Adult and Higher Education (2023)
Clausius Scientific Press, Canada

DOI: 10.23977/aduhe.2023.050306
ISSN 2523-5826 Vol. 5 Num. 3

Evaluation of Effectiveness in Online Teaching Based on AHP Method

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Keywords: Teaching Method Reform, Online Teaching, Evaluation of Effectiveness, Analytic Hierarchy Process

Abstract: High quality online university courses are required during the outburst of the pandemic. The teaching and learning efficiency of online courses could attribute to various internal and external factors. Taken the characteristics of online teaching into consideration, this paper uses the online teaching interactions as the main determinants. In the empirical analysis, the effectiveness of an online financial engineering courses is evaluated. AHP method is applied to evaluate the learning efficiency of individual students. The result from the empirical analysis supports the hypothesis that effective communication in an online courses would improve learning efficiency. The students with the best communication skills would have the best performance in the final exams. To improve the quality of online teaching and distance learning, seamless communication and efficient interaction are the most crucial tasks.

1. Introduction

During the pandemic outburst of Covid-19, online teaching and other distance learning methods were adopted in university courses. Various online teaching platforms and different methods are used by different universities in different courses in various disciplines [1-2]. In online courses, the mediation between teaching and learning is quite different from traditional lectures. The teaching methods, teaching contents, assignment, and assessment should be adapted accordingly to ensure teaching quality. From the different perspectives of lecturers, students, and administration, the efficiency of online teaching is controversial. Some argue that the efficiency of online teaching is considerably lower than traditional lectures, while others think that the quality of teaching could be ensured as long as the communication channel is smooth [2-3]. Based on the course of financial engineering, this paper analyzes the effectiveness of online teaching. The research is structured as follows: the second part elaborates teaching reform and course design in the environment of online teaching, and then illustrates the determinants attributed to effectiveness in online teaching. The third part analyzes the effectiveness of online teaching based on communication and other factors, evaluates the learning efficiency of individual students by AHP method, and provides explanations

for empirical results. The fourth part provides conclusions and further discussions on the improvement of online teaching efficiency.

2. Teaching Reform, Online Course Design and Effectiveness in Online Teaching

2.1. Teaching Reform and Online Course Design

Teaching reform during financial engineering is integrated with online teaching during the outburst of pandemic. Four key measures were taken in the teaching reform, which were conducted in a same way to facilitate online teaching. First, the course of financial engineering is divided into two parts, the theoretical part and practical part, to enhance the practical capability amongst students. The course of financial engineering practice and experiment is organized online. To deal with the more severe challenges than theoretical courses, the step of experiment and data analysis were elaborated live online, in the form of video, audio, flow progress diagram, hand-written illustrations, which could be referenced later for students with difficulty in exercise. Second, teaching students in accordance with their aptitude [4]. The students were assigned different materials and assignments according to their learning ability, previous professional knowledge, mathematics knowledge, and English proficiency. The learning material and assignment were sent to each student according to their ability through the Dingtalk platform, while the syllabus of the course were announced in the course group which was available for all students. [5]Third, a new guidance teaching approach was adopted to interpret the difficult parts of the course. The course of financial engineering included various theories and formula calculation, which is difficult for undergraduate students. Moreover, the online courses increased the difficulty in teaching the calculation part of the course. Various mediations are used to interpreting calculations, elaborate hand-written steps, and live online teaching are helpful for students. [6] The coursework is reviewed instantly. Instead of announcing the correct answers, clues are provided for each student according to the mistake in their answers, so the students could solve the problems on their own. Fourth, a new interaction teaching approach is applied in the online course. Traditionally, a case study or discussion was organized in groups, while only students with the best performance participated in the presentation.

2.2. Influential Factors of Effectiveness

Compared with the traditional methods of classroom teaching, online teaching could be considered less efficient than face-to--to-face lectures. However, the optimization of learning resources from various mediations could mitigate the problem of low efficiency in online teaching. The effectiveness of online teaching depends on communication, that is to say, effective interactions to make up for the disadvantage of online teaching [7]. Taken the characteristics of online teaching into consideration, the efficiency of online teaching could be evaluated through the interactions between teaching and learning of different materials through different mediations. In the traditional teaching methods, classroom lectures take up a large proportion of undergraduate education. The teaching and learning could be considered segmented. The communication between students and lecturers are limited with office hours and rarely correspondence. Self study without guidance is prevalent amongst university students. The online courses provided by individual lecturers, while making full use of communication platforms, could achieve equivalent or even better teaching standards than traditional lectures. The interaction plays an important role in learning effectiveness, regardless of the way of learning, online or otherwise [8]. Taken the characteristics of the online courses into consideration, interactive teaching could turn the challenge

arising from the online courses into the opportunity to improve the quality of undergraduate courses [9].

