

A study on the integration of worked examples and blended learning in the curriculum during the COVID-19 epidemic

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Abstract. Both blended learning and work examples are used to enhance student learning. Due to the temporary suspension of classes due to COVID-19, the face-to-face course was temporarily converted to a full-scale online course. In order to provide a consistent learning foundation for students of all levels, The Next Generation Art course is based on segmented worked examples, supplemented by tutorial videos and supplementary videos. At the end of the semester, a questionnaire based on the TAM scale was administered to three classes in two school districts. Gender, 3D ability, and basic information of topic type were analyzed by Independent Sample t-test. The results showed that females had better 3D ability than males, which was also reflected in the TAM, and females preferred and were willing to apply the technology of the course. As expected, those with lower 3D ability chose 2D format for their topics. The relationship between the number of professional credits and 3D ability was analyzed by ANOVA. Unlike the prediction, it is not the case that more courses equals higher ability, but rather the students with moderate number of 3D courses considered themselves to have the highest 3D ability. It is possible that the Dunning-Kruger effect is caused by the worked example and the blended learning.

Keywords: Technology Acceptance Model, Blended Learning, Worked Example, Next Generation Art.

1 Introduction

Since 2019, due to the epidemic of COVID-19, all educators need to combine face-to-face teaching, distance online teaching and online videos for blended teaching. Combining online and offline blended teaching requires careful instructional design and consideration of different strategies. Nowadays, due to external interference such as part-time jobs and mobile phones, students have low self-control, and the interference of COVID-19 has resulted in generally ineffective learning of 3D courses. Most students fall into a situation of low ability and low achievement, showing partiality Low learning motivation, low self-efficacy and low participation eventually turn into low

academic achievement and low satisfaction [1]. Blended learning emerged as a solution with the potential to improve their learning experience and engagement.

Worked example learning is a natural learning style in line with human cognition and provides an effective teaching method [4], and both blended learning can be used to enhance student learning outcomes. In Taiwan, the F2F course was temporarily converted to a full-fledged online course in May 2022 due to the mass suspension of classes, and teachers needed to adapt the course content differently from face-to-face classes for this purpose. The course of study teaches Next-Generation Art (NGA) application techniques and is the last course of all 3D technology courses, with students already in the graduation project stage. The course uses working examples to build a consistent foundation for learning, and video recordings are made during face-to-face and distance learning sessions for students to study after the class. A student survey is conducted at the end of the semester to understand students' perceptions of the work examples and blended learning, and use TAM to evaluate the effectiveness of software teaching in NGA courses.

2 Method & Material

2.1 The Technology Acceptance Model

The Technology Acceptance Model (TAM) [2], first proposed by Davis in 1986, has been a favored method for analyzing the use of new technologies or hardware and software, explaining and predicting the usage behavior of information technology, and is used to determine the decision factors or processes of users in accepting or using a new technology. The TAM framework has five main constructs: Perceived Usefulness (PU), Perceived ease of Use (PEU), Attitude toward Use (ATT), Behavioral Intention to Use (BI), and Actual System Use (AU) [3].

The Next-Generation Art (NGA) course focuses on the use of Adobe Substance 3D Painter, and TAM is used to assess students' acceptance of the technology as a reference for course learning outcomes.

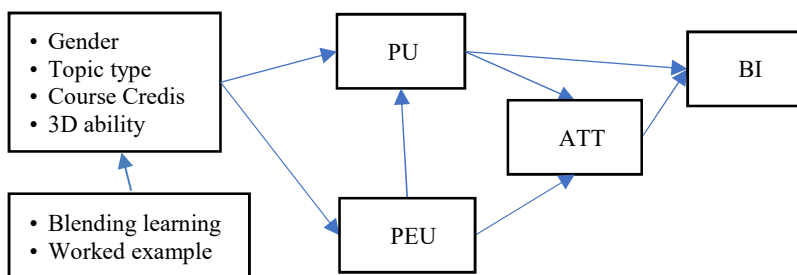


Fig. 1. Technology acceptance model of this research framework

2.2 Segmented worked example

The worked example effect is the best known and most widely studied of the cognitive load effect. The field's relative emphasis on this effect is justified. Worked examples provide an effective method of teaching [4]. Worked examples are teaching tools that teach problem-solving skills. They typically involve simulating the problem-solving process in a well-structured design template and presenting the steps and end results of the problem-solving process [5]. In addition, worked examples cannot be adapted to all learning environments and are more suitable for individual learning and not for collaborative learning [6].

