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# A Case Study of the Effectiveness of Applying Generic Learning Outcomes to the Planning of Educational Programs: Take «DIY Unmanned Aerial Vehicle» at the National Science and Technology Museum as an Example

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**ABSTRACT:** The National Science and Technology Museum launched the «Explore IOT Exhibition» in 2017. When curating the exhibition, it included the exhibit education activity: «DIY Unmanned Aerial Vehicle» in its planning to respond in a real time manner to the emerging issue of incorporating information, communication and digital technology into the Curriculum Guidelines for the 12-Year Basic Education, displaying the Museum's function in supporting formal education. Museum has to be innovative in terms of educational activity to meet various groups' learning needs. Using «DIY Unmanned Aerial Vehicle» activity as an example, this paper discusses the generic learning outcomes (GLOs) of non-formal educational institutions used in said activity to plan further activities and conduct learning evaluations. The objective is to see if it is feasible to practically use GLOs for the Museum's educational activities. The results of a qualitative and quantitative data analysis show that most participants gave positive feedback to learning effectiveness, attesting to learning goals based on the framework of GLOs set by the organizer. GLOs make it easier for the organizer to focus on the direction of the activity. The findings from this case study suggest that GLOs can serve as a reference for promoting the Museum's educational activities.

**KEYWORDS:** planning of the Museum's educational activities, generic learning outcomes, unmanned aerial vehicle.

## 1 INTRODUCTION

In 1984, the American Association of Museums (AAM) released the Museums for a New Century report, which accentuated the importance of museums' educational role by stating that if collections are the heart of museums, education is the museum's spirit (CMNC, 1984). Generally, museums' educational activities are not limited to specific contents and methods with which they are conducted. These activities are determined on the basis of the museum's characteristics, conditions, and operational requirements, and are adjusted and varied according to the activity theme and targets. In principle, museums must constantly introduce creative and innovative educational activities that fulfill the learning requirements of different museum visitors, in order to enhance the museum's operational performance and maximize the temporary timeliness of museum activities (Liu, Chang, & Chang, 2017). For this reason, the National Science and Technology Museum (NSTM) in Taiwan organized a special exhibition in 2017 called the Theory of Everything: Exploring the Internet of Things (IoT). In the initial phase of planning this exhibition, the organizer also incorporated an exhibition-based educational activity titled Do It Yourself (DIY) Unmanned Aerial Vehicle (UAV) (hereafter referred to as the UAV activity), which was aimed at addressing the integration of information technology in Taiwan's 12-Year Basic Education Curriculum, thereby showcasing museums' supporting role in education.

## 2 RESEARCH PURPOSE

In the Wang (2000) also indicated that the number of exhibitions and educational activities a museum launches actually cannot directly prove the museum's function; instead, the impact and outcome of museum-based learning for visitors are a direct evidence that museums present to the society for proving their value and function. In addition, the impact and outcome of museum-based learning have become a topic that museums must address, particularly in an era wherein the society constantly demands for better museum performance.

A complete and effective approach to planning activities is greatly beneficial for the development of professional competency and visitor-specific learning experiences (Tsai, 2013). In addition, the outcomes of learning in museums can be accurately determined only with an appropriate evaluation mechanism to assess whether an activity has successfully attained its goal and whether an ongoing activity can be revised during the process (Kao, 2001). The UAV activity in this study was based on the Generic Learning Outcomes (GLOs) model, which was developed in the UK's Learning Impact Research Project (LIRP) in the early 21st century. Instead of being a set of nationwide evaluation indicator with which all museums must comply, this model features the ability to fully realize museums' potential while preserving their independence and characteristics (Liu, 2011).

## 3 Literature Review

### 3.1 Museum-Based Educational Activity Planning

According to Eilean Hooper-Greenhill (1994), museum-based educational activities are planned by following the museum's vision and education policies. A strategy that museums adopt to interpret objects is having educators plan activities. Educational entertainment activities can deepen visitors' understanding of the knowledge relevant to the activity and boost the interactive relationship among museum workers. Therefore, museums play a significant educational role in the learning process of museum visitors (Tsai, 2013). The UAV activity in this study was organized for a specific exhibition at the NSTM. This activity involved extending the content of the exhibition to include the IoT application of UAV in an educational setting to not only attract visitors but also effectively utilize the museum's resources to embody the educational purpose of the museum.

