Project-based Learning incorporating Interdisciplinary Curriculums Increase Learners' Satisfaction

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Abstract

This study is intended to investigate the impact of perceived ease of learning, enjoyment, acquisition of useful knowledge on learning attitude, competence acquisition and satisfaction. Works developed by 40 fifth and sixth graders from Her Herng and Chu Wan elementary schools were gathered and analyzed. An experimental design was developed, and the subjects were divided into control and experimental groups. The results proved that the experimental group exhibited significant differences in terms of perceived ease of learning, enjoyment, and acquisition of useful knowledge as compared to the control group. Furthermore, the results of the regressions indicated that perceptions that knowledge is useful and ease of learning have a significantly positive influence on students' learning attitude. Additionally, learning attitude was shown to have a significantly positive influence on competence acquisition as well as competence leading to learning satisfaction. The results support the premise that designing an interdisciplinary curriculum with the elements of useful knowledge and ease of learning stemming from an enjoyable curriculum may help improve students' learning attitude and may also help them acquire competence and increased learning satisfaction in project-based learning environments.

Keywords: perceived ease of learning; enjoyment; useful knowledge; learning attitude; competence acquisition

Introduction

Project-based learning is regarded as one of the most effective approaches to cultivate learning in students with multiple intelligences in the field of contemporary education. Learning by doing, which causes students to acquire practical heterogeneous knowledge and gain competence, is embedded in formal educational contexts. It is considered an important pedagogy to develop students' competences in school. IQ-based education typically only yields feelings of pride or shame on the part of test-takers (Gardner & Moran, 2010). Additionally, Gardner and Hatch (1989) argues that IQ tests, which rely on paper-and-pen examinations, can only evaluate linguistic and logical-mathematical competences but do not demonstrate distinct competences in thinking and learning. Thus, Gardner (1983) argued that students will need multiple intelligences to handle teamwork environments in the future. An increasing number of teachers in schools have become aware of the trend toward multiple intelligences, and they are thus incorporating project-based learning into their curricula. For example, Barron et al. (1998) suggested that project-based learning assists learners to complete assigned tasks through either participating in activities or adopting acquired knowledge. Thus, it is believed that project-based learning causes students to acquire intellectual knowledge (Blumenfeld et al., 1991). The approach provides students with substantial opportunities to work in open environments that lead to multiple intelligence acquisition. In addition, trial and error implementation of acquired knowledge helps students acquire practical competences and complete assigned tasks.

However, other approaches are considered to be effective pedagogies as well. Formal education in Taiwan has adopted a "pouring-in" instructional process and pre-defined curricula, which only provide students with book knowledge and memorization skills. Additionally, the present measurements in the Taiwanese educational system may restrict the creative process. On the one hand, project orientation learning may provide students with practical experience and skills. On the other hand, the trial and error process challenges learners' endurance in terms of frustration and competence with problem solving.

It is widely believed that designing ease of learning into enjoyable curricula to instill useful knowledge in students may improve their attitude toward learning (Davis, 1989). This study is intended to provide students with an environment and experience based on learning by doing in order to help them transfer and apply the learned knowledge into competences. The curriculum is mainly based on Davis' Technology Acceptance Model, which argues that three important elements may improve students' attitude toward learning, behavior, and degree of satisfaction. From Davis' perspective, perceived ease of use, usefulness, and enjoyment are key factors that students need to experience to improve learning attitude (Davis, 1989). This study integrates project-based learning and interdisciplinary curricula to engage students in learning by doing surroundings in order to cultivate interdisciplinary competences. In the processes of implementing projects, students have to brainstorm for creative ideas and feasible solutions through teamwork. Some previous studies have demonstrated the positive impact of project-based learning on performance. For example, completing projects not only cultivates in people abilities related to designing, decision making and autonomy, but leads to the development of real products and polishes oral presentation skills (Thomas, Mergendoller, & Michaelson, 1999).

