Article

Continuance Intention of Augmented Reality Textbooks in Basic Design Course

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Abstract: The Basic Design course can help students understand design principles and visual art elements It is a compulsory basic course for the department of art and design in many universities. In recent years, Augmented Reality (AR) technology has found its way into the field of design education and has become a popular textbook tool in teaching courses. There are not many pieces of research on the application of AR in design courses. Therefore, this study attempts to explore the factors that affect students' acceptance of AR textbooks in Basic Design course and their continuance intention for AR textbooks. This study first focused on students with experience in using AR textbooks. Open-ended questions were used to collect factors that allow AR textbooks to be used in the design curriculum; then questionnaire surveys and factor analysis were conducted and the research hypotheses are presented. Then, the research hypotheses were verified through reliability and validity as well as structural equation modeling. Three factors and 15 items for students to accept AR textbooks in the Basic Design course were summarized in the research results, including the three factors named "Visual Attraction", "Knowledge-ability", and "Situational Experience". The analysis of differences showed significant differences in gender among these three factors and no significant differences between grades and departments. Also, it was found from the analysis results of the structural equation model that the factors of "Visual Attraction" and "Knowledge-ability" both had a positive effect on the continuance intention, of which "Knowledge-ability" was the most important influencing factor. The results of this study can help the application and development of AR textbooks in the Basic Design course.

Keywords: basic design; augmented reality; AR textbooks; continuance intention

1. Introduction

Augmented Reality (AR) is one of the most promising emerging technologies and has found its way into the research field of education, entertainment, games, daily life, and marketing, etc. [1–4]. Today, AR technology has gradually matured and become a research hotspot and trend in the field of education [5,6]. In a study on the application of AR technology in higher education during the period 2005–2019, it was found that computer science was prominent in the education field. With the proportion of published papers accounting for 27% followed by social science and engineering, each accounting for 19%, medicine of 6%, mathematics 4%, business, management, and accounting of 3%, arts and humanities subjects of 3%, and the proportion of research papers in other fields was less than 3% [6]. As learned from this study, AR technology has penetrated various fields of education. It is inseparable from the unique functions of AR technology that AR can become a key teaching tool in the field of education [5].

AR has two functions: (1) It can experience virtual objects generated by AR technology in a real environment, (2) It can manipulate virtual objects to interact with the real

environment for human-computer interaction [7,8]. AR technology not only integrates real-time virtual and real environments but also provides learners with a more realistic and immersive experience [9,10]. In an AR-based virtual learning environment, the learning methods are more interesting and more realistic than any other technology [11]. The difference between AR and traditional textbooks (the most common paper textbooks) is that AR can support low-cost handheld mobile devices, as well as innovative software [12]. AR textbooks not only have a significant improvement in the academic performance of the students but they are more active in learning [13,14].

AR textbooks have a significant impact on the classroom teaching environment and students learning behavior. For example, in a teaching classroom, the students can obtain different learning experiences through the use of mobile devices combined with AR textbooks [15,16]. This helps enhance the flexibility and interactivity of the learning process while stimulating students learning motivation [17,18]. The attitude of students using AR books to read not only affects their learning behavior but also increases their interest in learning using AR books [19]. In terms of complex teaching content, the use of AR textbooks can help students better understand, improve learning efficiency [20,21], and better complete learning tasks [20]. The teachers do not need to repeat explanations and students prefer to use AR textbooks for self-learning [22].

Basic Design is a compulsory course for the first-year students in the Department of Art and Design of the universities. The teaching of Basic Design can help students understand design principles and visual art elements, and lay the foundation for continuing to study design courses in the future [23]. Therefore, Basic Design is listed as a very important Basic Design course for design education in many countries [22]. Generally, Basic Design teaching in universities is mainly based on traditional teaching methods (direct lecturing) supplemented with paper textbooks. However, studies have found that it is not ideal to rely entirely on traditional teaching. By combining other teaching methods will have better teaching results [24]. Therefore, new teaching methods continue to emerge and technologies play an important role in the teaching process. It not only improves the quality of teaching but also enhances the effectiveness of learning [25].

For example, the research of Wilks, et al. [26] indicated that adding new methods or new technologies to the teaching environment of visual arts can improve the teaching effectiveness of teachers and the learning effectiveness of students. Aykac [27] found that the learning method of applying online mind maps in the courses of visual arts can help students remember the content of knowledge. Also, some studies have mentioned that the teaching environment is a key factor affecting students' interest in learning [28]. A creative learning environment not only affects students' academic performance but is more helpful for teachers to display teaching skills in the classroom. In the era of rapid development of mobile technologies, mobile devices such as smartphones and tablets are widely used in the learning environment which supports collaborative learning and provides learning opportunities that are not restricted by time and place [29].

