 4)}$$

3) CONTROL VARIABLE SETTING

Further considering the adjustment effect of the curriculum level factor on the independent and the dependent variable, four control variables are set as follows.

a: WEEK INDEX ($WEEK_{it}$)

According to the assumption that the diversity of the group will change with time, time is introduced. The first week of the specialization is set as the first time set, and up to the last week of October 2018, each specialization is time-stamped.

b: COURSE NUMBER ($SCOPE_{it}$)

Since each specialization contains 3-10 courses and the number of courses will change over time, the total number of courses in each specialization is introduced as the curriculum level control variable.

c: SPECIALIZATION CREATION WEEK ($CREATION_{it}$)

Coursera has been updated frequently since the opening of the specialization in March 2014. The opening time of each specialization is different. Therefore, with March 1, 2014 as the starting point, the opening time of the earliest course in the specialization is used as the calculation end point, measuring the opening time of the specialization, which is set as the curriculum level control variable.

d: INSTRUCTOR NUMBER ($SIZE_{it}$)

Each specialization contains a different number of instructors, so the total number of instructors in each specialization is introduced as the curriculum level control variable.

C. RESEARCH VARIABLE CALCULATION

1) DESCRIPTIVE STATISTICS

According to the data for the 397 specialization courses in 13 time periods, the corresponding research variables are calculated. The descriptive statistics are shown in TABLE 2.

2) DATA PROCESSIONG

From TABLE 2, the review volume shows a significant positive skewness (skewness coefficient $= 9.062 > 2$), and the rating presents a significant negative skewness (skewness coefficient $= -5.279 < -2$). Therefore, this paper determines the base 2 logarithm of the review volume and base 2 exponentiation of the rating. Moreover, a multi-collinearity analysis is performed for all independent and control variables. As shown in TABLE 3, the variance inflation factor (VIF) of all variables is far less than 10, and the tolerance is greater than 0.1, indicating that there is no multicollinearity among the variable [41].

TABLE 2. Discipline statistics of the research variables.

VARIABLE	Mean	SD	Skewness
Dependent Variable			
Review volume (*Review*)	522.96	1636.08	9.062
Rating(Rating)	4.56	0.74	-5.279
Independent Variable			
Duration difference (*TENRUE*)	0.23	0.27	2.929
Professional variety (*CATEGORY*)	0.19	0.27	1.202
Control Variable			
Week index (*WEEK*)	6.35	3.66	-0.159
Course number (*SCPOPE*)	4.81	1.14	1.472
Specialization creation week (*CREATION*)	989.37	339.36	0.346
Instructor number(*SIZE*)	3.18	2.21	3.167

TABLE 3. Collinear statistics of variables.

VARIABLE	Mean	SD
Duration difference (*TENRUE*)	0.957	1.044
Professional variety (*CATEGORY*)	0.963	1.038
Week index (*WEEK*)	0.982	1.019
Course number (*SCPOPE*)	0.873	1.146
Specialization creation week (*CREATION*)	0860	1.163
Instructor number(*SIZE*)	0.990	1.010

V. EMPIRICAL ANALYSIS

A. HLM FOR THE REVIEW VOLUME AND RATING OF THE SPECIALIZATION

1) HLM CONSTRUCTION FOR THE REVIEW VOLUME AND RATING OF THE SPECIALIZATION

Eq.5 represents an HLM with the review volume as the dependent variable, and Eq.6 represents an HLM with the rating as the dependent variable. There are two independent variables, i.e., the duration difference in the continuous opening course (TENRUE) and the professional disparity in the teaching field (CATEGORY) of the instructor group, and four curriculum control variables, i.e., the week index (WEEK), the number of courses in the specialization(SCPOPE), the opening time of the specialization (CREATION) and the instructor number of the specialization (SIZE).

An HLM with the review volume as the dependent variable Eq.5

$$\text{Level1} \quad RATEINGS_{it} = \pi_{0i} + \pi_{1i} * WEEK_{it} + \gamma_{it}$$

$$\text{Level2} \quad \pi_{0i} = \beta_{00} + \beta_{01} * TENRUE_{it} + \beta_{02} * CATEGORY_{it} + \beta_{03} * SCPOPE_{it} + \beta_{04}$$

$$* CREATION_{it} + \beta_{05} * SIZE_{it} + \beta_{06} * (TENRUE_{it})^2 + \beta_{07} * (CATEGORY_{it})^2 + \mu_{0i}$$

$$\pi_{1i} = \beta_{10} + \mu_{1i}$$

An HLM with the rating as the dependent variable Eq.6

$$\text{Level1} \quad SCORE_{it} = \pi_{0i} + \pi_{1i} * WEEK_{it} + \gamma_{it}$$

$$\text{Level2} \quad \pi_{0i} = \beta_{00} + \beta_{01} * TENRUE_{it} + \beta_{02} * CATEGORY_{it} + \beta_{03} * SCPOPE_{it} + \beta_{04} * CREATION_{it} + \beta_{05} * SIZE_{it} + \beta_{06} * (TENRUE_{it})^2 + \beta_{07}^{**} TENRUE_{it} * CATEGORY_{it} + \mu_{0i}$$

$$\pi_{1i} = \beta_{10} + \mu_{1i}$$

2) HLM ANALYSIS OF THE REVIEW VOLUME AND RATING OF THE SPECIALIZATION

Using HLM software, according to Eq.5 and 6, respectively, the HLM calculation results with the review volume as the dependent variable are shown in TABLE 4, and the HLM calculation results with the rating as the dependent variable are shown in TABLE 5.