To gain a further understanding of project-based learning in the Technology Acceptance Model context, students' learning attitude, competence acquisition and satisfaction were investigated through interdisciplinary curricula and project-based learning. Currently, scholars are engaged in verifying the role of perceived ease of learning, useful knowledge, and enjoyment in project-based learning. Perceived ease of use has been shown to have a positive influence on attitude and intention in wireless service businesses (Lu, Yao, & Yu, 2005), and Martin-Michiellot and Mendelsohn (2000) indicated that ease of learning can enhance students' attitude toward learning. Furthermore, perceived usefulness and enjoyment are the crucial factors that influence attitude during the processes of using technologies (Davis, Bagozzi, & Warshaw, 1992). Moreover, Delamare and Winterton (2005) stated that prerequisite key knowledge, attitude, and skills are important human resources. Finally, previous studies have reported that collaborative learning based on face-to-face instructions (Piccoli, Ahmad, & Ives, 2001) has a positive impact on people's learning experiences (Powers & Mitchell, 1997) and learning satisfaction (Wang, 2003). In the present study, an experiment was conducted to explore the effects of perceived ease of learning, acquisition of useful knowledge, and an enjoyable curriculum on learning attitude, competence acquisition and satisfaction. By gathering forty elementary students from Her Herng and Chu Wan elementary schools, this study was focused on investigating the following research questions:

- What are the impacts of perceived ease of learning, acquisition of useful knowledge, and enjoyment on students' learning attitude in project-based learning?
- Do students' learning attitudes influence their competence acquisition in project-based learning?
- How is competence acquisition related to learning satisfaction in project-based learning?

Method

Case Introduction

The principal of Her-Herng Elementary School intends to develop interdisciplinary curriculums and implement project-based learning to help students acquire heterogeneous competencies in independent thinking and problem solving, interdisciplinary cooperation, innovation, information collection and analysis, oral expression and writing skills, and image. With these capabilities, students will be capable of dealing with challenges in a competitive future. The school won the golden medal for their Program for Promoting Teaching Excellence in 2016.

Participants

The participants of this study were elementary students from Her Herng and Chu Wan elementary schools in Penghu, Taiwan. These students were chosen because interdisciplinary curricula and project-based learning are gaining increasing attention in primary schools. Hence, investigation of different pedagogies influencing learning attitude and satisfaction is needed. To measure how perceived ease of learning, useful knowledge and enjoyment influence students' learning attitude, knowledge acquisition and satisfaction during project-based learning, forty students in fifth and sixth grade from two different schools were divided in to two groups by purposive sampling.

The participants who did not participate in the interdisciplinary curriculum and project-based learning were the control group, and the remaining students were the experimental group. Furthermore, only a few teachers adopt interesting curriculum design and project-based learning in class in Taiwan, and most teachers in Taiwan fail to design interesting courses that will improve the learning attitude of their students. For example, Chinese classes are typically aimed at recognizing vocabulary; mathematics focuses on repeating calculated numbers, and science emphasizes the memorization of theory. The curriculums are boring and lack integrative interdisciplinary courses. Therefore, this study explored how project-based learning could be implemented to facilitate interdisciplinary curriculum design. Analyzing the heterogeneous competence acquisition of students through interdisciplinary courses is helpful to understand the effect of project-based learning on current elementary educational practices.

Procedure and project-based learning

This research is intended to explore the students' learning attitude, competence acquisition and satisfaction while implementing an interdisciplinary curriculum and project-based learning. One team from Chu Wan was the control group (n=24; 12 males and 12 females) while the other was the experimental teams (n=16; 10 males and 6 females). One group adopted traditional lecturing with individual courses. The other engaged in project-based learning with interdisciplinary curricula. Both groups of students had to complete their studies the following semester. In addition, we ran a pretest at the beginning of the semester. The results verified that there were no significant differences between the two groups in terms of perceived ease of learning ($t=0.63, p>0.05$), perceived acquisition of useful knowledge ($t=0.92, p>0.05$) and perceived enjoyment $(t=1.23, p>0.05)$.