### 3.2 Generic Learning Outcomes

Education is one of the main functions of a museum and also one of the main reasons explaining why the general public supports and recognizes the existence of museums (Bucaw, 1997). Hence, museums must develop a set of system for measuring the outcomes and impact of museum-based learning. After years of developing and piloting a planning framework, in 2001, the Research Centre for Museums and Galleries (RCMG) of the University of Leicester developed a set of GLOs that can be used to assess the outcomes of learning in informal learning institutions such as museums. GLOs are specifically developed to explore and analyze dimensions relevant to the experience and effectiveness of learning in information education. Numerous studies have verified the robustness and adaptability of this GLOs framework for measuring the impact of museum-based education and for inspiring future development ideas (Hsu, Wang, & Kuo, 2015). Therefore, the present study adopted the GLOs to design the questionnaire for the UAV activity and to conduct evaluation and analysis.

The conceptual framework of GLOs comprises the following five items:

1. Knowledge and understanding: Learning new facts or information, or using prior knowledge in new ways; increasing knowledge or understanding of different subject areas or making connections between or across subject areas; and finding out more information about how museums, archives or libraries operate.
2. Skills: Increase in basic skills, intellectual skills, information management skills, social skills, emotional skills, communication skills, and professional skills.
3. Attitudes and values: Change in feelings, perceptions, and opinions about self or other people and things.
4. Enjoyment, inspiration, and creativity: Evidence of feeling happy and having fun in the learning process and of feeling inspired that results in creativity or innovative ideas.
5. Change in action, behavior, and progression: Change in action and behavior primarily measures whether a learning outcome is translated into actual actions and behaviors.

### 3.3 The Development Of Unmanned Aerial Vehicles

UAV development began over 90 years ago and originally focused on military applications. Influenced by the concept of IoT in recent years during which the integration of information, telecommunication, and network technologies was made possible, UAVs have transitioned from consumable, recreational, entertaining toys to tools of considerable value in commercial, agricultural, and national defense settings. UAVs are roughly categorized into rotary-wing UAVs and fixed-wing UAVs according to their body structure and flight characteristics. Rotary-wing UAVs adopt either a single-rotor or a multi-rotor system. Multi-rotor UAVs are widely accepted because they are simpler, more stable, and suitable for amateurs and recreational users (Wang, 2014). Therefore, the multi-rotor UAV was adopted in the UAV activity of this study; this UAV was programmed to achieve various flight altitude and actions.

## 4 Case Study: Methods Of Planning And Evaluating The DIY UAV Activity

### 4.1 Background

The DIY UAV activity, establishing clear activity goals in line with the plans for the exhibition, providing technical consultation on UAVs, and developing information communication courses. The objective of the DIY UAV activity was to expand and extend the benefits of the exhibition and to elicit a mode of stimulus–response learning among participants so that they could acquire knowledge, improve skills, and develop feelings of happiness (Chiu, 2010).

### 4.2 IMPLEMENTATION AND CONTENT OF THE DIY UAV ACTIVITY

According to the above literature review, the subject knowledge imparted in the UAV activity covered information technology and aeronautical science. To highlight the NSTM's function in informal education, visitors' understanding of and interest in science and technology were reinforced through lectures, hands-on drone-assembling activities, and practical exercises, among other teaching strategies that make the exhibition hall more animated and the displays more diversified. The framework of the UAV activity is shown in Figure 1. The expected learning goals established on the basis of the five GLOs is shown in Table 1. Subsequently, these goals were used as the basis to develop activity implementation method, draft lesson plans, collect videos, and produce instructional PowerPoint slides.

