Research on Influencing Factors of Distance Learning Behavior Intention in Virtual Experimental Environment

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***Abstract*—In distance education, virtual labs conduct a paramount role in the construction and development of practical engineering majors. In turn, the behavioral intention of distance learners' willingness to use it determines whether virtual labs can be well used and promoted. For the sake of deeply understanding the factors which may exert certain influence on behavioral intention, this paper constructed a model of factors affecting behavioral intention of distance learning in virtual lab environment on the Unified Theory of Acceptance and Use of Technology (UTAUT), and conducted an empirical investigation study on 425 learners. As conspicuously revealed by the research findings, effort expectation, performance expectation, community influence, concrete experience, abstract conceptualization, active practice, and interactivity of the experimental platform can impose positive effects on learners' intention to use the virtual experimental platform. Aside from that, both reflective observation and imagination cannot remarkably affect behavioral intention. What's more, concrete experience has the most noticeable effect on behavioral intention.**

***Index Terms*—Behavioral intention, distance learning, influencing factors, UTAUT, virtual experimental environment**

I. Introduction

On the basis of the policy-driven, multi-linked and fast-paced information era, traditional education can no longer satisfy the actual learning needs of people in the new era, and distance education is developing like wildfire. Nonetheless, owing to the limitation of time and space, it is difficult for distance learners to practice the contents entailing experimental operation in a timely and efficient manner, thereby making it difficult for them to have a better understanding of science and technology disciplines with strong practical operation requirements. Hence, the problem of limited science and technology majors in distance education has become increasingly prominent. As a result, virtual labs have emerged. The desirable use and promotion of virtual labs do not depend on the advanced technology they are based upon, but on the users' overall knowledge of the system and their willingness to use it continuously [1].

In the past two decades, scholars domestically and internationally have conducted in-depth research on the development and application of virtual laboratories. In terms of the theoretical research, Zhu *et al*. describe the architecture of virtual labs in teaching applications while making a relevant elaboration on the meaning and development history of virtual labs, and make a detailed analysis of the current situation of their application in experimental courses with the characteristics of virtual labs [2]. Based upon the review of relevant literature, Shan gives the corresponding definition of virtual laboratory and probes into it with two cases to preliminarily discuss the future development direction of virtual laboratory [3]. In terms of the design and development of virtual labs, Zhao *et al*. predominantly discuss the hybrid programming of LabVIEW and MATLAB, and study the Dynamic Link Library (DLL) and SIT software package and compare their respective advantages in the process of building virtual power electronics labs, and finally, the virtual labs are successfully built with the help of both technologies [4]. Starting from the superiority of Unity3D, Ge put forth a method and design for the conversion of Euler angles in the world coordinate system to measure horizontal and vertical angles in the virtual experimental scenario, and the simulation of alignment leveling before instrument operation [5]. In terms of relevant applications, virtual laboratory is widely used in the teaching of electronics, machinery, chemistry and physics [6]. For a few examples, the Massachusetts Institute of Technology has established a Web Lab-based remote experiment system by adopting Java technology for the experimental teaching of electronic experiments and circuit design-related courses [7]; the University of Illinois at Chicago has developed a virtual laboratory for organic chemistry, aiming to use digital resources for teaching and instruction of chemistry experiments [8].

From the existing research results, domestic and foreign scholars have mostly focused on how to design and develop virtual labs and their related applications, but there are not enough research results on the influencing factors of virtual lab applications from the user's perspective, and there are few relevant empirical explorations. As a consequence, on the basis of the Unified Theory of Acceptance and Use of Technology (UTAUT), this paper constructs a model of factors influencing distance learning behavioral intention in the virtual lab environment, and uses empirical research to determine whether the factors in the theoretical model have an impact on distance learning behavioral intention and the correlation between the magnitude of the impact.

II. Related Concepts and Theoretical Basis

A. Review Stage Overview of Virtual Lab

The term virtual laboratory was first introduced in 1989 by professor William Wolfe to describe a networked, electronic and highly interactive virtual laboratory environment built by adopting computers with a sense of immersion [9]. In 1995, UNESCO defined virtual laboratories as virtual working

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environments that produce results through information and communication technologies for remote collaboration, scientific research and other high-tech activities in laboratories [10]. This definition expands the meaning of virtual laboratory.