The experiment, which developed twelve interdisciplinary curricula either combining Chinese, Science, Mathematics, Social studies, or Art, lasted for a year. We offer two examples as follows: first, the students at Her Herng were lectured about a curriculum entitled "***Meeting happiness***" in both Chinese and Art classes. The students in the experimental group were guided to brainstorm with classmates to deliver creative artworks and write Chinese poems. During the exercise, students learned green concepts, acute observation, independent thinking, creative thinking, problem solving, oral expression and writing skills. For the second example, the "***Legend of the floating boat"*** focused on local fishing skills and knowledge about buoyancy. On the one hand, we learned traditional fishing skills from local fisherman; on the other hand, the process led to further understanding of buoyancy that was implemented by conducting a floating boat experiment.

The purpose was to facilitate the perceived ease of learning, acquisition of useful knowledge and enjoyment that would lead to improvements in students' learning attitude, competence and acquisition (Wagner, 2010), and satisfaction (Piccoli et al., 2001). A set of measurements associated with the Learning Acceptance Model were borrowed from the concept of TAM (Davis et al., 1992), and the items were modified. Rubrics aimed at evaluating perceived ease of learning, acquisition of useful knowledge, learning attitude, competence acquisition and satisfaction (see Table 1-4) were provided to both groups to help them review the concepts of learning attitude, competence acquisition and satisfaction while learning. Pictures of the students implementing the interdisciplinary curriculum are provided in Figure 1. Figure 2 offers the experimental procedure for the study.

Table 1. Perceived ease of learning

Item	Rubrics
1	Teachers provide a clear teaching goal.
2	Teachers design a flexible and interactive curriculum.
3	Teachers create a scenario that students can access easily.
4	It is easy to learn the information lectured about in class.

Table 2. Perceived useful knowledge

Item	Rubrics
1	The knowledge learned in class is useful.
2	The knowledge learned in class enhances my attitude toward learning.
3	The knowledge learned in class can be applied in daily life.
4	The knowledge learned in class cultivates my image.
5	The knowledge learned in class helps me become a Maker.

Table 3. Perceived enjoyment

Item	Rubrics
1	This teaching approach made me enjoy learning.
2	I am looking forward to be taught with this teaching approach.
3	I am interested in this teaching approach.
4	I think this teaching approach increases my learning achievement.

Table 4. The purpose of the sample questions of learning attitude, competence acquisition and satisfaction

Dimensions	Purpose	Sample questions
Learning attitude	To understand students' attitude toward learning	Interdisciplinary courses are a good idea. The curriculum is worth participating in.
Competence acquisition	To understand the competence students acquired in class	The approach improved my competence with teamwork. The approach improved my competence with problem solving.
Learning Satisfaction	To understand students' satisfaction Degree to which students liked the interdisciplinary curriculum	Learning became more interesting. I enjoy this approach to lecturing.