TABLE 4 presents the null model, linear model and full model with the review volume as the dependent variable. We assessed the model fit using deviation differences (ΔDEV) and Bayesian information criterion (BIC) differences [42], [43]. Smaller values and a difference of negative 10 or greater suggested a better model fit. Therefore, the full model had a better fit than the other two models, so results of the full model were interpreted to test the hypotheses.

From the full model shown in TABLE 4, the intercept ($\beta_{00} = 7.134, p < 0.001$) denotes the average review volume ($2^{7.135} = 140$) of the specialization in the first time unit, and the week index ($\beta_{10} = 0.047, p < 0.001$) indicates that the review volume of the specialization has gradually increased from the first time unit with an average growth rate of 4.7%.

The dependent variable of the duration difference in the continuous opening course had a negative influence on the review volume of the specialization ($\beta_{01} = -3.402, p < 0.001$), and the dependent variable of the squared duration difference in the continuous opening course had a positive influence on the review volume of the specialization ($\beta_{06} = 1.650, p < 0.001$). Thus, research hypothesis 1 is supported.

The dependent variable of professional variety, i.e., the difference in the teaching field, had a positive influence on the review volume of the specialization ($\beta_{02} = 4.289, p < 0.001$). The dependent variable of the squared professional variety had a negative influence on the review volume of the specialization ($\beta_{07} = -5.249, p < 0.001$). Thus, research hypothesis 3 is supported.

The control variables of the course number in the specialization ($\beta_{03} = 0.075, p > 0.05$) and the instructor number in the specialization ($\beta_{05} = -0.061, p > 0.05$) also had no significant effect on the review volume of the specialization.

The control variable of the specialization creation week had a negative effect on the review volume of the specialization ($\beta_{04} = -0.003, p < 0.001$). As a result, the later the specialization is created, the less will be the review volume.

From the full model shown in TABLE 5, the intercept $\beta_{00} = 23.854 (p < 0.001)$ denotes the average rating ($log_2 23.854 = 4.6$) of the specialization in the first time unit,

TABLE 4. Results of hlm with the review volume as the dependent variable.

Variables	Null Model	Linear Model	Full Model
Intercept β_{00}	7.134***	7.135***	7.134***
	(0.113)	(0.113)	(0.085)
Week		0.049***	0.047***
		(0.004)	(0.004)
Duration difference			-3.402***
			(0.709)
Professional variety			4.289***
			(1.034)
Course number			0.075
			(0.087)
Specialization creation week			-0.003***
			(0.000)
Instructor number			-0.061
			(0.041)
Duration difference squared			1.650***
			(0.431)
Professional variety squared			-5.249***
			(1.277)
-2 log-likelihood	17280.86	17119.34	17961.58
Deviation (ΔDEV)		-161.52***	-157.76***
BIC	18228.86	17680.84	17499.16
ΔBIC		-548.02	-181.68

***p<0.001, **p<0.01, *p<0.05

TABLE 5. Results of HLM with the rating as the dependent variable.

Variables	Null Model	Linear Model	Full Model
Intercept β_{00}	4.55***	23.856***	23.854***
	(0.113)	(0.061)	(0.173)
Week		0.082***	0.047***
		(0.061)	(0.004)
Duration difference			-3.154***
			(0.113)
Professional variety			-0.952
			(0.637)
Course number			-0.353**
			(0.137)
Specialization creation week			-0.000
			(0.001)
Instructor number			-0.067**
			(0.045)
Duration difference squared			4.985***
			(2.370)
Multiplication of duration difference and professional variety			-4.748***
			(2.396)
-2 log-likelihood	6985.426	6947.27	6733.68
Deviation (ΔDEV)		-138.15***	-113.59***
BIC	7280.86	7144.95	7013.08
ΔBIC		-135.91	-131.87

***p<0.001, **p<0.01, *p<0.05

and the week index $\beta_{10} = 0.047(p < 0.001)$ indicates that the rating of the specialization has gradually increased from the first time unit with an average growth rate of 4.7%.