With the development of relevant research, virtual laboratories can be broadly divided into two categories: one is based upon the use of software to set up a specific virtual instrument with similar functions to traditional electronic instruments, which generates a guided experimental interactive operating environment that learners can use for relevant experimental operations; the other refers to the virtual experimental platform environment actualized through the use of simulation, virtual reality and other technologies. Both types highlight the advantages of virtual labs such as high simulation, scalability, and interactivity. On this basis, virtual labs become an effective extension and beneficial supplement to traditional experimental teaching, and are used in distance education to some extent.

The virtual laboratory on which this study was based is a remote virtual experiment environment created by adopting virtual reality technology for food science and engineering majors in distance education, which can be free of time, space and financial constraints. In this environment, learners can use the mouse to click and drag to perform various operations on various virtual instruments in the virtual laboratory to complete experiments in line with actual needs. At the same time, learners can record experimental data, discuss experimental operations and prepare experimental reports based on the platform.

B. *Experience Learning Circle Theory*

Experiential learning circle theory was first put forward by Kolb, as displayed in Fig. 1. He believed that experiential learning is on the basis of the association between learning and experience, and is the process of creating knowledge through the transformation of experience [11]. The experiential learning circle consists of four stages corresponding to questioning, exploring, transforming and creating, namely, that is, Concrete Experience(CE), Reflective Observation(RO), Abstract Conceptualization(AC) and Active Experimentation(AE) [12]. In the comprehension dimension, concrete experience and Abstract Conceptualization represent these two ways in which learners experience, perception and apprehension. In the transformation dimension, reflective observation and Active Experimentation are these two ways of experiential transformation, the former is the internal reflection process of connotation reduction and the latter is the process of extension transformation. The whole learning process is not a simple cycle, but an upward spiral.

C. *The Unified Theory of Acceptance and Use of Technology*

Whether the value of information technology can be realized depends on the degree to which the technology is accepted and used by users [13]. In 1989, Davis put forth a model of technology acceptance based upon the Theory of Rational Behavior (TRA), combined with Schultz and Slevin's expectancy theory model and Bandura's self-efficacy theory, on the basis of which scholars have addressed the issue of user acceptance of information technology [14]. On this basis, scholars have extensively discussed the user acceptance of information technology.

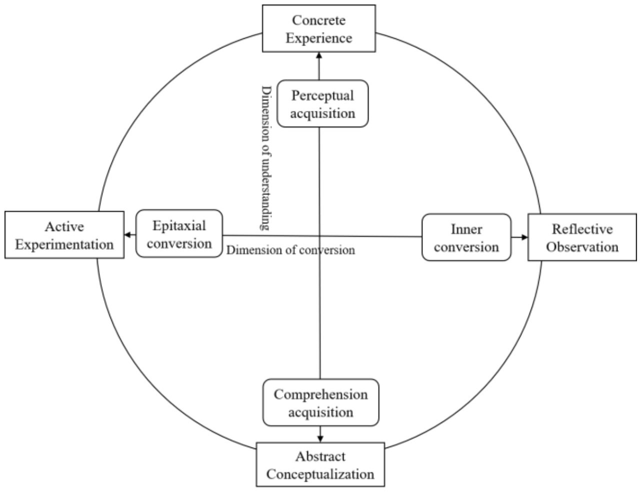

Fig. 1. Experience learning circle theory.

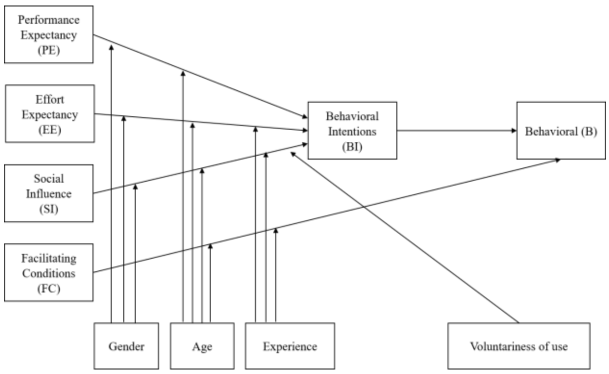

Fig. 2. The unified theory of acceptance and use of technology.