Beach cleansing

Designing floating ball

Articles about floating balls

Oral presentation

Making a lucky turtle

Floating ball creation

Decorating Campus

Sailing floating boat

Tour A

Figure 1. Pictures of students in project-based learning

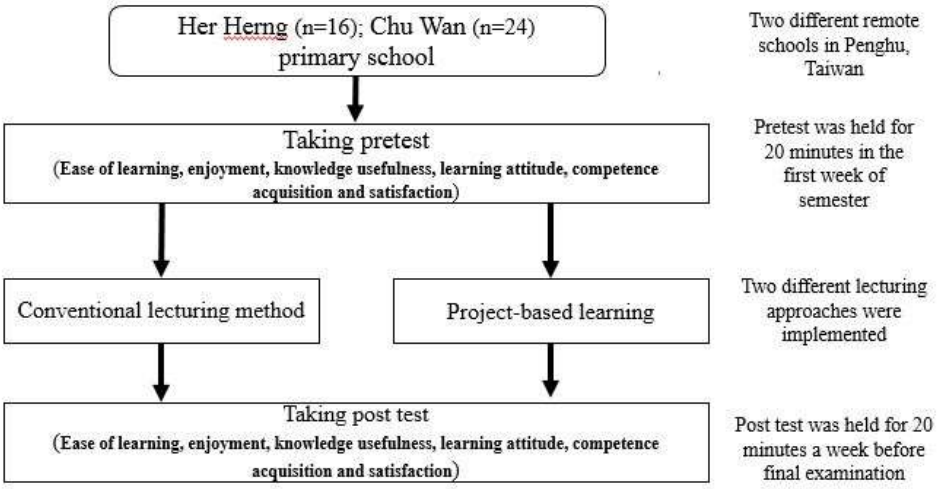

Figure 2. Experimental procedure

Results

Validity and Reliability

Some criteria for validity and reliability are given as follows: KMO >0.5, communality >0.5, eigenvalue >1, factor loading >0.6, Cronbach's alpha >0.7, and item-total correlation >0.6. The factor loadings for learning attitude, competence acquisition and learning satisfaction were as follows: Learning Attitude was 0.80, 0.91, 0.86, 0.90, and 0.85 (α=0.91). We kept items CA1, CA4, CA5 and CA6, which had factor loadings of 0.90, 0.92, 0.88 and 0.82 (α=0.90), in Competence Acquisition. Furthermore, the factor loadings for Learning Satisfaction were 0.82, 0.88, 0.84 and 0.82 (α=0.86). The independent variables, Useful Knowledge, Ease of Learning, and Enjoyment, were determined based on the literature review. We kept UK1, UK2 and UK3 in Useful Knowledge, which had factor loadings of 0.84, 0.84 and 0.91 (α=0.83). The factor loadings were 0.86, 0.85, 0.87 and 0.73 (α=0.84) in Ease of Learning. Finally, the factor loadings for Enjoyment were 0.81, 0.77, 0.85 and 0.80 (α=0.82).

Analysis of perceived ease of learning

Table 5 shows the descriptive statistics and Independent-Sample T Test results for perceived ease of learning. The mean value and standard deviations in the post-questionnaire were 6.64 and 0.096 for the project-based learning, and 5.64 and 0.34 for conventional lecturing, respectively. Based on the independent-sample t test results, a significant effect was found on perceived ease of learning (t=2.81, p<0.01). This suggests that project-based learning makes students feel that it is easy to gain new knowledge and skills.

Table 5. Descriptive data and t-test for perceived ease of learning using different teaching methods

Experiment design	N	Mean	SD	Std. error	t
Control group	24	5.64	1.36	0.34	2.81**
Experimental group	16	6.64	0.38	0.096	

Analysis of perceived enjoyment

Table 6 shows the descriptive statistics and the independent-sample t test results for perceived enjoyment. Both the mean value and standard deviations in the post-questionnaire were 6.57 and 0.14 for the project-based learning, and 5.90 and 0.29 for conventional lecturing, respectively. Based on the independent-sample t test results, a significant effect was found on perceived enjoyment (t=2.05, p<0.05). This suggests that project-based learning makes students feel comfortable about gaining new knowledge and skills.

Table 6. Descriptive data and t-test in perceived enjoyment toward different teaching methods

Experiment design	N	Mean	SD	Std. error	t
Control	24	5.90	1.17	0.29	2.05*
Experimental	16	6.57	0.56	0.14	

Analysis of perceived useful knowledge

Table 7 shows the descriptive statistics and independent-sample t test results for perceived useful knowledge. Both the mean value and standard deviations in post-questionnaire were 6.81 and 0.34 for the project-based learning, and 5.29 and 1.05 for conventional lecturing, respectively. Based on the independent-sample t test results, a significant effect was found on perceived useful knowledge (t=5.49, p<0.001). This suggests that project-based learning makes students feel that it is useful to acquire new knowledge and skills.

Table 7. Descriptive data and t-test for perceived useful knowledge using different teaching methods

Experiment design	N	Mean	SD	Std. error	t
Control group	24	5.29	1.05	0.26	5.49***
Experimental group	16	6.81	0.34	0.08	

Results and Research Model

There was good model fit based on the confirmatory factor analysis in this study for which the values were CMIN/DF=1.79, IFI=0.82, and CFI=0.81. The factor loadings were 0.72, 0.71 and 0.96 in Useful Knowledge. The factor loadings for Ease of Learning were 0.74, 0.86 and 0.84. The factor loadings were 0.74, 0.76 and 0.72 for Enjoyment. The factor loadings were 0.80, 0.83 and 0.81 for Learning Attitude. In addition, the factor loadings for Acquisition Competence were 0.92, 0.93, 0.78 and 0.71. Finally, the factor loadings for Learning Satisfaction were 0.88, 0.92 and 0.63.

