Content Analysis of Mathematics Websites in Taiwan

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***Abstract*:** Taiwan is well known for her products of PC and PC related accessories, wisdom mobile phones, and internet peripherals. With the advance of internet technology and raise of popularity rate of internet use world wide, besides the e-commerce opportunities, websites can also serve as a good platform to develop a country's cultural and creative industries, given the fact that Taiwan's international assessment on mathematics ranked number one based on the results of PISA in 2006. This study combined the content analysis method and four virtual spaces of ICDT model to analyze mathematics websites in Taiwan. The findings showed that most math websites in Taiwan remained at the stage of providing information, and were less on communication, and rarely on trade and delivery services.

***Keywords*:** Content Analysis, Mathematics Websites, ICDT **.**

1. Introduction

Taiwan is well known for her products of PC and PC related accessories, wisdom mobile phones, and internet peripherals. With the advance of internet technology and the more affordable and portable tools, such as Eeepc, wisdom mobile phones, the number of internet users has dramatically raised in Taiwan and world wide in recent years. Below are some statistics reflecting such trend in Taiwan according to the government's reports. There are 14.46 millions of people above age 12 who are internet users in Taiwan; 70.9% of Taiwan's population use internet, and 80.7% of domestic households use internet in 2010 [1].

Taiwanese students have impressed the world for recent international assessments on mathematics. For instance, Taiwanese 15-year-old students ranked number one in mathematics in 2006 on Program for International Student Assessment (PISA), a test executed by the Organization for Economic Cooperation and Development (OECD). Given the facts above, it is interesting to learn how these two factors, in terms of mathematics and websites are integrated in Taiwan which plays the lead in the areas of PC technology and students' mathematics achievement. Thus, this study combined the content analysis method and four virtual spaces of ICDT model to analyze mathematics websites in Taiwan. In addition to the e-commerce opportunities, website design can serve as a good platform to develop a country's cultural and creative industries. The results of this study can provide the government, educational sectors, and the technology industries some advice for developing the soft power, in Taiwan and other countries as well.

2. Literature Review

2.1 Mathematics Websites

It is a trend to utilize website technology to study the learning effects of students in mathematics. There are 5 master's theses in Taiwan studying this subject matter and all found positive effects for students to learn mathematics by using the websites as a tool. Two studies investigated the junior high students, whereas the rest three studied the high school students [2-6]. The reasons were diverse, but mainly attributed to the merits of the design and technology of websites in terms of instant feedbacks, learner self-paced process, timeless constraints, vivid and diversified demonstrations and/or representations to boost the learners' motivation, attention, comprehension, and thus the learning effects lastly.

2.2 Content Analysis

Content analysis is a methodology which started in the field of social sciences for studying the content of communication. The sociologist, Earl Babbie [7] defined it as the study of recorded human communications, such as books, websites, paintings and laws. Ole Holsti [8] extended the use of such methodology beyond the original study in communication, and offered a broader definition of content analysis as a technique for making inferences by objectively and systematically identifying particular characteristics in the messages. Weber [9] defined content analysis as a methodology providing the procedures towards logical reasoning when analyzing texts or subject matters. Neuendorf [10] offered the most extensive definition for content analysis which included 6 parts. She stated in her book that "content analysis is a summarising, quantitative analysis of messages that relies on the scientific method (including attention to objectivity, inter-subjectivity, a priori design, reliability, validity, generalisability, replicability, and hypothesis testing) and is not limited as to the types of variables that may be measured or the context in which the messages are created or presented" (p. 10).

In summary, content analysis is a summarizing technique that relies on the scientific methods that can provide quantitative and qualitative information for the analyses. Thus, in this study the results of content analysis can help us understand the types and applications of technology for services, which thus can provide marketing strategies and decision makings for the development of cultural and creative industries.

2.3 Content Analysis of Websites

It has become popular to adopt content analysis as a method to analyze websites. There are many studies in Taiwan applied this method for various purposes which ranged from marketing, technology design to educational. The topics were quite diversified which included the comparisons of e-retail websites in Taiwan and China [11], floral e-commerce websites[12], digitized dimensions and layers of design of private museums, comparisons of leisure farms in Taiwan and China [13], travel websites [14] and educational websites [15-19].