In 2000, Davis and Venkatesh *et al*. identified the need to integrate the numerous technology acceptance models that had previously emerged [15]. As a result, eight of the most competitive models were tested through data, and 32 primary influencing factors and four moderating variables were integrated and generalized to propose an integrated technology acceptance and use theory and its model framework structure, as exhibited in Fig. 2. Venkatesh confirmed through empirical explorations that the UTAUT has an explanatory power of up to 70% for individual acceptance of new information technologies.

In recent years, the Unified Theory of Acceptance and Use of Technology has progressively been adopted by scholars to investigate certain types of learners' willingness to use and use behaviors in the field of education. For instance, on the basis of the UTAUT with the addition of three variables of perceived interest, perceived financial cost, and personal innovation, Bao Riqin probed deeply into the crucial factors affecting learners' behavioral intentions in a study on the factors influencing mobile learning behavioral intentions of open education learners [16].

III. Research Hypothesis and Model Building

Considering the virtual experiment platform and learners' own platform-based experiential learning characteristics, this research will take the UTAUT as the theoretical framework and revise the core variables of the original UTAUT from three standpoints, namely UTAUT, virtual experiment platform-based experiential learning, and virtual experiment platform characteristics, so as to identify research variables, formulate relevant hypotheses, and then construct a research model.

A. Hypotheses Related to Technology Acceptance Perspective on the Basis of UTAUT

1) Behavior intention

In this investigation, behavioral intention refers to the likelihood of learners anticipating their personal use of the virtual lab in the future. As illustrated by the results of domestic and international studies on UTAUT, behavioral intention has a high predictive power for actual usage behavior [17], and only distance learners who have the intention to use the virtual lab will produce the corresponding usage behavior. As a result, the study of behavioral intention also indirectly explores use behavior. In such case, we adjust original model and select behavioral intention as the final variable of the model.

2) Effort expectation

Effort expectation refers to the degree to which users perceive the effort required to use the new system. In other words, learners perceive how easy or difficult it is to use the virtual lab. When learners hold a standpoint that they can use the virtual lab easily, their behavioral intention to continue by employing the virtual lab may increase. Meanwhile, their learning based upon the virtual lab will proceed more smoothly and their learning efficiency will be heightened. As a result, hypotheses H1 and H2 are put forward.

H1: Distance learners' effort expectations of virtual lab positively affects their behavioral intentions.

H2: Distance learners' effort expectations of the virtual lab positively affects their performance expectations.

3) Performance expectation

Performance expectation refers to the extent to which individuals believe that employing the system will help them to achieve their performance and benefits. In this research, it refers to the extent to which learners believe that employing the virtual lab will help them ameliorate their learning. If learners have adequate confidence and expectation in the virtual lab, they will use the platform more frequently, i.e., the stronger the learners' behavioral intentions towards the virtual lab. As a consequence, hypothesis H3 is put forward.

H3: Distance learners' performance expectations of virtual labs positively influence their behavioral intentions.

4) Social influence

Social influence refers to the extent to those people who feel it is crucial to them considering they should use the system. In this exploration, this means that the recommendation and encouragement of people such as teachers in school, teachers in distance education, and experts and scholars in the virtual lab, or the positive pressure from contemporaries who choose to use the platform, make learners more inclined to use the virtual lab, and also believe that the platform can elevate their learning efficiency. Hence, hypotheses H4 and H5 are put forth.

H4: The social influence on distance learners positively influences their behavioral intention towards virtual lab.

H5: The social influence of distance learners positively affects their performance expectations of the virtual lab.

B. Hypotheses Related to the Experiential Learning Perspective on the Basis of the "Experiential Learning Circle"

In this investigation, the learners underwent four stages of learning process from Concrete Experience, Reflective Observation, Abstract Conceptualization and Active Experimentation based upon the experiential learning environment of the virtual labs. During the continuous circulation of the four links, learners in dissimilar links will have diverse psychological changes in their behavior intentions for the continued use of the platform, the corresponding four hypotheses from H6 to H9 are put forward.

H6: Concrete experience positively influence distance learners' behavioral intentions toward the virtual lab.

H7: Reflective observation positively influences distance learners' behavioral intention toward the virtual lab.

H8: Abstract conceptualization positively influences distance learners' behavioral intentions toward the virtual lab.

