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International Journal of Multimedia Art, Design and Education

Prof. Siu-Tsen Shen

Editor-in-Chief

A warm welcome to the fourth edition of the International Journal of Multimedia Art, Design and Education (MADE), an open-access resource dedicated to publishing high quality, peer-reviewed research papers in all areas of design research.

The recent invasion of the Ukraine by Russia has focussed the world's attention on the subject of global shortages of Oil, Gas and Food, with the resulting impact of stagflation.¹ Rising food prices and inflation has pushed families to the brink.²

This is not a new issue, and has been gaining ground due, in some respects, to the recovery from the COVID-19 crisis which engulfed the world for the last two years.

In a rather bizarre twist of fate, Putin's actions in 'defence' of Russia has pushed more countries to join NATO and has arguably made the Russian economy tank.

The war is not going to plan, but the impact of it is affecting a large percentage of the world's population – particularly the EU and surrounding nations. The war has focussed the minds to the reliance on Oil and Gas supplies from Russia, and has had a bigger effect on countries such as Germany, which is heavily dependent on Russian gas.

The bigger question will be whether Russia is ultimately defeated in the Ukraine and how the Western world weans itself off of using fossil fuels, towards cleaner, greener energy sources – many see this is the positive to take away from this man-made disaster.

Our Editorial Board consists of leading design researchers and practitioners from all over the world, all of whom have proved willing to contribute their valuable time to the development of this new journal. To reach the widest possible audience, the journal will be published both online and in print. The online version will be open access, freely available for anyone, anywhere to download, read, distribute, and use, with proper attribution of authorship, for any non-commercial purpose. A printed version of the journal will also be available at cost.

The journal aims to provide an international forum for exchange of ideas and findings from researchers across different cultures, by encouraging research on the impact of cultural factors on design theory and practice. The journal also seeks to promote the transfer of knowledge between professionals in academia and industry. To help make our vision a reality, we invite you to submit your best work to the MADE Journal and to encourage your colleagues to do the same.

In these turbulent times, we all have a responsibility to use design tools to boost economic growth and provide opportunities to the younger generation. These are our future leaders, and together we can overcome the current challenges of Covid-19, recession and geo-political tensions in the world.

Acknowledgements

The fourth issue of MADE was only possible due to the hard work of the three contributors. Each of the contributors went through an extensive revision/review

process, which resulted in works of excellent quality. The reviewers in the various disciplines spent countless hours on top of their already busy schedules to ensure the works included are of the highest quality. The MADE executive committee not only had the goal of creating this journal, but also served a large role in determining the initial format and general guidelines for the journal. They had online meetings to discuss deadlines, submission, and their careful consideration helped the editorial board avoid a number of pitfalls we could have encountered with this issue. They were also charged with the difficult task of selecting the cover design from an impressive set of submissions. I also need to acknowledge the work of Assisting managing editor, Zhi-Xing Dai, who spent hours discussing policies, formatting, and any other number of other details about the journal with me.

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Prof. Siu-Tsen Shen

June 2022

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A Study on the Overall Satisfaction of an Online Assisted Learning Platform — A Case Study of Mainland Chinese Students in Taiwan

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With the rapid development of information and communications technology (ICT) today, the traditional education model is far from being able to meet the learning needs of students at this stage. In the midst of the global outbreak of the novel coronavirus (COVID-19), about 7,000 mainland students based in Taiwan were unable to return to Taiwan to study in a physical setting. In order to protect students' rights to education, Taiwan's universities and colleges set up online learning platforms for those who could not return to Taiwan. This study focuses on Microsoft Teams and Zoom, the two mainstream online teaching platforms used during the epidemic, to understand the overall effectiveness and satisfaction of online learning platforms among the mainland students studying in Taiwan during the epidemic. This study provides suggestions and recommendations for future online teaching and learning platforms.

In this study, we conducted in-depth interviews with students and teachers of the two software programs and compiled the key points to create a questionnaire. 325 valid questionnaires were collected. There is no significant difference in the satisfaction level of students' professional attributes with the online learning platforms.

Keywords – Online Assisted Learning Platform, Satisfaction Study, Students from Mainland China
 , COVID-19, Teams, Zoom.

Relevance to Design Practice – This study examines the overall effectiveness and satisfaction of students' online learning platforms, and the results are useful for suggesting appropriate online learning methods for students in an epidemic.

Introduction

General Background Information

The novel coronavirus (COVID-19) outbreak in Wuhan, China, in December 2019 has changed the way people live. As of June 21, www.madejournal.uk

2020, more than 8.8 million people worldwide have been infected with the novel coronavirus, with a cumulative death toll of more than 465,000 (SCCE, 2020), and according to UNESCO statistics as of June 19, 2020, more than 1 billion students worldwide have been

affected by the outbreak as countries have declared city and country closures. In 123 countries or regions, schools have been closed or partially closed. Students affected by the epidemic have been taking online learning courses at home that are "postponed, not delayed, and closed. The Ministry of Education of Taiwan (MOE) stated in 2019 that the effective use of digital technology and online media for personalized learning and adaptive teaching should be used to enhance students' learning effectiveness and independent learning (MOE, 2019), and it is especially important to actively explore more effective online teaching models.

Research Purpose

According to Kenneth C. Green (2019) in The Campus Computing Project (CCP) more than seventy percent (77%) of U.S. schools are using digital learning platforms (LMS) and 94% of users believe that the use of digital learning platforms has greatly improved student learning outcomes and are satisfied with the digital learning platforms. In contrast, in Taiwan, in 2019, the number of students using the LMS is expected to increase to 3.5 million. In contrast, in Taiwan, the 2019 Taiwan Tertiary Information Unit Organization and Funding Rationalization Survey reported that although 93.7% of schools use a digital learning platform, the overall satisfaction rate with the LMS is only 46.3%. With such a high usage rate, it is worthwhile for researchers to consider how to increase students' recognition and satisfaction of the e-learning platform. However, at this stage, no research has been conducted on the usage and satisfaction of existing LMS and online learning platforms

during the epidemic.

Therefore, this study examines the overall effectiveness and satisfaction of the online learning platform of mainland students currently studying in Taiwan in the context of the novel coronavirus (COVID-19), hoping to help teachers and students respond positively to the use of the online teaching platform in the future when the same situation occurs.

Literature Review

This paper contains the following four parts:

I. Definition of the Learning Management System, II. Ways to Enhance Learning Effectiveness, III. Elements of Online Teaching Design and Usage, and IV. Summary of Literature.

Definition of the Learning Management System

A Learning Management System (LMS), also known as an e-Learning system, is an efficient information-based training management model that provides electronic learning and teaching activities through digital methods such as computers and networks. In addition to providing online training and teaching management, the LMS can also provide an online learning platform for employees of enterprises and institutions, through which students can learn electronic courses, take online exams, and exchange and share learning experiences.

A learning management system is a software application or Internet-based

technology that is used to plan, implement, and estimate a specific learning process. Typically, a learning management system provides a tutor who is used to create and publish content, monitor student participation, and evaluate student performance. A learning management system also provides students with the ability to use interactive features such as threaded discussions, video conferencing, and forums. The Advanced Distance Learning Group, sponsored by the U.S. Department of Defense, has created a set of specifications called the Sharable Content Object Reference Model (SCORM) to encourage standardization of learning management systems.

In the 1970s, the concept of Computer-Aided Instruction (CAI) was developed, and digital learning systems with limited interaction gradually emerged; in the 1980s, audio and video were added and developed into multimedia teaching software. In the 1990s, with the popularity of personal computers and the Internet, e-learning gradually moved from stand-alone computers to the Internet, making it possible to learn, discuss with others, and pay for assignments through the Internet. In the 21st century, with the rapid development of electronic technology, technological breakthroughs have made the digital network learning environment increasingly mature, creating a digital learning environment that emphasizes interactive and multimedia digital learning, forming a wave of networked digital learning.

For traditional teaching, the learning management system is after all only a

supplementary means of knowledge learning and a supplementary way of learning, and cannot completely negate and replace the traditional classroom teaching mode. The ideal state is an organic combination of the two rather than an inversion. This is how the blended learning model was born. With the use of computers or mobile phones, blended learning can better facilitate the sharing of resources, communication and information transfer between teachers and students at different times (Chee Keong Chin, Hairiah Munip 2019). Traditional learning is a "teacher-centered" learning approach where students passively absorb knowledge and the teacher and students must be present at the same time and in the same environment to transfer knowledge; while digital learning is a "student-centered" learning approach where students actively learn and the teacher guides them to learn, using group or community-based group learning, allowing students to learn freely without time and space constraints.

Learning effectiveness enhancement approach

The improvement of learning outcomes is closely related to students' motivation and their own learning strategies. The purpose of measuring effectiveness is to enable students to understand their own learning and to serve as a basis for teachers to improve their teaching and students to improve their learning (Guay, Ratelle, & Chanal, 2008).

Motivation for learning

Motivation is a motivational tendency that
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guides and sustains students' learning behaviour and leads to certain academic goals. It consists of two components, learning needs and learning expectations, and can be classified into different categories according to different criteria. Different psychologists have interpreted learning motivation from different perspectives, mainly including reinforcement theory, attribution theory, hierarchy of needs theory, achievement motivation theory, self-worth theory, self-efficacy theory, etc. The main strategies to stimulate and develop motivation are to use inspirational teaching, control the level of motivation, give appropriate assessment, maintain motivation, and handle competition and cooperation properly. Motivation for learning is an important key to the success or failure of learning and is significant to learners (Lee, 2017). Since learning is a process in which learners actively construct knowledge, motivation for learning plays an important role in enhancing the effectiveness of learning (Wu, 2018). It is especially important for teachers to motivate students to learn in their daily teaching.

Learning strategies

There are four main categories of learning strategy characteristics: initiative, effectiveness, process, and procedure. Proactivity is a conscious mental process by which learners generally adopt learning strategies. When learning, learners first analyze the learning task and their own characteristics, and then, based on these conditions, develop an appropriate learning plan to learn actively. Effectiveness is the effectiveness and efficiency of learning. For example, if a list of English words is memorized

and read aloud over and over again, it will eventually be remembered given enough time. However, the retention time will not be long and the memory will not be very strong; if the mind mapping method is used, the effectiveness and efficiency of memory will be greatly improved at once (Wen, Kai, 2019). What to do and what not to do, what to do first and what to do later, how to do it, and how far to do it are called the process of learning. The so-called procedural nature requires learners to develop corresponding learning plans and methods. In a study conducted by Bing-Lin Cheng and Ching-Shan Lin (2002), they pointed out that learning strategies refer to the ways in which individuals set up their own learning processes in order to achieve their learning goals. Learning strategies have a positive effect on learning effectiveness, i.e., if certain learning strategies, such as cognitive strategies and postulated cognitive strategies, are adopted in the learning process, the more effective an individual's learning will be.

Online Teaching Design Elements and Usage

The construction of a learning management system should follow the three principles of usability in interaction design (IKD): ease of learning, flexibility, and robustness (McCarthy, J.C, 1993) and the four dimensions of interaction design language: text, visual representation, physical object or space, and time (Bill Moggridge, 2006). Lin, Shiang-Lin (2015): e-Learning platforms are mediated by information technology and consist of many heterogeneous learning modules, such as test

scoring modules and learning interaction modules, which provide a more flexible learning environment for instructors and learners. Currently, common learning management systems include discussion forums, assessment systems, learning history tracking, community functions, etc. Scholars have provided the following views on their functions.

1. Discussion forum:

the studies by L.P. Chang (2016), Can Cui (2017) and Jian Gao (2017) point out that setting up a discussion forum in a learning system can increase interaction between teachers and students, enhance the motivation and effectiveness of learning, and also relate to the pooling and creation of knowledge within the community, which has an important impact on the establishment of online communities.

2. Assessment system:

The study by Shuhui Zhang (2019) suggests that teachers can use an assessment test system to help identify students' learning problems in real time and provide guidance and encouragement. Leung Yau-shing (2017) also proposed an interactive online game assessment system to assess the game assignments developed by students online.

3. Learning history tracking:

Learning history tracking is not only to understand students' behavior and analyze it, but more importantly, it can be used for teachers' future curriculum planning. In the learning history system created by Chung (2017), the

teacher panel allows the teacher to understand the current status of students' answers; the student panel allows students to know their current learning status of the tracking system.

4. Community function:

In a study on learning guidance strategies based on mobile social networks, Chen, Shih-Yeh (2016) pointed out that, based on mobile learning theory to build an online learning environment, on the one hand, one can share one's own learning results through the online mobile learning system and provide peer observation of learning results; on the other hand, through observing and sharing each other's concept maps to continuously trigger learners' learning This allows learners to choose the appropriate learning direction and pace according to their own learning status and progress, and to interact with peers to avoid bottlenecks in their own learning.

According to the information from the Association of University Colleges and Schools for Admission of Mainland Students, there are 123 schools in Taiwan that admit Mainland students to study in Taiwan. According to the top 20 universities in terms of the proportion of Mainland students use LMS software (as shown in Table 1), since Google Meet can only be used in Mainland China with a VPN, it is estimated that the mainstream online learning platforms used by Mainland students are: Microsoft Teams and Zoom which are the two main software learning methods.

Table 1. Software use in the top 20 universities in terms of the proportion of mainland Chinese students.

<i>University</i>	<i>Microsoft Teams</i>	<i>Zoom</i>	<i>Virtual</i>	<i>Google Meet</i>	<i>WM5</i>	<i>Moodle</i>	<i>Adobe connect</i>	<i>WeChat</i>	<i>I-Learning</i>
<i>National Taipei University</i>	○								
<i>National Taiwan University of Arts</i>	○								
<i>Tamkang University</i>	○								
<i>Fu Jen Catholic University</i>	○	○							
<i>Chinese Culture University</i>	○								
<i>Shih Hsin University</i>		○	○						
<i>Soochow University</i>	○	○							
<i>National Chengchi University</i>		○			○	○			
<i>National Taipei University of Technology</i>	○	○		○					
<i>Taipei National University of the Arts</i>	○								
<i>National Taiwan University</i>	○			○					
<i>National Taiwan University of Science and Technology</i>						○			
<i>National Taiwan Normal University</i>		○				○			
<i>Shih Chien University</i>	○			○			○		
<i>Ming Chuan University</i>	○					○		○	
<i>Chung Yuan Christian University</i>	○								
<i>National Central University</i>	○			○			○		
<i>National Yang Ming Chiao Tung University</i>	○	○		○					
<i>National Tsing Hua University</i>	○	○		○					
TUNGHAI UNIVERSITY									○
<i>National Chung Hsing University</i>									○
<i>Feng Chia University</i>	○								
<i>National Cheng Kung University</i>	○	○				○			
<i>National Sun Yat-sen University</i>	○			○			○		
Sum Total	18	9	1	7	1	5	3	1	2

In 2019, Lin Jianhuan relied on Zoom, currently the most consistently used distance learning classroom platform, and after a year of teaching design and experimentation, surveyed 13 distance learning intermediate Chinese language learners and found that the Zoom distance learning approach also allowed students to interact online and was no less effective in terms of phonetics, vocabulary, grammar, and writing than teaching in a physical setting. Zaid Almarzooq, et al. also used Microsoft Teams to teach 20 graduate students in an online platform during the New Pneumonia epidemic. The results show that Microsoft Teams can be used for real-time chat, article sharing, and meeting cloud recording.

