Study on e-book teaching material on students' difference of ecological cognition: using e-book *Farm of Happiness* as an example

Ting-Sheng Weng

Department of Business Administration,
National Chiayi University,
580 Sinmin Rd., Chiayi City 600, Taiwan
Email: politeweng@yahoo.com.tw

Abstract: The use of pesticides in rural areas has changed the ecological environment. However, few research and analyses have focused on the influence of digital teaching materials of environmental education on students. To help students understand the ecology of villages, this study designed e-book teaching materials for environmental education. The subjects were 84 students from the College of Liberal Arts and the College of Business and Management at a university. Independent sample t-testing was conducted to verify the impact of the subjects' attitude toward the usage of digital teaching materials. The results confirm that both the students' reactions and the structure of the teaching materials have significant differences in their cognition of the ecology of villages. Students' ecological cognition can be developed or changed through e-book teaching materials for ecological environmental education; therefore, illustrated e-book teaching materials are effective in improving students' cognition of the ecology of villages.

Keywords: environmental education; digital teaching materials; e-books; cognition; environmental literacy.

Reference to this paper should be made as follows: Weng, T-S. (2023) 'Study on e-book teaching material on students' difference of ecological cognition: using e-book *Farm of Happiness* as an example', *Int. J. Innovation and Learning*, Vol. 33, No. 1, pp.1–13.

Biographical notes: Ting-Sheng Weng is an Associate Professor of the Department of Business Administration at National Chiayi University, Taiwan. He received his PhD in Division of Management and Information Science, Graduate School of Advanced Technology from Kinki University, Japan in 2000. He had served as a Visiting Professor at Meiji University in Japan from 2006 through 2007. His major research interests include science technology and management, e-learning, mathematics and science learning, 3D, information education, technology education, AI, MIS, and image processing.

1 Introduction

The United Nations (UN) designated 1990 as the Environmental Literacy Year, and its Connect (UNESCO/UNEP, 1989) newsletter was titled 'Environmental Literacy for All' (Roth, 1992). The UN emphasised that environmental education should be regarded as

the most important focus of education now and in the future. In 2015, the United Nations put forward another 15-year international plan, which aims at 'changing our world' and 'sustainable development', and reminds humankind that the earth is facing great challenges. Threats such as war, food insecurity, pollution, disasters, and climate change cannot be ignored, and education is an opportunity to change and create a better future (UNGA, 2015). The goal of environmental education is to change people's attitudes toward the environment and take action to protect the environment, thus, it is the base of environmental protection.

Through environmental education, it is the best way to arouse students' awareness of environmental protection and sustainability. Especially in the face of the conflict between economic and environmental sustainability, it is very important to actively build awareness of how to take into account both economic and environmental sustainability (Boca and Saraçlı, 2019; Mravcová, 2019).

The Ministry of Education included environmental education in the grades 1–9 curriculum (Watanabe and Wakamatsu, 2000; Hsiung, 2001; Wang, 2003; Ministry of Education, 2003) and grades 1–12 curriculum (Ministry of Education, 2014, 2017; Kao et al., 2018). Environmental education combines the application of life and learning (Huang and Lin, 2020), and enables sustainable education and lifelong education, thus, it is important to carry out digital research.

In recent years, trips that focus on the ecology of villages are a usual part of the curriculum design for environmental education in schools. By experiencing rural life, students change their cognition of the ecological environment, develop consciousness, and take action for environmental protection (Blair, 2009; Lin and Hsu, 2017; Chung, 2018; Yang et al., 2020). It is necessary to promote the connection between people, the local ecological environment, and land, and then cultivate a sense of the place. Environmental education establishes the correct ecological concepts and attitudes to fulfil ecological conservation.

2 Research motives

Ecological trips allow students to accept environmental education by experiencing and interacting with the environment. However, according to the findings of Chiang et al. (2008) regarding the depth and scope of environmental cognition, students' change of 'ecological knowledge' is the most and 'environmental knowledge' is less. In addition to the cognition of ecological knowledge, environmental education should include the influence of ecology on society (Lin, 2019). Ecological trips for environmental education require that students are on-site, meaning there are energy, time, and transportation costs, which is a burden for them. Therefore, if interactions with villages' ecologies can be included in school courses through technology, the contents can be practiced regardless of location. E-books (Soil and Water Conservation Bureau, 2020) are a kind of digital teaching material that can be used in class, and feature interactive functions, as the words and animations presented on the pages are more attractive than simple documents. Moreover, as the web pages are refined, and are not influenced by internet speed, users can read at any time with reading devices (Chen and Yang, 2006; Hung, 2012; Sung et al., 2014; Bian, 2017; Kang, 2018; Peng, 2019).