H9: Active Experimentation positively influences distance learners' behavioral intentions toward the virtual lab.

C. Hypothesis Formulation on the Basis of the Virtual Lab Perspective

The virtual lab based upon this exploration has convenient and diverse interaction methods, can create a relatively realistic experimental environment, is conducive to learners' imagination and matching, stimulates learning motivation, and reinforces learning experience. When learners have a satisfactory experience of the virtual lab, they will have a stronger willingness to use the virtual experiment platform. As a consequence, on the basis of the "interactivity" and "imagination" of the virtual lab, hypotheses H10 and H11 are put forth.

H10: The interactivity of the virtual lab positively influences the behavioral intention of distance learners towards the virtual lab.

H11: The imagination of the virtual lab positively affects the behavioral intention of distance learners towards the virtual lab.

D. Model of Influencing Factors of Distance Learners' Use of Virtual Labs

In accordance with the above analysis, this paper, on the basis of UTAUT, retains the four core variables of the original model, eliminates the independent variables propelling conditions and moderating variables in the original model, and adds a total of six new independent variables from a brand new viewpoint to construct a model of affecting factors for distance learners' use of virtual labs, as illustrated in Fig. 3, which includes a total of eight independent variables, one intermediate variable and one dependent variable.

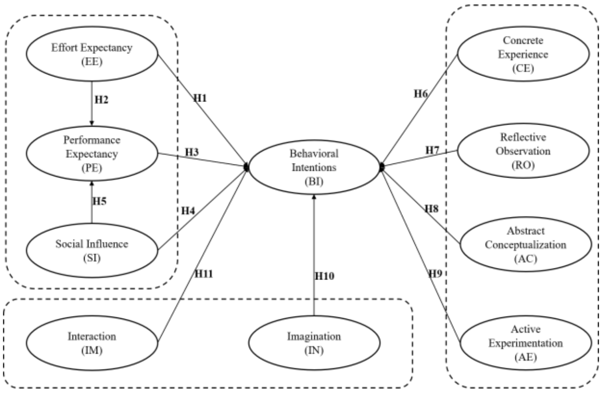

Fig. 3. Model diagram of factors influencing distance learners' use of virtual lab platforms.

IV. Empirical Analysis

A. Questionnaire Design and Data Collection

In an effort to validate the model of factors influencing distance learners' use of the virtual experimental platform, this paper designed a questionnaire with reference to the research scales of domestic and international scholars. Among them, performance expectation, effort Expectancy, social influence and the dependent variable behavioral intention are referred to Venkatesh's scale; the four variables of concrete experience, abstract conceptualization, reflective observation and active experimentation are referred to Kolb's learning style scale; interactivity and imagination are referred to Hu and Fang's scale [18]. The questionnaire consisted of two parts: basic information about the learners and the principal part of the questionnaire, with a total of 10 variables and 41 questions.

The questionnaires were distributed through the web-embedded virtual experiment platform, and a total of 425 students of the same major in seven higher education institutions in Jiangsu Province were surveyed, 405 questionnaires were collected, of which 386 were valid, and the questionnaire efficiency rate was 95.3%.

B. Reliability and Validity Tests

With the purpose of ensuring the reliability and validity of the sample data obtained from the questionnaire, this paper conducted reliability and validity tests with the help of SPSS 22.0 software. As exhibited by the data analysis results, the Bartlett's spherical test statistic of 8571.817 and the corresponding probability significance (Sig.) of 0.000 illustrated that there was a strong correlation between the variables, and the results are demonstrated in Table I. The internal consistency reliability of each variable was explored by calculating the Cronbach's α coefficient of agreement, and most of the values were above 0.70. As a consequence, the reliability of the questionnaire in this exploration was high, and the results are displayed in Table II. The Average Extracted Variance (AVE) was further examined, and the square root of AVE of each variable was greater than the correlation coefficient of the variable with other variables, as exhibited in Table III, which persuasively demonstrates that the distinct variables of the questionnaire in this investigation have satisfactory discriminant validity among each other.