The convergent validity values were 0.84, 0.85, 0.78, 0.85, 0.90 and 0.85. The AVE values were 0.64, 0.66, 0.54, 0.66, 0.70 and 0.67. These figures were higher than those required for composite reliability and average variance of 0.6 and 0.5 (Fornell, 1981), respectively. Hair argued that the square root of the AVE should be at least 75% higher than the correlation coefficients among the constructs (Hair, Anderson, Tatham, & Black, 1998). The square root of the AVE values 0.80, 0.81, 0.74, 0.81, 0.84 and 0.82 met these requirements, as shown in Table 8; thus, the constructs showed good discriminant validity.

Table 8. Discriminant validity

	UK	EOL	EJY	LA	CA	LS
Useful Knowledge	(0.80)					
Ease of Learning (EOL)	0.57***	(0.81)				
Enjoyment (EJY)	0.62***	0.73***	(0.74)			
Learning Attitude (LA)	0.46**	0.49**	0.45**	(0.81)		
Competence Acquisition	0.60***	0.60***	0.64***	0.48**	(0.84)	
Learning Satisfaction (LS)	0.44**	0.38*	0.39*	0.87***	0.53***	(0.82)

The results of the hierarchical regression are as follows: We examine the relationships between Useful Knowledge, Ease of Learning and Enjoyment and Learning Attitude (β=0.43，p<0.05), (β=0.45，p<0.01) and (β=0.12，p>0.05), respectively. The results proved that only H1 and H2 were supported. Then, we investigated the relationship between Learning Attitude and Competence Acquisition (β=0.60，p<0.001). The results indicated that having a good attitude toward learning positively influences competence acquisition. We found that the results supported H4. Finally, we examined the relationship between competence acquisition and learning satisfaction (β=0.55，p<0.01). The results verified that having more heterogeneous competences increasing students' learning satisfaction, as shown in Figure 3. The results thus supported H5. Therefore, H1, H2, H4 and H5 were supported as shown in Table 9.

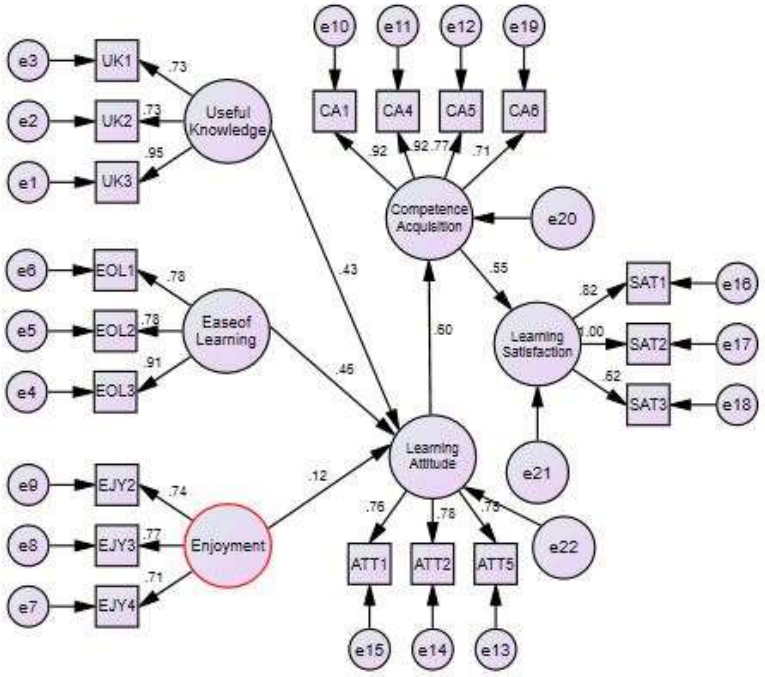

Figure 3. The framework of this study

Table 9. Results of Hypothesis

	Hypothesis	Results
H1	The more useful students feel the knowledge is that they acquire from lectures, the better learning attitude they will have.	Supported
H2	The more students feel that the curricula are easy to learn, the better learning attitude they will have.	Supported
H3	The more students enjoy in the curriculum, the better attitude toward learning they will have.	Not Supported
H4	The better the attitude toward learning, the easier it will be for students to acquire heterogeneous competences.	Supported
H5	The more competences students acquire in this curriculum, the higher their learning satisfaction will be.	Supported