Research methodology

Based on the above analysis, mainland students need to conduct video interviews on their experiences and effectiveness of using Microsoft Teams and Zoom software respectively, and then coding and subsequent development of corresponding questionnaires based on the key points of the interviews.

Pre-interview

In this study, two respondents were selected: one teacher (P1, an authoritative expert in online teaching software use in Taiwan) and one student (P2, a land student at Fu Jen Catholic University), and the mainstream online learning platforms (Zoom "A1" and Microsoft Teams "A2") were used as the main research carriers in the interviews. The interview outline was organized as shown in Table 2.

Table 2. Outline of the Interview.

<i>Variables</i>	<i>Question</i>
Software usage experience (Q1)	1. What is the software you use more often? Why?
	2. What do you think are the advantages and disadvantages of this software compared to other software?
	3. Do you have any inconvenience in using the two software? How did you solve them?
	4. What features do you recommend in developing similar online teaching/learning platforms in the future?

Effectiveness of software
use (Q2)

1. What do you think are the advantages and disadvantages of online teaching software compared to offline teaching mode? Is there any difference in the effectiveness of classroom interaction?
2. Which do you think is more time-consuming in terms of teaching/learning time, the online or offline teaching mode? Why?
3. Do you think the use of online teaching/learning mode has any impact on students' academic performance? Is there any assessment to verify? What are the results?
4. What do you think about students turning off their cameras? How can the teachers ensure the attendance of students?

Hypothesis Formulation and Questionnaire Design

Through the collation of highlights from the pre-interviews (as shown in Appendix I), the following four types of hypotheses are proposed.

T1: Student online 'learning outcomes' correlate significantly with online course 'classroom experience'.

T2: Student online 'learning outcomes' correlate significantly with online course 'student autonomy'.

T3: Student online 'learning outcomes' correlate significantly with online course 'teacher readiness'.

T4: Student online 'learning outcomes' correlate significantly with online course 'overall platform status'.

According to the proposed hypothesis, the questionnaire not only considered the basic

"gender", but also added students' "professional attributes" and "software usage". The questions were based on the following categories: Class A: "Course progress", "Classroom interactivity", "Classroom atmosphere", Class B: "Learning attitude", "Class completion rate", "Fairness of examinations", Class C: "Teacher proficiency", "Teacher courseware preparation", and Class D: "Platform functionality", "Platform stability", "Platform quality and clarity" to understand the overall satisfaction of students with the current online learning mode.

Analytical approach

In this study, the collected questionnaire data were entered into an electronic spreadsheet (Excel) and analyzed using SPSS statistical software for "questionnaire reliability", "gender", "professional affiliation", and "software usage" as well as descriptive analysis.

Results and Discussion

Analysis of sample data

In this study, a total of 342 questionnaires were distributed to Mainland students coming to Taiwan, of which 325 were valid (17 were invalid). As shown in Table 3, the most popular

majors were management (24.31%), art (19.38%), and engineering (13.85%). From the perspective of software usage, at this stage, Microsoft Teams accounted for 82.46%, Zoom for 9.85%, and other categories for 7.69% (Wechat live streaming was the main category among other categories).

Table 3. Analysis of sample background information (N=325)

<i>Background Variables</i>	<i>Category</i>	<i>Sample number (N)</i>	<i>Effective percentage</i>
gender	male	134	41.23%
	women	191	58.77%
Professional Attributes	Philosophy	7	2.25%
	Economics	24	7.38%
	jurisprudence	4	1.23%
	Pedagogy	31	9.54%
	literature	28	8.62%
	History	12	3.69%
	science	32	9.85%
	Engineering	45	13.85%
	Management Studies	79	24.31%
	Art	63	19.38%

Software Usage	Microsoft	268	82.46%
	Teams		
	Zoom	32	9.85%
	other	25	7.69%

Credibility analysis

Reliability is an indicator of the degree of truthfulness of the characteristics being measured, based on the consistency or stability of the results obtained from the test instrument. The confidence coefficient is used to indicate the magnitude of the confidence. The larger the confidence coefficient, the greater the degree of reliability of the measurement, 0.60~0.65 (best not to), 0.65~0.70 (minimum acceptable value), 0.70~0.80 (quite good), 0.80~0.90 (very good).

This questionnaire was used to investigate the satisfaction of Mainland Chinese students studying in Taiwan with the effectiveness of using the online learning platform through a four-item hypothesis and the focus of the preliminary interviews. The results are shown in Table 4, which shows that the four reliability scales of "classroom experience", "student autonomy", "teacher preparation", and "overall situation of the platform" are all very good.

Table 4: Analysis of Cronbach's alpha coefficient of the questionnaire.

<i>scale vector</i>	<i>Corresponding Title</i>	<i>Cronbach alpha coefficient</i>
Classroom Experience	4, 5, 6	.880
Student autonomy	7, 8, 9	.827
Teacher Preparation	10, 11	.868
Overall situation of the Platform	12, 13, 14	.871

Descriptive analysis

According to the analysis of the descriptive statistics in Table 5, for the 325 respondents, J. of Multimedia Art, Design and Education, Vol.2 No. 2, 2022

lesson progress (AVG: 4.54) was higher than classroom interactivity (AVG: 3.12) and classroom atmosphere (AVG: 3.17) in "classroom experience". "For 'student autonomy', the completion rate (AVG: 3.58) was higher than the learning attitude (AVG: 3.34) and fairness of the examination (AVG: 3.46). In

'Teacher Readiness', classroom courseware readiness (AVG: 3.72) was higher than classroom proficiency (AVG: 3.55). In "Overall Platform Condition," platform functionality (AVG: 3.51) was higher than platform stability (AVG: 3.33) and platform picture clarity (AVG: 3.36).

Table 5: Results of descriptive statistical analysis (N=325).

<i>Measuring the composition</i>	<i>Measurement Questions</i>	<i>minimum value</i>	<i>maximum value</i>	<i>average value</i>	<i>Standard deviation</i>
Classroom Experience	Course Progress	1	5	3.54	1.067
	Classroom Interactivity	1	5	3.12	1.075
	Classroom Atmosphere	1	5	3.17	1.113
Student autonomy	Learning Attitude	1	5	3.34	1.002
	Course Completion Rate	3	5	3.58	1.017
	Fairness of examinations	1	5	3.46	1.087
Teacher Preparation	Instructor Proficiency	1	5	3.55	1.034
	Teacher's preparation of courseware	1	5	3.72	0.995
Overall situation of the Platform	Platform functionality	1	5	3.51	1.008
	Platform stability	1	5	3.33	1.083
	Platform picture quality clarity	1	5	3.36	1.096

ANOVA analysis

Based on the descriptive statistics, ANOVA analysis was conducted again to investigate whether there were significant differences between the four major attributes on the above-mentioned dimensions of "classroom experience", "student autonomy", "teacher readiness" and "overall platform situation". The

results of the study showed that the 11 items of the four major components did not differ significantly ($P > 0.05$) from the professional attributes, but the classroom atmosphere ($P: 0.089$) and learning attitude ($P: 0.095$) were closer to the standard values of significant differences, as shown in Table 6.

Table 6: Results of ANOVA data analysis (N=325)

	Professional attributes (mean \pm standard deviation)										F	P
	Philosophy (n=2)	Economics (n=7)	Jurisprudence (n=4)	Pedagogy (n=31)	Literature (n=28)	Historiography (n=12)	Science (n=32)	Engineering (n=45)	Management (n=79)	Art (n=63)		
Course Progress	3.71 \pm 1.11	3.75 \pm 0.94	3.75 \pm 0.96	3.42 \pm 0.99	3.89 \pm 0.88	4.17 \pm 0.94	3.72 \pm 1.05	3.44 \pm 1.06	3.41 \pm 1.14	3.38 \pm 1.13	1.439	0.170
Classroom Interactivity	2.71 \pm 0.76	3.04 \pm 1.43	3.75 \pm 0.96	3.10 \pm 1.14	3.46 \pm 0.88	3.92 \pm 1.00	3.19 \pm 1.12	3.00 \pm 1.04	3.06 \pm 1.04	2.98 \pm 1.01	1.568	0.124
Classroom Atmosphere	3.00 \pm 0.82	2.92 \pm 1.38	3.75 \pm 0.96	3.10 \pm 1.22	3.50 \pm 0.84	4.08 \pm 0.79	3.16 \pm 1.19	2.96 \pm 1.09	3.13 \pm 1.09	3.16 \pm 1.08	1.697	0.089
Learning Attitude	2.86 \pm 0.69	3.38 \pm 1.01	3.50 \pm 1.29	3.32 \pm 0.98	3.75 \pm 0.80	4.08 \pm 0.79	3.25 \pm 1.11	3.29 \pm 1.10	3.22 \pm 0.94	3.30 \pm 1.03	1.671	0.095
Course Completion Rate	3.14 \pm 0.69	3.83 \pm 0.96	3.75 \pm 0.96	3.55 \pm 1.03	3.71 \pm 0.81	3.92 \pm 1.00	3.72 \pm 1.05	3.31 \pm 1.14	3.38 \pm 1.04	3.78 \pm 0.96	1.57	0.123
Fairness of examinations	3.29 \pm 0.49	3.54 \pm 1.10	3.75 \pm 0.96	3.32 \pm 1.05	3.79 \pm 0.99	4.00 \pm 0.95	3.38 \pm 1.16	3.38 \pm 1.15	3.27 \pm 1.05	3.62 \pm 1.16	1.217	0.284
Instructor Proficiency	3.71 \pm 0.49	3.79 \pm 1.06	3.75 \pm 0.96	3.45 \pm 0.93	3.64 \pm 1.06	4.00 \pm 0.95	3.72 \pm 0.99	3.44 \pm 1.03	3.41 \pm 1.07	3.54 \pm 1.10	0.806	0.611
Teacher's preparation of courseware	3.86 \pm 0.69	3.88 \pm 0.99	4.25 \pm 0.50	3.61 \pm 0.95	3.79 \pm 0.96	4.08 \pm 0.90	3.84 \pm 0.88	3.58 \pm 0.99	3.54 \pm 1.05	3.84 \pm 1.08	0.97	0.465
Platform functionality	3.29 \pm 1.11	3.54 \pm 1.10	4.00 \pm 0.82	3.45 \pm 1.03	3.82 \pm 0.67	3.92 \pm 0.90	3.56 \pm 1.13	3.27 \pm 0.96	3.38 \pm 1.02	3.62 \pm 1.04	1.208	0.289
Platform Stability	3.14 \pm 1.07	3.21 \pm 1.38	4.00 \pm 0.82	3.29 \pm 1.19	3.43 \pm 0.96	3.58 \pm 1.08	3.31 \pm 1.23	3.18 \pm 1.11	3.25 \pm 1.04	3.49 \pm 0.93	0.625	0.776
Platform picture quality clarity	3.14 \pm 1.35	3.46 \pm 1.14	4.00 \pm 0.82	3.32 \pm 1.08	3.61 \pm 0.88	3.67 \pm 1.15	3.44 \pm 1.22	3.13 \pm 1.16	3.27 \pm 1.09	3.41 \pm 1.06	0.778	0.637

* $p < 0.05$ ** $p < 0.01$

Conclusion and Suggestions

Conclusion

Overall, the data presented in this study are only about the overall satisfaction level of online learning platforms for students coming to Taiwan from mainland China during the novel coronavirus (COVID-19) epidemic, and do not reflect the overall situation of students worldwide. From the interview data, we can see that in order to protect students' right to education during the epidemic, teachers actively provided online learning methods for students who could not go to the physical school. From the teachers' point of view, the satisfaction level of using the online teaching platform is related to the type of subjects taught, with theoretical courses having less impact, but practical courses having more impact. Similarly, as students, students in practical courses spend a lot of time watching videos recorded by teachers and discussing with teachers after class. For the assessment of grades, teachers usually use a variety of methods for comprehensive assessment, such as using the usual attendance rate and the number of questions answered to determine the usual grade, and at the end of the midterm period, the camera is opened, key data is modified, and the order of questions is changed to prevent cheating among students.

From the 342 questionnaire data, it can be seen that the software used more often by mainland students in Taiwan is "Microsoft Teams", accounting for 82.46%. The highest satisfaction level of students with the online

learning method is "teacher's preparation of courseware" (AVG: 3.72), which indicates that the epidemic stage, as the teacher side can well protect the teaching rights of online students. The lowest overall satisfaction rating was for "classroom interactivity" (AVG: 3.12), which means that compared to traditional venues, the classroom interactivity of online learning is far from satisfying students' needs for classroom interaction. However, the classroom atmosphere (P: 0.089) and learning attitude (P: 0.095) in "classroom experience" and "student autonomy" were closer to the standard value of significant difference, which means that there are still some differences in classroom atmosphere and learning attitude among different majors.

Practical proposals

The following are some practical suggestions for students' overall satisfaction with online learning platforms during this epidemic.

1. This study only investigated the satisfaction level of online learning platforms among students from Mainland China who came to Taiwan, and its data has some limitations. In the future, it is suggested that relevant studies should take global students as the target population to understand the overall satisfaction level of online learning platforms among global students during the epidemic.

2. The results of this study show that the satisfaction scores in classroom interaction and classroom atmosphere are low, and it is recommended that both teachers and software development platforms should focus on how to

improve the interactivity of the online learning platform and the learning atmosphere in the classroom for students.

3. The stability of the online learning platform is also a concern for the students, and the overall student evaluation is low. Based on the results of the interviews, this study suggests that software developers should increase the amount of bandwidth and software users should ensure the stability of their own networks.