However, the number of research on educational websites using content analysis method was comparatively scarce than other subjects, such as tourism or marketing. Only 5 studies in Taiwan investigating content analysis of educational websites of which subjects included elementary school websites[15], early childhood education[16], natural sciences [17], ideal English teaching [18], and mathematics [19]. There was only one study more related to content analysis of mathematics websites, nevertheless it did not directly analyze the mathematics websites. It focused on surveying the needs of teachers for an internet teaching resource center of mathematics. Therefore, it highlights the importance of this study—to analyze the content of mathematics websites in Taiwan.

2.4 ICDT

The ICDT model was developed by Albert Angehrn [20], which is a systematic approach to the analysis and classification of business-related Internet strategies. This model serves as a basis for identifying how existing products and services can be extended and/or redesigned in order to take advantage of the Internet, as well as suggesting how new goods and services become possible through this new medium.

This model makes the virtual market space into four areas. They are Virtual Information Space (VIS), Virtual Communication Space (VCS), Virtual Distribution Space (VDS), Virtual Transaction Space (VTS). Lueng [21] states that a firm's sustainability depends on the increase of its overall profitability, which can be achieved by increasing revenues or decreasing costs. The design and content of a firm's website can cause an impact on a firm's revenue change.

VIS offers the channels by which a firm can provide information about herself, the products, and the services. This area can allow global reach and the ability to provide rich information. VCS allows for a firm to exchange information with the various stakeholders in the business, i.e., suppliers, customers, and strategic allies. The information in the VIS is one way and more top-down, whereas communication in the VCS can be bi-directional and more mutual. The Internet has allowed for high-speed and low-cost communication, unhindered by physical and geographical constraints; e-mail, discussion groups, chat rooms, twitter are available and very convenient now. VTS is more than turning a firm's phone book into electronic version. It also includes ways of payment, security agreement, and customer services. VDS is a new distribution channel which a firm can quickly distribute the goods and services, especially those without a physical component, such as digitized media (e.g., books, music, software, games) and services (e.g., consulting, technical support, education).

The ICDT model can help analyze the current status of a firm's products and hence provide advice for future development and strategies to a firm.

3. Methodology

This study has reviewed the mathematics websites in Taiwan, compared the functions of current business websites, and then combined the results of the investigations with the ICDT model. The framework for the analysis of this study has been generated after synthesizing the data collected in the above mentioned procedures. As a result, the content framework of mathematics websites for the content analysis of this study is shown in Table 1.

3.1 Content Framework of Mathematics Websites

The VIS framework for mathematics websites combined the current functions of VIS with the concepts of *search* and *comparison* processes during the surfing procedure, and the *problem recognition* process during purchase decision procedure as well as the features of mathematics websites. As a result, it came up with this study's VIS which could be broken down into 4 parts. They included math website information, math website service, math teaching units, and teaching levels.

The VCS framework was based on the *examination* concept in the process of internet transactions. Examination means to examine or inspect the products that were on the shopping list of the customers. It consisted of two sections, members only and interaction. However, it requires the customers to register as members before they can read the basic information or to have any further inquiry of information on most mathematics websites.

The VTS framework was modified from the theory of three-stage internet transactions from the customers' perspectives, which were purchase determination, purchase consumption, and post-purchase interaction [22]. Yet, the procedures or stages were not necessarily linear; they could be coming back and forth. Many mathematics websites did not provide any commercial services, thus only commercial related websites were categorized in this section.

Lastly, the VDS framework included the last stage of the internet transactions which could be divided into two parts: delivery and return policy. The area of delivery was outdated with the advance of delivery business and competitions of global economy.

Table 1 Content Framework of Mathematics Websites

Virtual Space		Categorization Variables
VIS	Math Website Information	News, activities, websites of math department, educational websites
	Math Website Services	Teaching materials, games, tests, teaching videos, journal articles/ reports, links, math articles
	Math Teaching Units	Number and quantity, geometry, algebra, statistics and probability, time
	Teaching Levels	K to elementary school, elementary school, junior high school, high school, college
VCS	Members only	Join member, contact us, newsletter, shopping cart info, membership

		value-added services, membership discount
	Interaction	Discussion board, message board, visitor counts
VTS	Products and Service Information	Cram schools, advertisement info, publishers, commercial online classes
	Type of Payment	Online credit payment, money transfer, TEL/FAX
	Security Agreement	Privacy policy, account and password security, copy rights
	Services	Return and exchange policy, Q&A services, membership services
VDS	Delivery	Logistics distribution, post office, pick-ups at convenience stores
	Return Policy	Pick-ups at home, post office, return by other delivery companies