TABLE I: Validity Test

Test of KMO and Bartlett		
The Kaiser-Meyer-Olkin metric of sampling adequacy		0.081
Bartlett's sphericity test	Approximate cardinality	8571.871
	df	741
	Sig.	0.000

TABLE II: Reliability Test

Variable	Number of items	Cronbach's Alph Value	Overall Cronbach's Alph Value
Specific experience	4	0.918	0.830
Reflect on observation	4	0.757	
Abstract Conceptualization	4	0.877	
Proactive Practice	4	0.840	
Effort Expectation	4	0.843	
Performance expectation	4	0.690	
Community impact	4	0.733	
Interactivity	4	0.817	
Imaginability	4	0.829	
Behavioral Intentions	4	0.850	

TABLE III: Table of Discriminant Validity Test between Latent Variables

AVE square root	1	2	3	4	5	6	7	8	9	10
Specific experience	0.903									
Reflect on observation	0.104	0.795								
Abstract Conceptualization	0.262	0.059	0.835							
Proactive practice	0.182	0.136	0.028	0.867						
Effort expectations	0.080	0.07	0.163	0.01	0.754					
Performance expectations	0.057	0.006	0.076	0.031	0.265	0.761				
Community impact	0.023	0.008	0.05	0.001	0.211	0.218	0.775			
Interactivity	0.082	0.091	0.09	0.023	0.075	0.134	0.044	0.278		
Imaginability	0.023	0.044	0.103	0.022	0.218	0.186	0.293	0.018	0.746	
Behavioral Intentions	0.422	0.149	0.387	0.300	0.300	0.286	0.293	0.267	0.191	0.809

C. Structural Equation Modeling Analysis

As persuasively demonstrated by the results of the above validity analysis, the variables selected in this investigation were independent and therefore suitable for structural equation analysis by adopting a combination of variables. The initial model was established by adopting AMOS 25.0 for preliminary fitting, and the model was modified in line with the fit results and the modification indices M.I. (Modification Indices). After four corrections, the indices are displayed in Table IV, which are: CMIN/DF value is 1.395, CFI value is 0.971, GFI value is 0.902, and PNFI value is 0.797, and the model fit is satisfactory. The model diagram of the structural equations after the four corrections is demonstrated in Fig. 4. The modified model path coefficients are depicted in Table V. Through Table V, we can get the interrelation among the variables, and the arrow in the path relationship represents the relationship direction of the latent variables. For example, the standard path influence coefficient of effort expectation on behavior intention is 0.142.

TABLE IV: MODEL FIT INDEX AFTER THE FOURTH CORRECTION

Fitness test indicators	Adaptation standards	Model results	Conclusions
CMIN/DF	1–3	1.5395	Conform
RMSEA	< 0.08	0.032	Conform
RMR	< 0.08	0.036	Conform
GFI	> 0.90	0.902	Conform
CFI	> 0.90	0.971	Conform
IFI	> 0.90	0.972	Conform
PNFI	> 0.50	0.797	Conform

TABLE V. STANDARD PATH COEFFICIENTS AND SIGNIFICANCE COEFFICIENTS

Path Relationships	hypothesis	Standard path coefficient	Standard Error	C.R.	Significance P	Results
BI□EE	H1	0.142	0.05	2.597	0.009	Established
PE□EE	H2	0.225	0.065	3.621	***	Established
BI□PE	H3	0.134	0.044	2.651	0.008	Established
BI□SI	H4	0.218	0.05	4.005	***	Established
PE□SI	H5	0.174	0.064	2.852	0.004	Established
BI□CE	H6	0.264	0.035	5.474	***	Established
BI□RO	H7	0.062	0.037	1.384	0.166	Not Established
BI□AC	H8	0.256	0.056	5.092	***	Established
BI□AE	H9	0.251	0.049	5.268	***	Established
BI□IN	H10	0.206	0.045	4.121	***	Established
BI□IM	H11	0.028	0.055	0.537	0.591	Not Established