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Appendix

Appendix I: Organizing interview highlights

<i>Interviewees</i>	<i>Highlights</i>
	<p>Zoom and Teams are both online live streaming tools, but Teams is Microsoft's O365 platform, but it does not have as many features as Zoom, so I personally prefer Zoom, such as background beautification, bokeh and beauty functions, and it is more convenient to put the prepared textbook pictures or videos on your background for students to understand. The second is to control the permission. The second one is to control the permission. When all students come in, the teacher can lock the meeting and students can't come in and out freely. In the case of Teams, it is possible to enter and exit freely, and students need to join the discussion group at the first lesson in order to watch it, which is not very convenient for spectators. In terms of stability, the sound quality and picture quality of Zoom is better than that of Teams, and the smoothness of Zoom is better than that of Teams for a class of 70 students.</p>
P1	<p>In the future, we hope to add the Ris (remote real-time interaction) function, so that students can directly share their homework and fill out questionnaires with the teacher during the class, instead of using another device to jump to another platform to complete it as it is now.</p> <p>3. Since I have more courses on information software operation, there are good and bad things about the online teaching mode. The advantage is that the teacher can teach smoothly and not be dragged by the students' progress at the moment, so that they can master the pace of the lesson well. The disadvantage is that it is not clear how well the students are learning, so it is necessary to find a separate assessment method. As a student, you can watch the video after the lesson to deepen your understanding of the areas you do not understand.</p> <p>4. Since this is a practical course, a quiz will be given at the end of the class, and the feedback is not much different from that of the physical field. The difference is that in the discussion sessions,</p>

you may not have the opportunity to discuss and interact in a similar way as in the workshop, and you can only listen to the teacher unilaterally.

The preparation time is about the same for the materials. The only difference is that online teaching requires more detailed teaching points, and students need to be asked from time to time if they understand the lesson, which will take more time than offline teaching, and the other difference is that the chance of replying to students will be higher online, which means practicing on their own. The advantage of the online course is that it will take more time to collide and test, and there will be more questions and more interaction. The physical course is to call the teacher if you don't understand, and let the teacher come directly, not to think.

Because of the bandwidth problem, the student camera is turned off during the class, and the students will interfere with the teacher if the camera is turned on, and the students will look at each other, which will lead to distraction. The only thing that will be done is to turn on the camera during the roll call, and then cut the picture.

As a student, the network stability of Teams will be more smooth and stable. In terms of functionality, I like Zoom because there are a lot of professional group discussions, and when I am in a large class, I can use Zoom to divide into many groups for discussion. There is no inconvenience in using Zoom. The Zoom server is in the United States, so American friends prefer Zoom, but we are currently in China, which is quite cross-server, so we prefer Teams in terms of stability.

P2

The teacher will use different software to send things. both Zoom and Teams have the function of raising hands.

Online courses are far worse than offline courses in terms of interaction, online is not as good as offline, online teaching is easy to lose patience with the teacher, it is difficult to Focus teacher,

our profession has a lot of group discussions, online can not face to face will be a waste of time, will produce a lot of misunderstanding.

4. The online course will take longer. Every minute of the offline discussion will discuss the main points, but in the online course I can lie in bed and so on to discuss and learn, which will waste a lot of time. It is better to do the homework or think about the problem after the class, because the teacher will teach more and absorb more.

5. Regarding the assessment, our course is very interesting. The teacher will assess the performance of individuals, their participation in class, attendance rate, whether they ask questions, whether they mention good questions, whether they answer questions, whether they give presentations, exams and finance courses, and the teacher will let students give presentations for assessment. There is a lot of water in the online exams. The teacher will open up the test between them, as long as they can find it. But the way it works is that you are given very little time to do a lot of questions. The finance teacher has to open the camera when answering the paper, but it does not affect the students to share their answers. It is still up to the individual, many questions on the Internet or can not find the answer, such as finance questions teachers will change the data, students have to calculate themselves. Smart people use excel to do data, you can get the answer in one click. The smart ones will do the hand calculations step by step and then enter it into the horizontal line.

Most of the time, the teacher will let the students turn off their cameras unless the teacher asks them to do so. Except for a few active students. The camera will be turned on during the lecture and will be more respectful. Most teachers will not take roll call. Teachers will take roll call 20 minutes before class starts. Different teachers have different methods. The finance teacher will take roll at the beginning of class and ask each person to speak at least once a day, whether it is to ask questions or answer them, and the attendance rate will be recorded, because the data will let you talk about the solution to the problem.

7. On top of handing in assignments, the school has its own online learning website, and exams are handed in on that system so that teachers can grade them. The exam will be combined with a video on teams, and the exam will be taken on the website.

Appendix II: Questionnaire development

Online Learning Platform Usage Satisfaction Survey Questionnaire

Hello! I am a graduate student at Fu Jen Catholic University. First of all, I sincerely ask you to take your precious time out of your busy schedule to complete this survey! The novel coronavirus (COVID-19) is now sweeping the world. As of June 19, about 1.1 billion students worldwide are unable to attend school for physical learning, and countries are adopting online teaching mode. The purpose of this survey is to understand the overall effectiveness and satisfaction of online learning platforms among students worldwide in the midst of the epidemic, and to provide valuable insights into online learning platforms.

This questionnaire is anonymous and all data will be used for statistical analysis only, so please feel free to fill it out and thank you for your help!

(i) Basic information

1. Your gender [Multiple choice]*

Male

female

Other

2. What is your current major? [Single-choice]*

- Philosophy
- Economics
- Jurisprudence
- Pedagogy
- Literature
- History
- theory
- Engineering
- Management
Studies
- Art Studies
- Other _____*

3. What is the main software you currently use for your online learning platform? [Multiple Choice] *

- Zoom
- Microsoft Teams
- Other _____*

(2) Satisfaction rating of online learning platform

4. How satisfied are you with the various aspects of online learning? [Rating question] *

	Very satisfied	Satisfaction	general	Dissatisfact ion	Very unsatisfactor y
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Course Progress

Classroom

Interactivity

Classroom

Atmosphere

Learning Attitude

Course

Completion Rate

Fairness of

examinations

Instructor

Proficiency

Teacher's
preparation of
courseware

Platform
functionality

Platform stability

Platform picture
quality clarity

Art Education after Reform: The Development and Future of Art Education in Taiwan

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Education reform has been underway for several decades. Taiwan has undergone Grade 1-9 Curriculum education, 12-year Basic Education. The Arts education has played an important role in the change of global orientation. Educational reform is a rolling revision that requires careful planning to advance. This research first takes the Grade 1-9 Curriculum Art education in Taiwan as the vertical and horizontal axis, and examines it through the literature on the Discipline-Based Art Education (DBAE) that influenced the Art education in Grade 1-9 Curriculum and the 12-Year Basic Education as an extension of it. The results of the research inferred that the "EEE" theory (Essence, Evaluation, and Effects). A theory oriented to the improvement of Art education in Taiwan, is an attempt to establish a model for Taiwan's educational and educational community to examine the current policies of Art education.

Keywords – Art Education, EEE, DBAE, Grade 1-9 Curriculum, 12-Year Basic Education.

Relevance to Design Practice – A set of practical theories is proposed for the review and optimization of Art education policies and practices in Taiwan.

Introduction

With the advancement of technology, the nature and form of education are constantly

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changing. In recent years, in the West, generational trends have changed and education has been reformed to respond to social changes. Art education in Taiwan has been deeply

influenced by the West, and the nature and content of Art education must be further explored. Art education plays an important role in the transition of generations in our country, and by reflecting on its connotations, the next step in education can be revolutionized (Liu, 2001; Lin, 2003). Looking at the development of Arts education over the years, we can see that there are still many problems in the education reform, including policies that operate contrary to the ideal in the actual teaching field, and difficulties in teaching due to the inconsistency of students' levels (Song and Zhou, 2003; He, 2004).

In order to suggest improvements to the rolling revision model of Arts education in Taiwan, this study examines the American Discipline-Based Art Education approach, the Grade 1-9 Curriculum, and the 12-Year Chinese National Education¹ that have influenced Taiwan's nine-year Arts education. Through a brief overview of the past and the present, it is hoped that the motivation for this research will be to explore the theoretical basis for future improvements in Taiwan's Arts education.

Because Taiwan's Grade 1-9 Curriculum Arts education is based on the Discipline-Based Art Education (DBAE) of the United States, and the 12-Year Basic Education is an extension of the Grade 1-9 Curriculum, the 108 curriculum is related to the 12-Year Basic Education, therefore, the scope of American Art education in this research is limited to DBAE and is included in the 108 curriculum when discussing the 12-Year Basic Education.

This research examines the strengths and weaknesses of Taiwan's imitation of other countries' Arts education systems by focusing on "the characteristics of Arts education in the United States" and "the influences on Taiwan". The research is categorized and coded by the content and evaluation of the papers presented by various scholars on this research topic, so that the theme of the study can be explored in depth.

Literature review

Art Education in the United States and Discipline-Based Art Education

Since the 1820s, Arts education in the United States has undergone changes such as Pragmatism, Holistic Development, the era of Child-Centered Development, Progressivism, and Subject-Orientedism. In a generation of rapidly changing social positioning, the status of Arts education in the United States has been constantly re-examined in order to achieve the role that Arts education plays in the learning process of children. In the past, education in the United States has returned to a focus on the major disciplines of science, English, and mathematics, reducing the amount of money and time devoted to Arts education.

Over time, the meaning of Arts Education has changed, and it is the concern of every educator to change the status and meaning of Arts education in the United States at the expense of Arts education in other professional disciplines (Tutt, 2014; Heilig, Cole, & Aguilar, 2010).

In the twentieth century, Art education in the United States was in an uproar, and many

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theories emerged to create a new status for Art education in the United States, among which the Discipline-Based Art Education advocated by E.W. Eisner was the most respected and was widely used as a reference for Art education reform around the world. The DBAE has been widely used around the world as a reference for Art education reform. It proposes four major aspects of Art education: Aesthetic, Art Criticism, Art Historic, and Art Creation, and attempts to separate the status of Art education into a single discipline, allowing students to learn in a progressive mode, and allowing teachers to transfer their status to the role of instructors in the actual teaching field, guiding children through teaching materials. The teacher's role is shifted to that of an instructor in the actual teaching field, and the teaching materials are used to guide the children and provide support in a way that is very different from the emphasis on child-centered and appropriate development (Kuo and Yang, 1988; Greer, 1987).

The DBAE has also had an impact on Art education in the United States, as it seeks to redistribute the Art curriculum to parallel other disciplines, and is generally considered to promote the idea that Art is not an Art, but is treated as a discipline (Burton, Horowitz, & Abeles, 2000; Basak, 2017; Chalmers, 1996). However, this model of teaching, with its emphasis on technical and formal qualities of Art, greatly inhibits students from engaging in formal critical learning and does not extend education to other aspects of visual culture (Efland, 1996; Schonau, 2019).

As education evolves, some scholars are beginning to argue that the teaching model of DBAE needs to be changed in the 21st century, that it should no longer be moved directly into the teaching field as it has been in the past. Rather, the current monolithic teaching model limits the complexity of Art, and because it has been the dominant Art education in the United States for so long, it has led teachers to think that not participating in the DBAE curriculum is not a good Art education program (Jebe, 2020; Gude, 2013; Gates, 2106; Hathaway, 2013). For example, Ghaffari (2017) conducted a variable manipulation with the presence or absence of Art criticism through a pedagogical study, and after collating the results from two classes. Found that the presence or absence of Art criticism in both classes would not actually have a significant impact on students' Art education, which does not mean that there is no need for Art criticism in DBAE. But rather, as previously mentioned, the teaching model of DBAE may need to evolve along with the development of the social environment over time.

This theory about DBAE was soon adopted by the U.S. Department of Education. It has become the educational method used to this day. However, many scholars have pointed out the problems with the DBAE theory, such as the content of the curriculum tends to be too boring, it does not take into account the children's personal background and character, and modern teachers ignore the importance of "Art creation", which causes children to lose their creativity and personal characteristics in the learning process.

In response to these shortcomings, Hamblen (1997) later proposed a modified version of Neo-DBAE, adding more aspects to the DBAE curriculum. such as discussion of feminist issues and business design. Although DBAE has since been replaced by newer educational theories, the framework of these theories can still be found in Art education curricula in many countries.

Educational Reform and Arts Education in Taiwan

The most influential aspect of Taiwan's Art education is the DBAE teaching model. In recent decades, Taiwan's education sector has been continuously exploring this model. In this section, the two aspects of the Grade 1-9 Curriculum and the 12-Year Basic Education will be explored, and the part on Art education will be further discussed.

In the 1990, the Grade 1-9 Curriculum was

formally implemented, and a new wave of educational reform was initiated by giving teachers autonomy to improve the previous educational system. (Chiang, 2002; Chang, Chen & Yang,2010).

According to the Ministry of Education (1987), the core concepts of the Grade 1-9 (see Fig. 1). There are 10 basic competency indicators included in the Grade 1-9 curriculum:

1. Understanding Self and Developing Potential.
2. Appreciation, Performance and Innovation.
3. Career Planning and Lifelong Learning.
4. Communication and sharing.
5. Respect and Care and Teamwork.
6. Cultural Learning and International

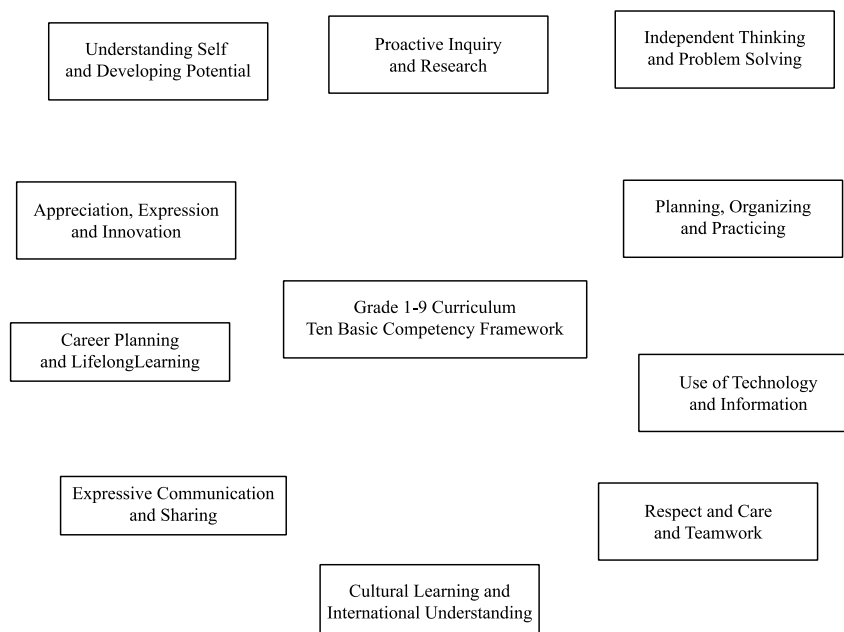


Figure 1. Top 10 Competency Indicators for the Grade 1-9 Curriculum.