As learned from previous research on AR technology and art design, AR can be used as new technology and a new teaching method. It can be well integrated into the art design teaching environment. For example, Di Serio, et al. [30] demonstrated that the use of AR teaching in visual art courses can create a good learning environment. Compared with traditional guidance guides, AR guides allow users to enter the flow experience more effectively and improve the learning efficiency of art appreciation [31], and visitors can obtain interactive and knowledgeable artwork content through AR [31,32]. In the art education workshop, students use AR software to convert coloring between 2D graphics and 3D models while realizing the feasibility of applying AR to the art education environment [33]. In fashion design courses AR textbooks can increase student's learning attitude [34] and motivation to improve learning effectiveness [34,35]. Compared with traditional textbooks, AR textbooks have obvious teaching advantages, mainly in learning behavior and teaching environment. This study believes that students' continuance intention of AR textbooks cannot be ignored.

Some pointed out that AR technology solves complex problems for students and provides effective learning assistance in the teaching environment, and offers students opportunities to continue learning [10,36]. Wojciechowski and Cellary [37] indicated that attractive teaching content is essential because it will increase the learner's interest in learning. Research on the background of education has found that the thematic study of continuance intention is mainly distributed in learning environment systems such as Web-based learning [38], e-Learning [39], Massive Open Online Course (MOOC) [40], and mobile learning (M-Learning) [41]. For example, when learners use an online digital learning platform, their learning attitude is the decisive factor that affects their continuance intention [39]. A study on the theme of the MOOCs learning environment found that students' curiosity and attitude are the key factors that affect the intention of continuous learning [40]. For M-Learning, the usefulness of mobile technologies plays an important role in the continuance intention with higher perceptual flexibility [41]. It is found through the study of the continuance intention of learners using the learning environment system that different factors affect the continuous use by the learners. Although there is sufficient discussion about the continuance intention in learning environment systems such as online learning, the discussion about the continuance intention of AR textbooks in art design courses is very limited. Therefore, it is necessary for this study to explore the factors that affect students' continuous use of AR textbooks in Basic Design course.

Firstly, the research on the application of AR textbooks in the field of art design mainly focuses on the development of tools and the implementation of evaluating students' learning effectiveness [33,35] Secondly, the research on the continuous use of AR technology in higher education has found that AR technology is not much used in the field of art and design education [6], nor is there much exploration on the factors that influence students' continuance intention of using AR textbooks. This study believes that the application of AR technology in teaching classrooms has significant teaching benefits which can improve students' learning effectiveness, and AR has the potential as a textbook tool for long-term use in teaching. Therefore, the research purpose of this study are as follows:

(1) Explore the factors that affect students' using AR textbooks in learning Basic Design course, and further analyze the impact of student background variables on named factors
(2) Explore the impact of the factors of students' using AR textbooks in learning Basic Design course on continuance intention.

2. Research Design

2.1. Research Process

This research process was divided into two stages which were carried out from September to December 2020, respectively. In the first stage of the study, an open questionnaire was used to collect the factors for students' use of AR textbooks for learning. In the second stage, a questionnaire was summarized and applied to the Basic Design teaching activities of AR workshops. The subjects recruited in the second stage were all students of the Department of Design. In the 8-week teaching activity, students used AR textbooks to complete the learning tasks of the shaping unit of the Basic Design course and fill out the questionnaire after completing the learning tasks. The collected data samples were used for factor and differential analysis. After that, a research hypothesis was proposed based on the results of the factor analysis, and the teaching activities of the AR workshop were held to verify the hypothesis.

2.2. Questionnaire

The open-ended questionnaires in the first phase were distributed from September 2 to 8 September 2020. A total of 128 questionnaires were distributed, and 116 valid samples were recovered, with a valid return rate of 90.63%. There were 64 male students (55.2%) and 52 female students (44.8%). The subjects were all students from the Department of Design with the experience of using AR technology in classroom learning.

The first part of the questionnaire is the basic information of the individual, and the second part has open-ended fill-in-the-blank questions. The respondents needed to provide at least 3 to 5 subjective feelings The contents to be filled in the questionnaire were "the factors affecting learners' continuance intention of AR textbooks in designing courses". According to the filing requirements, the respondents can answer from the aspects of learning factors, environmental factors, and AR technology factors. In the questionnaire returned, the questionnaires with a lot of missing values or obvious deviations from the topic were considered invalid. Two teachers with basic teaching experience in design conducted semantic analysis and summarization with a relatively subjective analysis method.

It was found from preliminary observations and sorting, the responses of individual items contained multiple meanings. For example, there was an item that read "AR helps increase understanding and interest in learning content". This was divided into two items of "Understanding" and "Interest". Secondly, although there were different expressions for some of the item contents, the actual meanings described were the same. For example, some items read "Users will experience immersive feelings" and "Experiencers can feel that they are in a virtual environment". Based on the meaning of the respondent's expression, those items with duplicated semantic meaning were merged and sorted into a feeling of "Telepresence". After that, the question items with unclear expressions were revised into question items of a concise and clear semantic meaning. Therefore, a total of 395 items were recovered in this study and they were sorted into 23 items, as shown in Table 1.

Table 1. Questionnaire Scale for Basic Design Course.