3.2 Sampling

This study used 227 mathematics websites from Taiwan for final analysis. The source of data came from two biggest internet search engines in Taiwan—Yahoo and Google with keywords of mathematics (teaching) websites. The data collection time was from June 15 to November 15, 2010. There were 62 pages of results from Google and 100 pages from Yahoo which had been searched. On each page had 10 websites, and 609 results from Google and 997 results from Yahoo, that is, the total number of 1606 results were collected and searched. After deleting the results which were dead, unrelated to math websites, repetitive, or with risk alert from Google first, the same screening procedures were applied to the results from Yahoo. Consequently, a result of 900 internet links was gathered, from which consisted of 227 websites from Taiwan.

3.3 Reliability

Neuendorf [10] suggests that when human coders are used in content analysis, reliability translates to inter-coder/ inter-rater reliability. In other words, it means the amount of agreement or correspondence among two or more coders.

Wang [23] suggests the reliability coefficient to be 80% for the standards of the Gerbner's cultural index in the content analysis of communication. Thus, the reliability coefficients in the range between 67-80% are acceptable, of which results should be carefully defined and explained. In general, the reliability coefficient should be greater than 85% to show that the encoding results of the inter-coders are acceptable and reliable.

The formula for content analysis is as below:

$$\text{Intercoder agreement} = \frac{2M}{N_1+N_2}$$

M is the number of total agreement,
N_1 is the agreement number of the first encoder
N_2 is the agreement number of the second encoder

$$\text{Reliability} = \frac{n * \text{Average Intercoder Agreement}}{1 + [(n-1)\text{Average Intercoder Agreement}]}$$

n is the number of encoders

There were two researchers who coded the websites based on the construct of the ICDT model. The results in Table 2 showed that the inter-rater agreement and reliability coefficient value of the Math websites in Taiwan was on average above .90. It means the results of the coding were reliable.

Table 2 Inter-rater Agreement and Reliability Coefficient Value of the Math Websites in Taiwan

Coefficient value / Constructs / Items	VIS	VCS	VTS	VDS
Inter-rater agreement	0.93	0.91	0.93	0.92
Reliability	0.96	0.95	0.96	0.96

4. Results

4.1 Analysis of VIS

The results of analysis of VIS showed that about 33.5% of Taiwan's math websites provided information for other educational websites. Math website service was the major function for Taiwan's math websites. Providing links to other resources came as the first (52.4%), and teaching materials (42.3%) as the second frequent function. Tests (32.2) and math articles (34.4) accounted for 1/3 of frequency. Games and teaching video were less frequent but still made up roughly 20 %. Journal articles and research reports was the least frequent. The reasons could be that journal articles were collected and linked to various data base. Therefore, the designer of the math websites in Taiwan did not provide such service. Such needs could be supplemented by the function of 'links'.

In other words, it seemed that the needs of getting teaching materials or information on education related issues, and/or even information on math articles could be more easily met than the other functions from the math websites in Taiwan. The rest two sections were related to teaching materials function. In addition, the math teaching units and levels were interrelated due to the system of national entrance examinations for high schools and colleges in Taiwan. The content of teaching units matched with the teaching levels in that these units were the core topics for the mathematics of the entrance examinations. As a result, it is not surprising to see that the percentage for the levels of junior high and high school was the same, 33.5%. The elementary school was a bit higher than junior high and high schools, 33.9%. This could be attributed to the fact that parents in Taiwan value education and consider math as an important subject for their children to be successful in moving up to higher education.

Time is a difficult topic for many children due to its abstract nature. We can measure time, but it is hard to really feel its existence. The trouble thing for children to learn time is the seemingly arbitrary units to be remembered and to convert. However, time as a teaching unit did not come as often on the math websites in Taiwan (11% only). This could be that time did not weigh as much as other topics for the examinations.

Surprisingly, the teaching level from kindergarten to

elementary (usually below the 2nd grade) existed only 1.3%. Hopefully it had nothing to do with the entrance examinations.