- Understanding.
7. Planning, Organizing, and Practicing.
 8. Use of Technology and Information.
 9. Proactive Inquiry and Research.
 10. Independent Thinking and Problem Solving.

The second of these, Appreciation, Expression and Creativity, is related to Art education. The competency sub-category is to cultivate students' ability to feel, imagine, and appreciate Art, aesthetics, and expression and creativity. The main purpose of this educational reform is to change the past educational environment in Taiwan and to achieve a coherent and unified curriculum.

According to Suen (2000), the subjects that are most easily unified under the Grade 1-9 Curriculum requirement of integrated learning are Arts and humanities, suggested that teachers can take the subject of Arts and humanities as the main unifying role in the education reform. But problems arise in the process of carrying out

the unification, such as the neglect of the Arts and humanities curriculum, insufficient recognition of collaborative teaching, and the handling of the teaching field of performing Arts (Lin, 2006).

In the Grade 1-9 Curriculum, in order to cope with globalization, collaboration, and autonomy, Arts education is conducted through a humanistic approach the Arts are used to cultivate students (Liao, 2005; Wu, 2005). In order to achieve this ideal model, the basic competencies of students are emphasized, but students are instrumentalized, causing problems in curriculum Articulation from lower to higher grades.

The policy at that time had not yet considered whether the current teacher qualifications were adequate for integrated teaching, teacher training institutions' training, and teachers' own significance in the teaching field. The Grade 1-9 Curriculum model really caused turbulence in the education sector

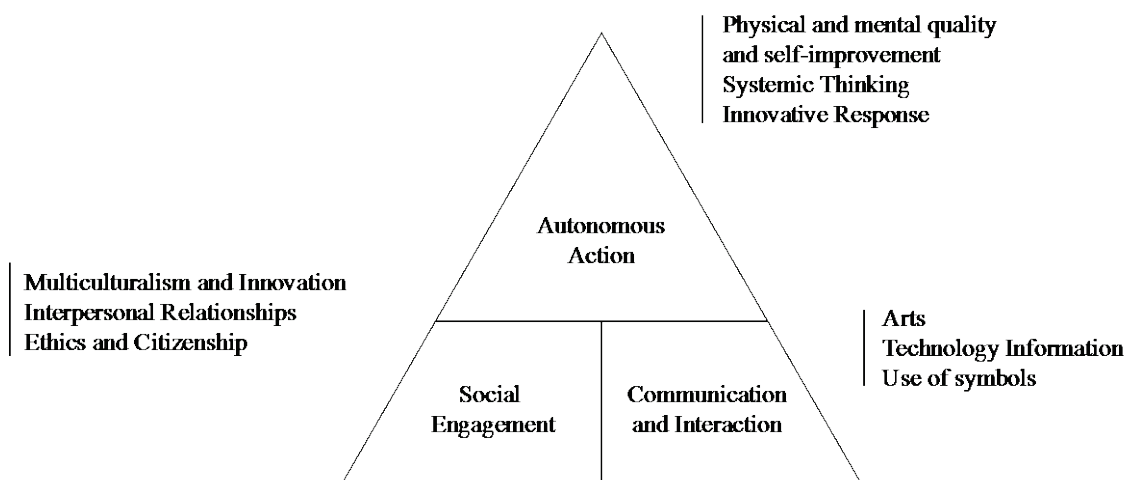


Figure 2. 12-Year Basic Education core literacy.

(Dan, 2019; Chung, 2017; Jiang and Ho, 2015; Chen, 2012; Pan, 2011).

In order to enhance the basic quality and competitiveness of the Taiwanese people, national education was changed to the 12-Year Basic Education. After Grade 1-9 Curriculum, students must be forced to enroll in the higher secondary education system to continue their studies, called 12-Year Basic Education, and the main goal of lifelong learning is to develop students' "core literacy" as shown in Figure 2.

According to the Ministry of Education (2020) in the 108 syllabus information website, the core literacy of the 12-Year Basic Education, the connotation of Arts education and the cultivation of aesthetic literacy are categorized as communication and interaction. In 2014, the Arts and humanities were categorized into the Arts domain to cultivate students' literacy in a non-coercive way and reduce the learning pressure of students. But the issues extended by the syllabus such as collaborative teaching, cross-disciplinary curriculum design, and teacher structure still need to be addressed by schools and the government. More efforts are needed in the cultivation of existing teachers and the promotion of the syllabus (Yang, 2019; Lin, 2018).

Taiwan's move from Grade 1-9 Curriculum to 12-Year Basic Education is an attempt to solve the current dilemma that education suffers from teachers in the school context, hoping to make changes in order to dispel students' and parents' myths about star high schools, which may instead deepen their obsessions (Cheng, 2017; Yang, 2010).

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There are many unrealized ideals in 12-Year Basic Education, such as the cultivation of Arts teachers, the promotion of the core concepts of the new curriculum, and the preservation of teaching quality and the use of teaching materials. In the context of co-teaching, interdisciplinarity does allow for the integration of Arts education with other disciplines, but it also causes difficulties for Arts educators in preparing lessons, as many of the relevant details have not been emphasized since the Ninth Year (Lin, 2018; Feng, 2018; Lin, 2019).

In this era of rapid change, Art education is the key to nurturing students. The design of curriculum for Art teachers, co-teaching, and interdisciplinary programs under the 12-Year Basic Education is not just a matter between teachers, students, and parents (Feng, 2018; Huang, 2019; Hsu, 2019; Ding, 2012; Chen, 2018).

Theoretical Development

In order for this research to be able to summarize the research questions to generate preliminary theories and thus establish a direction for examining Arts education in Taiwan. This research started by exploring through a large collection of literature that fits the research themes. An inductive approach is used to construct a theory that can explain the phenomenon of the problem.

In addition, this research is conducted in three directions, including Discipline-Based Art Education, Grade 1-9 Curriculum, and 12-Year

Basic Education. And it is also coded step by step in order to operate the theoretical procedures.

Definition of the research issues

The reform of education is a gradual change, and the scope of Arts education in Taiwan is so broad that both the educational and social communities are expecting changes in Arts education (Lu, 2019). Therefore, this research chose to define the problem for this investigation in terms of the improvement of Arts education.

This research adopts a standard sampling method to define the current Art education in Taiwan as the core issue of the research, and to identify the DBAE and the in order to take initial root in the theory. The first things were collected literature by using the three components of the DBAE, Grade 1-9 Curriculum and 12-Year Basic Education. Conducted open coding to conceptualize the data, as shown in Table 1 below. as an extension of the Grade 1-9 Curriculum of Taiwan's Art education on the horizontal axis.

Open Coding

In order to conduct a preliminary theoretical grounding, this study first collected literature using the three dimensions of American academic-based Arts education, DBAE, Grade 1-9 Curriculum, and 12-Year Basic Education, and conducted open coding in order to maintain the qualitative and neutral nature of the study.

In the literature collection, the researcher categorized the same topics into positive and negative evaluations. After completion, the positive and negative evaluations were conceptualized. The flow of the theoretical construction of the research is shown in figure 3 below.

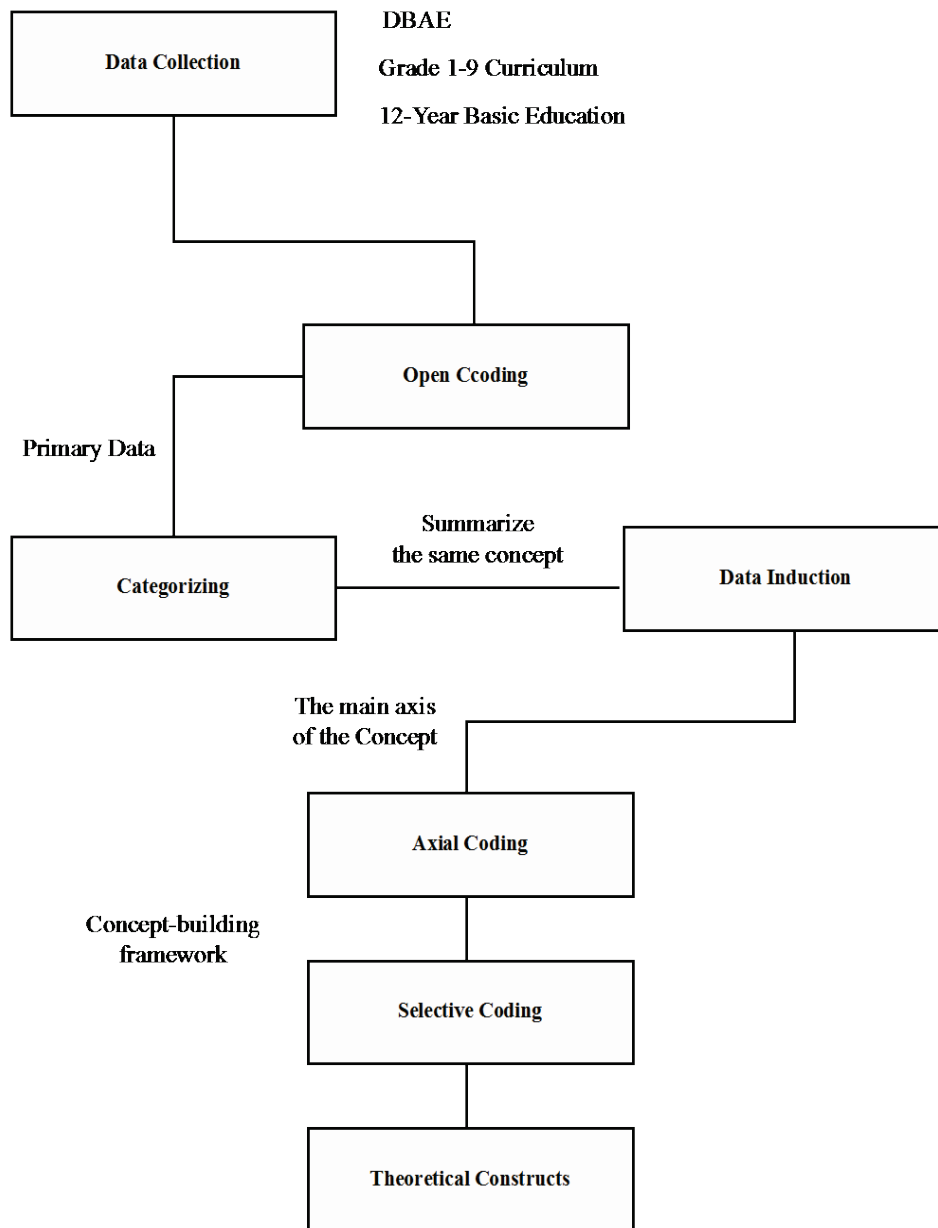


Figure 3. Flow of theoretical construction of the research.

The process of theory development in the research is clearly explained in Figure 3. The following procedures were conducted: Data collection, mainly from domestic and foreign literature and journals related to DBAE, Grade 1-9 Curriculum, and 12-Year Basic Education,

to provide academic support and reference for the research theory.

After the completion of the collection of relevant literature, the researcher conducted an open-ended translation and summarized the research literature according to themes.

Table 1. The DBAE literature open coding summarization table (a1~c4).

Theme: DBAE	
Co.	Abridged Literature Citation
a1	Having influenced art education over the past few decades, DBAE has been recognized as promoting art not as an art but as a discipline (Basak, 2017). a1
a2	The DBAE model of teaching in schools can improve students' creative, expressive, and oral discourse skills (Burton, Horowitz, & Abeles, 2000). a2
a3	The DBAE's emphasis on the formal qualities of technology and art also inhibits students from engaging in formally critical learning (Efland, 1996). a3
a4	GHAFFARI (2017) et al. found with a two-class experiment that whether art criticism in DBAE is taught or not does not have an impact on students' art education. a4
b1	In an attempt to reconfigure the arts curriculum to parallel more easily tested disciplines (Chalmers, 1996). b1
b2	The DBAE program focuses on four disciplines: aesthetics, art criticism, art history , and art practice (Hunter-Doniger, 2017). b2
b3	DBAE's education is limited to the arts and the institutional art world without expanding the field to all levels of visual culture. (Schonau, 2019). b3
b4	The DBAE program focuses only on the content of the course without any consideration for the community and the students (Stankiewicz, 2000). b4
c1	DBAE has been the dominant approach to art education since 1960, aiming to provide students with a comprehensive understanding of art. (Hamblen, 1987). c1
c2	Grounded in the worldview of Western culture and art, DBAE often presents examples of what has come to be regarded as a major cultural aesthetic (Hamblen, 1987). c2
c3	It is imperative for many scholars to consider any program that does not meet the DBAE acriteria to be a good arts education program (Hathaway, 2013). c3
c4	It is not the students who benefit from the creative experience of a typical DBAE arts education, but the government (Hathaway, 2013). c4

Table 2. DBAE literature open coding summarization table (d1~f4).