No	Item Description	Frequency	References
VAR 01	Telepresence Using AR textbooks to study can make me have "telepresence"	65	[42]
VAR 02	Fun Using AR textbooks can increase the "fun" of learning	59	[3,43]
VAR 03	Interactivity AR textbooks have "interactive" virtual learning scenes	41	[10]
VAR 04	Innovation The learning content of AR textbooks is "innovative"	34	[33]
VAR 05	Learning experience Compared with paper textbooks, learning with AR textbooks has a different "learning experience"	26	[15,16]
VAR 06	Easy to get started I think the operation of AR textbooks is "easy to get started"	24	[22]
VAR 07	Understanding level AR textbooks can increase my "understanding" of the learning content	16	[20,21]
VAR 08	Interest AR textbooks can increase my "interest" in learning content	14	[3]
VAR 09	Spatial Ability Using AR textbooks to study can improve my "spatial ability"	12	[14,16]
VAR 10	Learning efficiency Using AR textbooks to study can improve my "learning efficiency"	11	[20]
VAR 11	Vivid I think the learning content of AR textbooks is "vivid"	10	[31]
VAR 12	Visuality I think AR textbooks have "visual" learning content	10	[31,32]
VAR 13	Richness I think AR textbooks have learning content of "richness"	9	[32,34]
VAR 14	Portability AR textbooks have the function of "portability"	9	[44]
VAR 15	Imagination Learning with AR textbooks can improve my "imagination"	9	[45]
VAR 16	Teaching quality Compared with paper textbooks, I think AR textbooks have higher "teaching quality"	8	[34]

Table 1. *Cont.*

No	Item Description	Frequency	References
VAR 17	Teaching atmosphere AR textbooks can improve the "teaching atmosphere" of the classroom	8	[30]
VAR 18	Practicability I think AR textbooks have "practicability" in learning	7	[44,45]
VAR 19	Thinking ability Using AR textbooks to study can improve my "thinking ability"	7	[42]
VAR 20	Immersion Learning with AR textbooks can make me feel "immersed"	6	[31,46]
VAR 21	Curiosity Compared with paper textbooks, AR textbooks make me more "curious"	5	[13,35]
VAR 22	Paper textbook I think AR textbooks can replace "paper textbooks" in learning	3	[34]
VAR 23	Humanistic I think the design for learning content of AR textbooks is "humanistic"	2	[47]

3. Research Method and Results

3.1. Factor Analysis

After the items of the first-stage open questionnaire were sorted out, they were classified according to the AR reference literature in the relevant education fields in the second-stage of this study. The design was modified based on the Basic Design teaching content to serve as the questionnaire for factor analysis. For example, "Using AR textbooks to study can make me have 'telepresence'" and other question items were finally sorted into 23 question items with detailed question items shown in Table 1. Likert 5-point scale was used for the questionnaire, and the scale ranged from 1 (strongly disagree) to 5 (strongly agree). From 21 September 2020 to 16 October 2020 (4 weeks), 230 questionnaires were distributed, and 224 valid questionnaires were retrieved after eliminating invalid samples (incorrect answers or too many same options), with a valid return rate of 97.39%. The descriptive statistics of the respondents are shown in Table 2.

Table 2. Descriptive statistics of respondents.

Demographics		No. of Respondents	% of Respondents
Gender	Female	128	57.1
	Male	96	42.9
Age	19–20	64	28.6
	22–22	151	67.4
	23–24	9	4
Grade	Second	129	57.6
	Third	95	42.4
Major	Product design	94	42
	Digital media	75	33.5
	Environmental design	55	24.5

The recovered data were processed and analyzed with SPSS v26.0 (IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY, USA: IBM Corp) and the principal component analysis method was used to construct the factors that affect students' use of AR textbooks. The independent-sample *t*-test and single-factor variance analysis were used to determine the difference between students background, gender, grade, and major. The sample size of the questionnaire met the requirements for factor analysis [48,49]. Cronbach's α value was 0.900 and the 23 question items had high internal consistency.

Before performing factor analysis, it is necessary to use item analysis to determine whether the question item is relevant. Therefore, a factor was forcibly extracted using the principal component analysis method The factor loading in the "component matrix" greater than 0.5, and commonality greater than 0.3 were taken as the standard [50]. The research

results showed that VAR06, VAR11, VAR14, VAR16, VAR17, VAR18, VAR22, VAR23 were deleted based on the commonality greater than 0.3, and the corrected item-total correlation higher than 0.5 after the reliability test as the standard. After two rounds of item analysis, a total of 8 items were deleted, and finally, 15 items remained, as shown in Table 3.

Table 3. Corrected item-total correlation.

