

# Determinants of Learners' Self-Directed Learning and on-Line Learning Attitudes in on-Line Learning

Jing Li<sup>1</sup>, Chi-Jen Chuang<sup>2</sup> and Chi-Hui Wu<sup>3</sup>

<sup>1</sup>Music and Film College, Tianjin Normal University, Tianjin, China

<sup>2</sup>Ph.D. Program in Management, Da-Yeh University, University Rd., Chunghua, Taiwan

<sup>3</sup>Department of Management and Information, National Open University, ZhongZheng Rd., New Taipei, Taiwan

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**Abstract:** Self-directed learning and online learning attitudes are important learning behavioral factors for learners in online learning; meanwhile, they affect learning outcomes too. In addition, the criteria of self-directed learning and online learning attitudes have complex, tangled, interconnected relationships. Therefore, this study applied the Fuzzy Delphi method and Fuzzy DEMATEL method to clarify the complex relationship between self-directed learning and online learning attitudes and to provide schools with teaching strategies and curriculum design to motivate learners' learning behavior. The study revealed that, in terms of the dimensions, "self-directed learning" is the defining dimension of learners' learning behavior, which influences the "online learning attitudes" dimension. Furthermore, in the criteria section, "self-learning", "computer and network confidence", "online learning", "computer and smartphone use" and "computer and smartphone preferences" are the decisive criteria that influence the other seven criteria. Among them, online learning, computer and smartphone use, and computer and smartphone preferences are the three key criteria for learning, and therefore, enhancing learners' attitudes towards online learning is an important task.

## 1 INTRODUCTION

The Internet is a common learning platform for learners and teachers to interact, communicate, and collaborate in a specific way (Baran et al., 2011), and the use of information technology (IT) in teaching has been implemented worldwide for decades. The purpose of developing online learning is to use IT to enhance the quality of teaching and learning, create a high-quality learning environment, eliminate time and space constraints on learning, improve the management of teaching resources, and establish the integration of IT into teaching and learning in various fields (Wu et al., 2019).

Although there is a large literature on the association of learning behavior (Laer & Elen, 2019), learner's learning behavior is still a complex behavioral pattern and a complicated, multifaceted and uncertain concept (Wu et al., 2019), learners' on-line learning behaviors include self-directed learning (Oddi, 1986; Chen & Liang, 2009), learning motivation (Boshier, 1971; Chen & Lin, 2018), learning attitudes (Loyd & Gressard, 1984; Okwumabua et al., 2010), learning engagement

(Handelsman et al., 2005; Tsai, 2016), and self-directed learning, on-line learning attitudes are important dimensions of learning behavior (Wu et al., 2019).

Since learners' self-directed learning affects their motivation (Song & Hill, 2007; Saranraj & Shahila, 2016), learning attitudes (Zhang et al., 2012), learning effectiveness (Khodabandehlou et al., 2012; Chen et al., 2022), and that learning attitudes affect motivation (MacIntyre et al., 2012), self-directed learning (Khodabandehlou et al., 2012), learning engagement (Lauren, 2017; Josephine et al., 2018), learning satisfaction (Wang & Liao, 2008) and learning effectiveness (Masgoret & Gardner, 2003; Wang & Liao, 2008). Therefore, there is no consistent conclusion on the relationship between self-directed learning and online learning attitudes, and there are many different indicators of self-directed learning and online learning attitudes, and measuring self-directed learning and online learning attitudes requires consideration of multiple quantitative and qualitative criteria (Wu et al., 2019).

In order to understand the complex relationships and determinants between learners' self-directed

learning and online learning attitudes in online learning activities, this study used the Fuzzy Delphi method to survey scholars and experts on learning behavior to obtain indicators of self-directed learning and online learning attitudes and to establish a framework of self-directed learning and online learning attitudes. The study also analyzed the causal relationships between the dimensions and criteria of self-directed learning and online learning attitudes through the Fuzzy DEMATEL method and identified the determinants in order to provide educational institutions and schools with reference for teaching strategies and curriculum design for the integration of IT into online teaching. The study also constructs a causal model of self-directed learning and online learning attitudes for academics to further explore the complex interrelationships between key learning behaviors of learners who learn online.