Not all students will take all the 3D courses. NGA techniques, as the final integrated application course, requires the most 3D skills as the foundation. Since about half of the digital media students have low achievement in 3D technology and do not have the basic requirements to carry out the course content, in order to make the course progress smoothly, the teachers provide the 3D resources required for the course. However, the study found that effective examples are not always effective. Even when learners are given enough resources to do relevant activities, these activities do not necessarily lead to better learning [7]. Slightly earlier studies also found that giving complete working examples led to misjudgments of students' self-competence [8]. The learning effect involves students' autonomous motivation and ability foundation, so it is changed to provide staged work example files, split the work examples into raw materials, semi-finished products, and finished products, so that students can advance according to the course content on a certain basis, and modify the teacher's own basic paradigm for the next stage of learning activities.

2.3 Blended Learning

The mix of face-to-face and online components of blended learning provides learners with the opportunity to learn from multiple delivery methods [9]. Implementing blended learning is a challenging process that is influenced by many factors, with the teacher playing the most critical role. Teachers who implement blended learning should possess seven teacher attributes and avoid four attributes that hinder blended learning [10].

Usually, blended learning refers to face-to-face learning and online video learning. There are five ways to enhance the learning effect of video for teaching [11]. The NGA course in this study used OBS software to record videos during both F2F and online learning, and published them in Google Classroom. three classes had different progress and each had different videos.

Table 1. Principles for improving the effectiveness of video teaching and our corresponding methods

Principles	Correspondence in this study
Dynamic drawing	Real-time drawing and labeling function for emphasis during recording.

Gaze guidance	Use of the recording software's highlighting cursor to show mouse clicks and keyboard characters.
Generative activity	Not yet included in the course design, as it will increase the load on the course by increasing the teacher's assessment workload.
Perspective	Not applicable to software-operated courses.
Subtitle	Subtitling of videos requires text correction and verbiage retouching, which is time-consuming and labor-intensive to produce.

2.4 Questionnaire

At the end of the semester, during the school closure period, an anonymous online survey was conducted among students in three classes at two campuses. The content of the questionnaire included gender, major credits, topic type, self-rated 3D ability, etc. A five-point Likert-type scale with TAM as the main structure and three sets of qualitative scales were used, totaling 24 items. The collected questionnaires were analyzed and compared with IBM SPSS 26.

3 Result & Discussion

3.1 Preliminary Analysis

In two school districts, 76 responses were received from three classes of students, Table 2 shows the basic data list, of which 30 were male and 46 were female, and 55.3% of the graduation projects were full 3D and partial 3D use. only 18 of the 76 students identified themselves as having 3D ability above the class average, a percentage consistent with the number of people and the number of people who felt they could complete the full NGA work method, and consistent with previous research : Those with a high level of confidence in their abilities are perceived to have a strong sense of efficacy, which leads to better learning outcomes [12].

81.6% of the students needed tutorial videos, while only 4 out of 5.3% felt less needy. As many as 85.5% relied on the videos for learning and review, while 3.9% did not need them or did not need them. The need for videos to complete assignments accounted for 77.7%, indicating the necessity of tutorial videos.

In terms of work examples, about 40.4% of the respondents did not know how to do the work themselves and needed the teacher to provide examples, which is different from the actual situation or the teacher underestimated the students' ability. 72.4% agreed that the work examples were helpful for learning, while 4 people did not think they were very helpful.

After combining the work examples and blended learning, 15.8% felt that they could integrate 3D software, and 23.7% were confident in completing the process of next-generation art techniques, which is roughly similar to the percentage of students with high 3D ability. There were no students who didn't understand it at all, but 9.2% still didn't understand it very well.

Table 2. Basic Information Statistics Table

Basic information	Types	Number of people
gender	Male	30
	Female	46
Campus	Campus A	53
	Campus B	23
Graduation topic form	3D Content	42
	2D Content	34
Hours of professional courses	< 6 credits	2
	6-9 credits	26
	> 9 credits	48
Self-evaluation 3D capability	Good	2
	Not bad	16
	Fair	26
	Not so good	19
	Very bad	13

3.2 Reliability analysis

A total of 24 items on the scale were analyzed for reliability, and the overall Cronbach's alpha was .860, indicating that the factors in this scale have sufficient reliability and good internal consistency. The results of the reliability analysis for each component are shown in Table 3.

Table 3. Reliability analysis of each facet

Structure	Cronbach's alpha	Cronbach's alpha values based on standardized items	N of Items
PEU	.896	.898	4
PU	.633	.679	4
ATT	.804	.803	4
BI	.788	.798	3
Tutorial Video	.818	.818	3
Worked Example	.387	.430	3
Understand	.747	.742	3

3.3 Analysis of total validity and validity of various aspects

For construct validity was examined by factor analysis and the results are shown in Table 4, which can be judged by the KMO quality size according to Kaiser's (1974) selection criteria. The KMO value for this scale is .831, which is greater than the recommended 0.8, indicating that it is suitable for factor analysis. The Bartlett's test value for sphericity is less than 0.05 and therefore significant.

Table 4. KMO and Bartlett test determination.