The dependent variable of the duration difference in the continuous opening course had a negative influence on the rating of the specialization ($\beta_{01} = -3.154, p < 0.001$), and the dependent variable of the duration difference squared $(TENRUE_{it})^2$ in the continuous opening course had a positive influence on the rating of the specialization ($\beta_{06} = 4.985, p < 0.001$). Thus, research hypothesis 2 is supported.

The dependent variable of professional variety, i.e., the difference in the teaching field ($CATEGORY_{it}$) had no influence on the rating of the specialization ($\beta_{02} = -0.952, p > 0.05$). Thus, hypothesis 4 is not supported.

Multiplication of the duration difference and the professional variety had a negative influence on the rating of the specialization ($\beta_{07} = -4.748, p < 0.001$).

Both the control variables of the course number and the instructor number in the specialization had negative effects on the rating of the specialization ($\beta_{03} = -0.353, p < 0.001$; $\beta_{05} = -0.067, p < 0.001$). The control variable of the specialization creation week had no effect on the rating of the specialization ($\beta_{04} = -0.000, p > 0.05$). Therefore, the greater the number of courses and number of instructors in the specialization, the lower was the rating of the specialization.

B. HLM FOR THE INSTRUCTOR DIVERSITY OF THE SPECIALIZATION OVER TIME

1) HLM CONSTRUCTION FOR THE INSTRUCTOR OF THE SPECIALIZATION OVER TIME

Eq.7 represents an HLM with as the dependent variable, and Eq.8 represents an HLM with as the dependent variable. There are four curriculum control variables, i.e., the week index (WEEK), number of courses in the specialization (*SCPOPE*), opening time of the specialization (*CREATION*) and instructor number of the specialization (*SIZE*).

An HLM with the duration difference as the dependent variable Eq.7

$$\begin{aligned} \text{Level} \quad & TENRUE_{it} = \pi_{0i} + \pi_{1i}^{*} WEEK_{it} + \gamma_{it} \\ \text{Level2} \quad & \pi_{0i} = \beta_{00} + \beta_{01}^{*} SCPOPE_{it} + \beta_{02}^{*} CREATION_{it} \\ & \qquad + \beta_{03}^{*} SIZE_{it} + \mu_{0i} \\ & \pi_{1i} = \beta_{10} + \mu_{1i} \end{aligned}$$

An HLM with the professional diversity as the dependent variable Eq.8

$$\begin{aligned} \text{Level1} \quad & CATEGORY_{it} = \pi_{0i} + \pi_{1i}^{*} WEEK_{it} + \gamma_{it} \\ \text{Level2} \quad & \pi_{0i} = \beta_{00} + \beta_{01}^{*} SCPOPE_{it} + \beta_{02}^{*} CREATION_{it} \\ & \qquad + \beta_{03}^{*} SIZE_{it} + \mu_{0i} \\ & \pi_{1i} = \beta_{10} + \mu_{1i} \end{aligned}$$

2) HLM ANALYSIS FOR THE INSTRUCTOR OF THE SPECIALIZATION OVER TIME

Using HLM6.08 software, according to Eq.7 and 8, respectively, the HLM calculation results with the duration difference in the continuous opening course by the instructor group of the specialization as the dependent variable are shown in TABLE 6, and the HLM calculation results with the professional disparity in the teaching field by the instructor group of the specialization as the dependent variable are shown in TABLE 7.

The full model in TABLE 6 had a better fit than the other two models. From the full model shown in TABLE 6, the

TABLE 6. Results of HLM with duration difference as the dependent variable.

Variables	Null Model	Linear Model	Full Model
Intercept β_{00}	0.309***	0.309***	0.313***
	(0.012)	(0.012)	(0.011)
Week		-0.018***	-0.017***
		(0.001)	(0.001)
Course number			0.011
			(0.010)
Specialization creation week			0.002***
			(0.000)
Instructor number			0.0167**
			(0.005)
-2 log-likelihood	6386	-7370	-7497
Deviation (ΔDEV)		-984***	-127***
BIC	-6191.48	-6318.53	-6508.61
ΔBIC		-127.05	-190.08

***p<0.001，**p<0.01, *p<0.05

TABLE 7. Results of HLM with professional disparity as the dependent variable.

Variables	Null Model	Linear Model	Full Model
Intercept β_{00}	0.191***	0.191***	0.191***
	(0.013)	(0.013)	(0.013)
Week		-0.006***	-0.017***
		(0.001)	(0.001)
Course number			0.003***
			(0.012)
Specialization creation week			-0.001***
			(0.017)
Instructor number			0.0017**
			(0.006)
-2 log-likelihood	-9386	-9603	-9873
Deviation (ΔDEV)		-217***	-270***
BIC	8738.35	8580.83	8357.20
ΔBIC		-157.52	-223.63

***p<0.001，**p<0.01, *p<0.05

intercept $\beta_{00} = 0.313(p < 0.001)$ indicating the average duration difference in the continuous opening course by the instructor group of the specialization in the first time unit was 0.313; the week index $\beta_{10} = -0.017(p < 0.001)$ indicating a negative effect of time on duration difference in the continuous opening course by instructor group of the specialization and gradually decreased from the first time unit with an average growth rate of 1.7%. Thus, hypothesis 5 is supported.