Drucker (2004) and Chen and Lin (2017) pointed out that although digital technology is only one of the many new characteristics of the future society, it nevertheless exerted a

great influence on teaching. The development of teaching materials and tools for digital learning presents more choices. Subsequently, it gradually affects the interaction between teachers and students in traditional teaching, thereby changing the teaching structure and educational essence (Connolly et al., 2007). Although e-books have the previously listed advantages, further study is required to determine if e-book teaching materials and students' attitude of usage will result in students' different cognition. Therefore, the motivation of this study is to determine whether e-books, as digital teaching materials for environmental education, have a significant difference on students' cognition of the ecology of villages.

3 Research purposes

Concerning the above motivations, this study explored students' attitudes toward using digital teaching materials, as well as the degree of their reaction to the structure of teaching materials, in order to determine if e-book content results in different cognition of the ecology of villages. The hypotheses of this study are shown as follows:

H1 The degree of attitude toward using digital teaching materials has a significant difference on the cognition of the ecology of villages.

H2 The degree of reaction to the structure of digital teaching materials has a significant difference on the cognition of the ecology of villages.

The expected research findings are shown in Table 1.

Table 1 Expected research finding

Validation of the purposes in this study	*H1 and H2 are validated.*
Extended research direction of this study	Enhancement effectiveness of comic digital teaching materials on the cognition of the ecology of villages.
	Correlation between comic digital teaching materials and learning effectiveness of the ecology of villages.

4 Literature review

4.1 Environmental education

Orr (1992) advocated that 'all education is environmental education', which strongly reminded people to reflect on the essence of human education and further consider the important relationship between 'environmental education' and 'ecological education'. Attaching importance to the environment and ecology means attaching importance to ourselves. Everything in the earth's ecology is a community of life, and every creature has its meaning and value of survival. Only by respecting the lives of all species, cherishing the environment, and caring for the earth can we have a future and hope (Shih and Shih, 2019). Therefore, human beings should pay more attention to the protection and balance of the whole ecology, and should not damage the environment and ecology for short-term self-interest.

According to environmental education scholars in Taiwan, in a narrow sense, environmental education is part of ecological education, which mainly studies the interactions between the ecological environment and human beings; however, in the broad sense, environmental education is not limited to ecological education. As the environment interacts with human beings, including economy and politics, they can be included in environmental education. Since the main content of this study is the ecology of villages, environmental education is defined by the narrow sense (Chang and Ku, 2003; Chuang, 2008).

Ou et al. (2010) suggested that environmental education changes students' values by cognition to lead to actions. In recent years, the curriculum of environmental education has been extended to environmental disasters. The course of environmental disasters at the University of Alabama, Birmingham, USA probed into chemical and nuclear disasters (Becker, 2000). As many pesticides are toxic to the human body, there are often food safety concerns regarding pesticide residues (Tsai et al., 2021). Pesticides may be chemically synthetic or biological pesticides, viruses or bacteria, fungicides, anti-infective agents, or any substance or mixture capable of repelling or alleviating pests by means of its anti-pest contents. Yu (2017) mentioned that proper pest management for many crops can effectively avoid dependence on chemically synthesised pesticides.

The e-book teaching material in this study focuses on the usage of pesticides in villages and expects that more students will recognise the environmental damage caused by pesticides and have active behaviour to avoid such damage.