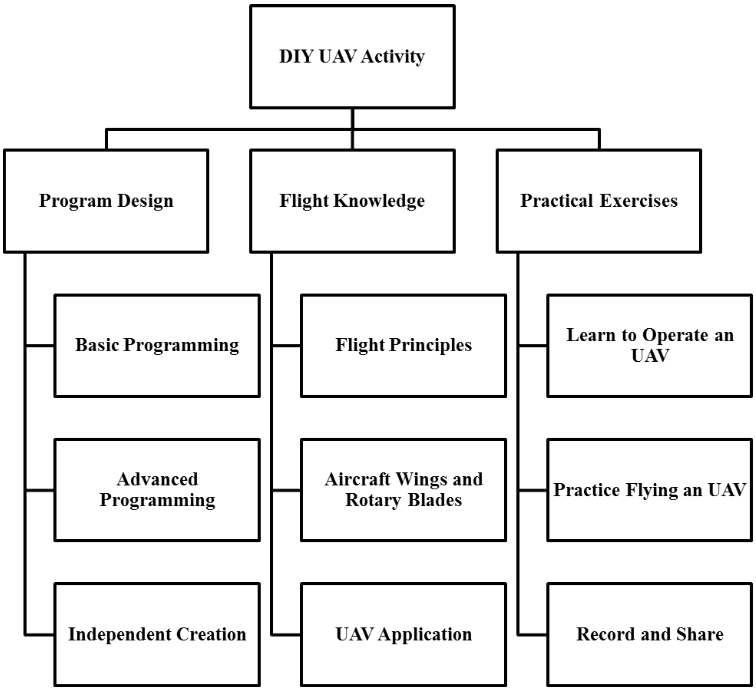


*Fig. 1. Framework of the DIY UAV exhibition-based educational activity*

*Table 1. Expected learning goals based on the five GLOs*

| Measure | Content |
|---|---|
| Increase in knowledge and understanding | 1. Understand how humans simulate flight<br>2. Understand the difference between multi-rotor and single-rotor drones<br>3. How were the Bernoulli's principle and Coandă effect discovered and experimented<br>4. Understand basic graphic control programming language |
| Increase in skills | 1. Learn how to use flight controller correctly<br>2. Assembling the drone correctly<br>3. Can write programs to control aircraft light, rotational speed, and special effects<br>4. Learned to edit footage with app software<br>5. Understand that a drone must be paired and calibrated before flight |
| Change in attitude or value | 1. Perceived that operating a drone or writing a program is more difficult than imagined<br>2. Willing to attempt learning new technologies<br>3. Willing to understand differences regarding flight principles and structural functions of all types of aircrafts |
| Enjoyment, inspiration, and creativity | 1. Aroused curiosity for flying<br>2. Inspired creativity in programming and improved logical thinking<br>3. Enhanced creativity and enjoyment in writing special effect programs for drones |
| Change in action and behavior | 1. Understand the structures and functions of different aircrafts<br>2. When traveling on an airplane, the learner pays attention to and feels the thrust/lift and changes in the wings as the airplane takes off<br>3. Maintain/handle drone parts with care |

### 4.3 Research Method

#### 4.3.1 Questionnaire Design

The questionnaire design was based on the GLOs, the learning goals for the UAV activity (see Table 1), and Liu et al. (2017). The questionnaire was compiled by the author and comprised four parts. Part 1 was an evaluation of the GLOs, with each outcome consisting of four items. Part 2 was a survey of satisfaction with how the activity course was planned. Parts 1 and 2 were measured using the 5-point Likert scale, with score options of 1 to 5; the scores on each GLO were summed and then averaged, with high scores indicating that the respondent responded strongly to an experience or questionnaire item. Part 3 contained two open-ended questions soliciting the participants' recommendations, and Part 4 involved participants' demographics.

The questionnaire had the following Cronbach's α reliability coefficient: 0.856 for "increase in knowledge and understanding", 0.847 for "increase in skills", 0.888 for "change in attitude or value", 0.857 for "enjoyment, inspiration, and creativity", 0.868 for "change in action and behavior", and 0.891 for "satisfaction with activity course planning". The Cronbach's α value of the questionnaire as a whole was >0.80, which implies that the questionnaire was sufficiently reliable to support the study results according to Cuieford (1965) who suggested that Cronbach's α of 0.7–0.98 is indicative of high internal consistency.