Theme: DBAE	
Co.	Abridged Literature Citation
d1	DBAE helps to initiate change in arts education into a positive experience for everyone involved in the educational process (Douglas, 2018). d1
d2	Aesthetics courses in the DBAE expand opportunities for students to engage in aesthetic analysis of nature and the world (Cowan & Clover, 1991). d2
d3	The single, standardized perspective of understanding art in the DBAE approach limits the complexity of art education and art itself (Jebe, 2020). d3
d4	The DBAE curriculum is not constructed to allow students to explore the meaning of visual principles in their lives (Gude, 2013). d4
e1	In DBAE teachers guide students through specific restrictions that begin to standardize the learning of art (Parks, 1992). e1
e2	DBAE entered the field in the 1960s and has continued to maintain its position, remaining at the forefront of the U.S. for decades. (McCollum, 2019). e2
e3	Art education in the 21st century needs to emphasize dialogue and art, rather than copying the entire artwork as DBAE did (Gates, 2016). e3
e4	DBAE must move away from the concept of relying on children to grow as artists on their own and support the construction of a formal art curriculum (Geer, 1984). e4
f1	Chinese scholars have attended numerous DBAE trainings, using cultural infiltration to allow education scholars to immediately learn about new developments in American arts education (Zhang, 2018). f1
f2	By incorporating social justice into DBAE's arts education, students can learn to use their work to advocate for a just and democratic society (Li, 2020). f2
f3	Many teachers are now beginning to hesitate to break away from the DBAE approach to teaching (Bedrick, 2012). f3
f4	The educational conditions of DBAE are not compatible with China's high economic development nor can they construct a system of art education in China (Niu, 2005). f4

The researcher has selected the literature as open translation for highlighting and summarizing the table where Tables 1 and 2 are the domain of DBAE. The Discipline-Based Art Education is designed as a revision of the American child-centered instructional approach. As an extension of the former doctrine, the DBAE believed that child-centered teaching was too permissive, and the DBAE, led by

Eisner, he thought that there were many Art educators who had the opposite of visual culture and Art. They think that they are studying visual culture without studying any Art, and as a result, these people cannot even define visual culture (Duncum, 2002).

As an educational approach that promotes Art education as a discipline, they try to make Art education an equal subject with other disciplines. They have a comprehensive approach to teaching and learning that emphasizes both theory and practice. As can be seen from Tables 1 and 2, the DBAE model has indeed become the approach to Arts education

in the United States and many other countries around the world. In practice, however, this model has many shortcomings that have been criticized, particularly the suppression of students' creative abilities and the excessive pursuit of a reputation as a general academic discipline, to the detriment of the role that students play in society.

Table 3. The Grade 1-9 Curriculum literature open coding summarization table (g1~i4).

Theme: The Grade 1-9 Curriculum	
Co.	Abridged Literature Citation
g1	For teachers, globalization, collaboration, and autonomous sustainable growth are required for the development of a new generation of citizens (Liao, 2005). g1
g2	It is a life-centered approach that works with students' ability development, respects their personality development, and stimulates their potential (Wang ,2015). g2
g3	Because of the inconsistency in the level of each student in the class, it is dif ficult to operate in practice (Ho, 2004). g3
g4	There are too many items in its core philosophy that are not ideal for operation in the real world and need to be clarified (Song and Feng, 2003). g4
h1	To build students' basic literacy and cultivate cultural citizenship through exploration and expression, aesthetics and understanding, and practice and application (R.O.C Ministry of Education, 2020). h1
h2	Art education is conducted through the use of art to cultivate and nurture the humanities, combining both intrinsic and non-intrinsic theories (Wu, 2005). h2
h3	The basic competencies emphasized in the educational reform of the nine-year consistent curriculum will instrumentalize students (Dan, 2019). h3
h4	In the nine-year consistent curriculum, the articulation between the upper and lower grades is problematic (Chung, 2017). h4
i1	In addition to focusing on the basic subjects of culture, professional and technical skills are strengthened to meet the needs of further education and career preparation (Wu, 2018). i1
i2	To share resources with peers in an open and accepting manner in order to jointly promote good student learning outcomes. (Wu, 2019). i2
i3	The first-line teachers have not been trained in integrated teaching, and teacher training is still based on subspecialty education. (Jiang, 2009). i3
i4	The Grade 1-9 curriculum should not occasionally have articulation problems because it was originally intended to address articulation issues (Jiang, 2009). i4

Table 4. The Grade 1-9 Curriculum literature open coding summarization table (A1~C4).

Theme: The Grade 1-9 Curriculum	
Co.	Abridged Literature Citation
A1	During the implementation period, some schools practiced curriculum integration, but some schools augmented the curriculum with existing materials (Zhao, 2018). A1
A2	Some teachers joined the experimental team to develop their own teaching materials without using textbooks because they agreed with the nine-year consistent curriculum concept (Cheng, 2018). A2
A3	Under the nine-year system, teachers are severely overloaded with roles in the field and have too many roles at the same time, blurring the space for teachers (Chen, 2012). A3
A4	This educational reform has instead created unrest among teachers in the actual teaching field (Pan, 2011). A4
B1	The development of experimental schools in the nine-year-old school helps schools become the mainstay of development their own characteristics becomes the core of the reform (Yang, 2017). B1
B2	The nine-year consistent middle school curriculum integrates various domains, which helps to develop students' confidence, like gender equality education does well (Wang, 2018). B2
B3	In Taiwan, from the past to the nine-year consistent reform, there is still not enough emphasis on the promotion of culture (Chiu, 2015). B3
B4	All issues should be taken into account in the design of the curriculum, so that the subjects do not continue to compete with each other as they did in the past (Zhou, 2003). B4
C1	In Taiwan, the school-based curriculum has been thoroughly implemented in schools from the nine-year consistent education to the new 12-year national education curriculum (Chen, 2018). C1
C2	The nine-year consistent curriculum allows for consistency in the number of classes taught by instructors in each area (Chen, 2020). C2
C3	Information-based instruction has been commonly used in teaching, but for nine years there has been no emphasis on so-called cross-disciplinary learning (Liu, 2017). C3
C4	It has been more than ten years since the Nine-Year Plan was established, but adjustments are still being made to the teaching methods and models (Jiang, 2017). C4

Likewise, many subsequent researchers and educators have begun to doubt the effectiveness of DBAE, believing that its development is limited by its own theoretical framework and that Art education is confined to the institutional Arts.

Table 3 (see previous page) and Table 4 are related research on the Grade 1-9 curriculum teaching schemes in Taiwan.

The summary table is a collection of positive and negative evaluations of the Grade 1-9 curriculum in Taiwan. The intent of the curriculum is to improve the knowledge level of Taiwanese citizens. To improve the learning patterns of the students at that time and to create a systematic and coherent teaching program.

This curriculum has not only caused a lot of problems for Arts education in Taiwan, but also scholars and researchers in the education field feel incomprehensible about the deliberate implementation of this curriculum. In terms of merit, the nine-year curriculum does operate in a teaching environment that is responsive to student development and respectful of each

student. The Arts education component is able to build students' basic literacy through the practice and application of the Arts (h1, g1).

The most criticized point is that when the Ministry of Education introduced this teaching model in Taiwan, it did not take into account the current situation of the educational environment.

Table 5. The 12-Year Basic Education literature open coding summarization table (D1~F4).

Theme: The 12-Year Basic Education	
Co.	Abridged Literature Citation
D1	In addition to emphasizing academic literacy, the main focus in the field of art is on developing connotation and aesthetic literacy (Ministry of Education, 2018). D1
D2	The arts are not limited to knowledge and skills, the whole person through expression, appreciation, and practice (Ministry of Education, 2015). D2
D3	The current situation of art teaching materials emphasizes lesson plan design and teaching, diversity and variability, and ineffective teaching of combined subjects, (Chen, 2018). D3
D4	In the second specialization of the new syllabus, practical courses must be greater than theoretical to develop in-service teachers' aesthetic sense of art (Xu, 2019). D4
E1	Twelve years of national education is intended to change the current dilemma that education is experiencing, and teachers are hoping for change (Cheng, 2017). E1
E2	From the separation of subjects in the past to the current unification, the three skills of art creation, appreciation, and practice can be cultivated (Cheng, 2017). E2
E3	Schools should have to nurture arts teachers to promote the spirit of the syllabus, the quality of teaching, and the use of textbooks (Lin, 2018). E3
E4	The Ministry of Education lacks the autonomy of school development and is overly involved in the autonomous power of school curriculum planning (Chen, 2020). E4
F1	The new syllabus emphasizes the arts as incorporating technology learning, cross-disciplinary exhibits, and design thinking, allowing students to learn more holistically (Huang, 2019). F1
F2	The Visual Arts Society was changed to Visual Applications, and the curriculum focuses on design, multimedia, and aesthetic applications that can be integrated with life (Wang, 2019). F2
F3	The government should promote aesthetic education programs and the like, using the arts to link the development of various disciplines in a rolling revision (Lu, 2019). F3
F4	The art field often becomes a collaborative effort with other subjects, costing art teachers more time to prepare for the course (Feng, 2018). F4

Table 6. The 12-Year Basic Education literature open coding summarization table (G1~I4).

Theme: The 12-Year Basic Education	
Co.	Abridged Literature Citation
G1	Teaching staff in the teaching field have medium to high awareness of this educational reform, but low awareness of assessment (Pan, 2020). G1
G2	The new syllabus recommends the use of supplemental software for learning so that students can fully diversify their learning to enhance the use of smart classrooms (Shi, 2020). G2
G3	The schooling and curriculum in the syllabus should focus on quality rather than weight, allowing schools at all levels to develop appropriately and take on the task of education (Huang, 2014). G3
G4	It is not easy to reform education, but it is necessary to give students and parents complete information and to improve step by step based on trust (Ding, 2012). G4
H1	Pursuing a second area of expertise does help in the development of in-service teachers' ability to integrate across disciplines (Xu, 2019). H1
H2	The use of digital tools for integrated education in the ocean and the arts is helpful (Lu, 2019). H2
H3	Parents are more concerned about their children's school in post-secondary education rather than simply attending college, the question is where to study (Yang, 2010). H3
H4	Moral education has not been given much attention since the nine-year rule, and it still needs to be improved even in the twelve-year national education (Lin, 2019). H4
I1	There are many electives in the new curriculum for the arts that students can use as a reference for their future career choices (Huang, 2019). I1
I2	The addition of A to STEM becomes STEAM, showing that arts education is the key to developing students in the future (Fung, 2018). I2
I3	Twelve years of national education cannot really dispel the myths of star high schools and address the pressure of students to go on to higher education (Yang, 2010). I3
I4	Remedial teaching in twelve years of national education should be truly accessible to disadvantaged students (Tang, 2013). I4

And school teachers were not able to meet the demand. The system also tends to turn students into robots in the Art curriculum, giving up the ability to think.

In terms of curriculum Articulation, the biggest reason for the creation of this program was to solve the problem of children's inability to integrate new knowledge with their original

knowledge when they enter higher grades. However, the nine-year consistent curriculum model makes bridging more difficult (g3, g4, h3, i4). Table 5 and Table 6 summarize the literature of the 12-Year Basic Education. The 12-year Basic Education serves as an extension of the Grade1-9 Curriculum. It should have been able to resolve the situation that was occurring in the teaching environment. Nowadays, it has become

the target of criticism by all teachers, and even by many education professionals.

Many scholars in the education field have even called out to the Ministry of Education in Taiwan in front of the media that this teaching model cannot be called national education at all.

When the Art program was introduced in this mode of teaching, it turned out that the Department of Education wanted students to develop their own temperament and sense of beauty in the Art field. However, in the actual application of the curriculum, the teachers were at a loss. Many education scholars believe that the approach taken by the Ministry of Education in Taiwan has failed to dispel the myths that students and their parents have about prestigious schools (D1, D2, G1, H3, I3).

In this research, the collected literature was initially coded and then open-translated. Literature with the same concepts in Tables 1 to 6 were grouped in order. The initial concepts can be classified into four factors as follows:

1. Core Concepts: (a-1, a-2, a-3, a-4, g-1, g-2, g-3, g-4, D-1, D-2, D-3, D-4)

2. Operational Models: (b-1, b-2, b-3, b-4, h-1, h-2, h-3, h-4, E-1, E-2, E-3, E-4), "social level" (c-1, c-2, c-3, c-4, i-1, i-2, i-3, i-4, F-1, F-2, F-3, F-4)
3. Academic Level: (d-1, d-2, d-3, d-4, A-1, A-2, A-3, A-4, G-1, G-2, G-3, G-4)
4. Passive Influence: (e-1, e-2, e-3, e-4, B-1, B-2, B-3, B-4, H-1, H-2, H-3, H-4)
5. Active Influence: (f-1, f-2, f-3, f-4, C-1, C-2, C-3, C-4, I-1, I-2, I-3, I-4).

Based on the initial concepts categorized in this section, it was further categorized and these combined conceptual areas were spoken of and named as the following three areas:

1. Essence: Including “Core Philosophy” and “Operation Model”.
2. Evaluation: Including “Social Level” and “Academic Level”.
3. Effects: Including “Active Influence”, “Passive Influence”.

And the concept of preliminary categorization is taken as the property of this

Table 7. Concept Categories.

Categorizing		
Category	Nature	Orientation
Essence	Core Philosophy & Operation Model	Positive / Negative
Evaluation	Social Level & Academic Level	Positive / Negative
Effect	Active Influence & Passive Influence	Positive / Negative

research. The summarized literature is divided into positive and negative aspects; Table 7 below is the summarized table of this research.

Axial Coding

The insights obtained through a step-by-step approach based on the literature read in the three directions of the research are as follows:

According to the relevant literature:

1. DBAE has indeed had an impact on Arts education in the United States over the past few decades (a-1, a-2, e-1, e-2, c-2)
2. The teaching model of DBAE may need to be changed in response to generational changes (a-4, b-3)
3. DBAE practices may inhibit the development of other student skills (b-4, d-3, e-4, e-3)
4. The reason for the DBAE change may come from the government (c-4)

According to the literature related to the Grade 1-9 Curriculum and the 12-Year Basic Education, it can be found that:

1. The government needs to give more help to education reform and Arts education (E-1, E-4, F-3)
2. Policies still need to be improved (g-4, i-3, i-4, C-4, G-3, I-3, I-4)
3. More mutual support is needed between schools and teachers (g-1, i-2, A-1, A-3, B-1, B-2, C-2, G-1)

4. Interdisciplinary Arts education can be helpful to students (I-1, I-2, H-1, F-2, F-1, E-2, D-2, D-1, A-2)
5. Materials issues in Art education (H-2, G-2, D-3, B-3, i-1)

Selective Coding

This research uses the aforementioned translation as the foundation for theoretical construction. Since the Grade 1-9 Curriculum is influenced by DBAE and the 12-year Basic Education is an extension of it. This research combines these three elements and attempts to establish a theory of EEE (Essence, Evaluation, and Effects) for Arts education reform in Taiwan.

The theory is derived from the following three elements that need to be considered in order to improve Arts education in Taiwan.

First, we should examine the "Essence" of the current Arts education policy or model, and look for problems in the core philosophy and operational model of the current policy or model to review. Secondly, examine the adequacy or inadequacy of the current policy through "evaluation", and examine the inadequacy of the current policy or model through evaluation at both the social and academic levels. Thirdly, examine the active or passive impact of the current "impact" on society or students to understand whether the current policy or model has improved Arts education or caused difficulties for schools, teachers, and students, so that it can be revised.