4.2 Digital teaching materials

With the advent of the digital age, e-books and picture books have become an easy way to read in our lives. The future is a generation of digital aborigines, where students are born in the environment of network and digital technology – a trend and an inevitable outcome. Therefore, educators should consider the kinds of teaching methods that arouse the interests of these digital aborigine students toward learning. Wu (2004) and Ni (2020) suggested that digital teaching material means to digitalise the materials of instruction, which can be downloaded to and used by related devices, and such content presentation is more diverse and rich. Wang (2019) and Lai (2021) indicated that digital textbooks could effectively improve students' learning effectiveness as an aid in teaching. Mayer (2001) suggested that digital teaching materials can integrate digital elements in the design of teaching materials, and such rich materials will trigger students' learning interest and motivation. Interest is the basic premise of any learning, and only interest can provide the motivation to lead students to learn. By cultivating students' positive environmental attitude, students can appreciate and feel grateful for nature and its operating system. While appreciating and accepting different ecological cultures, students also learn to care about the importance of ecological species and the ecological chain to rural areas, and care for the living environment and development of future generations.

Thus, in order to trigger students' learning interest through the characteristics of digital teaching materials, and change their behaviour, this study adopts the e-book for the environmental education of the ecology of villages.

4.3 Attitude toward the usage and structure of digital teaching materials

When using digital teaching materials, students will be influenced by their attitude toward the usage and structure of teaching materials. According to the theory of reasoned action (TRA), as proposed by Fishbein and Ajzen (1975), individual attitudes will influence behavioural intention. Davis (1985, 1989) extended the theory to the usage of technology and suggested that attitude toward the usage of technology will influence usage intention.

In addition to attitude toward usage, content structure is also an important factor. By using the content structure planning for the teaching materials of e-learning as an example, Chen (2010) indicated that good content and structure must be easily used by students. When content is not designed properly, students' learning time will increase and they might even stop learning. Lin and Yeh (2004) introduced the concept of the human-machine interface in the practice of design and emphasised that content symbols should match real-life situations, the content presentation should be based on the information needed by learners, and there should be more images instead of just text. Therefore, the design of teaching materials should rely on the content structure and students' attitude toward usage, in order to enhance students' intention to read the contents of digital teaching materials.

4.4 Importance of cognition

Chiang (1999) and Chiang and Lin (2006) reorganised the levels of cognition, as classified by B. Bloom. In this study, knowledge means the designed contents of e-books. Through e-books, the knowledge of villages can be easily accessed. As students can conveniently learn the ecology of villages, it will enhance their comprehension, application, and general analysis of the ecology of villages, which can change their attitude and encourage them to take action. Lee and Wang (2012) used the consumption of green products as an example. After reviewing the related literature, they found that the consumption of green products has a positive relationship with consumers' ecological knowledge. Therefore, when digital teaching materials deliver knowledge, they can change students' behaviour to protect the environment.

People naturally enjoy listening to stories. Through e-books and picture books, we can attract readers' attention, increase their cognition of the environment and ecological chain, promote them to absorb the value of the contents, cultivate their kindness and care for our environment, and improve their environmental literacy.

5 Research method and design

This study designed and developed a comic e-book through animate. The contents of the book discussed with Professor A from the NCYU Department of Agronomy. Through story-telling, this e-book probed into the damage caused by pesticides on the ecology of villages and found that the solution is to cooperate with bats and other animals in nature, to contribute to the production of crops, and replace the use of pesticides to avoid damage to the ecology of villages. This e-book provides the knowledge of bats for students'

reading and learning, and students can play interactive games and learn by playing. Figure 1 shows a screen of the teaching material:

Figure 1 Screen of e-book *Farm of Happiness* (see online version for colours)

5.1 Research hypotheses

This study determined whether the effect of digital teaching material on students' cognition of the ecology of villages is significantly different, thus, the previous statements are the research goals, which are validated to obtain specific research findings.

Therefore, this study developed H1 and H2 and generalised the hypotheses, as follows:

H1 The degree of attitude toward the usage of digital teaching materials has a significant difference on the cognition of the ecology of villages.

H2 The degree of reaction to the structure of the digital teaching materials has a significant difference on the cognition of the ecology of villages.

5.2 Research design

The main points of the excerpts from the storyline design are, as follows:

> "An orphan boy in the village is self-reliant. He raises chickens, ducks, and geese, and farms without pesticides."
>
> "Pesticides destroy the ecology and pollute rivers. Birds, fish, and other creatures die suddenly. Furthermore, pesticide cans are discarded everywhere,

> and the smell of pesticides is foul. The boy discourages other farmers from using pesticides and advocates protecting the ecological environment of the village."
>
> "As bats like to eat insects and mosquitoes, the boy builds a bat house and makes good use of the ecological chain. By balancing the food chain relationship among creatures in the ecosystem, the damage caused by pests to crops is reduced. It is necessary to attach importance to maintaining the ecological environment of villages and advocate attaching importance to ecological homes."