## 2 THEORETICAL BACKGROUND

Self-directed learning is an effective learning method, it is flexible and not limited by time and space, and learners can continuously enrich their professional knowledge, diagnose their learning needs, find learning resources through their learning goals, and implement appropriate learning strategies to achieve learning outcomes (Chen et al., 2021). Enhancing learners' self-directed learning can motivate learners to learn (Chen et al., 2021), and the higher the propensity for self-directed learning, the higher the satisfaction level of learners (Chen et al., 2021); in addition, the higher the self-directed learning, the better the learning outcomes (Chen et al., 2021; Chen et al., 2022).

Researchers who study self-directed learning have different perspectives, for instance, some scholars have adopted the readiness argument (Fisher et al., 2001; Chen, 2021), and self-directed learning readiness refers to the attitudes, abilities, and attributes that one possesses when engaging in self-directed learning (Chen, 2021). Scholars who have studied self-directed learning readiness have different views on its criteria. Fisher et al. (2001), Chen (2021) suggested that the criteria of self-directed learning readiness include self-management, desire for learning, and self-control. However, Chen, (2021) considered that the criteria for self-directed learning readiness include hope for the future, understanding of the self, active learning, self-confidence in learning things, and self-management.

Chang & Chang (2010) and Liang & Lai (2007), suggested that the criteria for self-directed learning readiness are effective learning, enjoyment of learning, motivation of learning, active learning, independent learning, and creative learning.

Other scholars (Tough, 1979; Tang et al., 2022) have applied the ability argument that self-directed learning ability affects online learning performances (Chou, 2012), and self-directed learning ability is often seen as valuable skill in school settings (Rees & Bary, 2006; Chou, 2012). Tang et al. (2022) suggest that the criteria for self-directed learning ability include self-management ability, information ability, and cooperative learning ability.

Some scholars (Knowles, 1975) have suggested the learning contract theory, which is considered to be the process by which learners, with or without the assistance of others, can diagnose their own learning needs, set learning goals, identify learning resources, select and implement appropriate learning strategies, and evaluate learning outcomes (Knowles, 1975). Self-directed learning from the learning contract theory can be applied to the effective planning of teaching and learning (Siriwongs, 2015), and emphasizes learner autonomy, two-way interaction between teacher and learner, and learner-centered teaching to develop learners' independent and autonomous learning skills (Chen et al., 2022).

This study integrates different perspectives on self-directed learning and classifies it into seven criteria: self-learning, continuous learning, efficiency learning, independent learning, self-understanding, planning learning, and favorite learning.

Learning attitudes are determined by the interaction between learners and their surroundings during the learning process; therefore, the factors that influence learners' attitudes are complex (Huang, 2003). Learning attitudes refer to learners' attitudes toward their interactions with the learning environment and, depending on their abilities and experiences, their more persistent affirmative or negative behavioral tendencies or internal states toward learning things (Liu et al., 2010).

Online education is an important delivery method in various educational settings (Ku & Lohr, 2003), and computers and the Internet designed for education have fundamentally changed university education (Liaw & Huang, 2011), with learner attitudes affecting not only online teaching (Chang, 2000) but also learning satisfaction (Wang & Liao, 2008) and learning outcomes (Masgoret & Gardner, 2003), while some other scholars argue that learning attitudes affect motivation in learning behavior

(MacIntyre et al., 2012; Çevik & Bakioğlu, 2022) or self-directed learning (Khodabandehlou et al., 2012). Online learning is the use of computers and smartphones as a medium of transmission, providing a diverse teaching environment where different learners have different problems and attitudes when using computers for learning. Rainer and Miller (1996) suggested that one of the most important factors in computer use is the learner's attitude towards the computer, so building positive learning attitudes and computer skills can have a positive effect on the learner's learning outcomes. Hignite (1990) argued that computer attitudes refer to learners' general perceptions of personal and social use of computers. This study was conducted on learners who were taking online music lessons, so online learning attitudes are defined as learners' willingness, interest, and emotional response to learning and interacting with computers and the Internet, as well as their ability to use computers and the Internet to equip and operate computers at speed.