The "EEE" theory proposed in Figure 4.

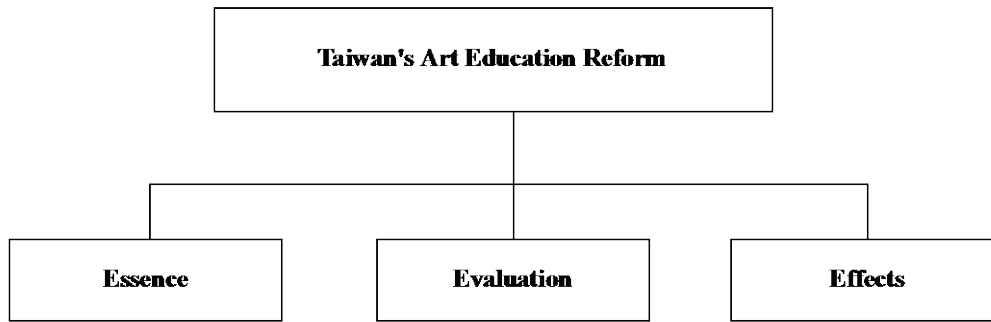


Figure 4. EEE Theory.

Conclusion

Educational reform should never be rushed, but must be improved slowly and step by step. In the past few decades of educational reform in Taiwan, it has been promoted by educational groups and private citizens.

In order to make corrections to education and Arts education over time. The research examines the characteristics of Arts education in the United States and the influences on it in Taiwan. The Grade 1-9 Curriculum of Arts education have been the vertical and horizontal axes of the research, and through the Discipline-Based Art Education that has influenced Arts Education The 12-Year Basic Education as an extension of it, the three related literature be used to further qualify the theory of "EEE" for the improvement of Arts education in Taiwan.

In the future, when reviewing whether Arts education in Taiwan needs to be improved, a comprehensive review of Arts education can be conducted through the three dimensions of E (Essence), E (Evaluation), and E (Effects).

The "EEE" theory proposed in this research is the theory of "Improvement-oriented Arts Education in Taiwan".

It is based on a review of the current policy or operational model of Arts education, i.e., the three identical levels of "Essence," "Evaluation," and "Effect," with no order or hierarchy among them.

It is also suggested that the conclusions of this research can be used as literature to conduct in-depth interviews with the stakeholders of the topic and to verify the conclusions of the research, so that it can serve as a force for improving policies in the Arts education sector in Taiwan.

The researcher has two practical suggestions for the follow-up research. First, if qualitative research is conducted, in addition to the aforementioned in-depth interviews, the theories proposed in this study can be deepened through a grounded theory approach; for quantitative research, the Analytic Hierarchy Process (AHP) can be used to weight the importance of theories through quantitative data.

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Growing Green, Benign by Design (Part 3 of 3)

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The project is an attempt to cover the aspects of production and application of materials from renewable sources, for sustainable product development. The report is divided into three parts describing the role of renewable materials in the past, present and future.

The first chapter, named Chemurgy, places the topic in a historic perspective. The word Chemurgy was introduced in the thirties to describe a branch of chemistry which dealt with the application of natural raw materials, especially from farm products. As a result of agricultural over-production and the advent of the economic depression, American farmers were in search of new outlets for their produce.

Industry (especially the newly created automobile industry) on the other hand, was in great demand of materials. One of the important car manufacturers at the time was Henry Ford. He was a Chemurgist, whose vision it was to grow cars from the soil. His cars included many components from renewable materials, such as gluten or soy plastics and used alcohol for fuel, which was gained from vegetables. Presently, cars in Brazil use alcohol for fuel, extracted from sugar cane.

Two of the most important chemurgic plants were soy and hemp, the latter of which was banned in 1937. The two plants (both originate from Asia) were cultivated on a large scale, primarily for non-food purposes. Many important discoveries had been made, which found wide application still in use today.

The chapter concerned with current development consists of two parts, i.e. renewable materials and sustainable ways of production. The part about renewable materials is divided into five areas of consumer application. Of particular interest to industrial designers are natural fibers and bioplastics. In the area of natural fibers, the PLATO manufacturing process seems a promising development.

The technique upgrades wood or plant fiber to make it more strong, more light-weight and more resistant to rot. Plant fibers which have been treated are finding application in the car industry. Moving on to bioplastics, the first generation of bioplastics, which still contained some synthetic material, has been superseded by a generation which is totally biodegradable. Most bioplastics, which are currently available, are designed to be thermoplastic, to be processed by conventional industrial machinery. A particularly interesting development is the production of a plastic like Biopol (Polyhydroxybutyrate), by plants instead of bacteria.

The second part of this chapter is about methods of production. There is a shift noticeable towards the utilization of transgenic plants or bacteria to produce materials. Biotechnology assists in the improvement of production efficiency and product quality. An example of this is corn and potato which have been modified not to produce amylase, so the process of starch extraction has become easier and cleaner.

The third chapter begins with an assessment of the developments towards sustainability, including economical, technical, social, and ecological aspects.

In the race towards a sustainable future, there are two scenarios, i.e., Aquafication and Prosumerism, put forward for consideration. Presently, agriculture for industrial purposes does hold the promise of sustain ability. However, if it were to be applied on a grand scale, it would pose two major problems in the near future, i.e., a shortage of fresh water and a shortage of land.

There have been successful attempts in transplanting bacterial genes into plants, which enables them to be salt-tolerant. This way, it would be possible to shift agriculture for industrial purposes to sea (aquafication). The plants would be grown on the sea surface and its industry would make use of the natural forces readily available for its energy needs, like wind-, water- and solar power.

Alternatively, in a cocooning society (F. Popcorn), with working at home becoming more common and leisure time increasing, self-sustainability will become a possibility. The prosumer household, (producer/consumer, A. Toffler) will be self-sufficient in all its needs, like consumer goods, food, cosmetics, medicine, fuel, clothing, etc. All these goods will be “grown” through the application of fast-growing plants.

To test the feasibility of this concept I have conducted several experiments. For example, Giant Jersey Cabbages have been grown into shapes, suitable for furniture application. Tree-free furniture from local resources will become a possibility. Similarly, bottle gourds have been grown in moulds which have taken on geometrical shapes for packaging purposes.

Some other experiments have been carried out with “dead” natural materials. One example is that of mussel shells, (a waste material from the seafood industry) which I have applied into building materials. Another example is the fiber of the Loofah gourd which has been compressed into shapes for shock-resistant packaging or other purposes.

Keywords – Benign-design, biobased design, biobased materials, biodesign, ecological design, green design, green technology, renewable materials, sustainable product development (s.p.d.).

Relevance to Design Practice – This research probably has the most relevance in concept stage of product design, in choice of sustainable materials and greener production techniques. But it may also influence the designer’s awareness and responsibility of the impact his product will have on the environment.

3rd chapter two Scenarios

An introduction

We are in crisis at the moment. We have an environment crisis. The way in which the West uses science and technology in relation to nature has catastrophic effects. There is

also a moral crisis. Ethics seems to have become a matter of personal taste. Both are an expression of estrangement between man and nature. At the end of the second millennium and at the beginning of the Post- Industrial Era there is a need for a global (damage) assessment and a plan for recovery. As our natural resource stocks are dwindling, a wide application of materials from renewable

sources seems the only option. As the problem of waste disposal is increasing and locations for landfill sites are getting fewer, there is a growing need for biodegradable products. Presently, plants and bacteria are being employed to clean industrial polluted soil and water.

An assessment

Economical aspects

Renewable materials have to compete with materials derived from petro-chemicals which at the moment are still cheaper to produce. On the long run though, with all stages of the products' life cycle considered, it will be proved feasible to apply renewable materials from an economic standpoint. For example, in some countries there have been laws created to counteract pollution and the growing waste problem. In Germany, the DSD taxes for synthetic packaging are 15 times as high as for natural materials. So it pays to apply biodegradable materials.

Because of the environmental measures, industry must comply to new standards, companies are made to re-think their production methods. Often, this may result to innovation, the effects of which might cut production costs. Obviously, the economic situation of the agricultural sector would improve. The market as it is today, is quite limited and is mainly food oriented. So the market will be more diverse with the supply of agricultural materials for industry.

Another advantage of an agriculturally based economy is that of greater national independence. Many countries do not like to be too reliant on goods from other countries.

Since the advent of biotechnology there has been a switch in corporate investment to agricultural research, particularly by firms

that produce Agri-chemicals. The reasons being that plants won't need any chemicals in the future as they will be made by the plants themselves by genetic modification. The chemical industry which sells the package-deal (modified seeds together with the herbicide) makes the agricultural industry more dependent. The farmer buys the seed because of high yields and of low crop maintenance. The seeds however are mostly hybrids, requiring him to purchase new seed every year. Indeed, patent may prevent the use of farm-saved seed. It was predicted that 12 large multinationals such as Sandoz, Ciba-Geigy and Pioneer Hi-bred will dominate the global seed business shortly after the year 2,000.

Furthermore, the chemical industry will have a better grip on the food industry. Food and pharmaceutical companies are interested because plants can be adapted or be tailor-made to meet their needs.

"Nature patents"

Industry will shortly have total control over the seed business. A few super crops will dominate agriculture. Biodiversity is being threatened. Besides this, [modified] life is being patented.

Technical aspects

The production techniques for bioplastics and natural fibers rely mostly on conventional methods. There have been some new techniques introduced which are specifically developed to handle natural fibers like pultrusion. However major developments are being made in the area of biotechnology. There is a distinction between old and new biotechnology. Old biological processes include brewing, bread and cheese making, while the new ones include techniques like genetic engineering. Biotechnology, as defined by the Office of Technology J. of Multimedia Art, Design and Education, Vol. 2, No. 2, 2022

Assessment of the U.S. Congress, includes any technique that uses living organisms (or substances of living organisms) to make or modify a product, to improve plants or animals, or to develop microorganisms for specific uses. Dan Clickman (American minister for agriculture) pleaded for a second green revolution in which biotechnology would play the major role. Without it a lot of forest would have to be cut or agricultural fields will be exhausted, to supply in the demand for food and materials. (The first green revolution was the widespread use of chemicals in the seventies, which meant the industrialization of agriculture).

“Genetics: tailor-made products”

A plant can be genetically modified to grow anywhere. It can be made tolerant to temperature extremes. Genes from deep sea flat-fish which are found near the poles were transplanted into tobacco plants. The gene stimulates production of an enzyme which controls the flow of water. So now the plant is able to grow in colder regions. Furthermore, crops can be made to survive heat and drought. For regions which are commonly flooded plants can be made tolerant to salt water *4. They can also be made to change colour, as described in a previous chapter. The genes of the indigo plant were transplanted into a cotton plant, so blue cotton can be harvested for the jeans industry without bleaching it first. Amongst other plants Cassava has been made disease resistant. It is manipulated further to stimulate production of pesticide by its own. A plant can also be made herbicide resistant. A soybean has been made resistant to a herbicide manufactured by the same company.

Social aspects

The population is increasing 2 % per annum or doubling every 30-40 years. It was

calculated the earth could support 22 billion people at the most. Today’s situation in the Europe, we are faced with agricultural over-production. There are agricultural surpluses and farmers are subsidized not to produce more than agreed to. In effect, the surpluses could partly be used for non-food application. Also, a lot of agricultural land lies fallow, which could be used for non-food purposes. It has been predicted that job opportunity will increase, as the demand for natural fibers like flax will continue to rise. In Holland, the flax production chain which is currently being set up will offer several new jobs.

Benefits of plants and renewable materials:

Directly, the benefit that plants bring us supply us with oxygen and filter the air. In this respect large-scale agriculture for non-food purposes can do its share by providing society clean air.

In our homes or offices equipment such as copy machines and printers emit a lot of dust. Sick- building syndrome which is caused by bacteria in the air-conditioning system, can be helped by introducing plants. Plants with large leaves will help humidify the space. NASA has experimented with sansevieria which they say breaks down toxic substances in the air and feeds on it. Also, the purely visual aspect of plants have proved to have very positive effects on humans. People seem to get cured faster and are less prone to stress. The use of natural materials in the personal environment have proved to regulate humidity and neutralise excesses like noise, electrostatics, smells, etc. Also psychologically speaking, natural materials are known to have a positive effect. One example is the use of wood and leather in car interiors. Apart from the traditional healing powers of certain plants and herbs, plants

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seem to be the ideal hosts for alien genes responsible for the production of substances for medical purposes and replicating them.

Besides this, the production of bioplastics by means of production through plants, seems also to be worthwhile.

Possible restraints for use of renewable materials:

Large scale agriculture for industrial purposes would increase the demand for water and jeopardizing water supplies for human consumption. Also, with an exponential growth of the population, space is becoming a scarce commodity. The priority for space will be for housing and food production. The way some crops are being managed today like cotton leaves much to be desired. The best description would be chemical warfare, including actual defoliating techniques for easy access to the cotton.

A most recent example is the soybean which has been treated to withstand a herbicide which kills off all weeds in the area. A gene of a soil bacteria (agrobacterium) which produces a protein which is immune to the herbicide is transplanted into the DNA of the soybean. The seeds are sold as a package together with the herbicide by Monsanto in America.

Ethics concerning biotechnology:

There are pressures from consumers directed to companies and governments to take responsibility on certain social issues such as the environment and public health. There is particular concern on the issue of biotechnology. The public wants to be informed about the dangers to health and is also stuck with ethical questions, like:

- Can life be patented?
- Isn't cloning a danger for the diversity?

- Is there a possibility of cross pollination with cultivated or wild varieties?
- Is genetically engineered food really safe?
- Is it fair to exploit life for human demands?
- When is the labelling for information about genetic modification going to be introduced?
- Should everything scientifically possible be carried out, just to have return on research investment?

Most ethical questions probably concern non-food products as well.

Ecological aspects

Having arrived at the 2nd millennium in the post-industrial era, we are assessing the damage caused by the effects of the Industrial age. Natural resources have been plundered for a large extend. The landscape is scarred and eroded. Forests are scarce. The soil, air and water are polluted. The temperature is rising globally, and the sea level is rising. Land, air and water are polluted.

Today we use 10 times as much energy as 100 years ago, globally. Coal was the main source of power until the first world war. Oil, natural gas and nuclear power are the sources for energy right now. Biodiversity is threatened and a mono-culture is the result. Some desirable plant species are intensively cultivated, while others are exterminated. For example, out of the original 12.487 varieties of rice about 7,000 have already been lost.