*** indicates that the P value is less than 0.001; the significance level is 0.05

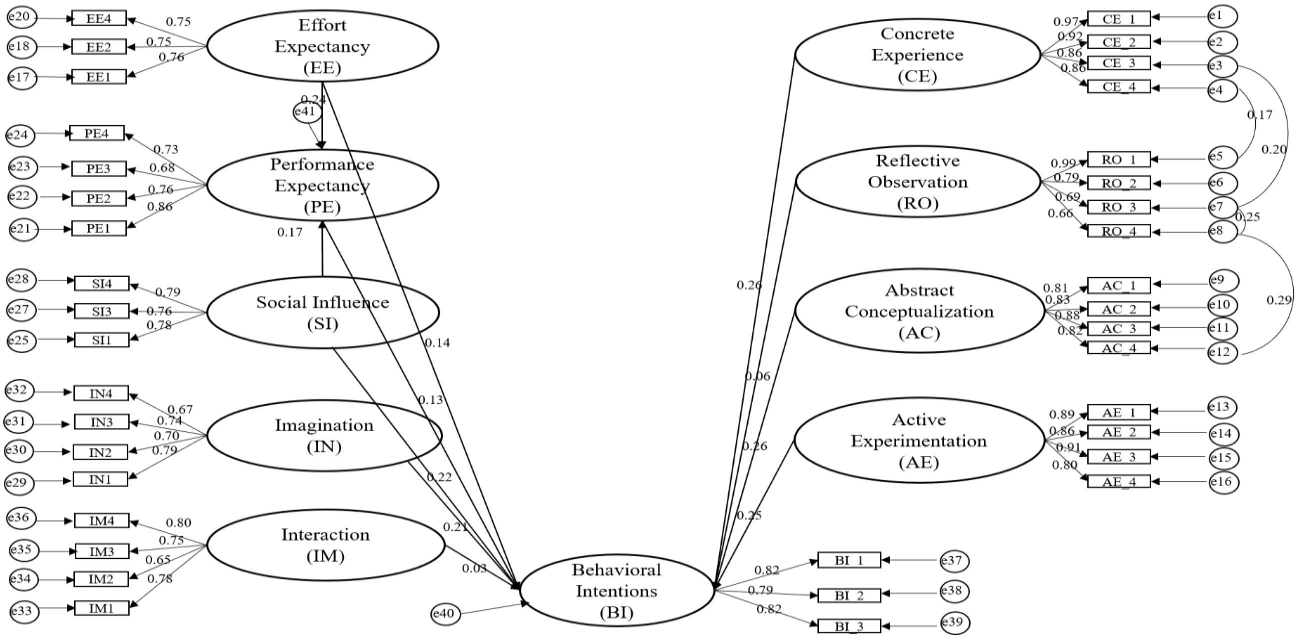

Fig. 4. A model of factors influencing behavioral intention for distance learning in a virtual experimental environment and standardized coefficients.

As exhibited by the results in Table V, the hypothesis that the absolute values of the critical ratios of H1, H2, H3, H4, H5, H6, H8, H9, and H10 are all >1.96, and the P-values of H2, H4, H6, H8, H9, and H10 are all striking at the level of 0.001, the P-value of H1 is 0.009 and noticeable at the level of 0.05, the P-value of H3 is 0.008 and remarkable at the level of 0.05. As a result, the hypotheses H1, H2, H3, H4, H5, H6, H8, H9, and H10 are valid. Hence, it can be seen that effort expectancy, performance expectancy, social influence, concrete experience, abstract conceptualization, active experimentation, and interaction strikingly affect learners' behavioral intention. Hypothesis H7 and H11 have P-values greater than 0.05, so the original hypothesis is not valid. Aside from that, reflective observation and imagination have no conspicuous influence on learners' behavioral intention.

D. Discussion and Analysis

As conspicuously revealed by the research findings, effort expectancy, performance expectancy, social influence, concrete experience, abstract conceptualization, active experimentation. What's more, interactivity of the experimental platform had a positive effect on learners' intention to use the virtual experimental platform, in descending order of the degree of influence, concrete experience (0.528), abstract conceptualization (0.512), active practice (0.502), social influence (0.482), interactivity (0.412), effort expectancy (0.344), and performance expectancy (0.268). In contrast, reflective observation and the imagination of the virtual experimentation platform had no noticeable impact on the intention to use the virtual experimentation platform for learners. The specific analyses were as follows.

1) Distance learners' effort expectations of the virtual lab positively influence their behavioral intentions

This corresponds with the hypothesis in the original UTAUT, indicating that distance learners' receptive behavior toward the virtual lab accords with this pattern of the original model. This suggests that distance learners are more concerned about the ease of use of the virtual lab. If distance learners perceive that the platform's operational controls are simple and can be used in an easy manner, and they can master the use of the platform at a smaller cost, their behavioral intention toward the platform may increase, i.e., distance learners will be more willing to use the virtual lab.