#### 4.3.2 Sample Collection And Analysis.

The UAV activity involved a two-day course, which was given 16 times over the period from June 23 to August 26, 2018. The questionnaire survey targeted all learners who had participated in the UAV activity and was administered at the end of the activity. In total, 201 questionnaires were distributed throughout the activity period, and 193 valid questionnaires were collected (for a recovery rate of 96%) after incomplete questionnaires were eliminated. After data were collected and organized, the author analyzed them by using SPSS for Windows 22. Subsequently, the questionnaire statistical data and interview content were combined for the following data analysis.

### 4.4 Activity Evaluation And Analysis

The implementation of museum-based educational activities should be reviewed by evaluation methods to ascertain whether the activity was planned and effective as expected. The results can serve as feedback for the activity. The evaluation of the UAV activity was discussed in four sections, namely, demographics, the five GLOs, overall satisfaction with the activity, and cross-analysis of other background variables.

#### 4.4.1 Demographic Statistics

In the UAV activity, male and female participants accounted for 76.17% and 23.83%, respectively. Regarding age group, most of the participants were aged 10–13 years (78.76%), which is consistent with the initial target setting. The learners participated in the activity mostly because they were interested in drones (66.80%), and secondly because their parent asked them to (19.70%). Everyone was interested in signing up for the UAV activity because UAV is a novel issue, and relatively few courses on this topic are open to parents and children.

#### 4.4.2 The Five Generic Learning Outcomes Analysis Results

Anonymous questionnaire survey was conducted when the UAV activity was implemented. The purpose of anonymity was to encourage learners to express their personal opinions. The questionnaire was designed to include both closed-ended and open-ended questions to present the multiple impressions that learners have after the activity. The open-ended questions were aimed at collecting learners' diverse opinions or views to understand aspects about their learning outcome, which would increase the breadth of analyzable data (Liu, Chang, & Chang, 2017). Following calculations, the author obtained the following mean scores on each learning outcome: 4.69 for "increase in knowledge and understanding", 4.60 for "increase in skills", 4.63 for "change in attitude or value", 4.65 for "enjoyment, inspiration, and creativity", and 4.59 for "change in action and behavior". These scores show that learners were satisfied with their learning outcome. Because the types of items under each outcome differed, numerical values cannot be used directly for comparison and can only serve as reference.

#### 4.4.3 Analysis Of Satisfaction With Overall Activity

The learners' satisfaction with the UAV activity was 4.75. The mean scores of course arrangement, teaching method and venue, and environment were 4.70, 4.76, and 4.69, respectively, which indicate favorable result, suggesting that the learners had approved of the activity planner's thoughtful arrangements. From the interviews, the author found that to properly arrange a flight test site where learners could experience test-flying a drone in a safe environment, planners K1 and K2 had engaged in back-and-forth discussions with the executive and curator of NSTM and finally decided on an indoor exhibition space inside the museum.

#### 4.4.4 THE EFFECTS OF BACKGROUND VARIABLES ON GLOS AND SATISFACTION WITH ACTIVITY COURSE

##### PLANNING

First, independent sample t test was adopted to examine the effects of "gender" on GLOs. Subsequently, one-way ANOVA was used to explore the effects of "reason for participation" on GLOs and the effects of "frequency of participation" on activity satisfaction.

##### EFFECTS OF GENDER ON GLOS

As shown in the Levene's test on the equality of variances for the five GLOs revealed that the F test statistic had a significance level greater than 0.05, indicating non-significance, which suggests that variance for the two groups was homogenous. Subsequently, independent sample t test was used to determine whether the mean value of the two parent groups differed significantly. The result showed that the five GLOs did not achieve a significance level of 0.05, indicating that the GLOs did not differ significantly because of learners' gender. The mean scores of the two sample groups ranged between 4 (*agree*) and 5 (*strongly agree*). Based on this mean score, female learners outperformed male learners in all five GLOs.