This study focuses on the integration of IT into teaching and learning, where learners have to use computer devices and the Internet to learn the content of music lessons; therefore, it refers to the computer attitude scale (Lloyd & Gressard, 1984), the online teaching attitude scale (Graff, 2003), and related online learning attitude studies (Okwumabua et al., 2010), the online learning attitudes were categorized into five components: computer and network confidence, network use, online learning, computer and smartphone use, and computer and smartphone preference.

### 3 RESEARCH METHODOLOGY AND DESIGN

In this study, the main factors of learners' self-directed learning and online learning attitudes were summarized based on the literature review, with a total of 12 criteria in two major dimensions. The main targets of the study were scholars and experts in western Taiwan and Beijing-Tianjin, China, who studied online learning (IT-assisted music teaching). The study was conducted by using the Fuzzy Delphi method first to select the criteria with higher relative importance and then the Fuzzy DEMATEL method to explore the relationship among the dimensions and the criteria, construct a matrix of the relationship among the dimensions and the criteria, draw a cause-effect relationship diagram, and analyze the path of the cause-effect relationship. This study aims to

explore the determinants of learner self-directed learning and the attitudes of learners in online learning.

This study uses the fuzzy Delphi method to screen out relatively important criteria of self-directed learning and online learning attitudes. The Fuzzy Delphi Method (Lin et al., 2020) is a four-step process. Step 1: Gather the views of the decision-making community; Step 2: Create a triangular fuzzy number; Step 3: Defuzzification; and Step 4: Selection of evaluation criteria. The retention dimensions and criteria questionnaire were distributed to 20 academics and practical experts with more than ten years of experience in studying online music learning programs at universities, who used their knowledge and experience to determine whether to retain the criteria. The threshold used in this study is 70% (Wu et al., 2022), meaning that the criterion will be kept if more than 70% of academics and experts agree to keep it. The two dimensions and 12 criteria identified in this study have all been kept because more than 70% of experts and academics agree to keep them, as shown in Table 1.

Table 1: Fuzzy Delphi Method Questionnaire Item Statistics.

No.	Self-directed learning (S)/ online learning attitudes (O)	Thresh hold (Fuzzy performance values)	Retain / Delete
1	Self-learning (S1)	0.870	Retain
2	Continuous learning (S2)	0.889	Retain
3	Efficiency learning (S3)	0.726	Retain
4	Independent learning (S4)	0.744	Retain
5	Self-understanding (S5)	0.844	Retain
6	Planning learning (S6)	0.898	Retain
7	Favorite learning (S7)	0.825	Retain
8	Computer and network confidence (O1)	0.836	Retain
9	Network use (O2)	0.879	Retain
10	Online learning (O3)	0.870	Retain
11	Computer/smart phone use (O4)	0.853	Retain
12	Computer/smart phone preferences (O5)	0.799	Retain

The Fuzzy DEMATEL is a method that combines fuzzy semantic variables and DEMATEL method. The formula and calculation steps (Wu et al., 2020) as followed have seven steps.

- Step 1: Define the evaluation criteria and design a fuzzy semantic scale, and
- Step 2: Create a direct association matrix.
- Step 3: Build and analyze the structural model.
- Step 4: Total association matrix
- Step 5: Defuzzification.
- Step 6: Centrality and Causality.
- Step 7: Result Analysis.

## 4 ANALYSIS AND DISCUSSION OF THE FINDINGS

In this phase, 20 scholars and practical experts with more than ten years of experience studying online music learning programs at universities were invited to take the survey. The questionnaires were then distributed on-spot to these researchers and practitioners for completion. After three months of the survey, there were 20 valid questionnaires, including 10 for researchers and 10 for practitioners. The results of the various dimensions and criteria were then analysed.

### 4.1 Results of the Analysis of Each Dimensions

The evaluative dimensions are self-directed learning (S) and online learning attitudes (O). First is defining the evaluative dimensions, designing the fuzzy semantic scales, establishing the direct association matrix, building and analysing the structural model, and creating the total association matrix and defuzzification. The formulae and calculations, and the defuzzification matrix for each dimension, are shown in Table 2. The column and row values of each dimension are shown in Table 3 after the calculation of the centrality and causality. Then, after obtaining the values of  $d+r$  (centrality) and  $d-r$  (causality). The value of  $d+r$  (centrality) represents the strength of the influence between the dimensions, the higher the value, the stronger the influence. When the value of  $d-r$  is positive and if the value is higher, it represents the "cause" of the influence of other dimensions, and when  $d-r$  is negative and if the value is lower, it stands for the "effect" of the influence of other dimensions.