Item	Commonality	Corrected Item-Total Correlation
VAR 01 Telepresence	0.390	0.574
VAR 02 Fun	0.320	0.502
VAR 03 Interactivity	0.315	0.512
VAR 04 Innovation	0.347	0.538
VAR 05 Learning experience	0.394	0.564
VAR 06 Easy to get started	0.284	0.480
VAR 07 Understanding level	0.378	0.556
VAR 08 Interest	0.379	0.548
VAR 09 Spatial ability	0.331	0.510
VAR 10 Learning efficiency	0.343	0.523
VAR 11 Vivid	0.285	0.472
VAR 12 Visuality	0.350	0.530
VAR 13 Richness	0.370	0.549
VAR 14 Portability	0.286	0.485
VAR 15 Imagination	0.393	0.566
VAR 16 Teaching quality	0.260	0.457
VAR 17 Teaching atmosphere	0.273	0.473
VAR 18 Practicality	0.245	0.445
VAR 19 Thinking ability	0.319	0.510
VAR 20 Immersion	0.336	0.521
VAR 21 Curiosity	0.381	0.558
VAR 22 Paper textbook	0.183	0.379
VAR 23 Humanistic	0.174	0.374

The remaining 15 items were used for the factor analysis. The Bartlett sphericity test and the KMO value as shown in Table 4. The KMO value was 0.895 (>0.8), and the Bartlett sphericity test result was 0.000 (<0.05). Both reached significance, so the results showed that they were suitable for factor analysis. Then the factor analysis process was performed with the principal component analysis method to finally extract 3 factors with a feature value greater than 1. After the rotation of the maximum axis rotation method the feature value of Factor 1 was 3.139, the feature value of Factor 2 was 2.645, and the feature value of Factor 3 was 2.404. This explained 20.926%, 17.634%, and 16.030% of the variable variance respectively, and the total explainable variance was 54.590%. As mentioned in the study of Hair, et al. [51] where information is often less precise, it is not uncommon to consider a solution that accounts for 60 percent of the total variance (and in some instances even less) as satisfactory. Therefore, the total amount of interpretable variance of this study was within an acceptable range.

Table 4. Barrett sphericity test and KMO value.

Barrett Sphericity Test and KMO Value		
KMO sampling fitness measure		0.895
Bartlett sphericity test	The approximate chi-square	1088.429
	Degrees of freedom	105
	Significance	0.000

The results of the factor analysis are shown in Table 5. The distribution of feature values of the factors after the axis rotation was more even and the explainable proportions changed, with Factor 1 (37.505%→20.926%), Factor 2 (8.879%→17.634%), and Factor 3

(8.206%→16.030%). There was a decrease in the proportion of variance explained by Factor 1, and an increase in the proportion of variance explained by Factor 2 and Factor 3. The commonality of the 3 factors and the relative position scale remained unchanged. The integration of feature values and the total cumulative variance remained unchanged at 54.590%. At the same time, 15 items were classified into groups because of the same potential characteristics or similar specific factors. There were 7 items for Factor 1, 4 items for Factor 2, and 4 items for Factor 3.

Table 5. Result of factor analysis.

Item Number	Factor 1	Factor 2	Factor 3
VAR 02	0.691	–	–
VAR 12	0.665	–	–
VAR 08	0.641	–	–
VAR 05	0.629	–	–
VAR 13	0.625	–	–
VAR 21	0.575	–	–
VAR 07	0.573	–	–
VAR 19	–	0.782	–
VAR 09	–	0.725	–
VAR 15	–	0.692	–
VAR 10	–	0.596	–
VAR 03	–	–	0.748
VAR 01	–	–	0.734
VAR 20	–	–	0.716
VAR 04	–	–	0.606
Eigenvalue	3.139	2.645	2.404
Extraction sums of squared loadings %	37.505	20.926	8.879
Rotation Sums of Squared Loadings %	20.926	17.634	16.030
Total explanatory variance %		54.590	
The overall-scale Cronbach's α		0.880	
Subscale Cronbach's α	0.816	0.763	0.754

As shown in Table 5, there were 7 items in Factor 1 after extraction, which were fun, visuality, interest, learning experience, richness, curiosity, and understanding level. These items reflected the subjective behavioral feelings of students using AR textbooks to learn. The students think that they had fun and learning interest as well as obtained different learning experiences when using AR textbooks in their studies. The visuality and richness of the learning content of AR textbooks can enable students to improve the understanding level of study. AR textbooks provided help in learning and made students curious. Therefore, this study named Factor 1 "Visual attraction". There were 4 items in Factor 2, which were thinking ability, spatial ability, imagination, and learning efficiency. In the previous literature review, it was found that compared with traditional textbooks, students using AR textbooks achieved a significant improvement in the learning ability [5]. From the 4 items of Factor 2 and the commonalities, it can be seen that students' using AR textbooks to learn had an impact on the improvement of their behavioral ability at the learning level. Therefore, this study named Factor 2 as "Knowledge-ability". For Factor 3, there were 4 items which are interactivity, telepresence, immersion, and innovation. In the teaching process, students can interact with real scenes when they use AR textbooks to manipulate virtual objects. It is an innovative function as compared to traditional textbooks. AR technology has brought immersive feelings. When students were to complete the learning task, immersing in it formed a state of flow experience. Therefore, Factor 3 was named "Situational Experience" by this study.

3.2. Variance Analysis

Whether students of different genders have differences in the dimensions of the three factors was tested through independent sample *t*-test analysis. The research results showed

significant differences between male and female students in Factor 1 "Visual Attraction" (t = −2.699, $p < 0.01$), Factor 2 "Knowledge-ability" (t = −702, $p < 0.01$) and Factor 3 "Situational Experience" (t = −2.460, $p < 0.05$), as shown in Table 6, suggesting that male students scored significantly higher than female students in the three factors.