***Table 2. T test results of the effects of gender on GLOs***

| Learning Outcome | Gender | Mean | Levene's Test on Equality of Variance | | T Test on Equality of Mean | |
|---|---|---|---|---|---|---|
| | | | F test | Significance | T value | Significance |
| Increase in Knowledge and Understanding | Male | 4.6895 | .520 | .472 | -.139 | .889 |
| | Female | 4.7014 | | | | |
| Increase in Skills | Male | 4.5939 | 1.873 | .173 | -.315 | .753 |
| | Female | 4.6250 | | | | |
| Change in Attitude or Value | Male | 4.6067 | 2.555 | .112 | -.850 | .397 |
| | Female | 4.6944 | | | | |
| Enjoyment, Inspiration, and Creativity | Male | 4.6417 | 2.805 | .096 | -.707 | .480 |
| | Female | 4.7083 | | | | |
| Change in Action and Behavior | Male | 4.5748 | .578 | .448 | -.468 | .640 |
| | Female | 4.6250 | | | | |

**p<.05 **p<.01 ***p<.001*

##### THE EFFECTS OF REASON FOR PARTICIPATION ON GLOS

One-way ANOVA was used to determine whether GLOs differed because of learners' reason for participation. According to showing a Abstract of the ANOVA result, the significance level for the five GLOs was greater than 0.05; therefore, the null hypothesis was accepted under a confidence level of 0.95. In other words, the learners' GLOs did not differ because of their reasons for participation. However, based on the mean analysis, the mean scores of the five GLOs were the lowest for learners who participated because their parent asked them to, as compared to learners who participated because of the other five reasons. This result was consistent with the findings of Huang (2007), who reported that "learning outcome was more favorable and learning attitude was more positive among students who were motivated to learn folk art because of their personal interest, than among those whose motive was based on parent's suggestion or arrangement."

*Table 3. Abstract of one-way ANOVA results of the effects of reason for participation on GLOs*

| Learning Outcome | Reason for Participation | N | Mean | Standard Deviation | F Test | Significance |
|---|---|---|---|---|---|---|
| Increase in Knowledge and Understanding | Parent asked them to | 38 | 4.5461 | .56609 | 1.011 | .413 |
| | Have an interest in topics relating to UAVs | 129 | 4.7229 | .43328 | | |
| | Invited by family and friends | 4 | 4.7500 | .35355 | | |
| | Introduced by teacher | 3 | 4.7500 | .25000 | | |
| | Became interested after a visit to the IoT exhibition | 12 | 4.7083 | .48656 | | |
| | Other | 7 | 4.8214 | .37401 | | |
| Increase in Skills | Parent asked them to | 38 | 4.4211 | .65012 | 1.327 | .254 |
| | Have an interest in topics relating to UAVs | 129 | 4.6279 | .51644 | | |
| | Invited by family and friends | 4 | 4.6250 | .47871 | | |
| | Introduced by teacher | 3 | 4.9167 | .14434 | | |
| | Became interested after a visit to the IoT exhibition | 12 | 4.7292 | .29113 | | |
| | Other | 7 | 4.6786 | .42608 | | |
| Change in Attitude or Value | Parent asked them to | 38 | 4.4276 | .62576 | 1.466 | .203 |
| | Have an interest in topics relating to UAVs | 129 | 4.6531 | .56016 | | |
| | Invited by family and friends | 4 | 4.7500 | .50000 | | |
| | Introduced by teacher | 3 | 5.0000 | .00000 | | |
| | Became interested after a visit to the IoT exhibition | 12 | 4.7083 | .35086 | | |
| | Other | 7 | 4.7500 | .38188 | | |
| Enjoyment, Inspiration, and Creativity | Parent asked them to | 38 | 4.5132 | .59544 | 1.357 | .242 |
| | Have an interest in topics relating to UAVs | 129 | 4.6725 | .49883 | | |
| | Invited by family and friends | 4 | 4.8125 | .37500 | | |
| | Introduced by teacher | 3 | 5.0000 | .00000 | | |
| | Became interested after a visit to the IoT exhibition | 12 | 4.8333 | .30773 | | |
| | Other | 7 | 4.5357 | .50885 | | |
| Change in Action and Behavior | Parent asked them to | 38 | 4.3816 | .61165 | 1.435 | .214 |
| | Have an interest in topics relating to UAVs | 129 | 4.6279 | .56260 | | |
| | Invited by family and friends | 4 | 4.6875 | .47324 | | |
| | Introduced by teacher | 3 | 5.0000 | .00000 | | |
| | Became interested after a visit to the IoT exhibition | 12 | 4.6042 | .65243 | | |
| | Other | 7 | 4.6071 | .60994 | | |