The control variable of the course number in the specialization had no effect on the duration difference in the continuous opening course by instructor group of the specialization($\beta_{01} = -0.011, p > 0.05$). Both the control variables of the specialization creation week and the instructor number of the specialization had a positive effect on the duration difference ($\beta_{02} = 0.0002, p < 0.001$; $\beta_{03} = 0.016, p < 0.01$); thus, the later the specialization is established, the more instructors there are and the greater is the duration difference in the continuous opening course by instructor group of the specialization.

From the full model shown in TABLE 7, the initial intercept $\beta_{00} = 0.191(p < 0.001)$ denoting the average professional disparity in the teaching field by instructor group of the specialization in the first time unit was 0.191. The slope $\beta_{10} = -0.017(p < 0.001)$indicating a negative effect of time on professional disparity in the teaching area by instructor group of the specialization gradually decreased from the first time unit with an average reduce rate of 1.7%. Thus, hypothesis 6 is supported.

The control variable of the course number in the specialization had no effect on the professional difference in the teaching field by instructor group of the specialization($\beta_{01} = 0.003, p > 0.05$). The control variable of the specialization creation week had a negative effect on the professional difference in the teaching field by the instructor group of the specialization($\beta_{02} = -0.0001, p < 0.05$). The control variable of the instructor number had positive effect on the duration difference in the teaching field by instructor group of the specialization ($\beta_{03} = 0.017, p < 0.01$). Therefore, the earlier the specialization is established, the more instructors there are and the greater is the professional difference in the teaching field by instructor group of the specialization.

C. ANALYSIS OF THE RESEARCH RESULTS

Based on the above analysis, the results of the hypothesis verification are shown in TABLE 8. Overall, 5 out of 6 hypotheses are supported by the data.

TABLE 8. Research hypothesis verification results.

Hypothesis	Supported
H1 There is a curvilinear relationship between the duration difference in the continuous opening course and the review volume. Increases in duration difference lead to a decreasing review volume. Increasing the duration difference beyond certain levels will increase the review volume.	Yes
H2 There is a curvilinear relationship between the duration difference of the continuous opening course and the rating. Increases in duration difference lead to a decreasing rating. Increasing the duration difference beyond certain levels will increase the rating.	Yes
H3 There is a curvilinear relationship between professional disparity and the review volume. Increases in professional disparity lead to an increasing review volume. Increasing professional disparity beyond certain levels will decrease the review volume	Yes
H4 There is a curvilinear relationship between professional disparity and the rating. Increases in the teaching field will lead to an increasing rating. Increasing professional disparity beyond certain levels will decrease the rating	No
H5 The difference duration of the continuous opening course significantly declines over time	Yes
H6 The professional disparity significantly declines over time	Yes

1) THE INFLUENCE OF INSTRUCTOR GROUP DIVERSITY ON THE REVIEW VOLUME AND RATING

Both H1 and H2 are supported. The duration difference of the continuous opening course by instructor group in the specialization indicates the degree of time dispersion in the courses offered by instructors. When the duration difference is small, it indicates that the duration of the course in the specialization is less heterogeneous and has a resource aggregation effect. Therefore, the learner is more sensitive to the duration difference. Additionally, the increase in duration difference has a negative impact on the review volume and rating. When the duration difference exceeds a certain level, the instructor group can continuously improve and update the structure of the specialization with sufficient experience, reflecting the resource innovation effect. Accordingly, the learning experience of participating learners can be improved, and thus, the increase in the duration of the course has a positive impact on the review volume and rating. In general, the duration difference of the continuous opening course by instructor group in the specialization is in line with the review volume and rating of the course. Thus, the duration difference of the continuous opening course has a curvilinear relationship with the review volume and rating, respectively.

H3 addresses the curvilinear relationship between professional disparity and the review volume is supported. The professional disparity of the teaching field by instructor group in the specialization indicates the degree of discipline dispersion offered by instructors. With the popularization and improvement of interdisciplinary knowledge, there are often professional differences in the teaching field by instructors in each specialization. For example, the specialization ''Music Business'' combines music and art in interdisciplinary art and humanities, resulting in the data analysis of data science and business. This combination forms a multidisciplinary learning chain to attract more learners and thus has a positive impact on the review volume. However, when the professional disparity of the teaching field exceeds a certain level, the subject is too scattered in the specialization, so although the learner is satisfied by pursuing the disciplinary diversity, the difficulty of the course in different disciplines is not the same, which may lead learners to abandon their continuous learning. As a result, the increase in professional disparity of teaching field has a negative impact on the review volume. In general, the professional disparity has a curvilinear relationship with the review volume.