The seed market is being controlled by large multinationals some of which have their main business in the supply of agri-chemicals. Shell, the oil company, is the world's largest

owner of forests *18. In Holland, a private initiative called "Hof van Eden", has been set up to collect the seeds of most plant species from around the world to save the bio-diversity. Some plants are actually applied to help clean polluted air, soil and water.

Large scale agriculture for materials for industrial use will have its effects on the environment. Beneficial is the renewal of the oxygen supply, removal of chemicals from the atmosphere and the absorption of CO₂. Increased agriculture partly for industrial purposes will have a negative impact on the environment, such as soil erosion and exhaustion. About 13.4 billion ha. is available world-wide for agricultural use. The availability of land for non-food agriculture largely depends on the demand of for food and living space. The other problem may be that of drinking water supplies. Of the total water reserve only less than 0.7 % is fresh water. The oceans contain 97.13% of the total amount of water. Around 2% is locked in ice caps and glaciers. One suggestion was to transport icebergs to where water would be needed. Large reserves of water lay beneath the earth's surface. In the future, hydro power, solar power, wind power and power from biomass will be important energy sources in the future.

Options:

Desert agriculture is one option in the future. Deserts are expanding at the moment. It is possible to make plants survive in drought areas, by genetic modification. However, irrigation will still be necessary. Agriculture in space seems unlikely in the near future because of high harvesting / transportation costs. But conditions in space seem suitable to many plants. Experiments are being conducted with aid from NASA on

vegetables like potatoes and also an Alga called Spirulina amongst other crops. Another option is farming at sea. Already, the sea has proven to be a rich source for medicines in particular. New developments allow for terrestrial plants to be salt-tolerant through genetic modification. This could mean that agriculture might be possible on the sea surface.

Aquafication

For our material sources we are land oriented. Alternatively, the sea offers a rich source for materials. There are already some non-food applications of aquatic materials. Waste materials like fish skins, are applied in fashion items as an alternative for lizard or crocodile skin. Seashells are used as isolation in houses. Certain cosmetic products are being made from algae.

Besides waste as a source for materials, water provides another interesting area which is not really explored yet, i.e. agriculture for industrial purposes. We rely on terrestrial plants for starch and proteins in bioplastics, while aquatic plants could provide an interesting option. As a source of fibers, marine plants are already being processed into carpets. As about 80% of the earth's surface is water, the sea seems an interesting option for further exploitation. It is rich in renewable resources and the elements can provide energy (solar, wind and hydraulic power).

Aquafication is a scenario where the conventional concept about agriculture for industrial purposes is maintained, but the location or situation has moved to sea. Here, the scale of production could be significantly enlarged and realized.

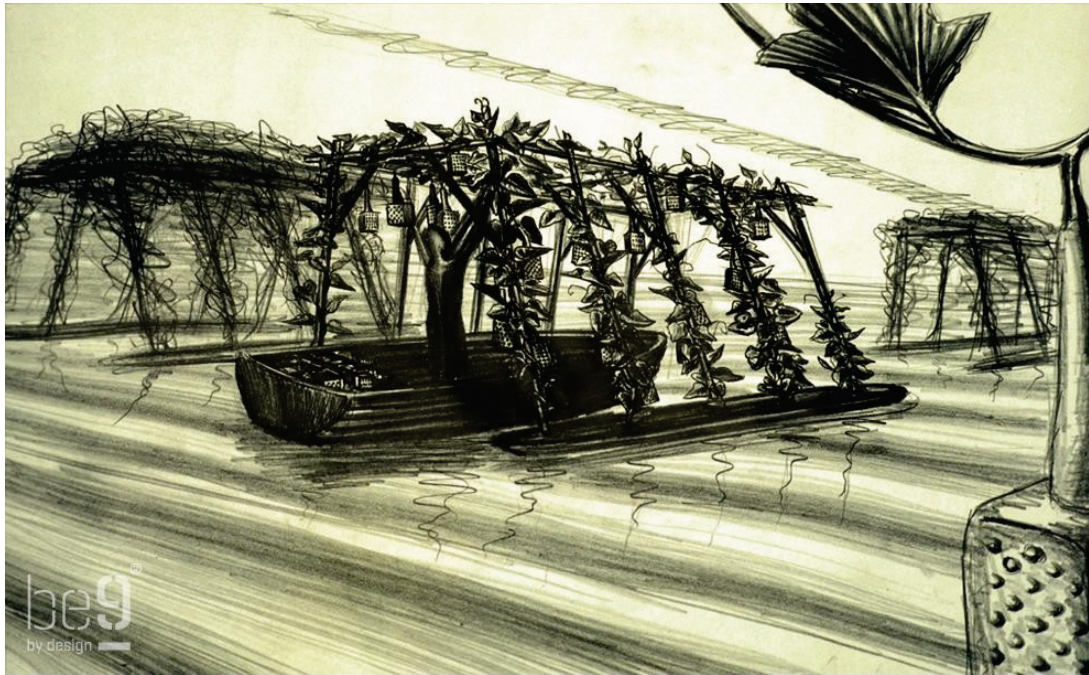


Figure 1: Aquafication (by author).

Agriculture on fresh water

In the past there already exist several examples of agriculture on water.

The Aztecs introduced floating gardens called Chinampas, which provided its population with food and materials. The Aztec chinampas probably originated in Mexico in the 13th century. By the 15th century chinampa fields in Xochimilco, were constructed on a large-scale. They were about 30 m long and 2.5 m wide. The fences were made from wattle. To stabilize these plots tall slender willows were planted around the perimeter. It provided the Aztecs with food crops like maize, beans and chile peppers. A particularly important non-food crop were gourds or squashes for the production of

containers. Also herbs and flowers were grown there. Today, the gardens are anchored by the roots of the candle willows.

In China, gourds are planted on the banks of village ponds. The plants grow over a bamboo framework erected over water. This method provides abundant water for the plant and the framework over the water permits the land to be used for other purposes.

In more recent times, hydroponics has grown more popular. This is the technique where by plants are being grown on rockwool and water, on an industrial scale. The advantage is that the cultivation can be regulated and largely automated and there is no weed problem.



Figure 2: Chinampas (in Mexico).

Agriculture on salt water

Halophytes such as eelgrass grow in sea water and contain many seeds. The protein and starch content compares favorably to major terrestrial economic grains. The Seri Indian harvested the seed and ground them into flour. The advantage of this plant is that it probably doesn't need any fertilizer or pesticide. The problems of maintaining and harvesting a plant which is submerged in tidily active water is a challenge. Once mastered, farming at sea will be possible. There has been an experiment conducted involving halophytes under irrigation of sea water to see if economic yields were possible. Perhaps starch could be produced for bioplastics by halophytes, instead of potatoes. Potatoes are quite heavy and should be collected within a radius of 50 km. from the factory, otherwise the transport costs are too high.

In Holland and in Portugal experimental fields have been set up for the domestication of certain saline crops, such as Sea lavender (*Aster triplium*) or Sea kale (*Crambe maritima*) for food purposes. The fields are irrigated by sea water, which is pumped up

from 35 meters down into a storage basin, through a closed circuit of drainpipes. These vegetables can be grown in saline or brackish soils which are unproductive or less economical for traditional crops.

Because of the threat of a freshwater shortage in the future and a space problem on land agriculture for industrial purposes could move to sea. There are interesting developments in the area of salt-tolerance in plants. It may take some time before terrestrial agricultural crops are fully salt-tolerant, to be grown on the sea surface, but it open up new possibilities. It would not apply to food crops as the taste may affect the product because of the salt content. So I think aquafication will apply for non-food crop production only.

If plants could be made salt-resistant or tolerant, many important fiber plants and crops for bioplastics could be transferred to sea for production. The plants would grow on floating gardens similar to the Aztec which would be connected to one another. Advantages are that at sea there are no weeds, probably less insects, more sunlight and a

constant supply of water. Harvest would be quite simple by dragging the gardens to a central place. Its processing industry should also be located at sea, where many forms of energy are readily available, such as solar power, wind power and waterpower.

“Salt-tolerance”

Plant cells mostly burst in salty water because of a build-up of osmotic pressure. In Sweden, biochemists have transplanted a gene for salt resistance from the bacteria *Escherichia coli* into a tobacco plant. The gene which is called *betA* produces an enzyme called choline dehydrogenase. This enzyme converts choline

into an amine called glycine betaine. This works as an osmolyte which is a compound that protects some bacteria and higher plants against the effects of salt. But there are probably more genes needed to make plants sustain salt-water floods.

“Growing products”

In his novel *Hitchhiker’s Guide to the Galaxy*, Douglas Adams, described a forest where the trees grow ratchet screwdrivers as fruit. “Very few things actually get manufactured these days, because in an infinitely large universe...most things...grow somewhere”.



Figure 3: Pitchfork (used in France).

Prosumerism

An alternative scenario to aquafication is that of prosumerism, a word introduced by A. Toffler in his book *The third wave*. The word prosumer is a marriage of producer and consumer. He predicts that in the future the consumer is going to be self-sufficient in all his material needs. He grows his own food in his apartment through the use of genetically engineered seeds, which do not need much

light. He can provide in his own user products by the application of a very advanced Cad Cam system. He imports the specifications to his taste into the computer and the complete product rolls out the other end, ready for use.

On Sardinia there was an experiment conducted, involving loofah gourds for shock-absorbent packaging materials. The skin disintegrates to leave fibers. By compression and heat the fiber of the fruit can obtain any shape. It can also be combined

with other materials. Other applications include shoe soles and engine filters. There are several well-known examples of ready-made products such as pitchforks

grown in Africa, walking sticks grown in Jersey and gourd bottles grown in Asia, America and Africa.



Figure 4: The Livingroom project (in Nuenen the Netherlands) growing chairs.

F. Popcorn introduced the word cocooning in the early eighties, describing the trend we are experiencing at the moment. We are working at home, growing our own food and doing home improvement ourselves. In this prosumer scenario, the prosumer is self-sustaining in all his material needs, but these products are grown. In his “living room” his chairs are growing. Cabbage stalks are growing into furniture frames. Fast-growing willow branches of the species *Salix viminalis*, are tied and woven into a dome where chairs are affixed. The branches keep on growing, blooming and expanding through the room.

The aquariums in his home are functional. In his aquarium, bowls, cups and plates are being produced. Shellfish like abalone, produce layers of crystals of calcium carbonate and layers of proteins which interlock to form a very tough material. At the moment researchers are not able to control the shape of growing crystals. But it might be

possible to grow the crystals inside molecules containing cavities that act as templates.

The terrariums in his home are functional. Social insects like termites build structures inside moulds, to serve as containers. The lighting is provided by fluorescent seaweed in tanks on the ceiling and luminescent fungi in boxes with dead wood in the walls of the room. Some fungi are known to be naturally luminescent. In Scandinavia pieces of dead wood with these fungi were used as lanterns to illuminate paths. Some species are known to be quite powerful in luminescence, like *Mycena lux-coeli* from Japan or members of the *Agaricus*.

Scientists have transplanted the genes responsible for making certain jellyfish glow, into tobacco plants. Similarly, the gene in fireflies has been transferred to plants, to make them glow in the dark. He picks his own antibodies from a pea plant, and his

cosmetics from herbs grown in the bathroom. His coloured cotton is growing in the bedroom. At the heart of his cocoon will be a biocomputer, regulating the ideal conditions of the direct environment. In the field of smart materials, scientists have discovered intelligent gels which respond to external stimuli like electrical shocks and temperature change and act accordingly. These materials may form the basis for a new kind of machine. As an experiment I have tried to realize parts of this scenario. I have grown packaging by employing moulds round gourds and I have tried growing chairs by modifying cabbages.

Experiments

Mussel shells

Introduction

I have applied mussel shells into building



Figure 5: Heap of Mussel shells at sea food factory.

Experiment

After many experiments with different binders like gelatine, casein with chalk and a vulcanic material with chalk, I had found cement to be the best option. As for colouring,

materials as a filler material but also for its aesthetic value.

Source

Mussel shells are a waste product from the sea food industry in the south-west of Holland. The season for mussels starts in autumn and ends in summer. The mussels are cooked and processed into jars. The subsequent mountains of smelly shells take up a lot of space, but they are finally deported in summer. The shells are too tough to serve as poultry feed and are subsequently shipped and dumped at sea sometimes as far as the coast of northern France. I found out the mussel shells do have an ecological part to play as a base for oysters.

I found light blue to be the most suitable combination. I did some experiments with natural pigments and dyes, like indigo, but the result was not up to expectation. Mineral pigments, like ultramarine performed better.

Process

The casting of shells with cement requires a different technique to the one common in traditional terrazzo manufacture. The shells are too fragile to be mixed in a cement mixer, so the cement is prepared separately. The shells tend to sink to the bottom of the mould, so the eventual product is face-down. The shells are cleaned first of all, before they are

put into the mould. White cement is mixed with ultramarine powder and is added to the shells. The product can be reinforced with steel and small fibers. The material should be left to dry about 5 days. The product is then freed from the mould. The material is ground until the top layer has gone to uncover a decorative pattern of shells. The surface can be polished further and treated with wax.

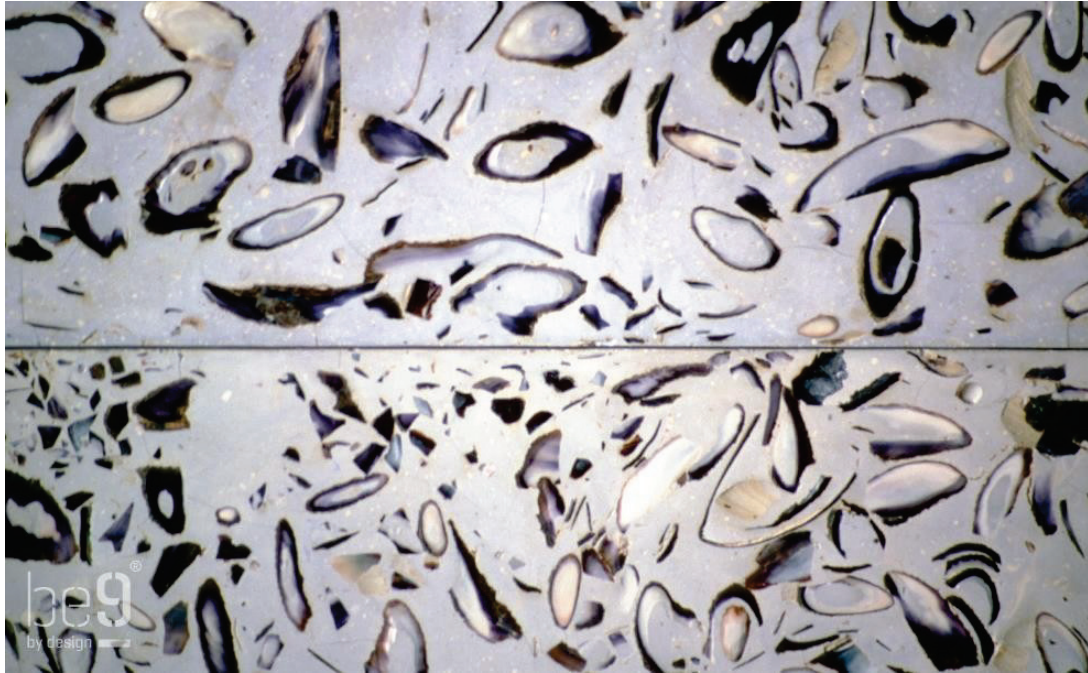


Figure 6: Building blocks with Mussel shells (design by author).