Table 6. Gender differences.

Factor	Gender	N	Mean	SD	t	p
Visual attraction	Female	128	3.826	0.527	−2.699	0.007 **
	Male	96	4.012	0.500		
Knowledge-ability	Female	128	3.641	0.627	−2.702	0.008 **
	Male	96	3.850	0.491		
Situational experience	Female	128	3.839	0.585	−2.460	0.015 *
	Male	96	4.023	0.535		

** $p < 0.01$; * $p < 0.05$.

As shown in Table 7, the independent sample *t*-test results indicated no significant difference in the three factors (Visual Attraction [t = 1.537, $p > 0.05$]; Knowledge-ability [t = 1.133, $p > 0.05$]; Situational Experience [t = 0.281, $p > 0.05$]) between the sophomores and juniors, which meant students of different grades had no difference on each other for those three factors.

Table 7. Grade differences.

Factor	Grade	N	Mean	SD	t	p
Visual attraction	Second	129	3.980	0.504	1.537	0.126
	Third	95	3.872	0.535		
Knowledge-ability	Second	129	3.797	0.529	1.133	0.258
	Third	95	3.711	0.605		
Situational experience	Second	129	3.953	0.565	0.281	0.779
	Third	95	3.932	0.565		

$p < 0.05$.

According to the results of variance analysis, students from different departments (Product Design, Digital Media, Environmental Design) have no significant differences between the three factors (Visual Attraction [$F (2, 221) = 1.225$, $p > 0.05$]; Knowledge-ability [$F(2, 221) = 0.380$, $p > 0.05$]; Situational Experience [$F(2, 221) = 0.720$, $p > 0.05$]), as shown in Table 8. It can be seen that students of different departments had no difference on each other in the three factors.

Table 8. Major differences.

Factor	Major	N	Mean	SD	F	p
Visual attraction	Product Design	94	3.991	0.559	1.225	0.296
	Digital Media	75	3.914	0.487		
	Environmental Design	55	3.857	0.485		
Knowledge-ability	Product Design	94	3.793	0.573	0.380	0.684
	Digital Media	75	3.717	0.543		
	Environmental Design	55	3.764	0.574		
Situational experience	Product Design	94	3.997	0.600	0.720	0.488
	Digital Media	75	3.907	0.498		
	Environmental Design	55	3.905	0.584		

$p < 0.05$.

3.3. Hypothesis Testing: Structural Equation Model

3.3.1. Measurement Model

Three factors affecting students' use of AR textbooks in the Basic Design course were derived from the results of factor analysis of this study, and it was concluded in the

differential analysis that there were certain differences between genders but there was no significant difference between grades and departments. Therefore, this study will further explore the relationship between the three factors and the continuance intention. In the learning environment of continuance intention of AR textbooks, Kim, Hwang, Zo and Lee [44] pointed out that the practicality of AR software will affect learners' continuance intention of AR textbooks. When students use AR textbooks for learning, the stronger their learning attitude, the stronger their intention to continue using AR learning [10]. Therefore, the hypotheses of this study are:

Hypothesis 1 (H1). *There is a significant positive correlation between students' Visual Attraction and their Continuance Intention of AR textbooks.*

Hypothesis 2 (H2). *There is a significant positive correlation between students' Knowledge-ability and their Continuance Intention of AR textbooks.*

Hypothesis 3 (H3). *There is a significant positive correlation between students' Situational Experience and their Continuance Intention of AR textbooks.*

The hypothesis model diagram of this research is shown in Figure 1. In the Post-Acceptance Model of IS, Bhattacherjee [52] defined the operational type of continuance intention as the user's intention for the continuous use of the information system. In this study, continuance intention is defined as the student's intention to continue to use AR textbooks for learning in the Basic Design course. Therefore, the questionnaire was designed based on previous scholars' research combined with the continuance intention of AR textbooks in Basic Design teaching, as shown in Table 9. The valid copies accounted for 91.57% of the total number of questionnaires collected during the 4-week AR Basic Design Teaching Workshop from 9 November to 4 December 2020, after eliminating invalid samples (incorrect responses or too many same options). A total of 249 copies were collected and the remaining 228 copies were valid. Table 10 shows the descriptive statistics of the respondents.
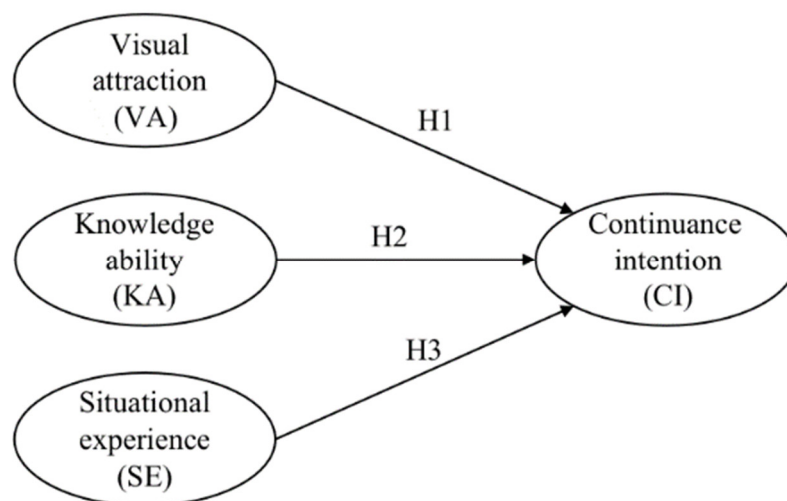

Figure 1. Research Model.