*$*p<.05$ $**p<.01$ $***p<.001$*

### THE EFFECTS OF PARTICIPATION FREQUENCY ON SATISFACTION WITH THE ACTIVITY

In this section, the author examined whether the learners' satisfaction with the activity planning differed because of their participation frequency. shows that F value equaled 1.146 ($P$=0.332>0.05) and did not achieve the significance level of 0.05, suggesting that "participation frequency" did not significantly affect the learners' satisfaction with activity planning. Moreover, mean satisfaction ranged between 4 (*agree*) and 5 (*strongly agree*), indicating a high level of satisfaction in general. Oliver (1997) proposed that customer loyalty refers to customers making repeated purchases of products or services and that future purchase behavior is not affected even if the situation changes. Therefore, the results of this analysis showed that participants who have participated in the museum's activity 3 to 5 times were generally more satisfied than those who have never participated or those who participated 1 to 2 times. This result is probably because these participants are loyal to NSTM and thus are generally supportive of the various activities it holds.

*Table 4. Summary of one-way ANOVA results of the effects of participation frequency on satisfaction with activity*

| | Participation Frequency | n | Mean | Standard Deviation | F Test | Significance |
|---|---|---|---|---|---|---|
| Activity Satisfaction | 0 time | 23 | 4.5761 | .63261 | 1.146 | .332 |
| | 1-2 times | 110 | 4.7409 | .45044 | | |
| | 3-5 times | 38 | 4.8026 | .38184 | | |
| | 6 times or more | 22 | 4.6932 | .57700 | | |

*$^{*}p<.05$ $^{**}p<.01$ $^{***}p<.001$*

## 5 Conclusion And Recommendations

Museum-based educational activity evaluation results are beneficial for educators in terms of revising their teaching methods, keeping abreast of activity direction, and improving activity contents. Evaluation is not intended to prove who performs the best or who is good or bad; rather, it serves to facilitate improvements (Chiu, 2010). In this study, the learners' learning outcome after participating in the UAV activity was explained using the GLO evaluation results. The results of quantitative and qualitative data analyses showed positive outcomes. The following conclusion and recommendations were obtained on the basis of the aforementioned analysis results:

### 5.1 The Promotion Of Popular Science Education Was Achieved

Among the five GLOs, increase in knowledge and understanding scored 4.69 on average. A detailed examination of the items under this dimension revealed that "...increased my knowledge on drones" scored the highest (4.77). Increasing knowledge and understanding and learning facts or information are the core values of a museum's educational activity. What is certain is that the UAV activity attained the intended goal and also successfully promoted popular science education.

The effects of background variables—gender, reason for participation, and frequency of participation—on GLOs and satisfaction with activity course planning were analyzed. Statistical analysis showed that all three variables did not achieve significance. In other words, the learning outcomes of the UAV activity did not differ because of "gender"; the mean score for the effects of "reason for participation" on GLOs showed that voluntary participants performed more favorably than did non-voluntary participants; and satisfaction was higher in learners who participated 3 to 5 times than in those who have never participated and those who have participated 1 to 2 times. These results reveal that the learners showed a degree of loyalty to the educational activities organized by NSTM, as evident by their repeated and continuous support for the museum.

### 5.2 Situational Learning In Museums Is Uniquely Attractive

The questionnaire results showed that the learners' satisfaction with the whole activity was 4.75 on average. The "DIY UAV and Flying an UAV" was the learners' most favorite module, reflecting John Dewey's Empirical Philosophy that focuses on "something to do" rather than "something to learn". Dewey asserts that students should be placed in an experiential learning circumstance so that they can "learn by doing" and also understand the linkages between different matters through active reflective thinking. Under these conditions, learning becomes "as natural as water flowing down a channel" (Wu, 2009). Experiential learning in museums has invariably been an element that makes museum-based education uniquely attractive.