In contrast to our predictions, H4, regarding the curvilinear relationship between professional disparity and the rating is not supported by the data. Although unexpected, one explanation for this unexpected finding is that although learners expand their knowledge stock as a result of the professional disparity of the teaching field by the instructor group in the specialization, the professional disparity has no significant effect on the rating because learners can jump out of a single field of study by choosing the professional disparity. Thus, the rating ultimately depends on the course quality.

Moreover, the interaction between the duration difference of the continuous opening course and the professional disparity of the teaching field by instructor group in the specialization has a significant negative impact on the rating. This phenomenon derives from the professional disparity of the teaching field by the instructor group, which does not directly affect the rating of the specialization, but multiplication of the professional disparity and duration difference has a significant negative impact on the rating.

2) THE TREND OF INSTRUCTOR GROUP DIVERSITY OVER TIME

Both H4 and H5 are supported. In the specialization, both the duration difference of the continuous opening course and the professional disparity in the teaching field by instructor group in the specialization gradually decrease with time because the control variable of the specialization creation week and the instructor number of the specialization have a significant positive impact on the duration difference of the continuous opening course and the professional disparity in the teaching field by instructor group in the specialization. The later the specialization course is opened, the more instructors there are the greater is the duration difference of continuous opening course by instructor group in the specialization.

The control variable of the specialization creation week and the control variable of the instructor number of the specialization have a significant negative impact and positive impact on the professional disparity of the teaching field,

respectively. The earlier the specialization is opened, the more instructors there are and the greater is the diversity of the instructor group. Therefore, with the improvement and number of the specialization, the instructor group members tend to be homogenous, and the duration difference in the continuous opening course gradually declines. Thus, the aggregation effect of the instructor group in the specialization becomes more obvious over time.

VI. RESEARCH CONTRIBUTIONS AND PRACTICAL ADVICE

A. RESEARCH CONTRIBUTIONS

Previous research on MOOC instructors have mostly been conducted from the perspective of individual instructors and explored the influence of the instructor behavior on learners' learning results and curriculum evaluation. This paper proposes the research hypothesis from the perspective of the instructor group and takes the Coursera specialization as the empirical object. The review volume and rating of the specialization are used as dependent variables. Two independent variables, i.e., the duration difference of the continuous opening course and the professional disparity of the teaching field by instructor group in the specialization, are set to describe diversity characteristics of instructors, and four control variables, i.e., week index, course number in the specialization, specialization creation week, and instructor number, are considered as the curriculum level control variables. The HLM is established to empirically verify the hypotheses, aiming to explore the influence of the instructor group diversity of MOOC specialization on the review volume and rating, as well as the trend of instructor group diversity over time.

This research supplements the research on MOOCs and emphasizes the important role of research on instructor group diversity in the specialization. Currently, most MOOC research focuses on learners, courses, and individual instructors. This paper focuses on the impact of the instructor group diversity in the curriculum evaluation specialization. On the one hand, it is confirmed that the instructor group diversity in MOOC specialization can affect the review volume and rating by learners; on the other hand, it explores the instructor group diversity in MOOCs and its trend over time.

In this paper, the theory of group diversity is applied to the study of the instructor group diversity in MOOC specialization to expand the theoretical basis of MOOC research. At present, research on instructor group diversity mostly focuses on the traditional offline instructor. With the development of information technology, online courses are rising rapidly. Therefore, it is more important to study the diversity of online instructors. In this paper, according to characteristics of the instructor group in the MOOC specialization, indicators are proposed for measuring instructor group diversity, and a quantitative analysis is conducted to demonstrate the influence of the instructor group diversity on the review volume and rating, enriching online group diversity theory research.

Considering that data are both hierarchical and dynamic, this paper uses the HLM for longitudinal research, and hierarchically processes the dataset with the timeline. By capturing the Coursera specialization data for half a year, the empirical data set is formed to construct the HLM, describing the continuous change in the instructor group diversity, thereby making more reasonable the independent variable representing the instructor group diversity and the control variables at the curriculum level, and the causal relationship with the dependent variable of course evaluation.

B. PRACTICAL ADVICE

Previous The practical advice for MOOC providers and instructors is provided as followings.

This study finds that the greater the duration difference of the continuous opening by instructor group in the specialization, the less will be the overall review volume and rating for the specialization; however, once the duration difference increases to a certain level, it will improve the evaluation of the specialization because of the refreshment of the specialization. Therefore, it is recommended that when setting up the specialization for MOOCs, synchronization of the course in terms of opening and duration time should receive more attention to avoid halting the updates to the course content after opening, resulting in inconsistent durations of different courses and, thus a loss of learners due to learning experience decline.