3. Empirical Analysis

3.1. Data Selection and Methodology

This research conducts a quantitative analysis based on AHP method, with the sample selected from the undergraduate students studying the course of financial engineering in Hangzhou Normal University. The effectiveness of online teaching is a complex issue which could not be simply evaluated by final exam results. The various factors influence the effectiveness in a different ways through different mechanisms, which could not be simply added up. [10] As the combination of quantitative research and qualitative analysis, Analytic Hierarchy Process method (AHP) could integrate different variables objectively and scientifically, which is suitable to evaluate the effectiveness of online teaching with both qualitative and quantitative determinant factors. This paper selected five students as the research sample. From the class of thirty students, five students from different geographic areas, with different learning abilities and having different information technology knowledge are selected, which forms a relatively balanced sample which could represent the typical student structure of undergraduate major in finance. Two types of variables are selected to evaluate the effectiveness of online teaching, one type covers the interactions in online courses while the other type depicts previous knowledge and learning ability of the students. The value of each indicator is determined by the specified learning behavior of each individual student.

3.2. Establishing the Evaluation Model

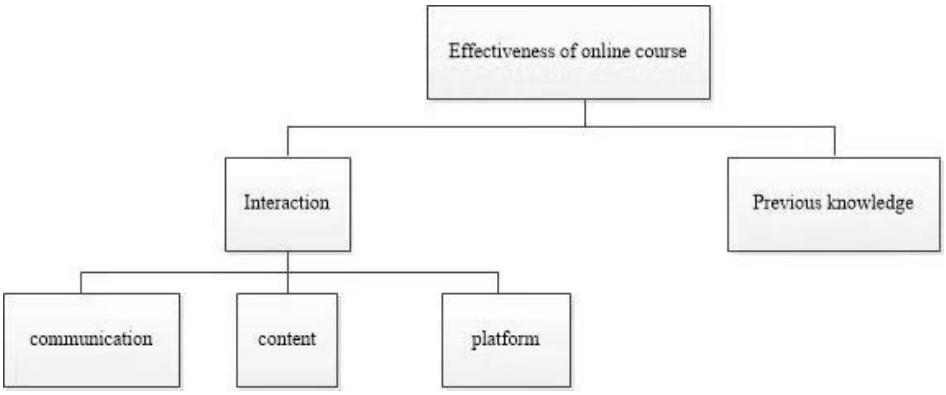

Figure 1: Structure model of effectiveness evaluation.

The evaluation of effectiveness is conducted with the following steps: first, build the evaluation system and specify the indicators; second, establish a matrix to compare and analyze different indicators; third, calculate the empirical results derived from the overall effectiveness; fourth, compare the empirical results with exam grades, to examine the validity of the model. According to the above analysis of the effectiveness of the online course, combining with its characteristics and the teaching reform in financial engineering, the structure of the evaluation could be illustrated in the hierarchy structure model (figure 1). The effectiveness of the online teaching course financial engineering is measured by the variables of interaction and previous knowledge. The interaction in teaching and learning is divided into three categories, which are as follows: interaction amongst lecturers, students, and experts in the industry (communication); interaction of teaching contents and material textbooks, academic research literature and industry practice (content); interaction of

different online teaching platforms (platforms). The previous knowledge is included as a control variable, which is measured by the exam results of the prerequisite courses, the mathematics level, and English language proficiency, as well as information technology ability.

3.3. Calculating the Comparing Matrices

Pairing comparison between individual students under each variable were conducted with complex measures for quantitative and qualitative analysis. The comparing matrices are as follows, respectively: the relative importance of interaction and previous knowledge, the relative importance amongst communication, content and platform; the comparison of individual students under the criteria of communication, content and platform; the comparison of preview knowledge amongst students. The result of pair comparison is calculated, the weight vector (wi) indicates the relative value or sequencing, which could be used in decision making.

The relative importance of the interaction and previous knowledge is depicted as the following matrix, while the weight is calculated as (0.666667, 0.333333).

$$\begin{bmatrix} 1 & 2 \\ 1/2 & 1 \end{bmatrix} \tag{1}$$

The relative importance amongst communication, content and platform is depicted as the following matrix, while the weight is calculated as (0.29696, 0.53961, 0.16342).

$$\begin{bmatrix} 1 & 1/2 & 2 \\ 2 & 1 & 3 \\ 1/2 & 1/3 & 1 \end{bmatrix} \tag{2}$$

The comparison of individual students under the criteria of communication is depicted as the following matrix, while the weight is calculated as (0.1155, 0.0772, 0.0564, 0.3074, 0.4435).

$$\begin{bmatrix} 1 & 3 & 2 & 1 & 1/3 \\ 1/3 & 1 & 2 & 1/3 & 1/5 \\ 1/2 & 1/2 & 1 & 1/2 & 1/4 \\ 1 & 3 & 2 & 1 & 1/3 \\ 3 & 5 & 4 & 3 & 1 \end{bmatrix} \tag{3}$$

The comparison of individual students under the criteria of content is depicted in the following matrix, while the weight is calculated as (0.1865, 0.08711, 0.08118, 0.1865, 0.45871).

$$\begin{bmatrix} 1 & 2 & 3 & 1/4 & 1/5 \\ 1/2 & 1 & 2 & 1/5 & 1/5 \\ 1/3 & 1/2 & 1 & 1/4 & 1/5 \\ 4 & 5 & 4 & 1 & 1/2 \\ 5 & 5 & 5 & 2 & 1 \end{bmatrix} \tag{4}$$