Table 3 Statistics of VIS Categorization of Math Websites in Taiwan

Categorization variables	Percentage	Taiwan (%)
Math Website Information	news	4.0%
	activities,	10.6%
	websites of math department	7.5%
	Educational websites	33.5%
Math Website Service	teaching materials	42.3%
	games	19.4%
	tests	32.2%
	teaching videos	19.4%
	journal articles/ reports	1.3%
	links	52.4%
	math articles	34.4%
Math Teaching Units	Number and quantity	23.8%
	geometry	26.0%
	algebra	20.7%
	statistics and probability	17.6%
	time	11.0%
Teaching Levels	K to elementary school	1.3%
	elementary school	33.9%
	junior high school	33.5%
	high school	33.5%
	college	16.7%

4.1 Analysis of VCS

The results of VCS showed that the functions of 'contact us' , 'join member' and 'message board' were the three most frequent functions on the math websites in Taiwan. However, the percentages did not exceed 20%. Shopping cart info, membership value-added services, membership discount, discussion board were less than 4%. The first three items were directly related to e-commerce and the low percentages suggested that this area of math websites in Taiwan can be further developed for VCS.

The differences between discussion board and message board were the directions of communication. Discussion board was more bi-directional; that is, back and forth discussions occurred in this section for the issues or questions posed. The level for the topics was usually more elaborated in discussion board. On the other hand, message board was usually for a quick or short question. Usually it was from parents to ask how to solve math problems or do math homework. The frequency for discussion board was only 1.8% when compared to 11.5% for message board.

Table 4 Statistics of VCS Categorization of Math Websites in Taiwan

Categorization variables	Percentage	Taiwan (%)
Members only	join member	12.8%
	contact us	18.1%
	newsletter	4.8%
	shopping cart info	3.5%
	membership value-added services	1.8%
	membership discount	1.8%
Interaction	discussion board	1.8%
	message board	11.5%
	visitor counts	11.5%

4.2 Analysis of VTS

Generally speaking, the percentage for the analysis of VTS was on average below 10%. The results suggested that most math websites in Taiwan still did not provide e-commerce services. In fact, on average only less than 4% of the math websites in Taiwan engaged with e-commerce services. On the other hand, it was quite interesting to see that, comparatively to the low percentage for the functions in VTS, almost 10% of the math websites provided credit card or money transfer services.

Table 5 Statistics of VTS Categorization of Math Websites in Taiwan

Categorization variables	Percentage	Taiwan (%)
Products and Service Information	cram schools	3.5%
	single ad info	1.3%
	publishers	0.4%
	commercial online classes	4.4%
Type of Payment	online credit payment	9.3%
	money transfer	9.3%
	TEL/FAX	7.9%
Security Agreement	privacy policy	4.4%
	account and password security	4.8%
	copy rights	5.3%
Customer Services	return and exchange policy	1.3%
	Q&A services	4.8%
	membership services	3.5%

4.3 Analysis of VDS

Due to the fact that the results of frequency of VTS were low due to not so many math websites in Taiwan engaged in e-commerce in this study, the results of analysis of VDS were not too different from those of VTS. In other words, when

there was less trade, then there would be less delivery and return of products.

Table 6 Statistics of VDS Categorization of Math Websites in Taiwan

Categorization variable	Percentage	Taiwan (%)
Delivery	Logistics distribution	1.8%
	post office	1.3%
	pick-ups at convenience stores	1.3%
Return Policy	Pick-ups at home	0.9%
	post office	0.4%
	return by other delivery companies	1.3%

5. Conclusions

The operational functions of math websites in Taiwan were unevenly distributed in the four sections of the ICDT model. The order was VIS, VCS, DTS, and VDS. Generally speaking, the math websites in Taiwan still remained in the stage of providing information and then more traditional way of communication. Information for math teaching materials, tests, and links to other related websites took up the major functions for VIS. Teaching units and teaching levels were interrelated which were strongly affected by the national junior high and high school entrance examinations. Games and teaching videos were only nearly 20% of the functions. Only 1.3% of the function was for the level of kindergarten to elementary children. These three areas can be further developed for e-commerce, given the fact that education, particularly math education is what Taiwanese parents are willing to invest for their children. This is a cultural value that website designers, Internet Company should keep in mind.

The functions for VCS dropped to less than 20%. Some of them were even less than 2%, such as membership discount, membership value-added services, and discussion board. Furthermore, the results of VTS were even lower. Online math commercial websites only consisted of less than 5%. Consequently, it is needless to say the even lower number for the VDS because of low VTS percentage.

Overall, this corresponds with comments Lueng [21] made a decade ago. He stated that with the new internet technology, "this new communication channel can be used for lobbying, influencing opinions, negotiating potential collaborations, and the creation of communities. However, in most organizations, this is an undeveloped area".

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