2) Distance learners' effort expectation of virtual lab positively affect their performance expectations

When learners hold a viewpoint that they can easily use the virtual lab, they will amplify their perceptions of the utility of the virtual lab platform and believe that the virtual lab-based experimental operations can make their learning smoother and their learning efficiency can be effectively elevated. In contrast, providing that learners are frustrated in learning on the basis of virtual laboratories, they will lessen their performance intentions on the virtual labs.

3) Distance learners' performance expectation of the virtual lab positively influence their behavioral intentions

This coincides with the hypothesis of the original UTAUT. To be more specific, distance learners are more concerned about the practicality and effectiveness of virtual labs. Furthermore, they accept and use virtual lab in that they expect the platform to help them gain some utility that can facilitate learning Only when the virtual lab can bring some improvement to the learning of distance learners, they have adequate confidence and expectation in the virtual lab and will use the platform more frequently.

4) The social influence on distance learners positively affects their behavioral intentions towards the virtual lab

This coincides with the hypothesis of the original UTAUT. Nowadays, every individual is in a society and cannot exist in isolation. In such case, everyone more often than not is influenced by his or her external social group. Aside from that, the recommendations of people who exert marked influence on distance learners will affect their use of the virtual lab. In this exploration, community influences will make learners more willing to use the virtual lab.

5) The social influence on distance learners positively affects their performance expectations of the virtual lab

Providing that the communities are positive about the virtual lab and encourage learners to use it, it will makes learners more inclined to use the virtual lab and increase their perception of the usefulness of the platform and its ability to ameliorate their learning efficiency.

6) Concrete experience positively influences distance learners' behavioral intentions toward virtual lab

Distance learners' perceived acquisition of concrete experience originates from actual operations in the virtual lab. Virtual lab provides learners with relatively realistic experimental situations that learners can intuitively experience. As a consequence, concrete experience has a positive effect on distance learners' behavioral intention to use virtual lab.

7) Reflective observation has no effect on distance learners' behavioral intention to use the virtual lab

Distance learners' reflective observation is to generate meaning and form concepts by observing and reflecting on specific experiences from diverse standpoints. The reason why hypothesis H7 is not valid as verified by the previous hypotheses resides in that the virtual lab on the basis of this investigation, although it can satisfy the distance learners' perceptual acquisition of direct concrete experiences, it does not have specific functions that can assist the distance learners in their reflective observation. Assuming that the learners are unable to reduce the connotation of the direct experience, the concrete experience gained through perception will be short-lived. As a consequence, reflective observation has no effect on distance learners' behavioral intentions to use the virtual lab platform.

8) Abstract Conceptualization positively influences distance learners' behavioral intention to use the virtual lab

Abstract Conceptualization is the process by which distance learners' experience of the virtual laboratory goes deep inside and rests with conceptual symbols to describe their perceptions. When distance learners can adequately use their thinking logic and smoothly carry out theoretical combing and construction, they are more likely to be willing to use the virtual lab. As a result, Abstract Conceptualization has a positive influence on the behavioral intention of distance learners to use the virtual lab.

9) Active Experimentation positively influences distance learners' behavioral intentions toward virtual lab

The Active Experimentation of distance learners means that they actively extend their comprehended knowledge to the external environment for practical verification. When the distance learners are well assisted by the platform in this process, their intention to continue the platform will increase as they smoothly convert their knowledge externally, thus active practice has a positive impact on the behavioral intention of distance learners to use the virtual lab.

10) The interactivity of virtual lab positively influences distance learners' behavioral intentions towards virtual lab

When distance learners perform experiments in accordance with the virtual lab, the convenient interaction on the basis of the platform facilitates the solution of learning problems, motivates learning and strengthens the learning experience of the learners, so the intention of distance learners to continue to use the virtual lab is reinforced.