In the causality ( $d-r$ ) section, according to the value of  $d-r$  (causality), the dimensions of self-directed learning and online learning attitudes are classified into cause and effect clusters. Those dimensions with positive  $d-r$  (causality) values are classified as cause groups. The positive value of the

self-directed learning (S) dimension directly affects another dimension. Therefore, schools, educational institutions, and teachers should consider this dimension as the main dimension in developing learners' learning behaviors in online learning programs.

Table 2: Matrix of Defuzzied Total Correlations of the Dimensions.

Dimension	Self-directed Learning (S)	Online Learning Attitudes (O)
Self-directed Learning (S)	6.941	7.558*
Online Learning Attitudes (O)	7.094	6.941

Note: \* Indicates above the threshold value of 7.133.

Table 3: Collation of Column and Row Values of Dimension.

Dimension	$d$ (column values)	$r$ (row values)	$d+r$ (column sums)	$d-r$ (column difference)	Quadrant	Causal relationship
S	14.499	14.035	28.534	0.464	2 <sup>nd</sup>	Affects another dimension
O	14.035	14.499	28.534	-0.464	3 <sup>rd</sup>	Independence dimension
Average			28.534	0		

Note: Self-directed learning (S), Online learning attitudes (O).

The main purpose of learners' learning behaviors is to enforce the dimension in cause groups, namely, self-directed learning, so as to improve self-directed learning. Hence, self-directed learning (S) is the strongest affecting dimension and should be listed as the main dimension which could strengthen a learner's learning behavior. While another dimension with negative  $d-r$  (causality) values was categorized as an effect cluster, namely, online learning attitudes (O). This means that it was affected by others, and the extent to which this dimension was affected was greater than its own influence, so schools, educational institutions, and teachers can therefore consider the online learning attitude dimension as a problem to be solved in the long-term development of learners' learning behaviors. The highest positive value of  $d-r$  is self-directed learning (S), which represents the "cause" of the most influence on the other dimensions, while online learning attitudes (O) are the "effect" of the most influence from the other dimensions. As such, the higher the value of self-directed learning (S), the stronger the online learning attitudes (O). Hence, the self-directed learning dimension is the foundation of the learner's learning behavior. In terms of overall consideration, if learners want to improve their learning behavior in an online learning course, they

should choose the most influential dimension, namely, "self-directed learning (S)", which directly affects the dimension "online learning attitudes" (O).

From Table 2, we can find that self-directed learning (S) affects online learning attitudes (O), and it is clear that the direction of the arrow of self-directed learning (S) towards the online learning attitudes (O) directly and strongly. Hence, learners should cultivate their self-directed learning to enforce their learning attitudes, in order to perfect their online learning course behavior.

### 4.2 Results of the Analysis of the Criteria

The assessment criteria are self-learning (S1), continuous learning (S2), efficiency learning (S3), independent learning (S4), self-understanding (S5), planning learning (S6), favorite learning (S7), computer and network confidence (O1), network use (O2), online learning (O3), computer and smartphone use (O4), and computer and smartphone preferences (O5). There are a total of 12 criteria. After defining the criteria and designing the fuzzy semantic scale, establishing a direct association matrix, building and analysing the structural model, the total association matrix, and defuzzification, the defuzzified total association matrix among the criteria is shown in Table 4. Once  $d+r$  (centrality) and  $d-r$  (causality) have been obtained, the cause-effect relationship diagram.

In terms of centrality ( $d+r$ ), these three criteria, computer and network confidence (O1), online learning (O3), and computer and smartphone preferences (O5), are the most important. In terms of the causality ( $d-r$ ), the value of these criteria self-learning (S1), computer and network confidence (O1), online learning (O3), computer and smartphone use (O4), and computer and smartphone preferences (O5) are positive values, which mean that these are the cause criteria. Among them, the strongest are online learning (O3), computer and smartphone use (O4), and computer and smartphone preferences (O5). Conversely, the values of these seven criteria - continuous learning (S2), efficiency learning (S3), independent learning (S4), self-understanding (S5), planning learning (S6), favorite learning (S7), and network use (O2), are negative, which means these criteria are effect criteria. Among these criteria, independent learning (S4), planning learning (S6), and network use (O2) have the highest negative values.