Conclusions

Recently, an increasing number of teachers have been focusing on the importance of interdisciplinary curricula (see tables 10 and 11) and project-based learning in the classroom. Designing curricula incorporating ease of learning, useful knowledge and an enjoyable experience not only improve the confidence of slow learners, but also train students to acquire heterogeneous competences in areas such as independent thinking, image, teamwork, innovation, and problem solving, which can be seen in their works of art. The results of this research indicated that interdisciplinary curricula improve students' attitude toward learning, transform acquired heterogeneous knowledge into competences, and increase their learning satisfaction. The results are in line with those of previous studies (Gardner, 1987; Wagner, 2010).

The results of study shed light on consideration of the incorporation of interdisciplinary curricula and project-based learning in classroom practice, especially in relation to how the Davis Technology Acceptance Model may apply to teaching practices in the classroom. One advantage of the implementation of interdisciplinary curricula and project-based learning in classrooms is the smiles one sees on students' faces during their learning experience. Students get together to brainstorm for creative ideas, develop independent thinking, and propose solutions for assigned projects. The results are in line with those of prior studies (Davis, 1989).

This study applied the Technology Acceptance Model to the education field as a theoretical framework to implement an interdisciplinary curriculum and project-based learning. For instance, in the class for exploring buoyance, the students were inspired to visit a local village with the purpose of learning traditional fishing skills and buoyancy as it applied to fishing boats. The students were then guided to adopt buoyancy theory and apply the knowledge they acquired to make mini floating boats in teams. Finally, the students had to share their experiences with this curriculum through presentations. From the perspective of completing assigned projects, we found that ease of learning, acquisition of useful knowledge, and enjoyment in learning do improve students' attitude toward learning, polish competences, and increase learning satisfaction. These findings suggest that the Technology Acceptance Model is helpful for the perfect match between interdisciplinary curriculum design and project-based learning.

The study also found that the implementation of Davis's Technology Acceptance Model in the classroom did not have a significant positive influence on perceived enjoyment. It was found that some students may feel anxious about project deadlines. Future research should examine different forms of measurements that may influence students' learning attitude and satisfaction related to interdisciplinary curriculum design and project-based learning.

In this study, we found that perceived ease of learning, useful knowledge, and enjoyment exhibited significant differences between the control and experimental groups. The control group students did not experience ease of learning by reading traditional lectures word by word. Second, teachers repeatedly tested memorized knowledge, which made the students feel unable to apply the knowledge to daily life. Third, simply reading word by word and repeated testing bored the students. However, students in the experimental group showed great interesting in learning. Teachers in this group provided an interdisciplinary curriculum and project-based learning to their students. The interdisciplinary curriculum had clear goals, an interesting scenario, and the lectures were flexible and interactive. Project-based learning demands that students apply learned knowledge in class with the purpose of completing an assigned task. The findings suggest that providing a course of study that perceived as easy to learn that lead to the acquisition of useful knowledge, and is conducted in an enjoyable learning environment will improve students' attitude toward learning and in turn, increase satisfaction.