Kaiser-Meyer-Olkin Sampling Suitability		.831
	Approximate Cardinality Determination	1080.531
Bartlett's spherical check	Degree of freedom	276
	Significance	.000

3.4 Independent sample t-test

Independent sample t-test was conducted on 3D ability, TAM, teaching video, work example, and comprehension in the form of gender and topic. The results are summarized in Table 5.

Table 5. Results and analysis of the independent sample t-test

Item	Result
Gender - 3D ability	Significance (two-tailed) $0.030 < 0.05$, significant, females have stronger 3D ability than males.
Gender - TAM	Some of the topics in the ATT and BI sections are significant, and it can be argued that women prefer to use the NGA technique more than men, and are more willing to apply it to topics.
Topic - 3D ability	The type of topic and 3D ability were checked, and as expected, those with weak 3D ability chose 2D topic format.
Topic - TAM	The students whose topic is in 2D form show significance in some items of PEU and PU and all items of BI, expressing that they feel the ease of use and usefulness of NGA techniques and increase their willingness to use them.
Topic - Understanding	Significance (two-tailed) $0.010 < 0.05$, indicating that combining work examples with blended learning improved understanding of NGA techniques for students who chose 2D topics (low 3D ability).
Topic - Worked Examples	The students of the 3D topic showed a significant (two-tailed) $0.000 < 0.05$ for the item "Using work examples because they can't do it by themselves". It is speculated that those with high 3D ability understand the difficulty of implementation, so their self-assessment is more correct.

3.5 Analysis of variance (ANOVA)

The present study categorized students' enrollment in 3D professional courses into three levels: over 9 credits, 6 to 9 credits, and below 6 credits. The number of credits was used as a factor to analyze the variance in self-evaluated 3D abilities. It was initially hypothesized that students with a higher number of enrolled professional courses would evaluate their 3D abilities more positively. The analysis results are presented in Table 6, and a Scheffe post hoc test was conducted, as shown in Table 7. The results showed

that students with an intermediate number of credits evaluated their 3D abilities as the strongest. However, it was found that the NGA technique course, which requires a foundation of all 3D professional course knowledge, adopted a staged working example, which coincidentally made up for the deficiencies of students with an intermediate number of enrolled courses. As a result, they overestimated their abilities. The Dunning-Kruger effect, which describes a tendency for incompetent individuals to overestimate their abilities, cannot be ignored [13]. Although students with the least number of enrolled 3D courses did not exhibit cognitive bias, the impact of the working examples cannot be overlooked.

Table 6. Analysis of variance

	Sum of Squares	Degrees of freedom	Mean Square	F	Significant
Between Groups	10.821	2	5.411	5.200	.008
In Group	75.955	73	1.040		
Total	86.776	75			

Table 7. Scheffe's method

(I) Credit	(J) Credit	Mean Difference (I-J)	Std. Error	Sig.	95% confidence interval	
					Lower Bound	Upper Bound
1.00	2.00	.19231	.74850	.968	-1.6781	2.0627
	3.00	.95833	.73615	.433	-.8812	2.7979
2.00	1.00	-.19231	.74850	.968	-2.0627	1.6781
	3.00	.76603*	.24839	.011	.1454	1.3867
3.00	1.00	-.95833	.73615	.433	-2.7979	.8812
	2.00	-.76603*	.24839	.011	-1.3867	-.1454

4 Conclusion

Combining worked examples and blended learning, students with low 3D ability have successfully improved their acceptance of NGA techniques and course understanding. The mixture of face-to-face (physical/distance) and teaching videos in blended learning provides learners with opportunities to learn in a variety of teaching methods and increases the flexibility of students' learning [14]. In addition, the worked example stage is divided into raw materials, semi-finished products, and finished products to reduce the impact of differences in students' 3D abilities. Videos are recorded during lectures to operate the software and explain the functions. The content of the videos is detailed and there are a large number of videos. Students can arrange their own learning or query functions afterwards. In view of the addition of videos that only operate without explanation during the suspension period, it is another reason why students rely on the high proportion of videos. According to research, all detailed explanations should be provided in the initial teaching and minimized when operating with worked examples [4]. Also making videos from material that is taught face-to-face to students in the classroom can lead to content overload, repetition, and is not an effective way to generate

blended learning [15]. However, teaching first and then recording two-stage lectures will greatly increase the burden on teachers in teaching, and the school's resource injection is required before it can be considered for implementation.

5 Limitations and Future Prospects

The 3D ability used for comparative evaluation in this study was based on students' self-reported assessments. Self-assessment may be biased because students may not accurately judge their skill level. Therefore, in the future, it is necessary to consider conducting questionnaire surveys in a named manner, and link them with actual classroom grades to make quantitative judgments.

In addition, the work examples are a viable solution for addressing differences in students' basic proficiency levels. However, efforts must be made to exclude students who do not need work examples for learning, as people tend to choose the easiest way to achieve their goals.

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