This study finds that the greater the disparity in the teaching area by instructor group in the specialization, the more review volume is available for the specialization. Additionally, if the duration difference of the continuous opening course is small, then the rating is higher. However, once the professional disparity of the teaching field has increased to a certain extent, it will have a negative impact on the review volume for the specialization. Therefore, it is recommended that when setting up the specialization for MOOCs, the development trend of interdisciplinary subjects should be combined to appropriately increase the diversity of subjects within the specialization so that learners can learn from different professional fields. Concurrently, if the curriculum fields in the specialization are quite different, the course should have a centralized arrangement to satisfy different learners; if the difference in curriculum fields in the specialization is small, the course should have a dispersed arrangement for learners to learn in a step-by-step manner, to effectively avoid wasting resources and improve the overall evaluation of the specialization.

This study finds that the duration difference of continuous teaching by instructor group in the specialization gradually decreases with time, as does the professional disparity of the teaching field. Therefore, it is recommended that the richness of teaching field in the specialization increased as much as possible to attract more learner participation, for example, through the MOOCs ''micro-professional'' training model, effectively use the diversity value of the instructor group, quickly enable learners to acquire knowledge, and meet the human capital requirement of enterprise, so that the specialization can be developed in a more scientific and rational direction.

VII. LIMITATIONS AND FUTURE RESEARCH

First, the data used in this study are from the Coursera, and more MOOC platforms should be evaluated in the future to further promote the research landscape of the instructor diversity in the specialization course.

Second, the time period for collecting the data in this paper is mainly concentrated in the second half of 2018, so the length of time selection is limited. Therefore, data should be further collected for future longitudinal research.

Finally, the independent variables, dependent variables and control variables in this paper have not yet been involved in text mining and content analysis of MOOC platform data. Therefore, the model analysis variables need to be further expanded. Moreover, the effect of the world-wide lockdown of 2020 on MOOC platforms should be a future research considering.

REFERENCES

[1] S. Sanchez-Gordon and S. Lujan-Mora, "Research challenges in accessible MOOCs: A systematic literature review 2008–2016," *Universal Access Inf. Soc.*, vol. 7, no. 4, pp. 70–74, Nov. 2018, doi: 10.1007/s10209-017-0531-2.

[2] G. Veletsianos and P. Shepherdson, "A systematic analysis and synthesis of the empirical MOOC literature published in 2013–2015," *Int. Rev. Res. Open Distrib. Learn.*, vol. 17, no. 2, pp. 198–221, Mar. 2016, doi: 10.19173/irrodl.v17i2.2448.

[3] M. Zhu, A. Sari, and M. M. Lee, "A systematic review of research methods and topics of the empirical MOOC literature (2014–2016)," *Internet Higher Educ.*, vol. 37, no. 4, pp. 31–39, Apr. 2018, doi: 10.1016/j.iheduc.2018.01.002.

[4] B. Li, X. Wang, and S. C. Tan, "What makes MOOC users persist in completing MOOCs? A perspective from network externalities and human factors," *Comput. Hum. Behav.*, vol. 85, no. 8, pp. 385–395, Aug. 2018, doi: 10.1016/j.chb.2018.04.028.

[5] A. Bozkurt, E. Akgün-Özbek, and O. Zawacki-Richter, "Trends and patterns in massive open online courses: Review and content analysis of research on MOOCs (2008–2015)," *Int. Rev. Res. Open Distrib. Learn.*, vol. 18, no. 5, pp. 118–147, 2017.

[6] O. Zawacki-Richter, A. Bozkurt, U. Alturki, and A. Aldraiweesh, "What research says about MOOCs—An explorative content analysis," *Int. Rev. Res. Open Distrib. Learn.*, vol. 19, no. 1, pp. 242–259, Feb. 2018, doi: 10.19173/irrodl.v19i1.3356.

[7] Y.-H. An, L. Pan, M.-Y. Kan, Q. Dong, and Y. Fu, "Resource mention extraction for MOOC discussion forums," *IEEE Access*, vol. 7, pp. 87887–87900, 2019, doi: 10.1109/ACCESS.2019.2924250.

[8] A. Adams, T. Liyanagunawardena, N. Rassool, and S. Williams, "Use of open educational resources in higher education," *Brit. J. Educ. Technol.*, vol. 44, no. 5, pp. E149–E150, Sep. 2013, doi: 10.1111/bjet.12014.

[9] G. Allione and R. M. Stein, "Mass attrition: An analysis of drop out from principles of microeconomics MOOC," *J. Econ. Educ.*, vol. 47, no. 2, pp. 174–186, Apr. 2016, doi: 10.1080/00220485.2016.1146096.

[10] P. M. Moreno-Marcos, C. Alario-Hoyos, P. J. Munoz-Merino, and C. D. Kloos, "Prediction in MOOCs: A review and future research directions," *IEEE Trans. Learn. Technol.*, vol. 12, no. 3, pp. 384–401, Jul. 2019, doi: 10.1109/TLT.2018.2856808.