Application

The shell material is quite strong and can be applied in products like building blocks for building walls or as elements for facades.

However, as the surface of the material is not resistant to wear, it is better not to be applied as tiles. The production could be done by the existing terrazzo industry.

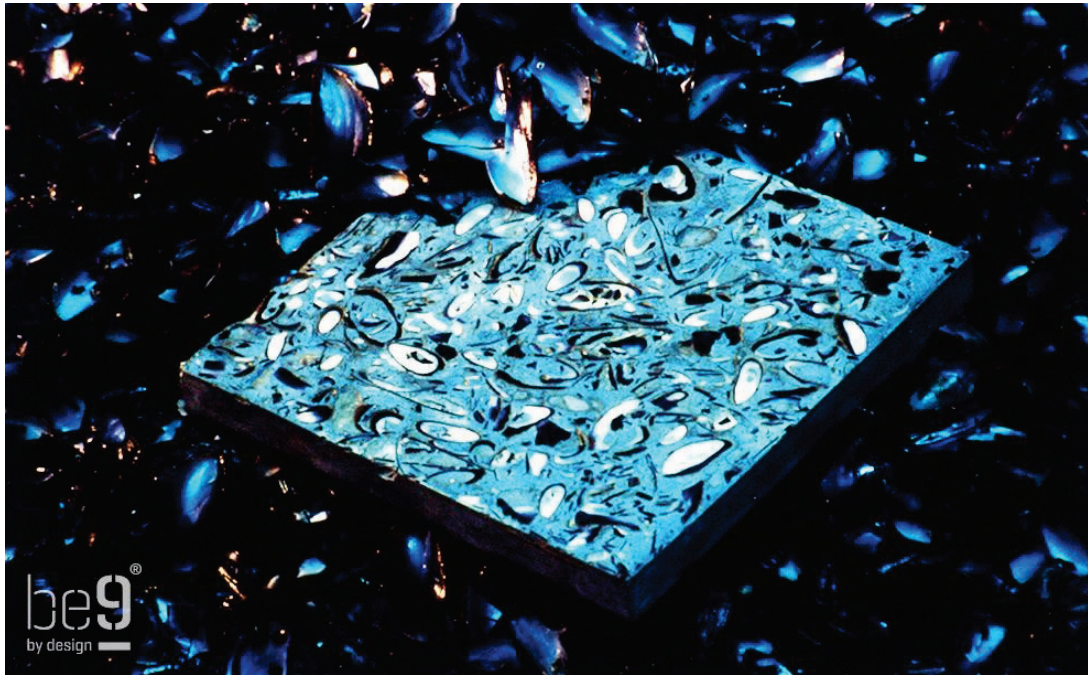


Figure 7: Mussel shell tile (design by author).

Opportunities

The cement can be made from chalk by burning mussel shells, as was done in the past, before the age of Portland cement. Shells are a sustainable source. As reinforcement for concrete, natural fiber could be used. As mentioned in the previous chapter, pineapple fiber could find application for this use. However, natural fiber does need preparation before being applied in cement. Usually this requires the fibers to be boiled in water. The colour pigment should be from a sustainable source as well. I did try several natural pigments, but they are mostly too light and tend to float to the surface.

Loofah gourds

Introduction

The name Loofah comes from Arabic. The fruit has been widely used as flesh-brush or sponge. Its fibers have also been applied for technical purposes as filters for engines, as upholstery filler or even in shoes as soles.

Source

Loofah is an annual plant, which grows in

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warm climates. It originates from south-east Asia, but its cultivation has been spread to most warm parts of the world. Within Europe, it's mainly cultivated in Greece and Bulgaria.

Experiment

I found the fibers of the loofah gourd could be compressed into a mould after it had been soaked in warm water. Once dry, its fibers retain the shape of the mould.

Process

The mature gourd is left to dry, after which the skin and seeds are removed to leave a cylindrical structure of fibers. The fiber structures are soaked in a bath of warm water and pressed into a mould. The water escapes and the fiber is dried. The mould is removed to reveal its new shape.

Application

Besides its traditional applications there are new areas of application to be explored. The technique for altering the shape, opens up new possibilities. Environment friendly packaging as shock-resistant material is one area of particular interest.

Opportunities

As described in the previous chapter, Loofah has been subject of an experiment financed by the EU on Sardinia, for fiber production.

One of the options for application is for packaging purposes, but there are plans for application in acoustic/thermal isolation panels. The fiber can also be applied in combination with bioplastics to make composites.

Giant Jersey Cabbage

Introduction

One experiment concerns a certain type of



Figure 8: Jersey Walking stick Cabbages (by author).

The cabbages have been grown on Jersey for the production of walking sticks for nearly two centuries. Particularly in the nineteenth century this was a thriving arts and crafts industry. The sticks have also found application as crutches for use in English hospitals and are very popular, due to their strength. These days, the cabbages are grown in an area called L'Etacq, in the north-west of the island. Here the crop is grown for making walking sticks from the stalks. At the local

cabbage, the Giant Jersey Cabbage (*Brassica oleraceae longata*) which I intended to grow into prefabricated furniture frames by using various techniques. This cabbage is a fast-growing plant, which turns woody when dried.

Source

The origin of this cabbage is thought to be Portugal, where it has been grown as a food crop since Roman times. In the past, the stalks have been used as construction material for barns, for palisades and fences.

wood shop L'Etacq Woodcrafts, the owner Philip Le Gresley, follows on his family's tradition of growing walking sticks, behind his wood shop. The leaves on the vegetable are used to feed cattle. Twenty plants is sufficient to feed one cow the whole year through.

Experiment

At the start of 1996, I began growing around 50 cabbage plants on a field of a farmer who

tended them. I had built a frame around the plants in order to guide them to grow straight up.

Shape

To attain a shape of a chair frame, I first



Figure 9: Jersey Walking stick Cabbage (by author).

Another possibility I tried was to rotate the plants into certain directions at certain times while they grew. The cabbage stalks kept their shape as they grew towards the sunlight. This way any desired angle or shape can be attained in one piece of wood. This method proved a lot more effective, and a fair degree of accuracy could be reached. One useful result was that when a stalk was chopped mostly two new shoots appeared. This fact is interesting to the possibility of a design of an upside- down chair.

Joints

These experiments explored the possibility of making connections between stalks, involving grafting and other techniques. In one case I've peeled away the outer skin up to the cambium of two plants and bound them together to see if the stalks would join. The purpose of this is to create a stronger stem. In another

planned leading the stalks through moulds with an opened end through which sunlight could enter. The result was no good, as the front leafs got entangled and blocked the passage.

experiment I had grafted one stem on to another one, to make cross joints possible. In another case I had drilled a hole in one stalk and led another stalk through it, the roots of which were left in soil. The hole was covered with tape, to ensure a good connection. In most cases the connections seemed to work but when the tape was removed there was no real sign of integration. This might be a question of time.

Strength

To increase the strength of a stalk I have bound weights around it. By gradually increasing the weight the stem might thicken.

However, there was no sign to suggest any change in thickness after 6 months. There were differences in length and thickness already between the individual plants.

Process

The seeds are sown at the end of the winter and the sticks can be harvested at the end of next autumn. They will be about 150 cm long. However, they can be kept for another season if the winter allows. The stalks reach a height of about 3 meters, although there have been exceptions known of lengths of up to 6 meters.

The stalks are light-weight and strong once dried. The sticks are dried horizontally, after which they are prepared. They may be sanded down and varnished.

Application

The area of application is furniture. The dried stalks have good properties like strength and lightweight.

Opportunities

There are several advantages to applying cabbage stalks, e.g.

- **Speed**
Cabbages are fast growing plants. Furniture could be designed and produced to specification while you wait. For a piece of furniture made from cabbage stalks you would have to wait one season. This compares favourably to one made from wood which would take at least 10 or 20 years.
- **The optimization of materials**
Because the cabbage plant grows directly into a product, the amount of waste will be minimal. While there is about a 50% loss of material when wood is cut into planks.
- **Local European material**
There are other alternatives for

wood of course which are being successfully applied in the furniture industry, like rattan, ramie, and bamboo. But these materials are not attained locally and have to be imported. The giant cabbage can be grown in most European climates.

- **The environment**
The eventual product is “tree-free”.
- **Experience**
The expertise for growing cabbage plants is already there. European farmers grow a wide variety of cabbages, I’m sure the giant cabbage doesn’t differ that much from those cabbages.

Bottle gourds

Introduction

I have started this project several years ago, but each year I try to improve the technique and hence the final product. The experiment started out as an idea for an environment-friendly packaging design for cosmetics. There are mainly two kinds of gourd, i.e. ornamental gourds and bottle gourds. Ornamental gourds are generally smaller and more vulnerable, while bottle gourds (*lagenaria siceraria*) have a tough outer shell, which is water-resistant, with a soft lining.

Source

Gourds have been used as containers for storing food or drink, throughout history, across the world. Besides containers, gourds also serve other purposes for instance as musical instruments or floats for fishing nets. The origin of gourds is not certain, but it is either Asia or Africa.



Figure 10: Modified bottle gourd (by author).

Process

Gourds are annual plants. The seeds are sown in March and the seedlings are transplanted outdoors in May or kept in a greenhouse. Outside, pollination will occur with the help of bees. In a greenhouse, the female flower is usually hand-pollinated. The fruit develops beneath the female flower around July. The small gourds are led into box shaped moulds, which they fill within two or three weeks. Around September the moulds are taken off and left to mature. The gourds are harvested around October or November when their stems have become wood-like. The gourds are then dried, emptied and prepared.

Application

The area of application is packaging for cosmetic products like bath oil, bath salt and powder soap.

Opportunities

Both process and final product are completely environment friendly. Nature manufactures packaging. The gourds plants grow rapidly and are suited to most conditions. In warmer climates there is the possibility to have more

than one yield a year. The plant could be optimized, by utilizing the oil extracted from the gourd seeds, for the production of cosmetics. Other parts of the plant like the stems, leaves or flowers could also be of use in cosmetics. This way, the packaging is not transported empty. In a discussion with C. Snijders (researcher at CPRO in Wageningen) it was suggested a possibility that in the future gourds could be grown in square shapes without the aid of moulds. In gourds there are variations known of fruit with three, four or five chambers. The four chambered gourds could be grown and selected consistently, until a near-perfect shape is reached, without the involvement of genetic modification. This is what happened with the common green and red peppers which have been developed box-like to make storage and transport easier.



Figure 11: Cured bottle gourds (by author).

In conclusion

In this chapter there is a short assessment on the state of the world and the benefits of applying agriculture for industrial purposes. In conclusion, I found two major problems which will affect the future, i.e. a shortage of living space and a shortage in water supply. There are two scenarios suggested. One scenario involves traditional agriculture for non-food purposes which takes place on the sea's surface. Its scale is industrial, and its products are to a large extent pre-fabricated. For reasons of renewable energy availability and of transport costs, its industry is also located at sea.

The second scenario, Prosumerism, is based on a concept introduced by A. Toffler in his book *The Third Wave*. The consumer is also producer. In my scenario the prosumer grows all products himself and is thus self-sustaining in all of his material needs.

Remarks

The possibility of realisation of either of these scenarios, depend to a large extent, on progress in the field of biotechnology. Nevertheless, the effort of the public, particularly in the prosumer scenario will also play a crucial part in its realisation.

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Epilogue & recommendations

Having done this research project, I have a better overview on renewable materials and sources. I have learned to place the topic in historical, economical, technical, social and ecological context. The following developments are worth investigating more closely, I think.

Soybean plastics

One of the areas that raised my interest in the first chapter was the early application of plastics from soybean. In 1908 a waterproof glue was realised and was applied in plywood. Also transparent film was developed on soy base. Today, the soybean is mainly grown for the food industry. In America, the soybean has been genetically engineered to withstand herbicides. In Europe there is some reluctance to import this bean for the human consumption. Here may lie opportunities for application in the non-food area. I spoke to M. Engel of ATO-DLO, who is part of a two-man team investigating the opportunities for soy plastics. Soy plastic is still not totally waterproof. It can be modified to be thermoplastic by addition of glycerine to make it more flexible and to raise its melting point. The soybean protein is imported to Holland but is cultivated elsewhere in Europe.

The price of soy protein granulate is about Hfl 4 per kg. With an additional

material the price can be lowered to Hfl 3 per kg. Application of soy plastic lay in the area of packaging and disposables.

This is unless a way has been found to improve the susceptibility to moisture.

Scanning current development in the area of renewable materials, I thought the EU project on Sardinia involving the growth of loofah gourds on a large scale, was a good initiative. The remaining fibers can be compressed into any shape, by the simple use of heat and moisture. The process is quite low-tech and does not need a lot of energy.

Staying in the field of fibers, I think the application of pineapple fiber seem to have great opportunities. An interesting development in manufacture is the PLATO technique of “cooking” wood or plant fibers to upgrade its quality. The fiber is made more resistant to decay and its weight is reduced significantly. The paste-like material could also be pressed into shape.

With the aid of biotechnology the production of PHB (similar to Biopol) is now made possible by plants. Modified plants seem to tolerate the bacterial gene and produce plastics beside their “normal” products. The prospect of using nature for the production of complete products I find fascinating. There are several artists working with willow presently. It is possible to weave large structures which, when stuck in the ground keep on growing. After several years the structure is able to carry the weight of humans. This may be an interesting topic for research for landscape artists, as an idea for street furniture.

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