Table 9. Items of Continuance intention.

Item Description	References
CI1 I plan to continue to use AR textbooks in Basic Design course in the future	
CI2 I plan to use AR textbooks in Basic Design courses often in the future	[53,54]
CI3 Generally speaking, I intend to continue to use AR textbooks in Basic Design course	

Table 10. Descriptive statistics of respondents.

Demographics		No. of Respondents	% of Respondents
Gender	Female	133	58.3
	Male	95	41.7
Age	19–20	51	22.4
	22–22	163	71.5
	23–24	14	6.1
Grade	Second	148	64.9
	Third	80	35.1
Major	Product design	126	55.3
	Digital media	68	29.8
	Environmental design	34	14.9

3.3.2. Reliability and Validity

In this study, SPSS v26.0 (IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp) was used to analyze the reliability and validity of the questionnaire to delete unstable items and establish the credibility and discriminant validity of the items. The results showed that Cronbach's α of all dimensions were higher than 0.7, showing the questionnaire was reliable, as shown in Table 11.

Table 11. Reliability and validity statistics.

Constructs	Items	Cronbach's α	Unstd.	S.E.	Unstd./S.E.	*p*-Value	Std.	CR	CV
Visual attraction (VA) Cronbach's α = 0.895	VA1	0.866	1.000	–	–	–	0.853		
	VA2	0.873	0.968	0.066	14.713	0.000	0.801		
	VA3	0.875	0.903	0.065	13.832	0.000	0.769		
	VA4	0.877	0.911	0.069	13.250	0.000	0.748	0.898	0.560
	VA5	0.879	0.902	0.068	13.234	0.000	0.747		
	VA6	0.892	0.769	0.073	10.562	0.000	0.635		
	VA7	0.889	0.709	0.065	10.950	0.000	0.653		
Knowledge-ability (KA) Cronbach's α = 0.808	KA1	0.759	1.000	–	–	–	0.722		
	KA2	0.756	1.056	0.100	10.537	0.000	0.747	0.807	0.512
	KA3	0.758	0.984	0.101	9.702	0.000	0.686		
	KA4	0.766	1.063	0.106	10.004	0.000	0.708		
Situational experience (SE) Cronbach's α = 0.844	SE1	0.824	1.000	–	–	–	0.712		
	SE2	0.791	1.126	0.103	10.950	0.000	0.779	0.845	0.578
	SE3	0.794	1.038	0.096	10.814	0.000	0.769		
	SE4	0.798	1.103	0.101	10.933	0.000	0.778		
Continuance intention (CI) Cronbach's α = 0.845	CI1	0.805	1.000	–	–	–	0.803		
	CI2	0.796	1.022	0.082	12.446	0.000	0.777	0.846	0.647
	CI3	0.751	1.085	0.080	13.522	0.000	0.834		

Note: Cronbach's α = Cronbach Coefficient Alpha with Delete Variable, Unstd. = Unstandardized factor loadings, Std. = Standardized factor loadings, CR = Composite Reliability, CV = Convergence Validity.

After the reliability and validity test was completed, this study used AMOS v22.0 (IBM SPSS Amos Version 22.0. Armonk, NY: IBM Corp.) to perform confirmatory factor analysis on the measurement model, using the maximum likelihood estimation method. The estimated parameters included factor loading, reliability, convergent validity, and discriminant validity [55]. According to the research of Hair, Black, Babin, Anderson and Tatham [51], Nunnally and Bernstein [56] and Fornell and Larcker [57] on convergent validity, and the study of Chin [58] and Hooper, et al. [59] on standardized factor loading, the standardized factor load of this study was higher than 0.7. The composite reliability of the research dimensions was higher than 0.7, and the average variance extraction was higher than 0.5 [51], indicating the good convergent validity for all dimensions.

The study of Fornell and Larcker [57] was adopted for discriminative validity. If the square root of AVE of each dimension is greater than the correlation coefficient between the dimensions, the model has discriminative validity. The results showed that the values of all diagonals in this study were greater than the values outside the diagonal, indicating that each dimension of this study has good discriminative validity, as shown in Table 12. Therefore, the model in this study has good convergent validity and discriminative validity, and it can be used for further analysis.

Table 12. Discriminant validity.

	AVE	VA	KA	SE	CI
VA	0.560	**0.748**	–	–	–
KA	0.512	0.709	**0.716**	–	–
SE	0.578	0.729	0.709	**0.760**	–
CI	0.647	0.709	0.698	0.670	**0.805**

Note: The items on the diagonal on bold represent the square roots of the AVE; off-diagonal elements are the correlation estimates.