[11] L. Haddadi, F. Bouarab-Dahmani, N. Guin, T. Berkane, and S. Lazib, "Peer assessment and groups formation in massive open online courses," *Comput. Appl. Eng. Edu.*, vol. 26, no. 5, pp. 1873–1887, Sep. 2018, doi: 10.1002/cae.22005.

[12] K. F. Hew, C. Qiao, and Y. Tang, "Understanding student engagement in large-scale open online courses: A machine learning facilitated analysis of student's reflections in 18 highly rated MOOCs," *Int. Rev. Res. Open Distrib. Learn.*, vol. 19, no. 3, pp. 69–93, Jul. 2018.

[13] K. van de Oudeweetering and M. Decuypere, "Understanding openness through (in)visible platform boundaries: A topological study on MOOCs as multiplexes of spaces and times," *Int. J. Educ. Technol. Higher Educ.*, vol. 16, no. 1, pp. 1–30, Jul. 2019, doi: 10.1186/s41239-019-0154-1.

[14] O. Almatrafi and A. Johri, "Systematic review of discussion forums in massive open online courses (MOOCs)," *IEEE Trans. Learn. Technol.*, vol. 12, no. 3, pp. 413–428, Jul. 2019, doi: 10.1109/TLT.2018.2859304.

[15] E. Er, E. Gómez-Sánchez, Y. Dimitriadis, M. L. Bote-Lorenzo, J. I. Asensio-Pérez, and S. Álvarez-Álvarez, "Aligning learning design and learning analytics through instructor involvement: A MOOC case study," *Interact. Learn. Environ.*, vol. 27, nos. 5–6, pp. 685–698, Aug. 2019, doi: 10.1080/10494820.2019.1610455.

[16] Y. R. F. Guillaume, J. F. Dawson, L. Otaye-Ebede, S. A. Woods, and M. A. West, "Harnessing demographic differences in organizations: What moderates the effects of workplace diversity?: What moderates the effects of workplace diversity?" *J. Org. Behav.*, vol. 38, no. 2, pp. 276–303, Feb. 2017, doi: 10.1002/job.2040.

[17] T. M. de Sousa e Silva, "Book review: A networked self: Identity, community and culture on social network sites," *Converg., Int. J. Res. New Media Technol.*, vol. 26, no. 2, pp. 448–451, Apr. 2020, doi: 10.1177/1354856519885481.

[18] K. Han, S. M. Colarelli, and N. C. Weed, "Methodological and statistical advances in the consideration of cultural diversity in assessment: A critical review of group classification and measurement invariance testing," *Psychol. Assessment*, vol. 31, no. 12, pp. 1481–1496, Dec. 2019, doi: 10.1037/pas0000731.

[19] K. A. Douglas, M. W. Zielinski, H. Merzdorf, H. A. Diefes-Dux, and P. Bermel, "Meaningful learner information for MOOC instructors examined through a contextualized evaluation framework," *Int. Rev. Res. Open Distrib. Learn.*, vol. 20, no. 1, pp. 204–220, Feb. 2019.

[20] H. W. Ware and A. Kitsantas, "Predicting teacher commitment using principal and teacher efficacy variables: An HLM approach," *J. Educ. Res.*, vol. 104, no. 3, pp. 183–193, Apr. 2011, doi: 10.1080/00220671003638543.

[21] N. R. Yancey, "Collaboration in teaching-learning: Honoring the wisdom of diverse perspectives," *Nursing Sci. Quart.*, vol. 32, no. 4, pp. 278–282, Oct. 2019, doi: 10.1177/0894318419864329.

[22] Y. Ren, J. Chen, and J. Riedl, "The impact and evolution of group diversity in online open collaboration," *Manage. Sci.*, vol. 62, no. 6, pp. 1668–1686, Jun. 2016, doi: 10.1287/mnsc.2015.2178.

[23] R. W. Walters and L. Hoffman, "Applying the hierarchical linear model to longitudinal," *Cultura y Educación*, vol. 29, no. 3, pp. 666–701, Jul. 2017, doi: 10.1080/11356405.2017.1367168.

[24] T.-Y. Chen and R.-C. Jou, "Using HLM to investigate the relationship between traffic accident risk of private vehicles and public transportation," *Transp. Res. A, Policy Pract.*, vol. 119, no. 1, pp. 148–161, Jan. 2019, doi: 10.1016/j.tra.2018.11.005.

[25] C. Maria, D. Ramona, and M. A. Andreea, "A comparative analysis of MOOC (massive open online course) platforms," *Inf. Econ.*, vol. 20, no. 2, pp. 5–14, 2016, doi: 10.12948/issn14531305/20.2.2016.01.

[26] M. C. Díaz-Fernández, M. R. González-Rodríguez, and B. Simonetti, "Top management team diversity and high performance: An integrative approach based on upper echelons and complexity theory," *Eur. Manage. J.*, vol. 38, no. 1, pp. 157–168, Feb. 2020, doi: 10.1016/j.emj.2019.06.006.