Table 4: Collation of Column and Row Values of Criteria.

Criteria	$d$	$r$	$d+r$	$d-r$	Quadrant	Causal relationship
S1	4.876	4.418	9.293	0.458	1 <sup>st</sup>	Core criteria
S2	4.403	4.428	8.831	-0.024	3 <sup>rd</sup>	Independence criteria
S3	4.329	4.491	8.820	-0.162	3 <sup>rd</sup>	Independence criteria
S4	3.757	4.462	8.219	-0.705	3 <sup>rd</sup>	Independence criteria
S5	4.033	4.464	8.497	-0.430	3 <sup>rd</sup>	Independence criteria
S6	4.042	4.623	8.665	-0.581	3 <sup>rd</sup>	Independence criteria
S7	4.252	4.653	8.905	-0.401	3 <sup>rd</sup>	Independence criteria
O1	4.961	4.497	9.458	0.464	1 <sup>st</sup>	Core criteria
O2	4.075	4.530	8.605	-0.456	3 <sup>rd</sup>	Independence criteria
O3	4.966	4.395	9.361	0.570	1 <sup>st</sup>	Core criteria
O4	4.916	4.403	9.319	0.512	1 <sup>st</sup>	Core criteria
O5	5.140	4.385	9.525	0.754	1 <sup>st</sup>	Core criteria
Average			8.958	0		

Note: Self-learning (S1), Continuous learning (S2), Efficiency learning (S3), Independent learning (S4), Self-understanding (S5), Planning learning (S6), Favorite learning (S7), Computer and network confidence (O1), Network use (O2), Online learning (O3), Computer/smart phone use (O4), Computer/smart phone preferences (O5)

According to the causal relationships obtained from the combined centrality and causality analyses, computer and smartphone preferences (O5) have the strongest influence, while the most influential criterion is independent learning (S4). Among the criteria of self-directed learning and online learning attitudes, Online learning (O3), Computer and smartphone use (O4), and Computer and smartphone preferences (O5) are the most influential criteria and are the main criteria for improving learner's self-directed learning, online learning attitudes.

In the causality ( $d-r$ ) section, the 12 criteria of self-directed learning and online learning attitudes can be grouped into cause-effect clusters based on the  $d-r$  (causality) values. Criteria with positive  $d-r$  (causality) values are categorized as cause clusters, with a total of five criteria categorized. Positive criteria have a direct impact on the other criteria. Therefore, scholars should consider these criteria as important targets for enhancing self-directed learning and online learning attitudes and strengthen the criteria ability of the cause group to enhance the other criteria of self-directed learning and online learning attitudes. The most influential criteria are "online learning (O3), computer and smartphone use (O4), and computer and smartphone preferences (O5)." These three criteria are the most influential criteria and should be treated as the most important criteria for self-directed learning and online learning attitudes and the most influential "cause" of the other criteria. The higher the proportion of online learning, computer and smartphone use, and computer and

smartphone preferences, the stronger the influence of other criteria on self-directed learning and online learning attitudes. Therefore, the learners' online learning, computer and smartphone use, and computer and smartphone preferences are the basis for self-directed learning and online learning attitudes. The negative value of  $d-r$  (causality) is classified as the effect cluster. A total of seven criteria were categorized as "effect clusters," representing the extent to which they are influenced by other criteria. The extent of being affected by these seven criteria is greater than their own influence; therefore, schools, educational institutions, and teachers can consider these seven criteria as the long-term development of learners' self-directed learning and online learning attitudes to be addressed in online learning programs.

## 5 CONCLUSIONS

Learners' self-directed learning and online learning attitudes are complex, multi-criteria indicators of competence that cannot be precisely defined and measured, and there are a complex and entangled relationships among criteria. The results of this study show that the dimension of self-directed learning influences the dimension of online learning attitude, that the criteria for self-directed learning and online learning attitude are correlated with each other, and that the degree of influence on online learning attitude varies between criteria.