The comparison of individual students under the criteria of the platform is depicted as the following matrix, while the weight is calculated as (0.1107, 0.20901, 0.06822, 0.20901, 0.40306).

$$\begin{bmatrix} 1 & 1/2 & 2 & 1/2 & 1/4 \\ 2 & 1 & 3 & 1 & 1/2 \\ 1/2 & 1/3 & 1 & 1/3 & 1/5 \\ 2 & 1 & 3 & 1 & 1/2 \\ 4 & 2 & 5 & 2 & 1 \end{bmatrix} \quad (5)$$

The comparison of preview knowledge amongst students is depicted as the following matrix, while the weight is calculated as (0.21536, 0.0735, 0.12081, 0.21536, 0.37497).

$$\begin{bmatrix} 1 & 3 & 2 & 1 & 1/2 \\ 1/3 & 1 & 1/2 & 1/3 & 1/4 \\ 1/2 & 2 & 1 & 1/2 & 1/3 \\ 1 & 3 & 2 & 1 & 1/2 \\ 2 & 4 & 3 & 2 & 1 \end{bmatrix} \quad (6)$$

3.4. Consistency Test

Consistency test is conducted for each comparison matrix, as well as the overall model. The weight vector calculated in AHP method is derived from pair-wise comparison, which could lead to the problem of inconsistency. Therefore, a consistency test is conducted to ensure the validity of the results. The consistency test is as follows. All values of CR are under 0.1, which indicate consistency in the results (see Table 1).

Table 1: Consistency test results of AHP method.

	CI=(λmax-n)/(n-1)	CR=CI/RI
Interaction (amongst 3 types)	0.004601356	0.008849
Communication	0.055019	0.049124
Content	0.043551	0.038885
Platform	0.004541	0.004054
Previous knowledge	0.008268	0.007382
Overall	0.0405815	0.03623

3.5. Overall Evaluation Results

The overall evaluation result are represented by the total sequencing weight vector, which is calculated as the weighted average value of the weight vector from each level of each criterium. The total sequencing weight vector is as follows: (0.17381247, 0.093892589, 0.088077022, 0.222506013, 0.421711906). The result indicates that, from the most efficient to the least efficient, the order of the five students are E, D, A, B, C. The final exam results, which could objectively reflect the final outcome from online learning, should be included to verify the validity of the AHP approach. The grades in the final exam of the five students are consistent with the empirical results, which confirm the validity of the AHP analysis results. In the teaching method reform in the lectures of the course, financial engineering which was integrated with online teaching the teaching methods, course design, assessment, and teaching content were all improved, to enhance learning efficiency [11]. A series of measures are applied in teaching reform, which include individualized teaching, learning situation analysis, personalized teaching design, and online and offline interactive teaching reform, teaching content reform, problem solving, capacity cultivation, inquiry lead teaching reform, communication and interaction reform, etc [12]. The measures have achieved

favorable outcomes, such as the improvement of teaching efficiency, the general improvement of exam results, the improvement of the accuracy of comprehensive thinking questions, the significant improvement of students' practical ability, and the improvement of professional awareness. The empirical results are as follows (table 2).

Table 2: Comparison of AHP results and final exam results.

	Total sequencing weight	Final exam result
A	0.17381247	85
B	0.093892589	73
C	0.088077022	70
D	0.222506013	87
E	0.421711906	96
A	0.17381247	85

4. Conclusion and Further Discussion

Distance learning and online teaching became prevalent in university courses during the pandemic outburst. Various factors attribute to the effectiveness of online teaching. This paper selected samples from the course of financial engineering in Hangzhou Normal University, analyzing the effectiveness of online teaching with AHP method. Considering the characteristics of the online course, the interaction plays an important role. Whether an online courses could achieve the same result as traditional classroom lectures relies on effective communication and interaction. Previous level of professional knowledge as well as language and mathematics skills is also included in the model. The empirical analysis result is collaborated with the final exam results. To conclude, the interaction between lecturers, students, and experts in the industry, the interaction of different sources of learning materials and the interaction of various distance learning platforms are the key determinant factors in the effectiveness of an online financial engineering courses. In the future, an interactive teaching methods should be developed in university courses to enhance knowledge formation and promote efficient learning. There are also some issues concerning the teaching reform, which could be improved in the future. In the future teaching during financial engineering, we should pay more attention to the balance between theory and practice, to further expand the basic teaching, and better match the practice teaching and theory teaching, to achieve the effect of mutual promotion between theory and practice [13]. Individualized teaching could be improved further to benefit all students [14]. When designing teaching contents, assignments, and research topics, the criteria of teaching contents could increase to meet the individual needs of students. Experts from the industrial and academic field of financial engineering could be invited to give lectures and provide guidance for students in online courses. [15] The online offline interactive teaching method could be applied in various courses in the major of finance and banking, investment and other financial related courses, to achieve higher teaching quality and provide a better, more efficient and individualized learning experience for undergraduate students.

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