[27] R. Deng, P. Benckendorff, and D. Gannaway, "Progress and new directions for teaching and learning in MOOCs," *Comput. Educ.*, vol. 129, no. 2, pp. 48–60, Feb. 2019, doi: 10.1016/j.compedu.2018.10.019.

[28] B. Y. Chen, D. E. Kern, R. M. Kearns, P. A. Thomas, M. T. Hughes, and S. Tackett, "From modules to MOOCs: Application of the six-step approach to online curriculum development for medical education," *Acad. Med.*, vol. 94, no. 5, pp. 678–685, May 2019, doi: 10.1097/ACM.0000000000002580.

[29] D. Jo, "Exploring the determinants of MOOCs continuance intention," *KSII Trans. Internet Inf. Syst.*, vol. 12, no. 8, pp. 3992–4005, Aug. 2018, doi: 10.3837/tiis.2018.08.024.

[30] Y. Wang and R. Baker, "Grit and intention: Why do learners complete MOOCs?" *Int. Rev. Res. Open Distrib. Learn.*, vol. 19, no. 3, pp. 20–42, Jul. 2018.

[31] Y. J. Joo, H.-J. So, and N. H. Kim, "Examination of relationships among students' self-determination, technology acceptance, satisfaction, and continuance intention to use K-MOOCs," *Comput. Educ.*, vol. 122, pp. 260–272, Jul. 2018, doi: 10.1016/j.compedu.2018.01.003.

[32] L. M. Shore, A. E. Randel, B. G. Chung, M. A. Dean, K. Holcombe Ehrhart, and G. Singh, "Inclusion and diversity in work groups: A review and model for future research," *J. Manage.*, vol. 37, no. 4, pp. 1262–1289, Jul. 2011, doi: 10.1177/0149206310385943.

[33] W. A. Firestone and M. L. Donaldson, "Teacher evaluation as data use: What recent research suggests," *Educ. Assessment, Eval. Accountability*, vol. 31, no. 3, pp. 289–314, Aug. 2019, doi: 10.1007/s11092-019-09300-z.

[34] H. van Dijk and M. L. van Engen, "A status perspective on the consequences of work group diversity," *J. Occupat. Org. Psychol.*, vol. 86, no. 2, pp. 223–241, Jun. 2013, doi: 10.1111/joop.12014.

[35] A. Pullen, C. Rhodes, C. McEwen, and H. Liu, "Radical politics, intersectionality and leadership for diversity in organizations," *Manage. Decis.*, early access, Dec. 2019, doi: 10.1108/MD-02-2019-0287.

[36] C. J. Bonk, M. Zhu, M. Kim, S. Xu, N. Sabir, and A. R. Sari, "Pushing toward a more personalized MOOC: Exploring instructor selected activities, resources, and technologies for MOOC design and implementation," *Int. Rev. Res. Open Distrib. Learn.*, vol. 19, no. 4, pp. 92–115, Sep. 2018.

[37] P. Landry, "A matrix that encompasses the diversity of successions in cultural organizations," *Int. J. Arts Manage.*, vol. 21, no. 1, pp. 61–75, 2018.

[38] S. Daniel, R. Agarwal, and K. J. Stewart, "The effects of diversity in global, distributed collectives: A study of open source project success," *Inf. Syst. Res.*, vol. 24, no. 2, pp. 312–333, Jun. 2013, doi: 10.1287/isre.1120.0435.

[39] S. Menon and G. Banerjee, "Evaluating effectiveness of a teacher training MOOC: Industry perspective," in *Proc. IEEE 10th Int. Conf. Technol. for Edu. (T4E)*, Dec. 2019, pp. 102–105.

[40] E. Niehaus, C. M. Campbell, and K. K. Inkelas, "HLM behind the curtain: Unveiling decisions behind the use and interpretation of HLM in higher education research," *Res. Higher Educ.*, vol. 55, no. 1, pp. 101–122, Feb. 2014, doi: 10.1007/s11162-013-9306-7.

[41] M. J. G. Bun and T. D. Harrison, "OLS and IV estimation of regression models including endogenous interaction terms," *Econ. Rev.*, vol. 38, no. 7, pp. 814–827, Aug. 2019, doi: 10.1080/07474938.2018.1427486.

[42] B. Van Dusen and J. Nissen, "Modernizing use of regression models in physics education research: A review of hierarchical linear modeling," *Phys. Rev. Phys. Educ. Res.*, vol. 15, no. 2, Jul. 2019, doi: 10.1103/PhysRevPhysEducRes.15.020108.

[43] K. P. Burnham and D. R. Anderson, "Multimodel inference: Understanding AIC and BIC in model selection," *Sociol. Methods Res.*, vol. 33, no. 2, pp. 261–304, Nov. 2004, doi: 10.1177/0049124104268644.