After illustrating the story, it was compiled into a digital picture book.

This study designed the activities through investigation. The subjects were students of the College of Liberal Arts and the College of Business and Management in one national university in southern Taiwan. A Likert five-point scale was adopted to design and conduct the questionnaire for the subjects.

This study aimed to determine whether the degree of students' attitude toward the usage of teaching materials, as well as their reaction to the structure of the teaching materials, significantly influenced their cognition of the ecology of villages. Therefore, this is a cross-sectional study.

5.3 Data collection and validation

By questionnaire, this study collected data from 84 valid samples. The design of the questionnaire was based on a Likert five-point scale, and statistical difference analysis was conducted by SPSS 20. This study applied independent sample t testing to determine if attitude toward using digital teaching material, as well as the reaction to the structure of the digital teaching materials, showed significant differences regarding cognition of the ecology of villages.

5.4 Analysis of validation

H1 The degree of attitude toward the digital teaching material (B51HL) has a significant difference on the cognition of the ecology of villages (B21).

H2 The degree of reaction to digital teaching materials (B52HL) has a significant difference on cognition of the ecology of villages (B21).

Therefore, according to the 'degree of attitude toward using digital teaching material (B51HL)', 'degree of reaction to the structure of digital teaching material (B52HL)', and 'cognition of the ecology of villages (B21)' this study conducted sample description and independent sample t-test.

5.5 Description of samples

There are a total of 84 samples in this study. The researcher developed high-score and low-score groups according to the original variables of 'attitude toward using digital teaching material (B51)' and 'structure of digital teaching materials (B52)' as 73% and 27%, respectively, as shown in Table 2.

Table 2 Frequency distribution (1)

		B51	*B52*
N	Valid	84	84
	Missing	0	0
Percentiles	27	12.0000	13.0000
	73	16.0000	16.0000

Based on the criterion of group division, the data of the original variables were allocated into high and low-score groups. Variables were changed to 'degree of attitude toward using digital teaching material (B51HL)' and 'degree of reaction to structure of digital teaching material (B52HL)', according to the frequency distribution, as shown in Table 3.

Table 3 Frequency distribution (2)

	B21	*B51HL*	*B52HL*
N	84	57	67
N(median)	-	27	17
Mean	15.1786	-	-
Std. deviation	2.56088	0.49812	0.49694
Variance	6.558	0.248	0.247

There are 57 samples in the high and low groups of 'degree of attitude toward using digital teaching material (B51HL)', and 27 samples are in the middle. Regarding the 'degree of reaction to the structure of the digital teaching material (B52HL)', there are 67 samples in the high and low groups, and 17 samples are in the middle. According to Table 4, after deleting the median and using the teaching material, 42.1% of the students had a more significant attitude toward using the digital teaching material. Regarding Table 5, after deleting the median and using the teaching material, 58.2% of the students had a more significant reaction to the structure of the digital teaching material.

Table 4 'Degree of attitude toward using digital teaching material (B51HL)'

		Frequency	*Percent*	*Valid percent*	*Cumulative percent*
Valid	1.00	24	28.6	42.1	42.1
	2.00	33	39.3	57.9	100.0
	Total	57	67.9	100.0	
Missing	System	27	32.1		
Total	84	100.0			

Table 5 'Degree of reaction to structure of the digital teaching material (B51HL)'

		Frequency	*Percent*	*Valid percent*	*Cumulative percent*
Valid	1.00	39	46.4	58.2	58.2
	2.00	28	33.3	41.8	100.0
	Total	67	79.8	100.0	
Missing	System	17	20.2		
Total	84	100.0			

5.6 Independent sample t-test

By independent sample t testing, this study tested 'the degree of attitude toward using digital teaching material (B51HL)', 'the degree of reaction to the structure of digital teaching material (B52HL)', and 'the cognition of the ecology of villages (B21)', and the results are shown in Table 6 and Table 7.