### 5.3 Further Exploration Of Satisfaction Is Recommended

The core learning objective of the UAV activity was to operate UAVs in practice. The activity was combined with lectures, hands-on drone-assembling, and practical exercises to create different learning experiences for learners. The activity was filled with different tasks such as DIY and knowledge-building courses that can only be completed with enthusiasm and attention. Although the questionnaire results showed significant learning outcomes, the learners only scored an average of 4.59 on change in action and behavior, which was relatively low compared to other GLOs. Positive feedback from learners does not necessarily mean they will continue to pay attention to issues related to UAVs, and the underlying reasons warrant in-depth exploration from the perspective of museum-based educational activity evaluations. The author recommends future researchers to incorporate observations or interviews for each individual course to understand learners' feedback and pay more attention to the learning outcomes of each individual course.

## REFERENCES


[1] Bucaw, G. E., 1997. *Introduction to Museum Work*. Walnut Creek, CA: Alta Mira Press.

[2] Cuieford, J. P.,1965. Fundamental statistics in psychology and education. New York, NY: McGraw-Hill.

[3] CMNC, Commission on Museums for a New Century, 1984. *Museums for a new century*. Washington, D. C.: The American Association of Museums, AAM.

[4] Chiu, C.Y. 2010. Research on the Effects of Educational Activities of National Museum. MSc Dissertation, Department of Education, National Taitung University, unpublished.

[5] Huang, P.Y. 2007. A Study of Elementary school Students' Learning Attitudes toward School and Private Visual Art Courses: Using Chinshui Town of Taichung County as Example. MSc Dissertation, Fine Art and Crafts Education, National Hsinchu University of Education, unpublished.

[6] Hsu, T.Y., Wang, Y.H., and Kuo, F.R. 2015. "Virtual and Physical Blended Learning Applications and Service Model for Popular Science Education in Museums: Curriculum-based Virtual and Physical Mobile Learning as an Example". *Museology Quarterly*, 29 (1), 99–115. doi： 10.6686/MuseQ.201501_29 (1).0009.

[7] Hooper-Greenhill, E. (Ed.), 1994. *The Educational Role of the Museum*. London: Routledge.

[8] Kao, H.F. 2001. "Exhibition-Based Museum Educational Programs: Planning and Evaluation". *Museology Quarterly*, 15 (2), 91–106. doi: 10.6686/MuseQ.200104_15 (2).0010.

[9] Liu, K.R., Chang, C.W., amd Chang, C.H. 2017. "The Evaluation of the Educational Activities on Tracing Mammalian Fossils in Taiwan for Science Museum". *Technology Museum Review*, 21 (2), 52–76.

[10] Liu, W.C. 2011. *Museum Visitor Studies*. San Min Book Co., Ltd., Taipei City.

[11] Oliver, R. L., R. T. Rust and S. Varki, 1997. "Customer Delight: Foundations, Findings and Managerial Insight". *Journal of Retailing*, 73 (3): 311-336. doi: 10.1016/S0022-4359 (97) 90021-X.

[12] Tsai, H.K. 2013. A Case Study of the Effectiveness of Applying Generic Learning Outcomes to the Planning of Educational Programs: Take "Welcome to Silk Paradise" at the National Museum of Natural Science as an Example. *Technology Museum Review*, 17 (3), 87–116.

[13] Wang, H.W. 2014. Integration and evaluation of UAV-LiDAR system. MSc Dissertation, Department of Civil Engineering, National Taipei University of Technology, unpublished.

[14] Wang, C.H. 2000. "The Development and Implication of Research on Museum Visitor Learning Outcomes and Impact". *Museology Quarterly*, 22 (4), 91–107. doi: 10.6686/MuseQ.200810_22 (4).0006.

[15] Wu, M.K. 2009. "The Insights of John Dewey's Empirical Philosophy for Curriculum and Teaching". *Journal of University of Taipei Education*, 40 (1), 35–54. doi: 10.6336/JUTe/2009.40 (1) 2.