3.3.3. Model Fit Test

Based on the research of Kline [60], Schumacker and Lomax [61], and Hu and Bentler [62] this study selected multiple indicators (MLχ^2, DF, χ^2/DF, RMSEA, SRMR, TLI, CFI, NFI, GFI, PGFI, PNFI, IFI) to evaluate the fit of structural models. Visual Attraction, Knowledge-ability, and Situational Experience were measured according to research hypotheses and models. As shown in Table 13, all standard model fit evaluation indicators met the independence level and combination rules of the recommended fit at the same time. It proved that the structural model had a good fit, and the theoretical framework of the research hypothesis was consistent with the actual survey results.

Table 13. Evaluation results.

Indicators	Norm	Results	Judgment
MLχ^2	–	225.658	–
DF	–	129	–
χ^2/DF	$1 < \chi^2/DF < 5$	1.749	Yes
RMSEA	<0.08	0.057	Yes
SRMR	<0.08	0.043	Yes
TLI (NNFI)	>0.9	0.952	Yes
CFI	>0.9	0.959	Yes
NFI	>0.9	0.911	Yes
GFI	>0.8	0.901	Yes
PGFI	>0.5	0.680	Yes
PNFI	>0.5	0.768	Yes
IFI	>0.9	0.960	Yes

Note: MLχ^2 = ML chi-square, DF = Degrees of Freedom, χ^2/DF = Normed Chi-square, RMSEA = Root Mean Square Error Approximation, SRMR = Standardized Root Mean Square Residual, TLI = Tucker-Lewis Index, CFI = Comparative Fit Index, NFI = Normative Fit Index, GFI = Goodness of Fit index, PGFI = Parsimony Goodness of Fit Index, PNFI = Parsimony Normed Fit Index, IFI = Incremental Fit Index.

3.3.4. Path Analysis

Table 14 shows the results of path analysis, VA (b = 0.257, *p* = 0.013) significantly affected CI. KA (b = 0.547, *p* = 0.001). In terms of explanatory power, CA, KA and SE explained 75.2% of CI.

Table 14. Results of hypothesis testing.

Hypothesis	Hypothesised Relationship	Unstd	S.E.	Unstd./S.E.	*p*-Value	Std.	R^2	Result
H1	VA→CI	0.257	0.104	2.479	0.013 **	0.289		Yes
H2	KA→CI	0.547	0.168	3.251	0.001 ***	0.498	0.752	Yes
H3	SE→CI	0.135	0.157	0.855	0.393	0.128		No

** $p < 0.05$; *** $p < 0.001$.

3.3.5. Hypothesis Explanation

Table 14 shows the normalization coefficient of the SEM model in this study. The higher coefficient implies that the independent variable has a significant impact on the dependent variable. Figure 2 shows the influence between variables in the structural model.
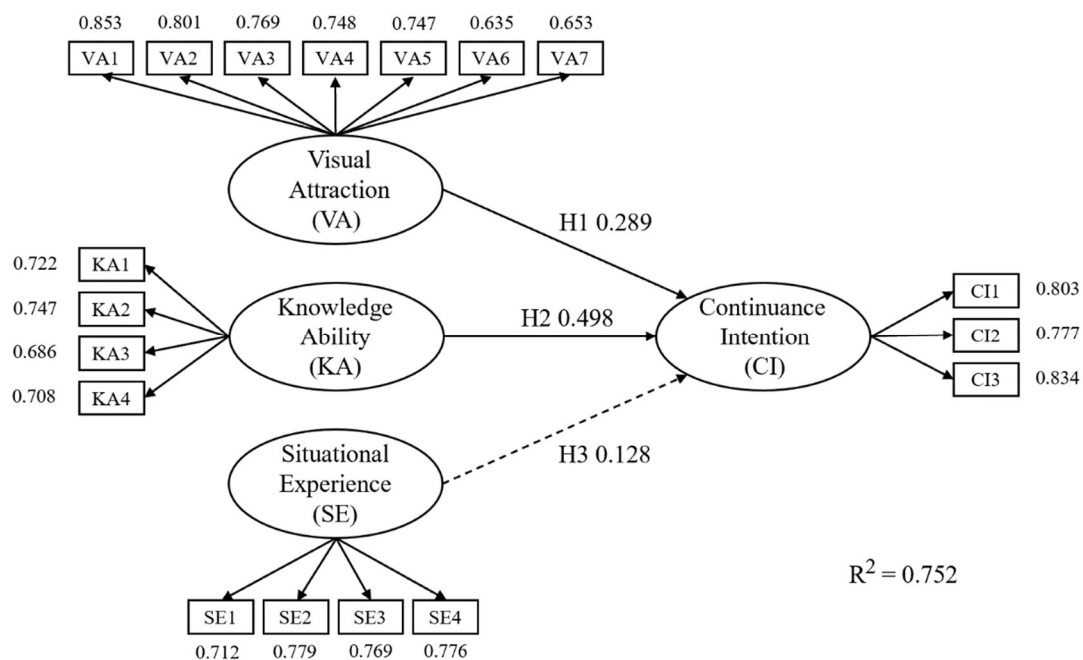
Figure 2. Result of testing the hypotheses.