Table 6 Independent sample t-test of the degree of attitude toward using digital teaching material on cognition of the ecology of villages

	Levene's test for equality of variances		*t-test for equality of means*		
	F	*Sig.*	*T*	*df*	*Sig. (two-tailed)*
Equal variances assumed	1.717	0.195	4.612	55	0.000
Equal variances not assumed			4.797	54.699	0.000

Regarding the independent sample t-test of the degree of attitude toward using digital teaching material on cognition of the ecology of villages, the F value of the 'Levene's test of equal variance' is 1.717 and significance = 0.195 > 0.05, which is insignificant. Therefore, the null hypothesis of the 'equality of variances' is accepted. Regarding the 'assumption of the equality of variances', the significance of the two-tailed test = 0.000 < 0.05. Thus, the null hypothesis of the 'degree of attitude toward using digital teaching material does not have significant difference on cognition of the ecology of villages' is not accepted. Hence, H1 is supported.

Table 7 Independent samples test of the degree of reaction to the structure of digital teaching material on cognition of the ecology of villages

		Levene's test for equality of variances		*t-test for equality of means*		
		F	*Sig.*	*T*	*df*	*Sig. (two-tailed)*
B21	Equal variances assumed	0.410	0.524	6.827	65	0.000
	Equal variances not assumed			6.714	54.625	0.000

Regarding the independent sample t-test of the degree of reaction to the structure of digital teaching material on cognition of the ecology of villages, the F value of the 'Levene's test for equality of variances' is.410, and significance = 0.524 > 0.05, which is insignificant. Therefore, the null hypothesis of the equality of variances is accepted. In the 'assumption of the equality of variances', the significance of the two-tailed test = 0.000 < 0.05. Therefore, the null hypothesis of the 'degree of reaction to the structure of digital teaching materials does not have significant difference on cognition of the ecology of villages' is not accepted. Thus, H2 is supported.

From the result, H1 and H2 are supported, which means that the introduction of digital teaching materials into the application of ecological education will indeed affect the students' attitude towards village ecological cognition, and the degree of influence varies with the degree of response to the textbook. Therefore, digital teaching materials have positive benefits for ecological education. Using technology acceptance model (TAM) to explain changes in students' attitudes can be traced back to the ease of use and

usefulness of digital teaching materials, which can improve students' positive learning attitude, and then Influencing willingness to learn (Weng et al., 2018).

6 Conclusions and suggestions

Agriculture is still the most important industry to maintain the sustainable assets of a country; therefore, the development of agriculture and biodiversity conservation are worthy of discussion. By conveying the story message of rural ecological cognition through words and pictures, it is easy for readers to become interested in the story and establish the concept of the important framework of ecological environment conservation. In terms of pest control, this illustrated storybook starts from the perspective of the agricultural ecosystem. By balancing the food chain relationship among organisms in the ecosystem, the damage caused by pests to crops was reduced. Mayer (2001) mentioned that digital teaching materials can integrate various digital elements in the design of teaching materials, and positive feedback can better stimulate students' interest and motivation in learning, due to the presentation of rich materials (Wang and Yu, 2020). The validation results support that the degrees of students' attitude toward using digital teaching material, and the structure of the digital teaching materials, have significant differences on cognition of the ecology of villages. H1 and H2 of this study are supported. With significant differences, students might have different behaviours regarding the ecology of villages.

There is a positive relationship between the behaviour of consuming green products and consumers' ecological knowledge (Lee and Wang, 2012). If digital teaching materials can transmit knowledge, there will be opportunities to change students' behaviour and increase their awareness of environmental protection. This e-book is presented in comic style, and the results of validation show that the e-book has a significant difference on the cognition of the ecology of villages. However, in order to demonstrate that comic teaching materials will actually influence cognition, follow-up studies are necessary. The extended research of this study is divided into the following two topics:

1 Enhancement effectiveness of comic digital teaching materials on the cognition of the ecology of villages.

2 Correlation between the comic digital teaching materials and learning effectiveness of the ecology of villages.

This teaching material aims to change students' cognition of the ecology of villages, which will allow students to be more actively concerned about rural issues and protect the environment, and thus, improve their environmental literacy.

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