In terms of the dimension, firstly, self-directed learning influences the online learning attitude. In terms of the dimension level, self-directed learning is the cause that influences another dimension, and online learning attitudes are the effect that is influenced by it. Therefore, to strengthen learning behavior in online learning, learners can start by constructing a self-directed learning dimension. Secondly, self-directed learning is the main determinant dimension of learners' learning behavior, and it directly influences the online learning attitude and is a fundamental factor in enhancing learners' learning behavior. Therefore, learners need to develop self-directed learning to establish the foundation of their learning behavior in online learning.

In the criteria section, firstly, self-learning, computer and network confidence, online learning, computer and smartphone use, and computer and smartphone preferences are the main influencing criteria for the other criteria. In particular, computer and smartphone preferences are the most influential

criteria, and among self-learning, computer and network confidence, online learning, computer and smartphone use, and computer and smartphone preferences, these criteria affect each other and also affect other criteria. In addition, the criterion of computer and smartphone preferences is the strongest influencing criterion for the other criteria. Learners can start with the strongest and most influential computer and smartphone preferences to enhance their online learning attitudes by getting learners to enjoy accessing and operating computers and smartphones. Learners can also enhance self-directed learning through self-learning to develop skills for continuous learning, efficient learning, and other skills.

Self-learning, computer and network confidence, online learning, computer, and smartphone use, and computer and smartphone preferences are the main influences on the other criteria of online learning attitudes and self-directed learning. Therefore, learners should have the skills of computer and network confidence, online learning, computer and smartphone use, computer and smartphone preferences, etc. Furthermore, learners need to develop self-learning skills. Secondly, self-learning, computer and network confidence, online learning, computer and smartphone use, and computer and smartphone preferences are key determinants of online learning attitudes and self-directed learning. Learners should be able to grasp learning opportunities and overcome barriers to learning; learners should be confident in their learning abilities and performance on computers and smartphones and the Internet; learners should enjoy and look forward to learning online; and learners should be able to use computers and smartphones in their studies, life, and work and enjoy accessing and operating them.

The determinants and interactions of online learning attitudes and self-directed learning have been less explored in previous studies, online learning attitudes and self-directed learning are important dimensions that influence learners' learning behavior. In addition, scholars who study online learning attitudes and self-directed learning have different theoretical perspectives. To understand the problems mentioned, this study combines the Fuzzy Delphi method and the Fuzzy DEMATEL method to propose a more comprehensive and complete set of determinants of self-directed learning and online learning attitudes. There is no research paper on this subject, so this study has academic value. In summary, the academic value of the findings of this study includes 1. The

study integrates theoretical perspectives on self-directed learning and online learning attitudes and uses a wide range of perspectives to collect and analyze relevant literature to select indicators of self-directed learning and online learning attitudes and to identify the dimensions and criteria of self-directed learning and online learning attitudes by integrating the views of researchers and experts in online learning. 2. Using the Fuzzy DEMATEL method to evaluate the dimensions and criteria of self-directed learning and online learning attitudes, the cause-effect diagrams computed and analyzed provide a clear and easy understanding of the complex cause-effect structure between the dimensions and criteria of self-directed learning and online learning attitudes and the strength and extent of the influence of these factors.

In terms of practical implications, the findings of this study reveal a number of important implications for the learning behavior of learners in online learning. Schools, educational institutions, and teachers can use the results of this study to identify the structural interrelationships and causal relationships among the indicators of learners' self-directed learning and online learning attitudes and to select the most important key indicators of self-directed learning and online learning attitudes, which will help schools, educational institutions, and teachers to understand learners' learning behaviors in online learning programs, target learners' self-directed learning and online learning attitudes, and improve online learning programs. This will help schools, educational institutions, and teachers understand learners' learning behaviors in online learning programs, focus on the key criteria of learners' self-directed learning and online learning attitudes, improve online learning programs, and cultivate the key criteria of learners' self-directed learning and online learning attitudes, which can effectively enhance learners' self-directed learning and online learning attitudes, and potentially improve learners' learning behaviors and learning outcomes.

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