11) The imagination of the virtual lab has no effect on distance learners' behavioral intention to use the virtual lab

When distance learners perform experimental operations based upon the virtual lab, the imagination of the platform, the simulated experimental apparatus and the raw materials, reagents and solutions required for the experiments need to be associated with the actual objects in reality; What's more, after the experimental operations, it's also essential for the learners to associate the experimental phenomena and results fed by the platform to match the actual phenomena in reality. The reason why hypothesis H11 is not valid consists in that the virtual laboratory on the basis of this investigation is developed based upon flash, programming language and various databases, which not only lacks the immersiveness of general virtual reality technology, but also has certain limitations in imagination, especially for some experiments entailing more expensive experimental instruments, which learners may not have been exposed to in traditional laboratories. Simple recognition may be in the video learning sessions of the virtual lab, but it is conspicuous that this is far from sufficient. As a consequence, the imaginative nature of the virtual lab has no impact on the behavioral intention of distance learners to use the virtual lab.

V. Conclusions and Recommendations

A. Conclusions

In accordance with the UTATU, this paper combines the theory of experiential learning circles with the characteristics of virtual laboratories, and incorporates the four learning stages of experiential learning circles, as well as these two characteristics of interactivity and imagination in virtual laboratories. A model of the factors influencing behavioral intention of distance learning in the virtual laboratory environment was constructed and empirically tested. As clearly indicated by the experimental results, effort expectation, performance expectation, community influence, concrete experience, abstract conceptualization, active experimentation, and interactivity of the experimental platform were the primary factors affecting distance learners' use of the virtual experiment platform, and all of them were positively and evidently influenced. In order of strength, the effects were: concrete experience, abstract conceptualization, active experimentation, social influence, interactivity, effort expectation, and performance expectation. Among the indirect mediating effects, both effort expectancy and social influence had a remarkable effect on performance expectancy. Reflective observation and imagination did not exert noticeable impacts on behavioral intention. Concrete experience had the most striking influence on behavioral intention.

Nevertheless, there are still some shortcomings in this exploration. First and foremost, the limited number of study participants and their characteristics were relatively uniform and concentrated. In such case, the moderating variables were not included in the middle study model; Furthermore, the rigor and perfection of the data analysis were inevitably limited by personal ability. Apart from that, the data analysis results and their descriptions might slightly differ from the actual ones or the wording might be inaccurate. This, further research can be conducted from the moderating variables to make the study more perfect.

B. Virtual Labs Improvement and Promotion Strategies

The discussion and conclusions of this paper can provide some suggested strategies for the current practice of ameliorating and propelling virtual labs.

1) Ameliorate both the relevant functions of the virtual laboratory and the problems of the reflective observation stage in the experiential learning process for distance learners

In the reflective observation stage, learners fix their attention on the meaning and context of concepts and ideas, concentrate on personal intuition and reflection. Hence, it's imperative developers to add modules in accordance with the characteristics of the reflective observation stage of experiential learning in which distance learners conduct experimental operations based upon virtual labs, so as to better distance learners' intention to use virtual labs.

2) Reinforce the imagination of virtual labs and ameliorate the intention of distance learners to use the experimental platform

It can start from technical means to make the simulated experimental instruments and experimental raw materials and reagents, solutions, etc. easier to match with the physical objects; Likewise, it can also start from the introduction of depleted instruments and drugs that usually have little contact with the learners. Based upon a better understanding of the physical objects. the distance learners can associate with the instruments and solvents in an easier manner.

3) Ameliorating the introduction process of the virtual labs will strengthen the learners' intention to use the platform

Notwithstanding the fact that the introductory process of the virtual labs for food science and engineering based upon this investigation is non-linear, most learners are relatively unfamiliar with the experiments and platform they are learning. Combined with our research findings, the navigation process of the virtual lab can be adjusted from the specific experiential aspects of experiential learning. Under such circumstance, the platform can have a better promotion effect on learners' behavioral intention.

4) Facilitate the application of virtual labs to expand the professional side of science and engineering disciplines in distance education

Despite the fact that this exploration launched an empirical study on the basis of food science and engineering majors, the science and engineering disciplines that are highly operational and require learning through experiments all have similar shortcomings. in such case, the virtual labs can be expanded to the daily teaching of science and engineering disciplines and other distance learning.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Li Sun: conceptualization, methodology, resources, formal analysis, data management, writing-original manuscript, writing-review and editing, supervision. Danyang Xu: investigation, verification, data curation, writing-original manuscript, visualization. All authors had approved the final version.

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