This study focused on an investigation of how perceived ease of learning, useful knowledge, and enjoyment may affect learning attitude, competence acquisition and satisfaction related to interdisciplinary curriculum design and project-based learning. First, it was found that perceived ease of learning may enhance students' confidence. Second, it was proven that learning useful knowledge helps students complete their assigned projects on time. Third, learning useful knowledge in class improves attitude toward learning. These findings are in line with the results of previous studies (Davis, 1989; Davis et al., 1992). Fourth, an improved attitude toward learning can support transfer of acquired heterogeneous knowledge into practical competences. Furthermore, the more competences that are learned from the processes involved in completing projects, the greater the learning satisfaction is. These findings are in complete agreement with those of previous studies (Lee, Lin, & Kang, 2016; Wang, 2003). Moreover, this study should be noted as a small-scale investigation on a project basis. The subjects of this study were elementary students in Taiwan. Cultural differences in design curriculum may have a potential impact students' learning attitude, competence acquisition, and satisfaction. It would be interesting to study implementation of interdisciplinary and project-based learning in junior high or senior high school in Asian countries. Finally, this study may provide other teaching approaches combined with interdisciplinary curricula intended to improve students' learning attitude and degree of satisfaction with their learning experience.

Table 10. The processes of curriculum design and competence cultivation

Project-based Learning in Science course				
Curriculum	**Concept**	**Idea generation**	**Artwork**	**Competence**
Environmental protection & Artwork	**Beach cleansing** **Buoyancy of floating ball** **Design floating ball toys**	**Recycle floating balls** **Design floating balls into artwork** **Poems**	 **Action figure & poems**	**Green concept** **Observation** **Independent thinking** **Problem solving** **Creative thinking** **Oral expression** **Writing skills**
Understanding fishermen daily life & innovation	**Fishing skills** **Snorkeling** **Buoyancy of boat**	**Buoyancy** **Eco-system** **Green concept** **Clean energy rafts**	 **Mini clean energy rafts**	**Fishing skills** **Swimming ability** **Buoyancy knowledge** **Knowledge utilization** **Knowledge integration** **Knowledge application** **Experimentation**
An adventure of sailing the floating boats	**Understanding fisheries** **Familiar local eco-system** **Training in sailing skills** **Maker spirit** **Innovation**	**Buoyancy** **Fisherman** **Boat** **Adventure** **Develop study tour routes**	 **Route B**	**Sailing skills** **Embracing challenges** **Technology** **Teamwork** **Communication** **Collaboration** **Tour planning**

Table 11. Module Curricula for Ocean Science Course

Grade	Lower Grade	Intermediate Grade	Higher Grade
Designing concept	Experience & discovery in life sciences ● The different buoyancies of floating balls ● Scientific toys of floating balls	Exploration & Application in life sciences ● Buoyancy theory & floating ball knowledge ● Buoyancy theory & scientific toys	Courage & adventures of Makers ● Making prototypes of floating boats ● Sailing floating boats
Activities	Activity 1. Wonderful buoyancy Activity 2. Experience interest in buoyancy	Activity 1. The secret of buoyancy Activity 2. Power floating boats	Activity 1. Little Makers- Floating boats Activity 2. Floating boat adventures
Teaching approach	I-Buoyancy knowledge G-The different buoyancy levels of floating balls C-Completed floating ball toys S- Exhibition of floating ball toys	I-Apply buoyancy knowledge to daily life G-Buoyancy theory on power mini-boats C-Collaboration for making mini-floating boats S- Presentation of improvements in mini-boats	I-Makers' spirits by cooperation & experience G-Step-by-step completion of floating boats C-Teamwork in manufacturing, modifying and testing S- Brainstorming, discussion, and demonstration
Students' feedback	S1: Felt amazing to design a cute rabbit. S2: Understands the method to make dinosaurs and their legs by using different shapes of floating balls.	S3: Unveiled the secret of buoyancy on his father's boat after taking this course, and he enjoyed making floating boats more than cars.	S4: Enjoyed the experience of sailing and learned team cooperation.
Parents' feedback	P1: Interesting curriculum that enriched the students' imagination. P2: Her son is full of confidence after participating in this innovative approach.	P3: Learning by doing helped his daughter learn practical skills.	P4: Her son has higher interest in science, and this curriculum opened a door for him.
Teachers' feedback	T1: Students are full of creativity and joy and enjoy applying knowledge.	T2: Integrating knowledge of buoyancy and power vehicles to make powerboats	T3: The maker curriculum helped students experience the relationship between square measure and pressure and buoyancy and improved their communication skills.

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