4. Discussion and Conclusions

The purpose of this study was to explore the factors that affect students' use of AR textbooks in Basic Design courses. The structural equation model was adopted to find out the factors that affect students' continuance intention of AR textbooks. This was used as a basis to form research strategies to provide a reference for using AR textbooks in the field of Basic Design education.

Three factors and 15 items were finally obtained from the research results of factor analysis. The three factors were named Factor 1 "Visual Attraction", Factor 2 "Knowledge-ability", and Factor 3 "Situational Experience". The "fun" dimension of Factor 1 "Visual Attraction" was the most frequent item considered by students as the factor that affected the use of AR textbooks in the open questionnaire of the first stage. As seen, students in an AR technology learning environment generally find learning with AR to be a fun activity and can increase their willingness to learn [3,44]. The "thinking ability" and "spatial ability" included in Factor 2 "Knowledge-ability" verified some of the previous researches. For example, the use of AR technology in design-based learning methods can improve students' advanced thinking ability [43]. Compared with traditional textbooks, the use of AR textbooks for teaching can help improve students' spatial skills [14]. The "interactivity" in Factor 3 "Situational Experience" was also one of the influential factors in the use of AR textbooks by students. Some scholars have pointed out that AR textbooks can help enhance

the interactivity of the learning process and stimulate students' learning motivation and learning efficiency [18,31].

As a result, AR technology can be used as part of the basic design curriculum, not only to enrich the existing teaching methods, but also to demonstrate the feasibility of using AR technology in design education courses [33]. Therefore, the "fun" of Factor 1 "Visual Attraction", the "thinking ability" and "spatial ability" of Factor 2 "Knowledge-ability", and the "interactivity" and "telepresence" of Factor 3 "Situational Experience" etc., have become influential factors for students' intention to use AR for learning in Basic Design course. We further analyzed the relevance of the following three factors in constituting the continued usability of AR materials.

On the other hand, the analysis of the differences shows that boys showed more interest than girls in the visual appeal of the content, the personal enhancement of knowledge and competence, and the contextual experience of the virtual scenarios when using AR materials in basic design courses. In other words, boys are more likely to use AR materials in basic design courses than girls, echoing the study of Echeverría et al. [63]. Nowadays, with the development of technology, girls may be more receptive to new technologies than boys, as Dirin et al. found that girls had a more positive attitude towards the experience of using new technologies (VR and AR) than boys [64]. There are no significant differences in the three factors across subjects and grades, but the mean number shows that students are generally receptive to learning with AR materials.

Also, it can be inferred from the results of the SEM research that among the students' continuance intention of AR textbooks in the Basic Design course, Factor 1 "Visual Attraction" and Factor 2 "Knowledge-ability" had a positive impact. Factor 1 "Visual Attraction" can reflect the sensory experience of students when using AR textbooks. The main key factor was that students focused more on considerations of knowledge and ability in the dimensions of Factor 2 "Knowledge-ability". It is conducive in enhancing the intention of continuing to use AR textbooks for learning. Factor 3 "Situational Experience" did not have a positive impact on continuance intention, which meant that the situational feelings such as "interactivity" and "telepresence" of AR textbooks did not affect students' intention to continue to use AR textbooks for learning in Basic Design course.

In general, students' continued use of AR materials in basic design courses indicates that they focus on the "intellectual" aspect, i.e., their personal knowledge and abilities, as well as the visual appeal of the content they learn through AR materials. In the future, the use of AR materials in basic design courses and the design of AR materials could focus on the "intellectual" and "visual appeal" factors, which would be more conducive to students' willingness to continue using AR materials for learning. In addition, the study of students' intention to continue using AR materials echoes the views of academics who argue that students' continued use of AR materials can help them in their learning process [10]. While the results of this study may contribute to the application and development of AR materials in basic design teaching, some of the limitations of this study may indicate future research directions:

First, this study was conducted from the perspective of students' use of AR materials, and the questionnaire data was collected from students in the school of art and design of a private university, with only second and third-year students participating in the teaching activities. The structural equation modelling phase of the study focused on testing the compatibility of the hypothesis, considering that only the gender of the students differed somewhat during the factor analysis phase. Of course, gender is also a variable that should not be overlooked, as Park et al. found that gender differences moderated students' acceptance and perception of using multimedia technology [65]. Therefore, in future research we plan to conduct a full year of teaching and learning activities, and even extend this to students in other university art and design schools, in order to test for differences in the intention to use AR materials consistently between different groups. In addition, it is possible to consider other courses than just the basic design course as a background.

Secondly, the purpose of this study was to explore students' intentions to use AR materials consistently in basic design instruction, but not to discuss teachers' intentions to use AR materials in instruction. This study focuses on the student perspective. The uncertainty of what factors may influence teachers' intentions to use AR materials consistently in their lessons may affect the effectiveness of their classroom instruction, and may even lead to students' continued use of AR materials. Therefore, future research could take this into account to strengthen the findings of this study.

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